Clinical and radiological features of patients with 2019 novel coronavirus (SARS-CoV-2) in Haikou, China

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Abstract

To describe the clinical and radiological findings of patients confirmed with 2019 novel coronavirus disease (COVID-19) infection in Haikou, China. A total of 67 patients confirmed with COVID-19 infection were included in this study. 50 were imported cases. Most infected patients presented with fever and cough. The typical CT findings of lung lesions were bilateral, multifocal lung lesions (52[78%]), with subpleural distribution, and more than two lobes involved (51[78%]). 54 (81%) patients of COVID-19 pneumonia had ground glass opacities. Consolidation was in 30 (45%) patients, crazy paving pattern or interlobular thickening in 17 (25%), adjacent pleura thickening in 23 (34%) patients. Additionally, baseline chest CT did not reveal positive CT findings in 7 patients (23%), but 3 patients presented unilateral ground glass opacities at follow-up. Importantly, the follow-up CT findings were fitted well with the clinical outcomes.

Introduction

In December 2019, a series of pneumonia caused by the Coronavirus disease 2019 (COVID–19) was first reported in Wuhan, capital of Hubei Province, China. Since then, the COVID–19 spread quickly around the world. By 10 AM,04 March 2020, a total of 93,090 persons have been confirmed with COVID–19 infection globally, including 80,422 confirmed cases in China and 12,688 cases abroad. 3,198 people have lost their lives due to the disease. So far, 76 countries abroad have been affected by the disease. The confirmed cases of COVID–19 is still rising. On March 4, 2020, WHO assessed the risk of this event to be very high in both regional and global level, suggesting that the novel coronavirus infections have posed a great threat to global health.

This pneumonia have been confirmed to be caused by a novel enveloped betacoronavirus (*1)* that has been named as sever acute respiratory syndrome coronavirus 2 (SARS-CoV–2). The SARS-CoV–2 resemble to SARS-CoV(*2)* and belongs to the family Coronaviridae and the order Nidovirales (*3).*. Most of the time, the symptoms of human with coronavirus infections are mild, and common cold symptoms are most often seen (*4).*. However, two betacoronaviruse including severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV), might result in fatal disaster (*5).*. Since SARS-CoV–2 is a new member of the

coronaviruses, clinical symptoms and CT findings of patients with SARS-CoV–2 infection may resemble to that of SARS-CoV and MERS-CoV infections, with fever, cough, and radiological ground glass lung opacities (*5).*.

In consideration of the confirmed cases of COVID–19 is still increasing, detailed analysis of confirmed cases may be beneficial for disease control. Plain chest CT is valuable for timely detecting lung lesions, for early treatment. Our purpose is to describe clinical and CT imaging manifestations in 67 confirmed patients with COVID–19 infection in Hainan Island, follow-up CT results and corresponding clinical outcomes.

Materials And Methods

Patients

The study was approved by the institutional review board of our hospital and written informed consent for was obtained before the retrospective study. All laboratory-confirmed COVID–19 infection patients were enrolled in our study between January 20, 2020, and February 9, 2020 (*Fig. 1).*. The clinical data including age, sex, exposure history, comorbid conditions, symptoms, and laboratory results were collected.

Image acquisition and analysis

All patients underwent plain chest CT in our hospital (Hainan General Hospital). All scans were performed on the NeuViz 128 CT (Neusoft, China) with automatic tube current (300 mA–496 mA). The section thickness was 5 mm; pitch set at 1.5; and breath-hold at full inspiration. Reconstruction was kernel used was lung smooth with a thickness of 1 mm and an interval of 0.8 mm All images were analyzed b two trained radiologists with 14 years, eight years of experience□F.C and H. J.C□by using the same standard. CT manifestations of each patient, including (1) lesion number, (2)lesions distribution features, (3) primary location of the lesions, (4) number of lobe involvement, (5) lesion patterns including pure ground-glass opacity(GGO) consolidation, cavitation, crazy paving pattern, and (f) other findings (e.g., adjacent pleura thickening, pleural effusion, pericardial effusion, thoracic lymphadenopathy). Lymphadenopathy was defined as the short-axis of lymph node size ≥ 10 mm; ground glass opacification was defined as hazy opacity that did not obscure underlying bronchial and vascular margins (*Figs. 2).*.

Sixty-five patients underwent follow-up CT scans. The lesions' evolutions of these images were assessed by the same radiologists as described above, using the same standard. According to the CT findings, the lesions changes were divided into no change, resolution (*Figs. 3)*,, first progression-resolution and progression (*Figs. 2)*.. The clinical outcomes were also described.

Results

A total of 67 patients (39 men and 28 women; mean age, 52 years (age range, 28–83 years) were included in this study. Table 1 demonstrates baseline patients' clinical characteristics. Most (91%) were imported cases or have close contact with infected patients; exposure history was unknown in 6 (9%) patients. A majority of patients presented with fever and cough. Seven (10%) patients were asymptomatic at first. Forty-five (68%) patients had increased level of C-reactive protein. More than half (52%) patients showed decreased Lymphocyte count.

Chest CT revealed lung lesions in 60 patients at baseline, and 51 (76%) patients had more than two lobes involved. 52(78%) patients had multiple lesions. More than half of the patients had bilateral lung abnormalities, with subpleural distribution. The lesions are mainly distributed in the bilateral lower lobes. Among these 67 patients included, 54 (81%) had ground glass opacification, 30 (45%) had consolidation, and 17 (25%) patients presented with crazy paving pattern/ interlobular septal thickening. 23 (34%) had adjacent pleura thickening. Pleural effusion, pericardial effusion, cavitation and thoracic lymphadenopathy were rarely seen in these patients (Table 2).

Fifty-five patients had chest CT examinations after their first CT scan. Among them, 5 patients (19%) had no changes, 22 patients (34%) had disease resolution, 35 patients (54%) had first disease progression and then resolution, 3(4%) (Table 3). In 3 patients (4%) had negative CT findings at baseline, follow-up CT revealed unilateral ground glass opacities after 3–10 days.

Discussion

We comprehensively analyzed the CT features of 67 patients confirmed with COVID–19 pneumonia in Hainan, an island in the south of China. We detailed described the epidemiologic and clinical features in these patients. Since most of the infected people in our study were imported cases or had close contact with infected patients. Our study provides further evidence of person-to-person transmission

in COVID–19 (*6, 7)*.. CT manifestation is helpful in early diagnosis of the COVID–19 and valuable for monitoring the disease evolution.

Consistent with recent studies(*8, 9)*,, our study found that the clinical features of COVID–19 infected patients resemble to that of SARS-CoV, with fever and cough most commonly seen. Gastrointestinal symptoms were uncommon seen, which differed from SARS-CoV, MERS-CoV, and seasonal influenza (*10, 11)*.. We should not neglect the fact that some patients (7%) might be asymptomatic at the early course of the disease. Our findings provide further supported the notion that the diagnosis of infection could not be ruled out in those patients without clinical symptoms. For the asymptomatic persons with a clear history of exposure to COVID–19, medical observation, home isolation, and further examination should be considered. Besides, we found lymphopenia in 52% of the cases, which was consistent with the results of two recent reports(*7, 9)*..

The confirmed cases with COVID–19 is still rapidly increasing across the world. Plain chest CT can discover lung lesions with high sensitivity (*12)*,, which is beneficial for early diagnosis and timely treatment. Our findings revealed some common CT imaging manifestations in patients confirmed with COVID–19 infection: bilateral, multifocal ground glass opacities, with subpleural distribution. Particularly, the lower lobes were the most affected lobes. Pleural effusion, pericardial effusion, cavitation, and lymphadenopathy were uncommon seen in these patients.

The most typical CT findings of COVID–19 is ground glass opacities. A recent pulmonay pathology study of COVID–19 revealed bilateral diffuse alveolar damage with cellular fbromyxoid exudates in the lung (*13)*.. Therefore, we deduce that the ground glass opacities might be associated with the diffuse alveolar damage including the pulmonary edema, since CT findings reflect the pathogenesis of viral infection. COVID–19 is a family member of Coronaviridae. Recent studies found that the pathological features of COVID–19 are similar to those seen in SARS and Middle Eastern respiratory syndrome (MERS) coronavirus infection (*13)*.. Thus, it is not surprising that the imaging features of COVID–19 resembles to that of SARS-CoV and MERS-CoV infection. In our study, a majority of patients showed bilateral multifocal involvement, which is fitted well with previous studies (*14)*.. SARS and MERS patients are tended to have unilateral involvement (*15, 16)*.. More researches should be done to

clarify whether this feature is specific to the COVID–19.

The follow-up CT scan showed that 3 of 7 patients who had negative CT findings at baseline scan, gradually progressed into unilateral ground glass opacities. Incubation period after infection with the COVID–19 may exist, a patient may be asymptomatic and CT could not detect any abnormalities at this time. At this stage, real-time PCR is crucial for the diagnosis of COVID–19 infection. Similarly, CT could be used to evaluate the disease evolution.

Of note, a few patients in our study had bilateral ground glass opacities in chest CT scans but with negative nucleic acid test for COVID–19. After twice of more times of nucleic acid tests, these patients were finally confirmed with by COVID–19 infection by real-time PCR. When this circumstance occurs, patient’s epidemic history, clinical symptoms, imaging features, along with laboratory tests are essential in the diagnosis of the disease. Also, for the patient had negative nucleic acid test but with epidemic history, home isolation is necessary.

CT findings during follow-up is closely with clinical outcomes. In this study, 65 patients had CT follow-up. Five patients had stable CT findings during follow-up, 22 patients showed disease resolution and 34 patients showed progression at first and resolved later all discharged from hospital later. CT scan could be effectively monitoring the disease evolution. Unfortunately, one patient with CT progression died. Two patients did not have CT follow-up because of sever condition and they died about 10 days after admission into the hospital. In conclusion, we found the CT findings fitted well with the clinical outcomes.

Our study had several limitations. Firstly, the sample size is relatively small. Second, most of the patients are imported cases. The difference between imported cases and local cases have not yet been clarified. Third, most of the patients presented with mild symptoms and they had a favorable outcome finally. Thus, our study could be considered preliminary.

Conclusion

Chest CT could be used as an important tool for early diagnosis of SARS-CoV–2, monitoring the disease evolution, judging the treatment effectiveness and predicting the clinical outcomes. The epidemic history of close contact with a SARS-CoV–2 infected patient, along with typical CT findings of

bilateral, multifocal, and peripheral ground glass opacities might be an indicator of SARS-CoV–2 infection. Therefore, plain chest CT is a useful tool for SARS-CoV–2 infection regarding diagnosis and treatment.

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Tables

Table 1: Demographics and baseline characteristics of patients infected with COVID-19

Gender	
Female	2842%
Male	3958%
Age(years) (28-83)	51.6 ±13.7
Exposure History	
Imported cases	50(75%)
Close contact with infected patients	11(16%)
Unknown cause	6(9%)
Clinical symptoms	
fever	53(79%)
cough	48 (72%)
Sputum production	19 (28%)
Headache	15(22%)
fatigue	24 (36%)
Nasal congestion	6 (9%)
rhinorrhea	4 (6%)
sneezing	0(0%)
Sore throat	13(19%)
Hemoptysis	1(3%)
Chest pain	2(3%)
Abdominal pain	1(1%)
Pleural pain	0(0%)
diarrhea	9 (13%)
Shortness of breath	12(18%)
Chest tightness	8(24%)
Poor appetite	7(10%)
Nausea	3(4%)
Vomiting	2(3%)
Treatment	
Hormone	13(19%)
interferon	63(94%)
Antiviral	67(100%)
Antibiotics	63(94%)
Thymopentin	51(76%)
Immunoglobulin	28(42%)
Oxygen therapy	7(10%)
Comorbid conditions	
Currently Smoking	5(7%)
Hypertension	10(15%)
Diabetes	5(7%)
Cardiovascular disease	3(4%)
Malignancy	1(1%)
Chronic liver disease	5(7%)

Table 2 Laboratory results of patients on admission

	Amount	Increased	Reduced
White blood cell count, × 10^9/L	67	3	16
Number of neutrophils, × 10^9/L	67	4	10
Lymphocyte count, ×10^9/L	67	1	35
Monocytes count, ×10^9/L	67	6	1
Eosinophils count	67	0	41
Basophils count	67	2	0

Red blood cell count	67	3	12
Hemoglobin	67	0	10
Platelet count, $\times 10^9$/L	67	2	9
Mean platelet volume	67	0	53
Thrombocytocrit	67	1	10
K	67	0	27
Na	67	0	48
Glucose	65	25	0
Urea	66	2	9
Total carbon dioxide	66	6	10
Uric acid	66	5	11
Urine creatinine	66	2	7
Total protein	66	0	45
Albumin	66	0	27
Aspartate aminotransferase	66	6	6
Prealbumin	66	0	58
Lactate dehydrogenase	66	25	0
Hydroxybutyrate dehydrogenase	66	31	0
Phosphocreatine kinase	66	4	13
Phosphocreatine kinase isoenzyme	66	4	0
C-reactive protein	66	45	0

Table 3 Manifestations of first CT in 67 Patients on admission

Lesion Number	
Single	6(9%)
Double	2(3%)
Multiple	52(78%)
Lesions distribution	
subpleural	33(49%)
Both subpleural and parenchyma	27(40%)
Bilateral involvement	
Number of lobes involved	
0	7(10%)
1	9(13%)
2	7(10%)
3	4(6%)
4	10(15%)
5	30(45%)
More than two lobes involved	51(76%)
Lobe of lesion distribution	
Left upper lobe	47(70%)
Left lower lobe	50(75%)
Right upper lobe	40(60%)
Right middle lobe	38(57%)
Right lower lobe	51(76%)
Bilateral upper lobes	35(52%)
Bilateral lower lobes	45(67%)
Lesion Patterns	
Ground-glass opacity	54(81%)
Crazy paving pattern/ Interlobular septal thickening	17(25%)
Consolidation	30(45%)
Cavitation	0
Other findings	
Pleural Effusion	2(3%)
Lymphadenectasis	0
Pleural thickening	23(34%)
pericardial effusion	2(3%)

Table 4 Follow CT changes and corresponding clinical outcomes in 65 Patients

	Patients	Clinical outcomes
No change	5(8%)	5 Discharged
resolution	22(34%)	22 discharged
First progression- resolution	35(54%)	34discharged, 1 still hospitalization
progression	3(4%)	2discharged 1death

Figures

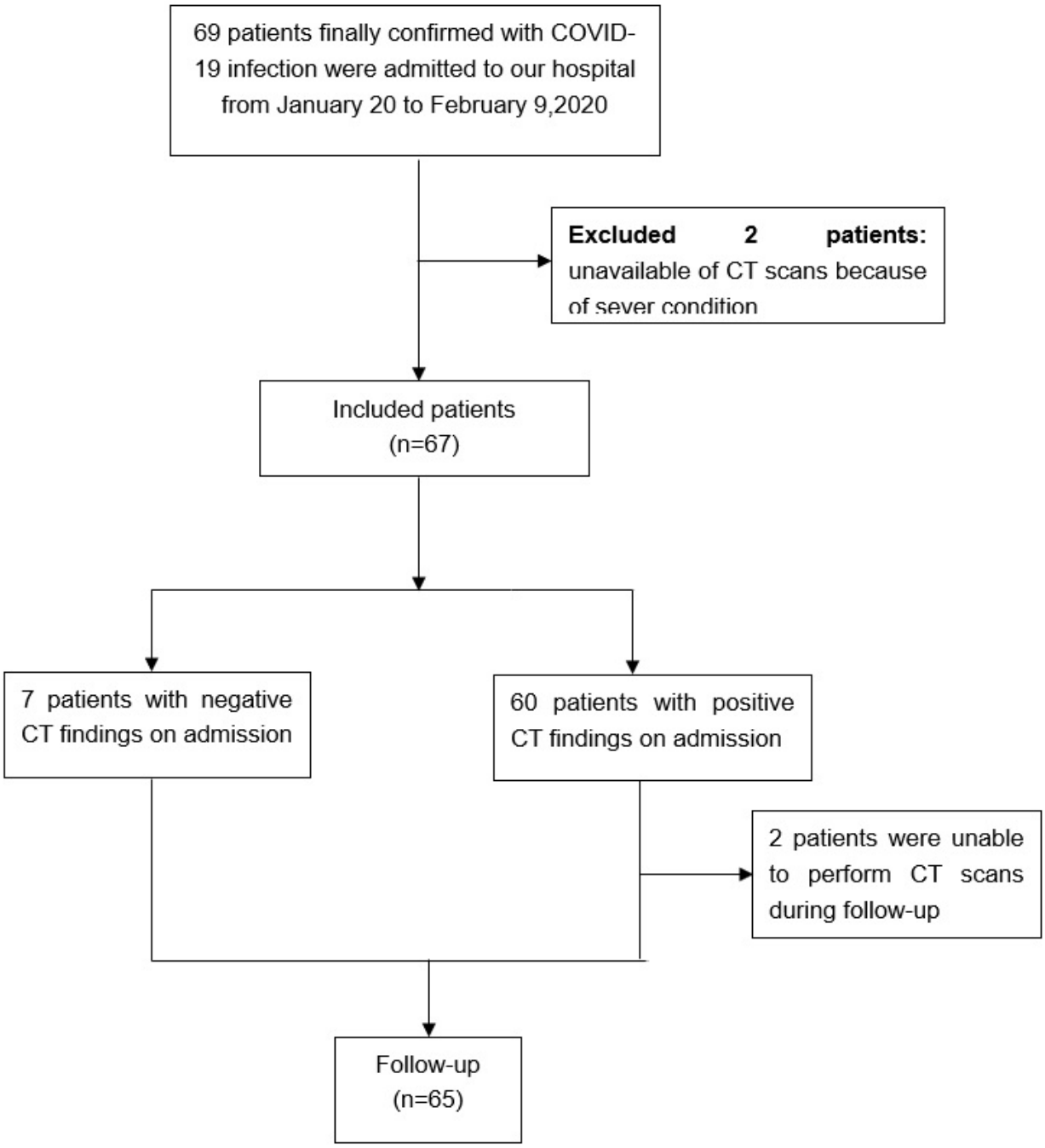

Figure 1

Flowchart of this study

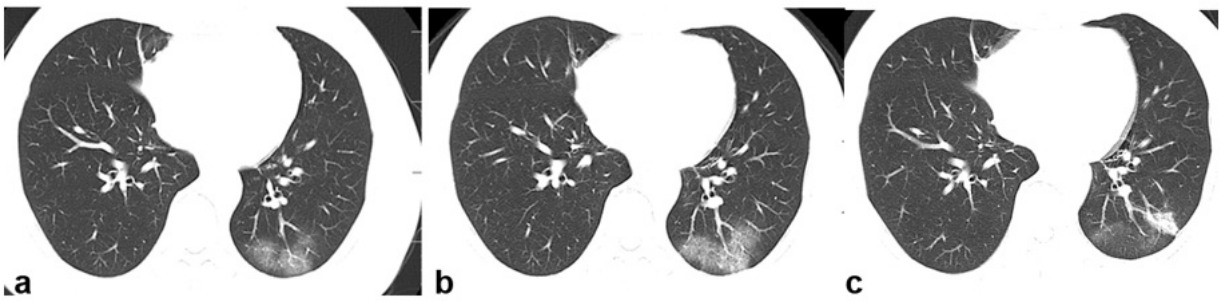

Figure 2

Axial CT scans in patients with COVID-19 pneumonia. a 49-year-old man of Wuhan local resident travel to Haikou presented with fever for 6 days. a, day 6 after symptom onset: peripheral ground-glass opacity in the left lower lobe. b, day 8 after symptom onset: Plain chest CT showed boundary of the ground-glass opacity is enlarging. c, day 13 after symptom onset: CT scan also demonstrated the lesions are partially resolved and consolidation in the left lower lobe. The patient was discharged from hospital 3 days later.

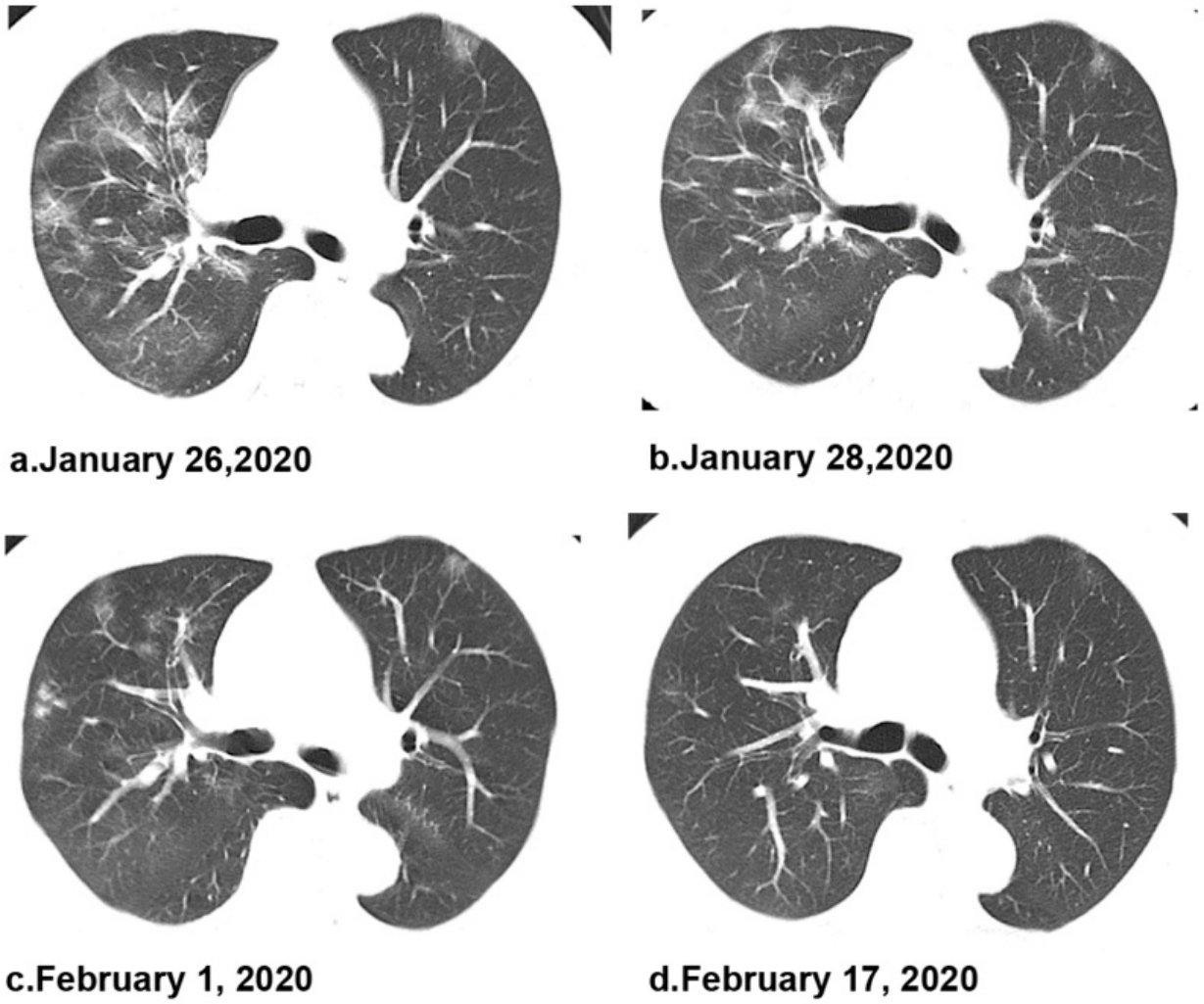

Figure 3

Axial CT scans in patients with COVID-19 pneumonia. A 55-year-old man of Wuhan local resident travel to Haikou presented with fever and cough for 4 days. a, day 4 after symptom onset: peripheral ground-glass opacity in the bilateral lobes. b, day 6 after symptom onset: Plain chest CT showed ground-glass opacity lesions were partially absorbed. c and d, day 11 and day 26 after symptom onset: CT scan also demonstrated the lesions were gradually resolved. The patient was discharged from hospital on February 6, 11 days after hospitalization.

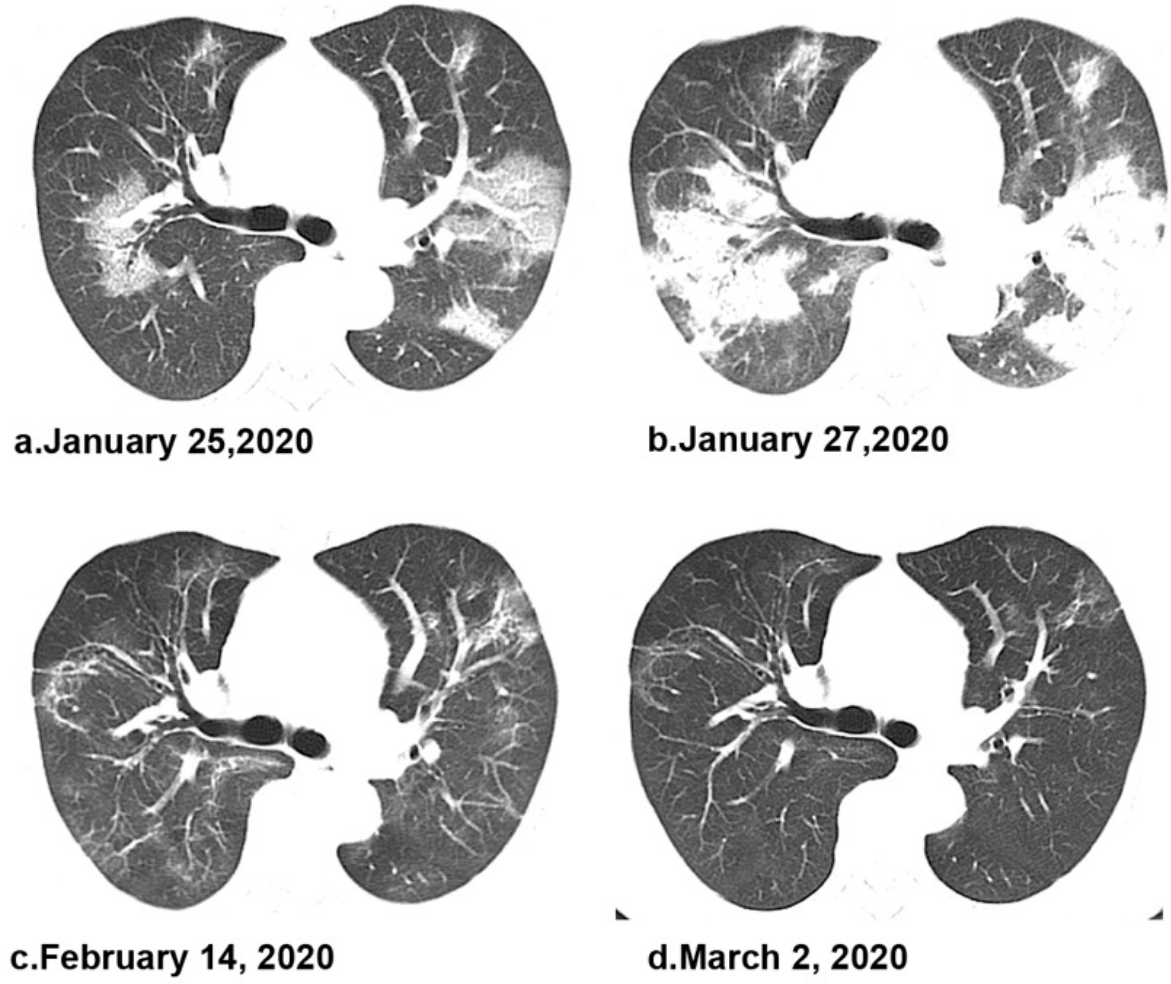

Figure 4

Axial CT scans in patients with COVID-19 pneumonia. A 64-year-old woman of Wuhan local resident travel to Haikou presented with fever for 7 days. a, day 8 after symptom onset: peripheral ground-glass opacity in the bilateral lobes. b, day 10 after symptom onset: Plain chest CT showed multifocal consolidations affecting the bilateral, subpleural lung parenchyma. The patient was admitted into ICU for treatment on this day. c and d, day 28 and day 45 after symptom onset: CT scan also demonstrated the lesions were gradually resolved. The patient was discharged from hospital on February 17, 24 days after hospitalization.