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Original Article

Clinical characteristics and prognosis of COVID-19 patients with initial presentation of lung lesions confined to a single pulmonary lobe

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Abstract: Background: COVID-19 patients showed certain characteristic features of multiple signs in bilateral lungs. Some patients only had a single pulmonary lobe lesion, which has not been reported previously. Single pulmonary lobe lesions are easily missed or misdiagnosed if they do not receive enough attention. Objective: To study the imaging manifestations, clinical features and outcomes of patients with COVID-19 with only one single pulmonary lobe lesion. Methods: Patient clinical data were collected only from patients with confirmed SARS-CoV-2 infection by RT-PCR, which was confined to only single lobe lesions on chest CT imaging findings at the onset. Which lobe was frequently involved, the imaging manifestations, clinical features and outcomes were also analyzed. Result: From January 1, 2020, to March 14, 2020, a total of 367 inpatients were diagnosed with COVID-19, in which 50 (13.6%) patients were confirmed with only one single pulmonary lobe lesion. The most frequently involved lobe was the right lower lobe (18 patients, 36%, highest). Lesions in the lower lobe easily spread to all lobes of the bilateral lungs ($P<0.001$, $\chi^2=10.264$), especially the left lower lobe, and were less frequent in the right upper lobe. During hospitalization, 2 (4%) patients were admitted to the ICU, 2 (4%) patients died, and 28 (56%) patients developed lesions in other lobes within 6.32±3.71 days. Conclusions: The general pattern of COVID-19 imaging with localized nodules may also cause severe respiratory symptoms of bilateral lung disease, serious complications, or even death in patients with multiple lobe lesions or bilateral lung lesions, which should not be underestimated.

Keywords: COVID-19, SARS-CoV-2, one single pulmonary lobe, CT, outcome

Introduction

Coronavirus disease 2019 (COVID-19) is a respiratory infectious disease that was first reported in Wuhan, Hubei Province, China, in December 2019, and pathogenic analysis determined it to be a single-stranded RNA virus [1, 2]. It was named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the WHO. SARS-CoV-2 belongs to the beta-type coronavirus genus. Its genetic characteristics are significantly different from those of severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) but closer to those of bat SARS-like coronavirus (bat-SL-CoV ZC45 and bat-SL-CoV ZXC21) [3-5]. COVID-19 is highly contagious. People of all ages are generally susceptible, and cases have been found around the world [4].

As a convenient and efficient screening method, chest CT is one of the methods for the rapid diagnosis of COVID-19 [6]. The imaging performance is mainly characterized by multiple ground glass opacities (GGOs) and consoli-

dation of the bilateral lungs, which is similar to severe acute respiratory syndrome (SARS) and Middle Eastern respiratory syndrome (MERS). Symptomatic patients with COVID-19 who come to the hospital for examination mostly have bilateral lung lesions [7, 8]. However, it is not clear whether patients with COVID-19 with only one lobular lesion are in the pre-stage of bilateral pneumonia, which lobe is frequently involved, or whether a good outcome is possible. Moreover, elucidating the clinical manifestations and pathological features of this disease in these patients is beneficial for preventing it from progressing to cancer and reducing transmission of the disease.

Methods

Methods of the case selection process

• Time: From 1 January 2020 to 14 March 2020.

• Setting: General hospital of Central Theater Command of the People's Liberation Army, a designated hospital for the treatment of COVID-19 in Wuhan, China.

• Patients: All SARS-CoV-2 nucleic acid positive patients as determined by real-time RT-PCR from oropharyngeal swabs or sputum specimens (n=367) with only one single pulmonary lobe lesion by chest CT on admission (n=50) were included in this study.

Methods of the clinical data selection process

We reviewed all the COVID-19 patients' medical records in our medical center. These 50 patients' clinical data were obtained from interviews of the patients and clinical records. The relevant data mainly include age, clinical symptoms, blood biochemical test results, therapy methods, prognosis, and so on. The institutional review board of the general hospital of the Central Theater Command of the People's Liberation Army approved the study.

Methods of chest CT date selection process

The CT scan was performed in a supine position with a spiral scan using a designated Toshiba 16-slice CT. Technicians took protective measures and performed hand disinfection and cleaning immediately after each contact with the patient. All waste from the patient was disposed of in accordance with the infectious clinical waste process. The image analysis was independently performed by two diagnostic imaging doctors. CT analysis included the distribution of the lesion, the location of the lesion, the number of lobes involved, the characteristics of the lesion and external involvement. Patients underwent chest CT re-examination in our hospital, and by comparing the re-examination of chest CT with the first CT images, the outcome of their pulmonary treatment progress was evaluated.

Statistical analysis

SPSS 23.0 statistical software was used to analyze the data. The measurement data with a normal distribution are described as the mean ± standard deviation (X ± S). The counting data were described as examples and percentages [n (%)]. Comparisons between groups with proportions for categorical variables were compared using the χ^2 test. The difference was considered statistically significant when $P<0.05$.

Result

Clinical characteristics

Among the 50 patients, the average age was 45.04±16.50 years (no children or adolescents), including 27 males (54%) and 23 females (46%). Twenty-two patients (44.0%) had a direct exposure history of close contact, and 18 patients (36.0%) had underlying diseases, including hypertension, diabetes, tuberculosis, hyperuricemia, ulcerative colitis, hypothyroidism, anaphylactoid purpura and so on. There were 45 patients (95.0%) with symptoms of respiratory infection, 1 patient (2.0%) with non-respiratory symptoms and 4 asymptomatic patients (8.0%) (**Table 1**).

Disease symptoms

On admission, the clinical symptoms were mainly fever in 38 patients (76.0%) and cough in 33 patients (66.0%), of which 23 had dry cough (46.0%), 17 with fatigue (34.0%), 14 with chills (28.0%), 14 with muscle soreness (28.0%), and 10 with sore throat (20.0%). The less common symptoms were headache in 8 patients (16%), diarrhea in 5 patients (10.0%) and chest tightness in 3 patients (6.0%). It should be noted that 4 patients (8.0%) did not

Table 1. Characteristics and laboratory findings in COVID-19 patients with only one single pulmonary lobe lesions

	Patients (n=50)
Patients demographics	
Mean age, years (range)	45.04±16.50 (24-93)
Men	27 (54%)
Women	23 (46%)
Exposure history	
Exposure	22 (44%)
Unknown exposure	28 (56%)
Current smoking	5 (10%)
Comorbid conditions	
Any	18 (36%)
Hypertension	9 (18%)
Diabetes	7 (14%)
Coronary heart disease	3 (6%)
Tuberculosis	3 (6%)
Hyperuricemia	1 (2%)
Ulcerative colitis	1 (2%)
Hypothyroidism	1 (2%)
Anaphylactoid purpura	1 (2%)
Signs and symptoms	
Fever	38 (76%)
Cough	33 (66%)
Fatigue	17 (34%)
Sputum production	15 (30%)
Chills	14 (28%)
Muscle soreness	14 (28%)
Sore throat	10 (20%)
Headache	8 (16%)
Diarrhea	5 (10%)
Chest tightness	3 (6.0%)
Asymptomatic Patients	4 (8%)
Leucocytes ($\times 10^9$ per L; normal range 3.5-9.5)	
Increased	2 (4.0%)
Decreased	9 (18.0%)
Normal	39 (78.0%)
Neutrophils ($\times 10^9$ per L; normal range 1.8-6.3)	
Increased	7 (14.0%)
Decreased	1 (2.0%)
Normal	42 (84.0%)
Lymphocytes ($\times 10^9$ per L; normal range 1.1-3.2)	
Increased	0
Decreased	13 (26.0%)
Normal	37 (74.0%)
Interleukin-6 (pg/mL; normal range 0.0-7.0)	
Increased	20 (40.0%)
Normal	30 (60.0%)
Erythrocyte sedimentation rate (mm/h; normal range 0.0-15.0)	
Increased	13 (32.5%)

Normal	27 (67.5%)
C-reactive protein (mg/L; normal range 0.0-5.0)	
Increased	15 (31.9%)
More than twice the normal range	8 (17.0%)
Normal	32 (68.1%)

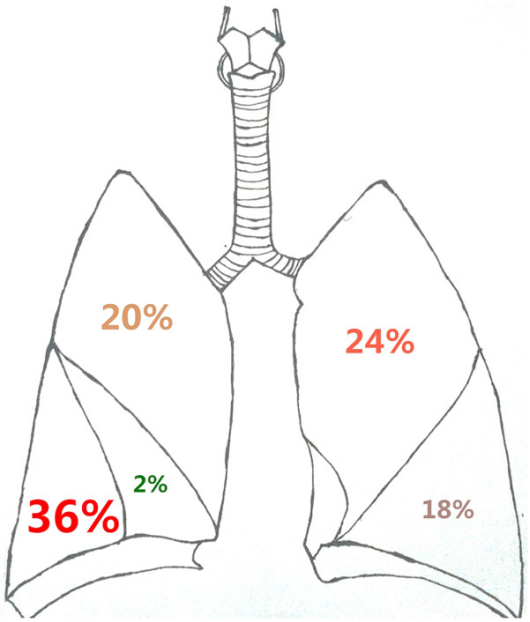

Figure 1. The percentage of the lobe distribution of 50 patients with only one single pulmonary lobe lesions with COVID-19 (this sketch drew by Miss Mao Jie).

have any special symptoms at the time of onset, and no further progression of the lesions was found during hospitalization (**Table 1**).

Result of CT findings on initial presentation

On the first CT examination at admission, 21 patients (42.0%) had left lung involvement, and 29 patients (58.0%) had right lung involvement. The lesions were located in the right lung more often than in the left lung and occurred more often in the lower lung than in the upper lung. There were 30 patients with a single lesion (60.0%) and 20 patients with multiple lesions (40.0%) (**Figure 1**).

GGO was the most common imaging characteristic of chest CT in 43 patients (86.0%), including pure GGO in 33 patients (66.0%) and pure consolidation in 7 patients (14.0%). GGO combined with consolidation was observed in 1 patient, GGO combined with pleural effusion in 1 patient, and GGO combined with bronchiectasis in 1 patient. In the first CT examination, none of the patients had hollow lungs, hilar or mediastinal lymph nodes, pericardial effusion, pneumothorax or atelectasis (**Table 2**).

Table 2. CT images findings and treatments of COVID-19 patients with only one single pulmonary lobe lesions

	Patients (n=50)
Distribution	
Periphery distribution	37 (74%)
Central Distribution	13 (26%)
Multifocal involvement	20 (40%)
Unifocal involvement	30 (60%)
Patterns of the lesions	
ground glass shadow	43 (86%)
pure ground glass shadow	33 (66%)
combined with consolidation	10
combined with pleural effusion	1
combined with bronchiectasis	1
consolidation	7 (14%)
Treatment	
Antiviral treatment	50 (100%)
Oseltamivir	41 (82%)
Lopinavir	19 (38%)
Abidol	19 (38%)
Interferon	24 (48%)
Antibiotics	45 (90%)
Single antibiotic	19 (38%)
Combination therapy	26 (52%)
Corticosteroid and gamma globulin	29 (58%)
Traditional Chinese medicine	22 (44%)
Admission to the intensive care unit	2 (4%)
Outcome	
Discharged	45 (90%)
Remained in hospital	1 (2%)
Died	2 (4%)
Transfer to another hospital	2 (4%)

Blood biochemical test results

At the time of admission, the white blood cell rate was lower than the normal range in 9

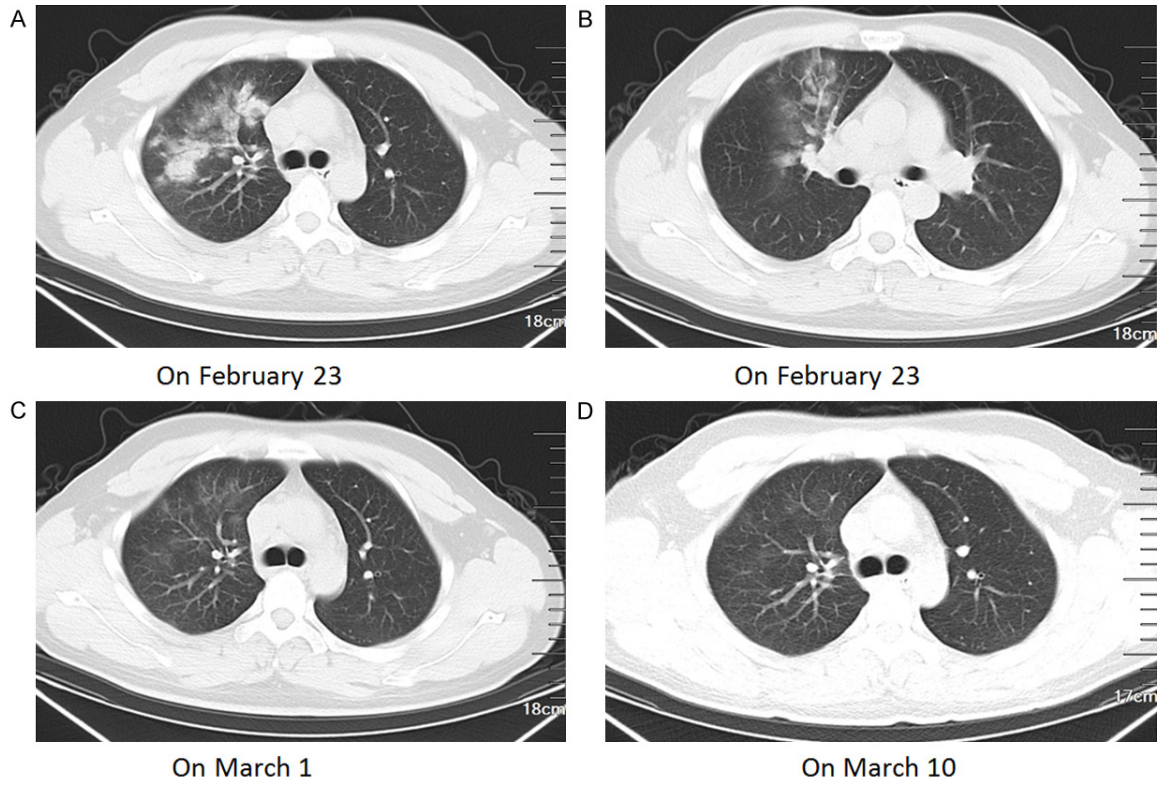

Figure 2. Male, 30 years old, a hyperpyrexia patient. It first presented as multiple consolidation combined with ground glass shadow in the right upper lobe. The scope of the lesion is very large and involves the entire right upper lobe. As a doctor, the patient attached great importance to it and received timely treatment. These large area lesions were gradually absorbed without progression until discharge.

patients (18.0%) and higher than the normal range in 2 patients (4.0%). Neutrophils were higher than the normal range in 7 patients (14.0%), and lymphocytes were lower than the normal range in 13 patients (26.0%). In terms of the infection index, hypersensitive C-reactive protein was higher than normal in 15 patients (31.9%) (10 patients' data were lost), and the erythrocyte sedimentation rate was higher than the normal range in 13 patients (32.5%) (3 patients' data were lost). Patients with a C-reactive protein that was more than twice the normal range (8 patients, 17.0%) had lesions that finally spread to other lung lobes (**Table 1**).

Summary of therapy methods

All patients were treated in isolation at the hospital. Fifty patients (100.0%) received antiviral therapy, including oseltamivir 75 mg/12 h orally, lopinavir 500 mg/12 h orally, arbidol 200 mg/8 h orally, and interferon 3,000,000 U/12 h ultrasonic spray inhalation. Most patients received antibiotics, including a single antibiotic in 19 patients (38.0%) and a combination therapy in 26 patients (52.0%). At the same time, concurrent treatment with gamma globulin was administered in 29 patients (58.0%), and methylprednisolone was administered in 29 patients (58.0%) (**Table 2**).

Outcome results

Of all the 50 patients, 44 underwent the chest CT review at our hospital in a short period. The lesion range was more serious than before and deteriorated to bilateral lungs in 28 patients (56.0%). Lesions were gradually absorbed without progression (**Figure 2**) in 16 patients (32.0%), and 6 patients (12.0%) were re-examined (because of the small lesion on admission and almost no clinical symptoms, 4 patients declined the re-examination). Among the patients with exacerbated conditions, 4 patients (8%) had developed lesions on one side of the lungs, 12 patients (24.0%) had bilateral lung lesions but they had not expand-

Table 3. Development of COVID-19 patients with only one single pulmonary lobe lesions*

		Patients (n=50)
Left upper lobe (12 cases)	Develop to one side of the lungs	2 (16.7%)
	Develop to both side of the lungs	7 (58.3%)
	Develops to all lobes of bilateral lungs	1 (8.3%)
	No development	2 (16.7%)
	Lost to follow up	0
Left lower lobe (9 cases)	Develop to one side of the lungs	0
	Develop to both side of the lungs	3 (33.3%)
	Develops to all lobes of bilateral lungs	5 (55.6%)
	No development	0
	Lost to follow up	1 (11.1%)
Right upper lobe (10 cases)	Develop to one side of the lungs	2 (20%)
	Develop to both side of the lungs	0
	Develops to all lobes of bilateral lungs	0
	No development	7 (70%)
	Lost to follow up	1 (10%)
Right middle lobe (1 case)	Develop to one side of the lungs	0
	Develop to both side of the lungs	0
	Develops to all lobes of bilateral lungs	0
	No development	0
	Lost to follow up	1 (100%)
Right lower lobe (18 cases)	Develop to one side of the lungs	0
	Develop to both side of the lungs	2 (11.1%)
	Develops to all lobes of bilateral lungs	6 (33.3%)
	No development	7 (38.9%)
	Lost to follow up	3 (16.7%)

*The probability of progression to all lobes in patients with only one single lobe lesions was statistically significant compared with that in patients with partial development and none development, χ^2=10.264, P<0.001.

ed to all lobes, and 12 patients (24.0%) had multiple lesions in all lobes of the lungs. In the non-deteriorate group, 7 patients (14.0%) had multiple lesions in a single pulmonary lobe, and 9 patients (18.0%) had a single lesion in a single pulmonary lobe. In the progressive group, the probability of progression to all lobes in patients with only one single lobe lesion was statistically significant compared with that in patients with partial development and no development (χ^2=10.264, P<0.001), especially the left lower lobe (total 9 patients, 5 patients had spread to all the lung lobes, 1 patient was lost to follow-up), while lesions in the right upper lobe (10 total patients, 7 with no development, 2 with spread only to the ipsilateral lung, 1 patient lost to follow-up) were less likely to expand to the other lobes (**Table 3**).

As of March 14, 2020, 45 patients (90%, containing 4 patients who had a small lesion on admission and almost no clinical symptoms) had recovered and were discharged. The average time of RT-PCR conversion was 10.33± 5.64 days; 2 patients (4%) died of severe respiratory failure and severe pneumonia, and 2 patients (4%) were lost to follow-up due to transfer to another hospital. Only 1 patient (2%) was still hospitalized, but their condition improved considerably. Among the discharged patients, GGO completely disappeared in 9 patients (20.5%), and the remaining patients still had a small amount of GGO in 16 cases (36.3%); a small linear shadow was observed in 19 cases (43.2%).

Description of death cases

For the two deaths, in more detail, a 67-year-old patient was admitted on January 23, 2020, for dry cough and simple ground glass density shadow in the right lower lobe by

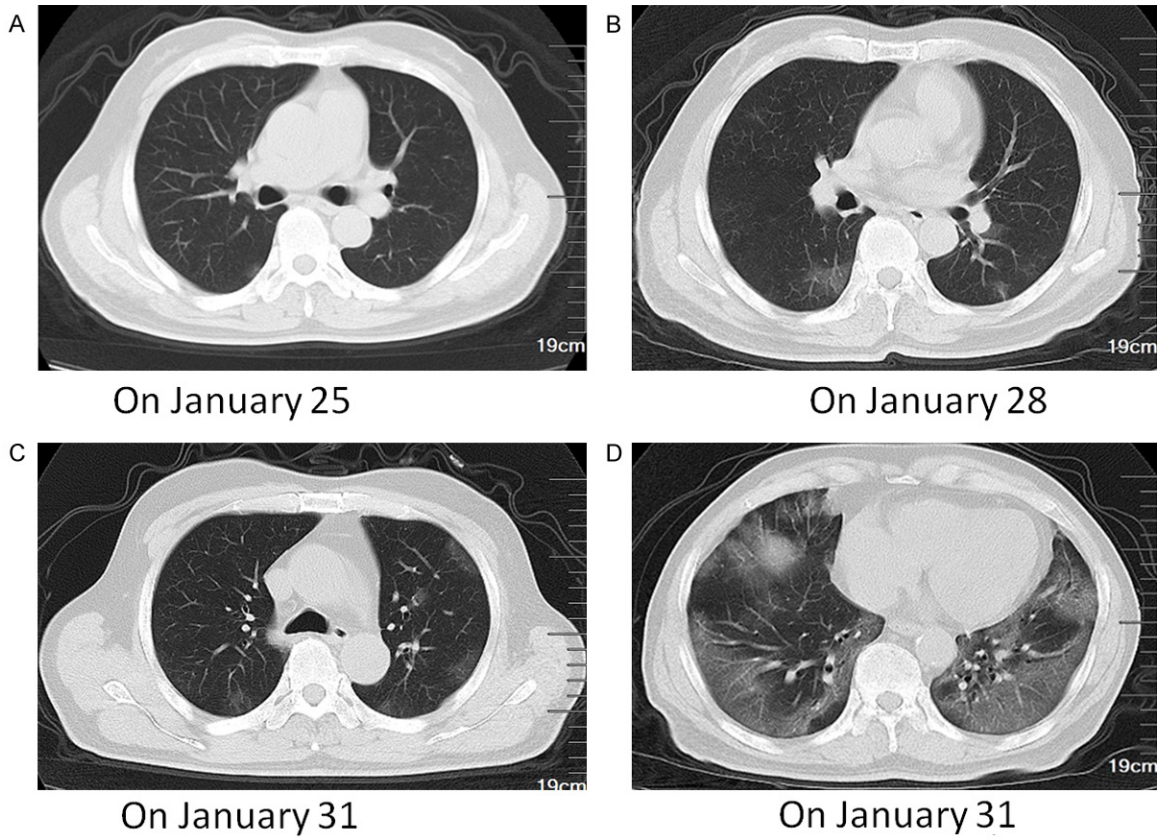

Figure 3. Male, 67 years old, smoking history, a patient with a cough on admission. It first presented as a single ground glass shadow in the peripheral area of the right lower lobe. The patient had no underlying disease but did not receive timely treatment. The shadow was significantly enlarged after 3 days and lesions developed to all the lobes of the lungs after 6 days. Unfortunately, the patient eventually died for respiratory failure.

chest CT examination in the outpatient clinic. On the 6th day after admission, chest CT re-examination showed bilateral lung involvement and respiratory failure on the 28th day (**Figure 3**). The other patient, who was 93 years old, was admitted on January 14, 2020, for fever, expectoration and a single left lower lobe GGO in the CT examination. It was complicated with upper gastrointestinal bleeding during hospitalization. On the 7th day after admission, a chest CT re-examination showed bilateral lung involvement combined with hypoxemia, and the patient died of multiple organ dysfunction syndrome on the 19th day.

Discussion

COVID-19 mainly manifests with bilateral lung involvement on imaging, with multiple small patchy shadows and interstitial changes in the early stage, especially in the peripheral zone [9, 10]. Then, GGO develops into multiple GGOs or infiltration shadows in bilateral lungs [11-13]. Lung diseases with only a one-lung focus are common in lung cancer and tuberculosis [14].

In some previous descriptive case studies, we also sporadically found that some COVID-19 cases presented with only a single pulmonary lesion [15]. However, these phenomena have not attracted the attention of researchers, nor have they received a more profound explanation of their situation [16]. As the outbreak in China is brought under control and the disease becomes known to the public, more cases with asymptomatic have only a single lung lesion [17, 18]. On the one hand, patients with only one pulmonary lesion, the diagnosis of COVID-19 was insufficient [19]. On the other hand, COVID-19 patients with only one single pulmonary lobe lesion are easily misdiagnosed and missed in clinical work.

Although nucleic acid detection is the gold standard for COVID-19 diagnosis [20, 21], the

test specimens are affected by various factors, such as test kits, specimen materials and patient medications, which may cause false negative results [16]. Chest CT is convenient to perform, especially in the outpatient work of asymptomatic infected patients and medical workers, which is conducive to the early detection of suspected cases. Even if there is only one lung lesion, the possibility of COVID-19 should be considered, especially in patients admitted from the epidemic area.

Therefore, studying clinical characteristics and prognosis of diseases of COVID-19 patients with a single pulmonary lobe lesion is a topic of great clinical significance. Our study found that COVID-19 with only one single pulmonary lobe lesion may be the early manifestation of this disease. We preliminarily found that flaky, peripheral and GGO were the main manifestations on CT imaging in COVID-19 patients with only one single pulmonary lobe lesion. Lesions in the right lobe were more common than those in the left lobe, and lesions in the lower lobe were more common than those in the upper lobe. The lesions in the lower lobe easily spread to all lobes of the bilateral lungs, especially in the left lower lobe, while the lesions in the right upper lobe were less likely to spread to other lobes. After timely and effective treatment, patients with COVID-19 with only one single pulmonary lobe lesion can still achieve a good outcome, even if the initial symptoms are severe and the imaging morphology of the lesions is large. Instead, nearly half (48%) of COVID-19 patients with a single pulmonary lobe lesion progressed to bilateral lung involvement during hospitalization, and 2 (4%) progressed to critical illness and died in this group. Our findings were similar to the official national statistics, which showed that the rate in this group was 4%. Through our study, we hope that medical practitioners can improve the treatment of COVID-19 patients with only one single lobe lesion and strengthen the treatment to obtain a better prognosis.

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Disclosure of conflict of interest

None.

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