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Analysis of Imaging Characteristics and Dynamic Changes of 3 Cases of Severe Novel Coronavirus Pneumonia in Qinghai Province

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Abstract: *Objective:* To analyze the characteristics, dynamic changes, and outcomes of the first imaging manifestations of 3 patients with severe COVID-19 in our hospital. *Methods:* Computed tomography (CT) findings of 3 patients with severe COVID-19 who tested positive by the nucleic acid test in our hospital were selected, mainly focusing on the morphology, distribution characteristics, and dynamic changes of the first CT findings. *Results:* 3 patients with severe pneumonia were older, with one aged 80. The first chest CT examination for all 3 patients differed. Imaging showed a leafy distribution of consolidation, primarily affecting the lower lobes of both lungs and extending subpleurally. A grid-like pattern was observed, along with changes in the consolidation and air bronchogram. These changes had slower absorption, especially in patients with underlying diseases. *Conclusion:* CT manifestations of severe COVID-19 have specific characteristics and the analysis of their characteristics and dynamic changes provide valuable insights for clinical treatment.

Keywords: COVID-19; Imaging; CT findings; Dynamic changes

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1. Introduction

Novel coronavirus pneumonia (COVID-19) belongs to the family of beta coronavirus [1,2]. It is an enveloped virus and is known to be contagious during incubation and highly infectious within the first 5 days of onset. The coronavirus is sensitive to ultraviolet rays and heat. Since the first case appeared in Qinghai Province on October 21, 2021, there have been 12 confirmed cases in Qinghai Province as of November 10, 2021, with a total of 4 severe cases, one of whom was 80 years old. Based on the existing case data, the imaging characteristics and dynamic changes of 3 COVID-19 cases were analyzed to provide a reference for clinical treatment. Timely and accurate assessment of the patient's condition can provide insights into clinical diagnosis and treatment.

2. Materials and methods

2.1. Clinical data

Three patients with severe COVID-19 confirmed by nucleic acid examination and treated in our hospital were selected. There were 1 male and 2 females, with the oldest being 80 years old. All patients had underlying diseases. Patients were diagnosed based on the Diagnosis and Treatment Plan for Pneumonia Infected by Novel Coronavirus (Trial Eighth Edition) formulated by the National Health Commission [2].

2.2. Methods

The GE64-row Revolution Maxition spiral computed tomography (CT) was used, with a slice thickness of 5 mm and high-resolution computed tomography (HRCT) of 0.625 mm. All patients underwent chest CT scans upon admission and every 3 days after treatment, and all patients underwent coronal, sagittal, and axial thin-section three-dimensional reconstruction. The lesions' distribution, shape, density, and changes in the dynamic absorption were observed.

3. Results

3.1. Imaging manifestations of the first chest CT findings of the 3 patients

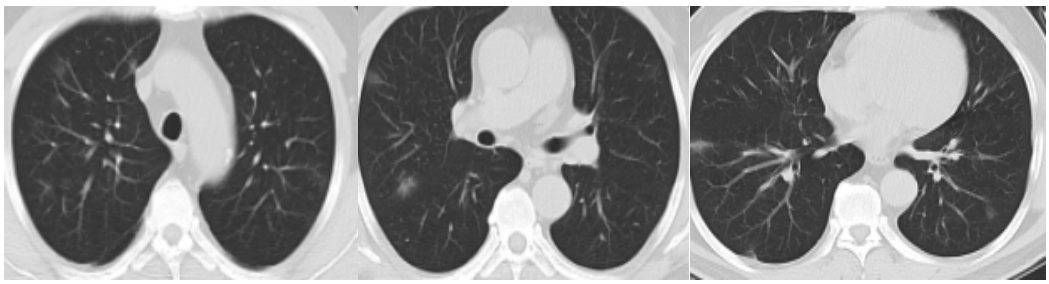
The clinical data of the 3 patients are shown in **Table 1**. As shown in **Table 2**, 2 cases had multiple scattered distributions, multi-global and multi-segment involvement in both lungs; 1 case showed multiple ground-glass opacity (GGO) and consolidation opacity (**Figure 1**), with subpleural lesions in both lungs. Air bronchial signs were also observed in the consolidation shadow, and the bronchus bundles around the lesions were thick; 2 cases were accompanied by pleural thickening, while 1 case had enlarged mediastinal lymph nodes. The first CT findings of the 80-year-old female patient showed chronic branch changes. Re-examination after 3 days of treatment showed a significant increase in the scope of the lesions and new GGO in 2 cases. The 80-year-old female patient had multiple new patchy GGO in both lungs, with scattered multi-lobed distribution, affecting the lower lobe. One case had significantly increased consolidation shadows. Clinical tests showed that 1 of the 3 patients had a decreased white blood cell count, 2 had increased neutrophil percentage, and 2 had decreased lymphocyte percentage.

Table 1. Clinical data of 3 patients with severe COVID-19 pneumonia

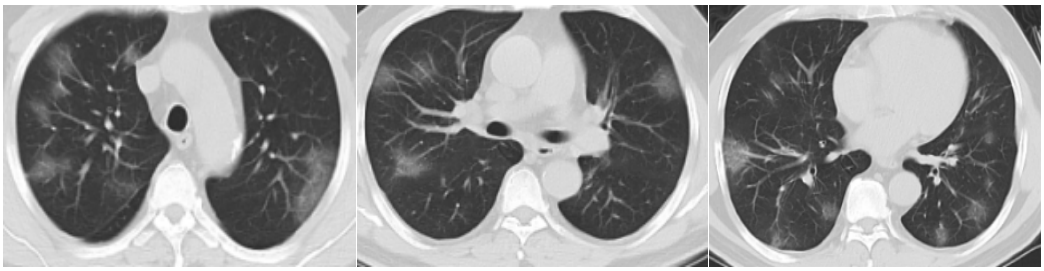
No.	Gender	Age (years)	First symptoms	Maximum body temperature (°C)	History of contact with epidemic areas	Presence of underlying diseases	Peripheral blood white blood cell count (x10^9/L)	Peripheral blood neutrophil percentage (%)	Peripheral blood lymphocyte percentage (%)
1	Male	59	Cough and expectoration for 1 day	37.5	Yes	Hypertension grade I, type 2 diabetes, hyperuricemia, fatty liver, renal cyst, splenomegaly	4.67	77.00	14.3
2	Female	59	Cough and sore throat for 5 days	37.3	Yes	Thyroid nodules	2.74	65.7	25.5
3	Female	80	Dry cough for 2 days	36.6	Yes	Chronic bronchitis, hypertension, diabetes	7.99	79.0	8.5

Table 2. CT manifestations and dynamic changes of the 3 patients

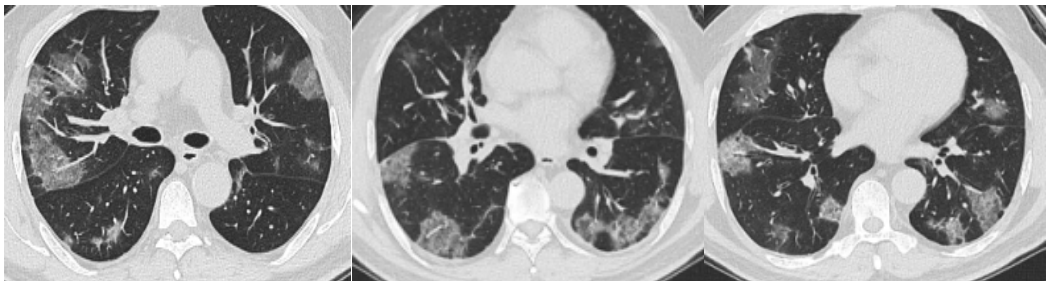
		First CT imaging							Reexamination after 7 days				
No.	Age (years)	Range of lesions	Consolidation shadow	Ground glass shadow	Air bronchogram	Cable shadow	Pleural thickening	Lymph nodes	Range of lesions	Consolidation shadow	Ground glass density shadow	Air bronchogram	Cable shadow
1	59	Scattered multiple lungs	None	+	+	+	Right pleural thickness	None	Significantly increased	+	None	+	New
2	59	Multiple lung diseases	+	+	+	+	Bilateral pleural thickness	None	Significantly increased	+	None	+	+
3	80	Slow branch changes	None	None	None	None	None	Mediastinal lymph nodes are enlarged and partially calcified	Significantly increased	+	+	+	Increase



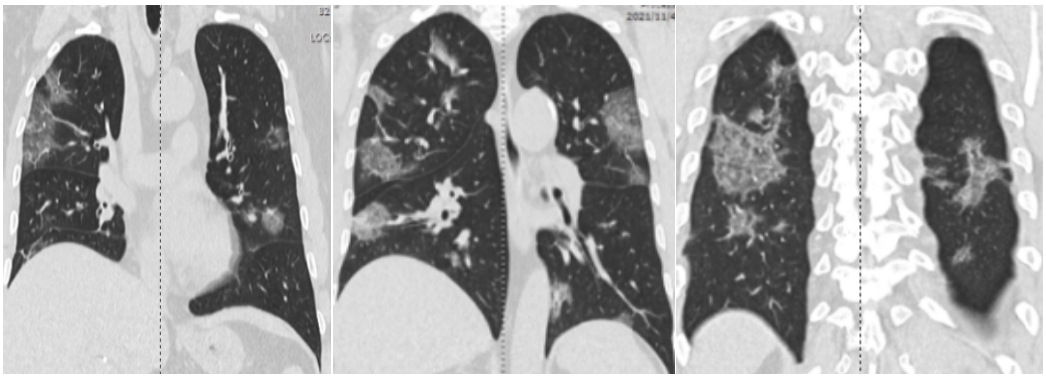
A: Patient's first (October 28) chest CT



B: Chest CT of the same patient 3 days after treatment



C: Chest CT performance on November 4



D: Coronal image of the chest on the same day as Figure C

E: Chest CT findings after 23 days of treatment

Figure 1. Patient No. 1, male, 59 years old; A–E are the same patient. Image A: first chest CT, scattered patchy ground glass density shadows in both lungs; Image B; reexamination 3 days later, the lesions in both lungs increased significantly; Image C: multiple new consolidations occurred in both lungs, with subpleural involvement, and the blood vessels and bronchial bundles around the lesions were thickened; Image D: coronal image on the same day as Image C. Image E: in the dissipation stage, the lesions in both lungs are absorbed, and new cord shadows appear

4. Discussion

COVID-19 is a disease caused by a new type of coronavirus, mainly characterized by inflammatory lesions of the lungs, where chest imaging manifestations exhibit certain characteristics [1].

The CT findings of the 3 severely ill patients in this study were diffusely distributed, mainly in the subpleural area of the middle and lower lobes of both lungs and parallel to the long axis of the pleura, the pleural parallel sign [2]. Observation of thin GGO in the lungs was common. When blood vessels pass through the lesion, the scope of the lesion expands by more than 40%, thus forming a phenomenon known as "white lungs" [3,4]. During this period, the patient's condition progresses and new symptoms gradually appear. Some patients may develop shortness of breath or hypoxemia and require immediate intervention.

The average age of the patients in this study was 66 years old, with all having epidemiological histories and underlying diseases. During the initial diagnosis, 2 cases of chest HRCT showed scattered multi-lobed and multi-segment distribution in both lungs, with patchy ground-glass density shadows without consolidation. Pleural traction was observed in both cases, with 1 case showing scattered cord shadows and the other on the right side of the lungs. The lower lobe bronchi were also slightly dilated. The first CT scan of the 80-year-old patient showed slow bronchial changes and mediastinal lymph node enlargement. When the chest HRCT was reviewed after 3 days of treatment, it was found that the lesions in both lungs of the 3 patients had significantly progressed, and the pleura was removed from both lungs. Lower and GGO were common. One case showed multiple consolidation shadows and air bronchial signs while varying degrees of pleural traction were seen in all 3 cases. One of the patient's chest CTs showed the largest consolidation range 9 days after admission. The most severe chest CT manifestations were seen in 2 patients 6 days after admission. CT scan revealed distributed subpleural consolidation shadows in both lungs. Air bronchial signs and fine mesh-like changes were seen in the consolidation shadows. The lesions in all 3 patients were similar to those of the long axis of the pleura, which is parallel; pleural adhesion and traction were observed and no pleural effusion was found. These findings were consistent with the reports of most studies [4,5]. Thickened blood vessels and posterior wall bronchus were present in the consolidation shadow. Its pathological manifestations include intra-alveolar edema, mild interstitial infiltration of inflammatory cells, and vascular congestion, covering the terminal bronchioles and the pulmonary interstitium around the respiratory bronchioles during the early stages of COVID-19. Fine grid-like shadows, called fine meshes, were observed in the consolidation shadow in all cases. The crazy-paving pattern indicates that the pathological changes were caused by the thickening of intralobular septa, reflecting interstitial lesions [6]. All 3 patients underwent chest CT for the first time within 3 days of admission and significant changes were observed in the imaging manifestations of intrapulmonary lesions. The range of intrapulmonary lesions in 3 patients significantly expanded, with a significant increase in ground-glass and consolidation opacities in one case. All patients underwent a second reexamination 6 days later. The intrapulmonary lesions significantly progressed in various forms, with the progression of GGO and consolidations, and new GGO appeared in 2 cases. All patients underwent chest CT reexamination every 3 days. During the initial examination and reexamination, 3 cases were accompanied by varying degrees of pleural traction and thickening without signs of pleural effusion or white lungs. In 2 of the patients, the lesions in both lungs were gradually absorbed and entered the dissipation stage after 9 days, and the consolidated lesions were somewhat absorbed and turned into GGO; in 1 patient, chest CT showed that the lesions in both lungs were gradually absorbed and entered the dissipation stage after 12 days; traction bronchiectasis was observed in the lower lobes of both lungs in 2 patients. A review after 70 days showed that the scope of consolidation shadows in 3 patients was significantly reduced and absorbed. In 1 patient, the lesions in both lungs were absorbed, with patchy and cord shadows scattered in the lower lobes of both lungs. In 2 patients with hypertension and diabetes, the absorption and

the lesions in both lungs were absorbed slowly. Multiple patchy light ground-glass density shadows were still observed, suggesting that imaging manifestations appear later than clinical manifestations [7]. In some cases, the range of lesions increases, or new lesions appear in the prognosis stage, and there were certain inconsistencies between imaging changes and laboratory tests. In this study, 2 patients showed fibrosis-like changes in the first CT images, suggesting that COVID-19 pneumonia may be self-limiting to a certain extent. COVID-19 is diverse and multiple states can exist simultaneously. Chest CT illustrates rapid changes, where some parts exhibit slower absorption. This may be related to patients having underlying diseases and low immunity [4].

CT findings in critically ill patients often precede the appearance of clinical symptoms, so early chest CT examination is crucial for the clinical judgment of severely ill patients. In addition, reduced lymphocyte count is a common feature of COVID-19 patients, which may be related to the severity and mortality of the disease. Related key factors in this study were that all 3 patients had a decreased lymphocyte count percentage and an increased neutrophil percentage when first diagnosed [8].

5. Conclusion

Chest CT in COVID-19 patients showed rapid progression and change of lesions, with multiple distributions in both lungs, consolidation shadows, and mainly ground-glass shadows. Some lesions were fused and expanded, with wedge-shaped and fan-shaped lesions, unclear boundaries, and subpleural multifocal pulmonary consolidation. The morphology changed greatly during reexamination within a short period and must be promptly dealt with. Analysis of dynamic changes in chest CT images plays an important role in guiding the diagnosis and treatment of severe and critical illnesses.

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Disclosure statement

The authors declare no conflict of interest.

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