

Evolution of CT Manifestations of 105 novel coronavirus pneumonia patients in Wuhan, China

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Abstract

Objectives: The purpose of this study was to observe the chest HRCT manifestation evolution of the 105 patients with pneumonia caused by SARS-CoV-2.

Methods: 105 confirmed patients were enrolled from January 11, 2020 to February 9, 2020. Chest HRCT were performed. The number of affected lung lobes, lesion shape, density, range, and dynamic changes of various lesions in each CT examination of each patient were recorded to comprehensively evaluate whether it is improved.

Results: CT images of 105 confirmed patients were collected. The patients underwent 2-7 chest CT examinations. M/F ratio: 49/56. The age range was 23-72 y, and the mean age was 48.6 ± 13.1 y. The patients' chest CT examinations were divided into 5 groups according to the re-examination interval, group A (25 cases): ≤ 3 days, group B (70 cases): 4-7 days, group C (75 cases): 8-14 days, group D (29 cases): 15-21 days, group E (4 cases): > 21 days. There was significant difference in the improvement and progress rates between group B and C. Furthermore, the changes of ground glass nodules (GGO), consolidation and cord lesions in each group were recorded.

Conclusions: The chest CT manifestations of the patients changed rapidly, and the re-examination of 7-14 days was of great significance in evaluating the prognosis of patients while minimizing the radiation dose.

Key Points

1. The manifestations of the novel coronavirus pneumonia are diverse and change rapidly.
2. Chest HRCT re-examination of 7-14 days was of great significance in evaluating the prognosis of patients with the novel coronavirus pneumonia.

Introduction

During the first week of December 2019, a few cases of pneumonia caused by a novel coronavirus appeared in Wuhan, Hubei province of China. The patients had a history of visiting the nearby Huanan seafood market where wild animals were sold.¹ With the spread of the disease, such cases have also been found in other parts of China and abroad. As of 12 February 2020, there have been 52 526 confirmed cases in China, including 8 030 serious, 1 367 deaths, and 5 911 cured.

The novel coronavirus was originally named 2019-nCoV, and was recently officially named by the International Committee on Taxonomy of Viruses as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The disease caused by SARS-CoV-2 was named COVID-19 by WHO. Like SARS-CoV, SARS-CoV-2 likely originated in bats, but the intermediary animal host was remain unclear. The nearest neighbors of the 2019-nCoV isolates from China was a Bat_SARS-like coronaviruses (Bat-SL-CoVZC45).²

There is a high risk of human-to-human transmission which has also been reported in family clusters and medical workers.^{3 4} The main route of transmission is respiratory droplets and contact transmission, and may also be transmitted through the conjunctiva and aerosol.⁵ Based on currently epidemiological survey, the latency period is generally from 3 to 7 days, with a maximum of 14 days. The affected patients presented with pneumonia-like symptoms, including fever, fatigue, cough, expectoration, pharyngalgia, anorexia, myalgia, and some patients have gastrointestinal symptoms, including diarrhea, nausea, vomiting and abdominal pain. In severe cases, acute respiratory distress syndrome, septic shock, difficult to correct metabolic acidosis, and coagulation dysfunction develop rapidly.^{5 6}

An increasing number of studies suggested the vital value of imaging examination, especially high-resolution CT (HRCT) of the chest, in new coronavirus pneumonia.^{7 8 9} Typical CT imaging manifestation included multiple, patchy, sub-segmental or segmental ground glass density shadows, multiple, patchy or large patches of consolidation in both lungs.¹⁰ The imaging of patients with the new coronavirus pneumonia often changed rapidly, so patients often performed multiple re-examinations.

To date, there are few researches about the dynamic changes of imaging in patients with the new coronavirus pneumonia. The purpose of this study was to observe the chest HRCT manifestation changes of the 105 patients with pneumonia caused by SARS-CoV-2.

Materials And Methods

- Population and CT image data acquisition

105 confirmed patients were enrolled from January 11, 2020 to February 9, 2020. CT chest scan protocol: The patient takes a supine position, arms are raised. The CT HD750 Discovery scanner from GE USA is used. Before the examination, the medical staff guides the patient to hold the breath and inhale. After exhaling all the gas, the patient hold the breath and scan and scanning ranges from the bottom of the lung to the apex of the lung. The scan time is 2s, the scan interval is 5mm, the scan layer thickness is 5mm, and the reconstruction layer thickness is 1.25mm. The patients' chest CT examinations were divided into 5 groups according to the re-examination interval, group A: ≤ 3 days, group B: 4–7 days, group C: 8–14 days, group D: 15–21 days, group E: > 21 days.

- Qualitative image analysis

Observe and record the number of affected lung lobes, lesion shape, density, range, and dynamic changes of various lesions in each CT examination of each patient, and comprehensively evaluate whether it is improved. When the number of lesions increases, the area increases, or the consolidation increases, it is considered as progress; when the number of lesions decreases, the lesion area decreases, the solid lesion becomes a ground glass one, or the number of cord increases, it is considered as improvement.

- Statistical analysis

Statistical analysis was performed on SPSS 17.0 (IBM Corporation, Armonk, USA). Measuring data were expressed as mean \pm SD.

Results

- Demographics and Grouping

CT images of 105 confirmed patients were collected. The patients underwent 2–7 chest CT examinations. M/F ratio: 49/56. The age range was 23–72 y, and the mean age was 48.6 ± 13.1 y. The patients' chest CT examinations were divided into 5 groups according to the re-examination interval, group A (25 cases): ≤ 3 days, group B (70 cases): 4–7 days, group C (75 cases): 8–14 days, group D (29 cases): 15–21 days, group E (4 cases): > 21 days.

- CT images analysis

By comparing with the previous CT examination, the changes in the range, shape, density, and number of affected lung lobes were analyzed to comprehensively assess whether the disease was better or worse. The results were shown in Figure 1 (1). We found that 18.2% of cases in group A improved, 77.3% of cases progressed, and 4.5% of cases remained unchanged; 33.3% of cases in group B improved, 58.0% of cases progressed, 1.4% of cases did not change significantly, and 6.3% of cases some lesions improved while some progressed; 68.3% of cases in group C improved, 22.2% of cases progressed, 3.2% of cases were similar, 6.3% of cases improved in some lesions, and some lesions progressed; group D. 84.6% cases improved, 11.5% cases progressed, 3.8% cases were similar; group E 100% of cases improved. It was worth noting that there was significant difference in the improvement and progress rates between group B and C. Furthermore, the changes of ground glass nodules (GGO), consolidation and cord lesions in each group were shown in Figure 1 (2). Besides, CT images of a patients with the novel coronavirus pneumonia were shown in Figure 2.

Discussion

Since the end of 2019, an outbreak of mystery pneumonia in Wuhan has been drawing tremendous attention around the world. Chinese government and researchers have taken swift

measures to control the outbreak and conduct the etiological studies. The causative agent of the mystery pneumonia has been identified as a novel coronavirus, i.e. SARS-CoV-2. As its name suggests, its genetic structure is 82% similar to SARS-CoV.¹¹

The most frequently affected organ of the new coronavirus is the lung. In the previous version of diagnosis and treatment guideline of pneumonia caused by novel coronavirus, patients were confirmed diagnosed with viral nucleic acids in throat swabs, sputum, and alveolar lavage fluid. However, recent guideline indicated that if suspected patients had typical chest CT findings, the patient would be considered a clinically-diagnosed case, which reflected the important role of chest CT in diagnosis.

Moreover, according to the current clinical experience, the chest CT manifestations changed rapidly, so many patients underwent multiple examinations during treatment. However, there are few studies on the dynamic changes of lesions in patients with new coronavirus pneumonia. To our knowledge, this study is by far the largest case series of imaging follow-up study of the novel coronavirus pneumonia.

In this study, we included 105 patients with confirmed new coronavirus pneumonia. The patients underwent 2–7 chest CT examinations. At present, it is inconclusive about the course of the new coronavirus pneumonia and when it should be re-examined. We grouped the patients' CT scans at different time intervals. The time interval grouping was based on current clinical experience and same with the imaging interval in the pneumonia diagnosis and treatment guidelines.¹⁰ We found no significant difference in the improvement or progression rate between groups A and B, or between groups C and D and E. That is, there was no significant difference in the improvement or progression rate when the patients were reviewed within one week or two weeks later. However, there were significant differences in the improvement and progression rates between groups A, B and C, which suggests that the review of 7–14 days is of great significance. During this period, the patient's condition changes rapidly and can be used to evaluate the prognosis of patients. Moreover, choosing a proper time to re-examine the chest CT can also reduce the radiation dose of the patient.

Our study followed up and evaluated the chest CT of 105 confirmed patients, and found that the chest CT manifestations of the patients changed rapidly, and found that the re-examination of 7–14 days was of great significance in evaluating the prognosis of patients. The purpose of this study is to help clinicians properly re-examine chest CT for patients with novel coronavirus pneumonia to understand changes in the patient's condition and assess the prognosis, while minimizing the radiation dose.

Declarations

This study was approved by the Tongji medical college, Huazhong University of Science and Technology Ethics Committee, and the patients' written informed consent were received.

Abbreviations

HRCT high-resolution computed tomography; GGO, ground glass nodules; SARS, severe acute respiratory syndrome.

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Figures

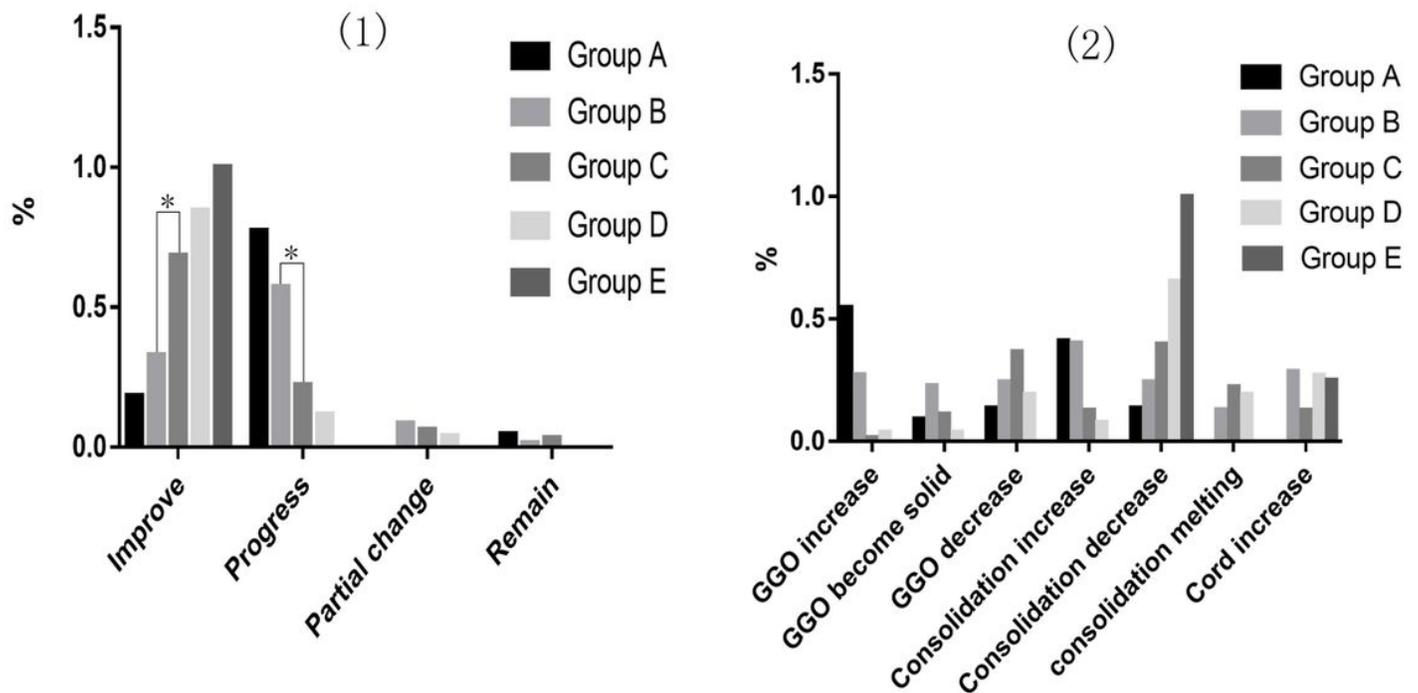


Figure 1

(1) The changes of CT in each group. Improve referred to the percentage of CT manifestation improvement in each group. Progress referred to the percentage of CT manifestation worsen in each group. Partial change referred to the percentage of CT manifestation partial improve and partial worsen in each group. Remain referred to the percentage of CT manifestation remain unchanged in each group. *: P < 0.05. (2) The changes of ground glass nodules (GGO), consolidation and cord lesions in each group. GGO, ground glass nodule. Consolidation “melting” means that the consolidation area of the lung begins to absorb, reducing its density and gradually becoming a ground glass opacity.

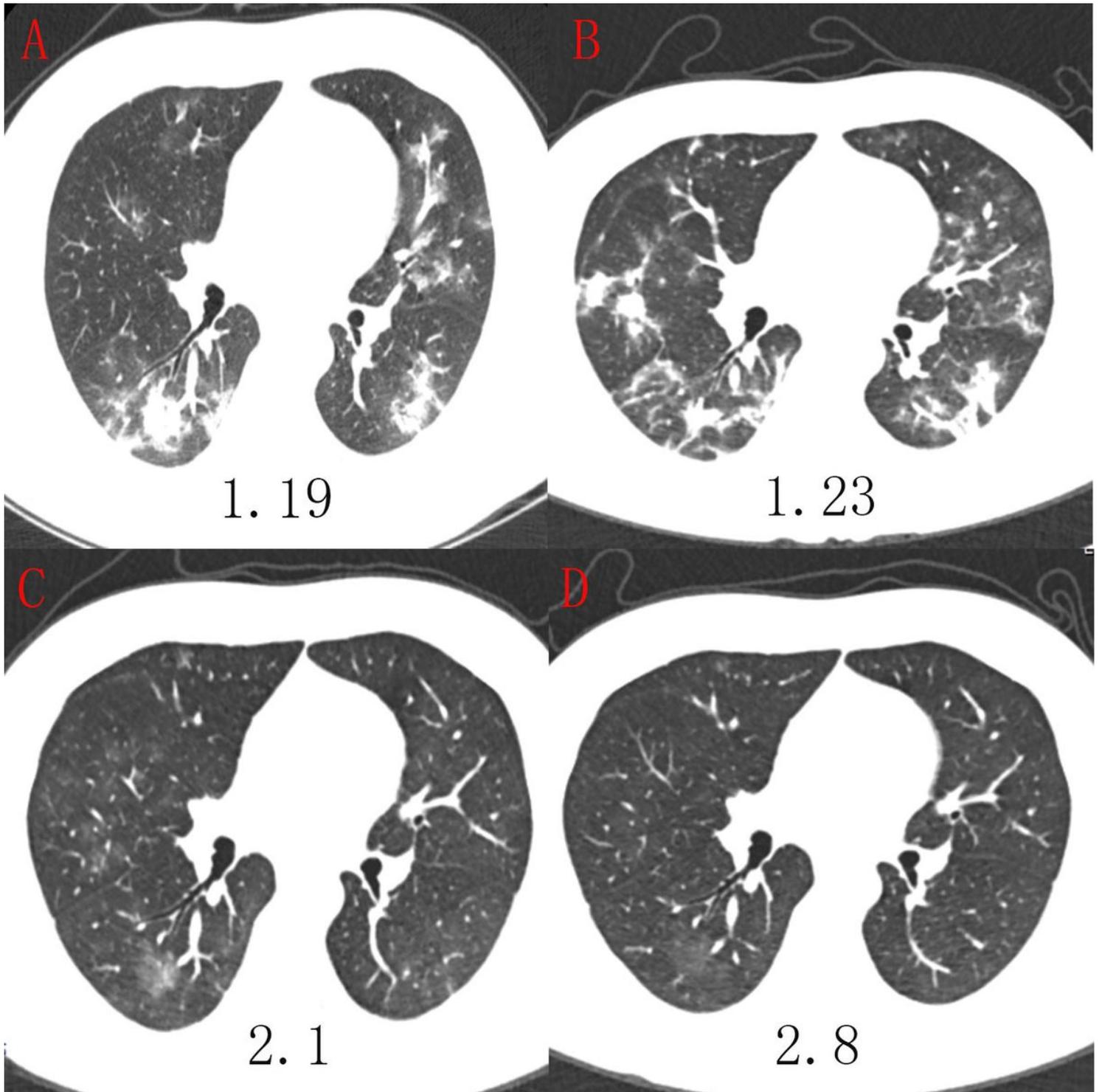


Figure 2

CT image of a patient with the novel coronavirus pneumonia. Figure A showed scattered solid and GGO shadows; Figure B showed multiple solid and GGO shadows, which were more than before; Figure C showed some GGO shadows, and the consolidation in Figure B almost disappeared; The density of GGO in Figure D was lower than before and the range is reduced.