Analysis of Clinical Imaging Characteristics of Patients with 2019-nCoV

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Research

Keywords: COVID-19, Communicable Diseases, Pneumonia, Computed Tomography, X-Ray

DOI: https://doi.org/10.21203/rs.3.rs-44768/v1

Abstract

Background: This article retrospectively analyzed the clinical characteristics and CT characteristics of chest CT of 10 patients with coronavirus disease 2019 (COVID-19) diagnosed in Heilongjiang Province.

Methods: A retrospective analysis of 10 COVID-19 patients confirmed by designated hospitals in Heilongjiang Province.

Results: The clinical manifestations were mainly fever (80%) and cough (50%). Laboratory tests showed elevated C-reactive protein (70%) and serum amyloid A (80%). CT mainly manifests as ground-glass opacity (100%) in the lung, more than two lung lobes (90%), and the lesions are mostly located in the right upper lobe (80%), and lobular septum thickening (60%) is common.

Conclusions: In this group of patients with COVID-19, the typical CT manifestations are double lung sheet ground-glass opacity, which are mainly distributed in the subpleural area, and the range of involvement is more than or equal to two lung lobes, “paving stones” changes; pulmonary lesions were absorbed and fibrous cord foci were formed during the transition period. It is worth noting that hilum, mediastinal lymphadenopathy, and pleural effusion are less common. During the study period, follow-up imaging performed by some patients showed mild / moderate disease progression and gradually dissipating.

Introduction:

The 2019 novel coronavirus (2019-nCoV) broke out in Wuhan, China in December 2019 [1, 2]. On January 30, 2020, the World Health Organization declared China's coronavirus a global health emergency. In February 2020, the World Health Organization (WHO) named the disease caused by this virus as coronavirus disease 2019 (COVID-19). As of February 20, 2020, the National Health Commission of the People’s Republic of China has reported 74665 confirmed COVID-19 cases, of which 476 were confirmed in Heilongjiang Province. It can be seen that the severity and challenge of the epidemic caused by COVID-19. Although the clinical diagnosis of COVID-19 mainly relies on viral nucleic acid detection, viral nucleic acid detection is susceptible to a variety of factors and has a certain hysteresis. CT is simple and fast and has certain characteristics for COVID-19. It is the preferred auxiliary examination method for clinical diagnosis of COVID-19. We reported 10 COVID-19 confirmed patients in Heilongjiang Province. The CT features of the patients showed pulmonary imaging features of the lung infection. The purpose was to familiarize radiologists and clinical teams with the imaging manifestations of this new disease. Early diagnosis of disease can speed up clinical treatment and isolate patients early.

Methods:

Normal Information

The study has been approved by the Medical Ethics Committee of the Second Affiliated Hospital of Harbin Medical University in Heilongjiang Province and is in line with the principles of the Helsinki

Declaration. According to the 2019-nCoV pneumonia diagnosis case diagnosis standard for the new Coronavirus-infected pneumonia diagnosis and treatment program (trial version 6) issued by the National Health Commission of the People's Republic of China [3], the inclusion criteria are: (1) Real-time fluorescent RT-PCR for detection of new crown virus positive nucleic acid; (2) Untreated newly diagnosed patients. Exclusion criteria: (1) Treated non-newly diagnosed patients. A total of 10 COVID-19 patients from designated hospital in Heilongjiang Province between January to February 2020 were included in the study. The patients included 5 (50%) males and 5 (50%) females, aged from 25 to 82 years. All patients underwent plain CT scans and laboratory tests (C-reactive protein, D-dimer, etc.) on admission. Collect clinical data of all patients.

CT Examination

All CT images were analyzed and diagnosed by two radiologists trained in New Coronavirus. Both doctors have more than 5 years of diagnostic experience. The two doctors independently diagnosed all patient images and reached consensus. For the disagreement between the two radiologists, a third trained radiologist with more than 10 years of diagnostic experience ruled on the final diagnosis. No negative control cases were examined. The features of plain CT images of 10 patients included in the study were evaluated as follows: (a) presence of ground-glass opacity; (b) presence of lobular septal thickening; (c) presence of "paving stones"; (d) lung involvement (single / double lung); (e) presence of fibrous cords; (g) presence of pleural effusion; (h) presence of thoracic lymphadenopathy (> 1 cm); (i) other lung diseases such as emphysema, bullae; and other abnormalities (For example: small nodules, calcification, bronchiectasis, etc.). During the study period, all patients were followed up for chest CT and found that one patient underwent multiple plain CT scans before and after treatment. Two experienced radiologists diagnosed this patient's lung CT manifestations over time in the same way.

Clinical Data

These patients usually have a history of epidemiological exposure. The clinical manifestations are mainly fever, dry cough, and fatigue. A few patients have symptoms such as nasal congestion, sore throat, myalgia and diarrhea. Mild patients can only show low fever and mild fatigue; severe patients can have dyspnea and hypoxemia, and severe patients can quickly progress to acute respiratory distress syndrome and metabolic acidosis. Laboratory tests usually include: blood routine (C-reactive protein), D-dimer, etc., nasopharyngeal test, sputum, lower respiratory tract secretions, blood, stool and other specimens are tested by real-time fluorescent RT-PCR to test for new crown virus positive Is the standard for the diagnosis of this disease.

Results:

Clinical Manifestations and Laboratory Tests

The clinical manifestation characteristics of all patients are shown in Table 1. In this group of studies, the proportion of male and female in 10 patients was balanced, all of which were 50%. The age range was 25–82 years, with a median age of 51.5 years. Among them, only 1 (10%) patients had a history of staying in Wuhan, and 9 (90%) patients had close contact with the virus-infected population. The temperature of 2 patients (20%) was normal (< 37.2 °C), and the temperature of 8 patients (80%) was between 37.4 ℃ -38.5 ℃. Of the 10 patients, 8 (80%) had fever, 4 (40%) had fatigue, 5 (50%) had cough and sputum symptoms, 2 (20%) had muscle soreness, and 1 (10%) Nausea, vomiting, abdominal pain and diarrhea were not seen. 1 (10%) of all patients were diagnosed without any clinical symptoms. In laboratory tests, C-reactive protein increased in 7 (70%) patients; D-dimer increased in 3 (30%) patients; and serum amyloid A increased in 8 (80%) patients.

Table 1
Patient clinical characteristics information(n=10)

Characteristics	Value
Age (y)	
Median age	51.5
Range	25-82
Gender	
Male	5（50）
Female	5（50）
Exposure history	
Wuhan sojourn	1（10）
History of contact with infected patients	9（90）
Unknown history	0（0）
Symptoms	
Fever	8（80）
Fatigue	4（40）
Cough	5（50）
Abdominal pain, diarrhea	0（0）
Headache	3（30）
Sick and vomit	1（10）
Muscle soreness	2（20）
No obvious symptoms	1（10）

Note: Unless otherwise stated, the figures in the table are the number of patients and the percentages are in brackets.

CT Imaging Features

The imaging characteristics of chest CT examination of 10 patients are shown in Table 2. All 10 patients (100%) showed ground-glass opacity (Fig. 1A); of these, 1 patient (10%) had only one lobe involved, and 2 patients (20%) had two lobe involvement, one patient (10%) had three lobe involvement, three patients (30%) had four lobe involvement, and three patients (30%) had five lobe involvement. Among the 10 patients examined by CT, 8 cases (80%) were involved in the right upper lobe, 5 cases (50%) were involved in the right middle lobe, 8 cases (80%) were involved in the right lower lobe, and the left upper lobe was involved Involvement was found in 7 cases (70%), and left lower lobe involvement was found in 7 cases (70%). Of the 10 patients with a ground-glass opacity in the lung, 8 patients had both lungs affected (Fig. 1B), and 2 patients had unilateral lung involvement (both right lungs). One of the 10 patients (10%) showed a round ground-glass opacity, the remaining 9 cases were flaky / pale flaked ground-glass opacities, and 1 (10%) was accompanied by a "paving stone" sign Performance; 6 cases (60%) of ground-glass opacity were distributed in the field zone of the lungs (subpleural area) (Fig. 1C). Six of the 10 patients (60%) presented with fiber strip shadows (Fig. 1D), and 6 (60%) patients had lobular septal thickening. Four patients (40%) had other lung diseases, including pulmonary nodules, pulmonary calcifications, and emphysema. Only 1 of the 10 patients had pleural hypertrophy, and all patients had no pleural effusion.

Table 2
Imaging features of initial CT examination of 10 patients

Finding	n（%）
≥ Two lung lobes involved	9（90）
Lobe involvement range	
Right upper lobe involvement	8（80）
Right middle lobe involvement	5（50）
Right lower lobe involvement	8（80）
Left upper lobe involvement	7（70）
Left lower lobe involvement	7（70）
Field involvement in both lungs	6（60）
Morphology of ground glass density shadow	
Round	1（10）
Flake	9（90）
Paving stone	1（10）
Leaflet septal thickening	6（60）
Fiber strand	6（60）
Other features	
Pulmonary nodule	2（20）
Calcification	3（30）
Lymphadenopathy	1（10）
Emphysema	1（10）
Pleural effusion	0（0）

Note: Unless otherwise stated, the figures in the table are the number of patients and the percentages are in brackets.

Follow-up Chest CT

During the study period, one patient (10%) underwent multiple chest CT follow-up examinations. During follow-up, the patient's CT manifestations ranged from progressive to dissipative, with no significant progression (Fig. 2). The first CT plain scan of this confirmed patient showed diffused of the 10 patients with a ground-glass opacity in the lung, 8 patients had both lungs affected on both sides, with the subpleural area of the lungs as the focus and the lobular septum thickening. After clinical treatment, the

patient underwent another CT review. Compared with the first comparison, the ground-glass opacities of the two lungs were absorbed more than before, but the ground-glass opacities of the bottom of both lungs changed. Multiple fibrous cord foci were seen in the right lower lobe and left lower lobe. The patient's temperature dropped to normal (36.6 ℃) the next day, and real-time fluorescent RT-PCR of the patient's sputum was negative for 2019-nCoV nucleic acid test results. After a few days of treatment, the patient underwent a third plain CT scan to show ground-glass opacity in the lungs. The previously shown consolidation image was absorbed more than before, and the lobular septum was further thickened with multiple fibrous cord foci. On that day, CT manifestations were mainly fibrous cord foci. On the same day, the patient's temperature was normal (36.9 ℃). The real-time fluorescent RT-PCR of the patient's sputum was negative for 2019-nCoV nucleic acid test results.

Discussion:

COVID-19 is a new type of outbreak that may have a profound impact on public health. According to the new coronavirus-infected pneumonia diagnosis and treatment plan (trial version 6) issued by the National Health Commission of the People's Republic of China, the group included patients in the study in terms of epidemiological history, clinical manifestations (including imaging manifestations), and pathogenic examination. The cases were identified as new coronaviruses, and all were confirmed cases in Heilongjiang Province. At present, the typical imaging features of COVID-19 are one of the important clinical manifestations in the "diagnostic criteria for suspected cases". It can be seen that the results of imaging studies are very important for the classification of cases and the choice of further treatment options. In addition, the plain CT scan of the chest has a clear manifestation of inflammatory changes in the lungs at various stages, and is the preferred imaging method for COVID-19 screening and diagnosis. The ground-glass opacity (100%) was observed in all 10 patients included in the study. It can be seen that ground-glass opacity is the most characteristic imaging feature of COVID-19. Moreover, the disease is likely to cause bilateral lung lobe involvement (8/10, 80%). Nine patients (90%) had ≥ two lung lobe, of which 6 (60%) were involved in extralobular lobe involvement, the upper lobe of the right lung is a common site of the disease (8/10, 80%). Thickening of lobular septum and fibrous cords are also multiple imaging features of the disease (6/10, 60%; 6/10, 60%, respectively). Other imaging findings include pulmonary nodules (2/10, 20%), emphysema (1/10, 10%), calcifications (3/10, 30%), and mediastinal lymphadenopathy (1/1 10, accounting for 10%). Pleural effusion is a negative feature associated with this disease.

One patient in this group underwent follow-up CT examinations: the initial CT findings were mainly ground-glass opacity, involving both lungs, and more often the disease course was in the advanced stage. After treatment, a comparison of the CT examination and the previous film showed that although the ground-glass opacities of the lungs were absorbed more than before, the ground-glass opacities at the bottom of the lungs had changed, and the ground-glass opacities and consolidation coexisted. It is still considered that the course of disease is in progress Period-based. The comparison of the CT results of the third review of the patient compared with the previous film showed that the ground-glass opacity and consolidation of the lungs were absorbed earlier, the density was reduced, and the lobular interval

was further thickened with multiple fibrous cords, it is a "paving stone" sign, considering that the exudate is absorbed or mechanized by the body. Generally, the lobular space is thickened with fibrous cords, and the disease course is mostly considered to be dissipating. This is also consistent with the recently published imaging features of the course of the COVID-19 course [4].

Viruses are a common cause of respiratory infections. The imaging findings of viral pneumonia are similar to other infectious and inflammatory lung diseases. Viruses in the same virus family have similar pathogenesis. Therefore, CT may help to identify the imaging features of patients with immune function [5]. Some data indicate that the CT findings of COVID-19 have many similar characteristics to other types of coronavirus (SARS) [6]. The SARS outbreak was also caused by a coronavirus. Therefore, the diagnostic experience of these epidemics may help manage the current epidemic. It may be valuable to correlate imaging findings from SARS patients with imaging findings from COVID-19 patients. In terms of CT manifestations, the two diseases are similar, such as ground-glass opacity and consolidation. Some research results show that the most common CT imaging manifestation of SARS is the presence of ground-glass opacity [7]. Müller et al. [7] reviewed the imaging findings of 12 SARS patients and found that unilateral / bilateral ground-glass opacity was the most common imaging manifestation of patients. Lee et al. [8] reviewed the radiological characteristics of 138 SARS patients and found that the lesions were mainly distributed in the peripheral zone of the two lungs, and there was no associated pleural effusion or hilar lymphadenopathy, which is consistent with the findings of this study. Pulmonary lesions often involve the extrapulmonary bands, and the cause of the subpleural area may be related to the pathogenesis of viral pneumonia in the early stage involving the terminal bronchi and respiratory bronchioles, and then the entire lobules and diffuse alveoli [9]. Similarly, SARS manifestations of thickened lobular septum and "paving stone sign" have also been found in some of our patients [10]. In our study, the multifocal nature of COVID-19 was more common than SARS in 2003 [11].

There is one special sample in this study. The 25-year-old young patient had no clinical symptoms at the time of initial diagnosis, but the CT examination revealed a round ground-glass opacity in the right upper lobe. The further positive of the new coronavirus nucleic acid test virus is to show the sensitivity of CT examination and the importance of clinical treatment options. The results of negative clinical symptoms in patients with known infections indicate that COVID-19 cannot be completely ruled out by the patient alone, especially in the early stages of infection.

The vast majority of patients in this study (80%) had varying degrees of fever, and half of the patients had respiratory symptoms (50%). Many patients in this group also have non-respiratory symptoms, including headache, nausea, and fatigue (70% in total), so clinicians need to pay great attention to such non-respiratory symptoms. In laboratory tests, most patients had elevated C-reactive protein (70%) and serum amyloid A (80%); a few patients (30%) had elevated D-dimers.

Our study has several limitations: (1) we have a relatively small number of patients; (2) we do not have chest X-rays, and the study is limited to chest CT because CT is more sensitive to early and / or mild disease and is more sensitive than previous SARS The outbreak is similar to [12]. However, it is

undeniable that chest X-ray examination may have some practicality, especially in medical environments with high incidence of disease but limited resources, which has the potential to serve as a first-line screening tool.

Conclusion:

In conclusion, this study is a characteristic study of chest CT manifestations of patients diagnosed with the 2019 novel coronavirus (2019-nCoV) in Heilongjiang Province in 2019 in order to familiarize clinicians with common imaging manifestations of the disease. At the same time, it is valuable to recognize that the CT findings of COVID-19 are similar to other diseases that cause viral pneumonia, especially SARS of the same virus family. Of course, the imaging performance must be closely integrated with the clinic, and any diagnosis is a comprehensive diagnosis, combined with comprehensive analysis of imaging performance, nucleic acid detection, clinical performance, epidemiological history, and so on. At present, global public health measures are being updated and developed daily. It is believed that with the discovery of new cases, more unique chest CT imaging findings will provide reference for the identification of suspected COVID-19 patient groups. In the future, we will include more such cases in Heilongjiang Province for more in-depth and regional characteristic clinical image feature analysis.

Declarations:

Ethics approval and consent to participate

The study has been approved by the Medical Ethics Committee of the Second Affiliated Hospital of Harbin Medical University in Heilongjiang Province.

Consent for publication:

Not applicable.

Availability of data and materials:

The datasets generated and analysed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interests.

Funding:

This study was supported by grants from the National Key Research and Development Program of China (2019YFC0118100), National Natural Science Foundation of China (81671760 and 81873910), Scientific Research Transformation Special Fund of Heilongjiang Academy of Medical Sciences (2018415); Scientific Research Project of Health and Family Planning Commission of Heilongjiang Province (201812 and 201622) and Postgraduate Research & Practice Innovation Program of Harbin Medical University (YJSKYCX2018-62HYD).

Authors' contributions:

Hao Jiang and Huijie Jiang contributed to the study concepts and to the study design. Ziao Wang, Ru Yi and Ruoshui Zheng performed the experiments of this work. Wei Guo contributed to the statistical analysis. Huijie Jiang obtained the grant and supervised the project. Hao Jiang, Huijie Jiang , Baomin Su and Li Sun contributed to the manuscript preparation and to the manuscript editing and reviewing. All authors read and approved the final manuscript.

Acknowledgements:

Not applicable.

References:

1. Organization WH. Novel coronavirus–China. 2020; Available from: http://www.who.int/csr/don/12-january- 2020-novel-coronavirus-china/en.
2. Organization WH. WHO/Novel Coronavirus-China. World Health Organization 2020.
3. China NHCotPsRo. Diagnosis and treatment of new coronavirus pneumonia (trial version 6)[EB/OL]. 2020; Available from: http://www.nhc.gov.cn/xcs/zhengcwj/202002/8334a8326dd94d329df351d7da8aefc2.shtml.
4. Guan H, Xiong Y, Shen N. Clinical and thin-section CT features of patients with 2019-nCoV-pneumonia. Radiologic Practice. 2020;35:125–30.
5. Koo HJ, Lim S, Choe J, Choi SH, Sung H, Do KH. Radiographic and CT Features of Viral Pneumonia. Radiographics. 2018;38:719–39.
6. Chung M, Bernheim A, Mei X. CT Imaging Features of 2019 Novel Coronavirus (2019-nCoV). Radiology. 2020;4:200230.
7. Muller NL, Ooi GC, Khong PL, Nicolaou S. Severe acute respiratory syndrome: radiographic and CT findings. AJR Am J Roentgenol. 2003;181:3–8.
8. Lee N, Hui D, Wu A, Chan P, Cameron P, Joynt GM, et al. A major outbreak of severe acute respiratory syndrome in Hong Kong. N Engl J Med. 2003;348:1986–94.

9. Phan LT, Nguyen TV, Luong QC, Nguyen TV, Nguyen HT, Le HQ, et al. Importation and Human-to-Human Transmission of a Novel Coronavirus in Vietnam. N Engl J Med. 2020;382:872–4.
10. Ooi GC, Khong PL, Muller NL, Yiu WC, Zhou LJ, Ho JC, et al. Severe acute respiratory syndrome: temporal lung changes at thin-section CT in 30 patients. Radiology. 2004;230:836–44.
11. Wong KT, Antonio GE, Hui DS, Lee N, Yuen EH, Wu A, et al. Severe acute respiratory syndrome: radiographic appearances and pattern of progression in 138 patients. Radiology. 2003;228:401–6.
12. Paul NS, Roberts H, Butany J, Chung T, Gold W, Mehta S, et al. Radiologic pattern of disease in patients with severe acute respiratory syndrome: the Toronto experience. Radiographics. 2004;24:553–63.

Figures

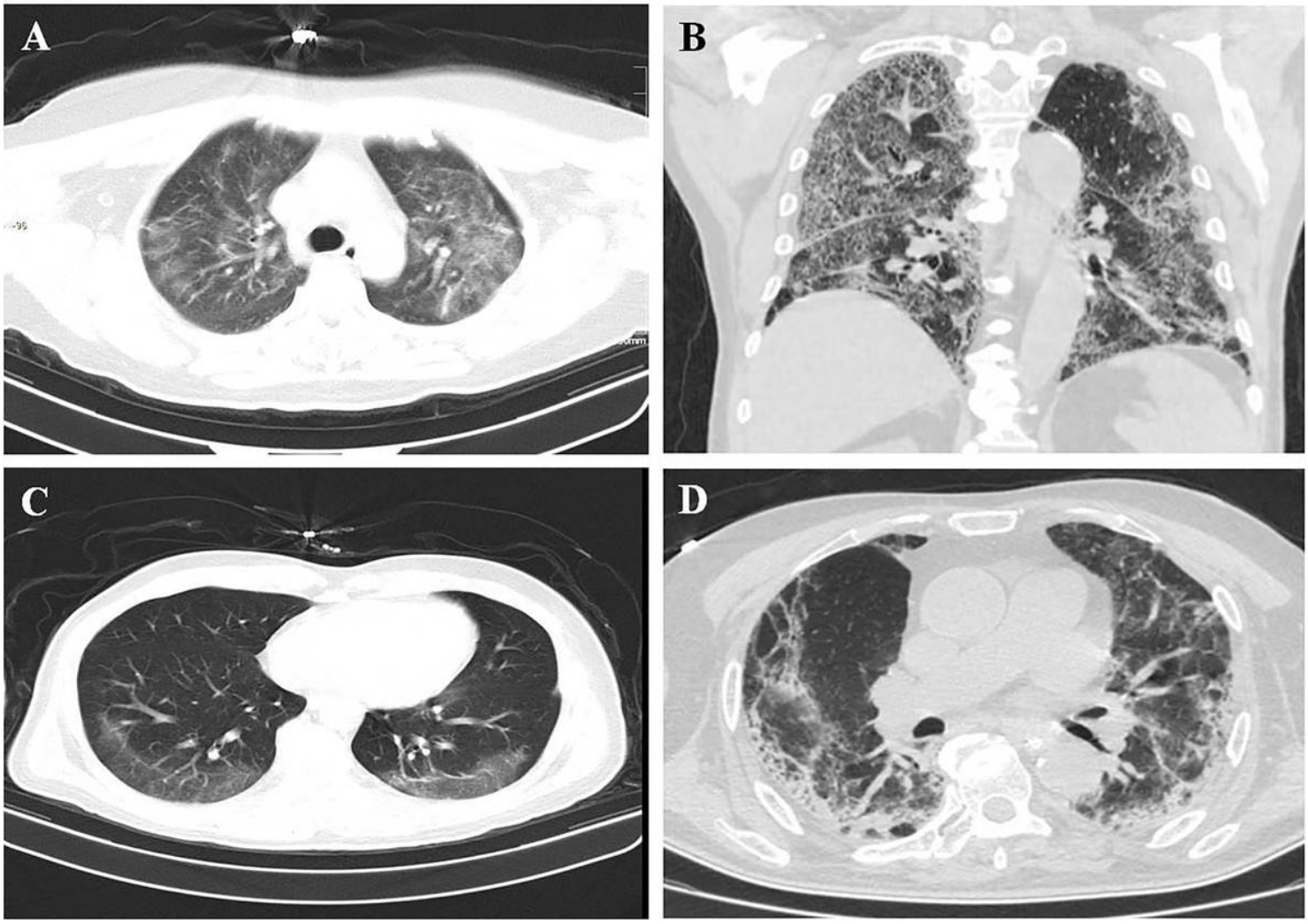

Figure 1

Various manifestations of the first CT examination of COVID-19 confirmed patients. A: ground-glass opacity in the two lungs; B: the change of ground-glass opacity in the two lungs ≥ two lung lobes; C: The ground-glass opacity of the double lung field zone (subpleural area) changes; D: Multiple fiber strips in both lungs.

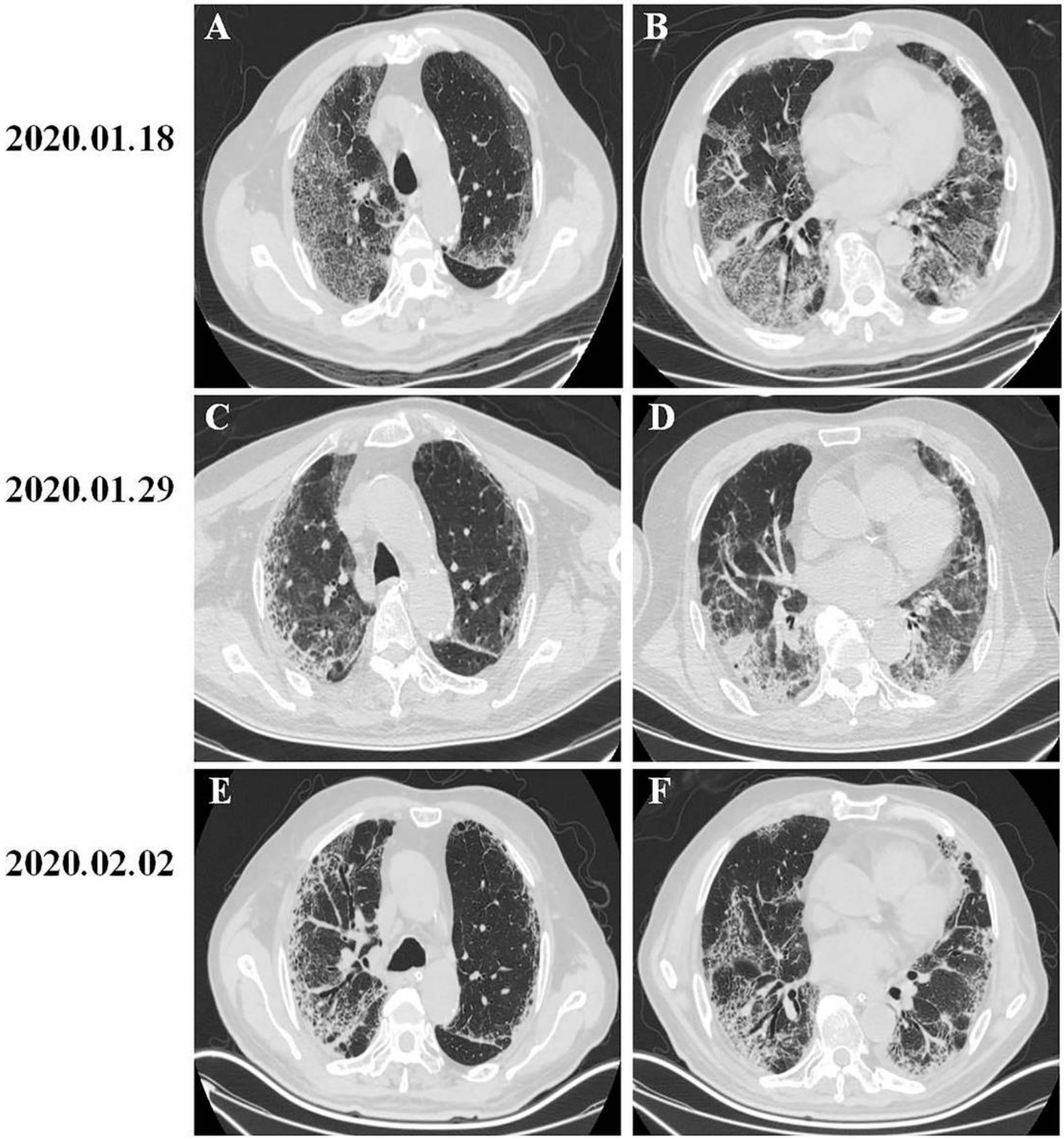

Figure 2

CT examination shows diffused ground-glass opacities on both sides with thickening of the "paving stone" -like leaflet space; 2020.01.29: Comparison with the previous film shows that although the ground-glass opacities of the two lungs are absorbed more than before, the ground-glass opacities at the bottom of the two lungs have changed, and ground-glass opacity and consolidation coexist, showing a sheet-like

distribution, and multiple fiber strands in the lungs can be seen; 2020.02.02: The comparison of the previous two images shows that the ground-glass opacity and solid-contrast images of the two lungs are absorbed earlier than before, the density is reduced, the consolidation lesions of the lungs gradually disappear, and the lobular septum is further thickened with multiple fiber cords.