



Early View

Research letter

High-resolution CT features of 17 cases of Corona Virus Disease 2019 in Sichuan province, China

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Title page

High-resolution CT features of 17 cases of Corona Virus Disease 2019 in Sichuan province, China

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Keywords: High-resolution CT, Corona Virus Disease 2019, Ground glass opacities

Summary: Bilateral ground-glass opacities and a combination of consolidation and ground-glass opacities mainly in the subpleural lung regions is a noteworthy high-resolution CT feature of Corona Virus Disease 2019 which may help in the early diagnosis of the disease.

The city of Wuhan, Hubei province in China is the focus of global attention due to the Corona Virus Disease 2019 (COVID-19) outbreak [1]. Sichuan, as a province near Hubei, also has been involved. As of February 12, 2020, 59741 confirmed cases of COVID-19 have been reported in China, of which 451 cases have been identified in Sichuan province. This disease is caused by infection of a new coronavirus named COVID-19 by the World Health Organization (WHO). According to the latest research, the novel coronavirus is 96% identical at the whole-genome level to a bat coronavirus, leading to speculation that this new coronavirus may originate from bats [2,3]. Current epidemiologic data indicate that person-to-person transmission of COVID-19 is occurring [4]. This disease has become a major health crisis in China, and has the potential to become a worldwide epidemic. According to the guidelines stated by the WHO, epidemiologic characteristics, clinical manifestations, chest images and laboratory findings represent the major screening tools for identifying COVID-19 infection. Diagnostic confirmation is ultimately dependent on respiratory samples tested by

real-time reverse-transcriptase-polymerase chain reaction (RT-PCR) [5]. However, the false-negative rate of RT-PCR is reported to be up to 70% at the early stage in the clinical course, which may lead to missed diagnosis and thus increased spread of illness. Further, the time required to do the PCR test, given patient flow in the current health crisis and the many other flu variants that can lead to similar symptoms, can delay treatment and appropriate patient isolation. Therefore, for patients with clinical manifestations and suspect exposure history to the novel coronavirus, clinical imaging findings can play an important role in making preliminary diagnoses and guide patient management decisions.

Currently, limited information exists regarding imaging findings of COVID-19. In this study, we retrospectively analyzed high-resolution CT (HRCT) findings in 17 patients suffering from the COVID-19 in Sichuan province, China, and discuss how to improve diagnostic accuracy based on these data.

Materials and Methods

Approval for this study was obtained from the local research ethics committee of West China - Guan'an Hospital of Sichuan University; informed consent was waived.

Subjects

Seventeen patients with COVID-19 infection confirmed by a positive RT-PCR of sputum samples and admitted to West China - Guang'an Hospital of Sichuan University during the epidemic outbreak in Sichuan province were included.

Imaging Techniques

A multidetector CT scanner (Somatom16; Siemens Healthineers) was employed to obtain chest images. The HRCT scan protocol was as follows: 120 kV, 150 mA and 1 mm slice thickness. The scanning range was from lung apex to diaphragm in the axial plane taken at the end inspiration.

Image Analysis

Two thoracic radiologists, with 7 and 11 years of working experience, reviewed the HRCT images independently and resolved discrepancies by consensus. The images were analyzed on PACS workstations, using both lung (width, 1500 HU; level, -700 HU) and mediastinal (width, 350 HU; level, 40 HU) settings.

Results

Epidemiology and clinical manifestation

Our patients included 17 individuals, 8 male and 9 females, with an age range of 23–74 years (median age, 48.6 years). Time from the onset of symptoms to hospital presentation ranged from 0 to 11 days (median, 4.05 days). The main presenting symptoms were fever (n = 12), cough (n = 9), muscle ache (n = 7), sputum production (n = 7), fatigue (n = 6), chills (n = 5), dizziness (n = 4), shortness of breath (n=1) and sore throat (n = 1). Eight patients had a history of living in Wuhan, 5 patients had history of contact with proven COVID-19 cases, and 4 patients had no known contact with any COVID-19 patient. Ten of the 17 patients had no significant medical history. The remaining 7 patients had a history of the following comorbidities: hypertension (n = 2), chronic gastritis (n = 2), rheumatic heart disease (n = 1) and chronic obstructive pulmonary disease (n = 2). RT-PCR of all the patient's sputum was positive for the novel coronavirus nucleic acid. All the 17 patients had lymphopenia on presentation. The white blood cell differential count showed that 8 patients had increased neutrophils, 15 patients had decreased eosinophils and 16 patients had decreased lymphocytes. All the 17 patients showed elevated blood levels for C-reactive protein and were transferred to infection isolation rooms.

HRCT findings

All patients underwent HRCT on the day of admission. The time from symptom onset to performing the initial HRCT ranged from 6 hours to 11 days (median, 4.04 days). The initial HRCT scan on the day of admission showed that 12 of 17 patients had ground-glass opacities (GGOs). Five of the 17 patients had a combination of consolidation and GGOs. The distribution of abnormalities was in the subpleural lung regions in 12 patients, bilateral in 14 and unilateral in 3 of 17 patients. Both upper and lower lobes were involved in 15 patients, only upper lobe was involved in 2 patients. Air bronchogram was identified in 3 patients. None of the patients had tree-in-bud pattern, cavitation or pleural effusion. Follow-up HRCT scan were performed in 5 patients. In three of the 5 that showed markedly decreased consolidation, fibrotic changes developed (The time intervals between the initial HRCT and follow-up was ranged between 6 to 11 days), while the other 2 patients showed mild progression with increased extent and density of opacities (The time intervals between the initial HRCT and follow-up was ranged between 2 to 3 days). figure1 shows the HRCT manifestations of 4 selected cases.

Discussion

COVID-19 is a new form of atypical pneumonia. It was first reported in the city of Wuhan in December 2019, and has spread rapidly to other

areas of China and multiple countries [6]. On January 30, 2020, this new outbreak was declared as a global health emergency by the WHO. Many patients with COVID-19 have developed severe pneumonia, ARDS, or multiple organ failure and died [6]. The main clinical symptoms of our patients were fever, cough, sputum production and muscle ache which were consisted with previous studies, but not diagnostically specific [7].

As GGOs were difficult to detect on chest radiographs, HRCT, as the first-line imaging modality to detect pulmonary changes, is more sensitive in evaluation of the lungs in patients and suspected infections.

The typical findings of initial HRCT in our patients were bilateral GGOs and a combination of bilateral GGOs and consolidation, usually located in the subpleural lung regions. Three patients showed unilateral involvement. Further progression of the disease leads to involvement of other areas within the lung, with more extensive consolidation lesions, suggesting an organizing pneumonia pattern of lung injury. During the recovery period, parenchymal scarring has been shown to develop .

Compared with reported cases in Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), the HRCT findings of our patients shared relatively specific features including GGOs, consolidation and fibrosis [8-10]. However, the presence and distribution of opacification patterns in our patients was typically multifocal with no upper or lower lobe predominance, which differs from

SARS or MERS. SARS commonly has a unifocal presence [11] and MERS predominantly showed basilar lobe distribution [10].

In conclusion, our study suggests that bilateral GGOs and a combination of GGOs and consolidation are the typical features of the COVID-19 patients. The abnormalities predominantly located in the subpleural regions is indicative of an organizing pneumonia pattern. Recognizing these features and pattern in acutely ill patients with exposure history or other reasons to suspect COVID-19 infection may aid in the rapid identification of likely infection and guide patient management decisions, which can be of great value to speeding treatment and reducing contagion of this communicable disease.

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Reference

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W. A Novel Coronavirus from Patients with Pneumonia in China, 2019. *N Engl J Med*. 2020.
2. Zhou P, Yang X-L, Wang X-G, Hu B, Zhang L, Zhang W, Si H-R, Zhu Y, Li B, Huang C-L, Chen H-D, Chen J, Luo Y, Guo H, Jiang R-D, Liu M-Q, Chen Y, Shen X-R, Wang X, Zheng X-S, Zhao K, Chen Q-J, Deng F, Liu L-L, Yan B, Zhan F-X, Wang Y-Y, Xiao G-F, Shi Z-L. A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature*. 2020;10.1038/s41586-41020-42012-41587.
3. Wu F, Zhao S, Yu B, Chen YM, Wang W, Song ZG, Hu Y, Tao ZW, Tian JH, Pei YY, Yuan ML, Zhang YL, Dai FH, Liu Y, Wang QM, Zheng JJ, Xu L, Holmes EC, Zhang YZ. A new coronavirus associated with human respiratory disease in China. *Nature*. 2020.
4. Chan JF-W, Yuan S, Kok K-H, To KK-W, Chu H, Yang J, Xing F, Liu J, Yip CC-Y, Poon RW-S, Tsoi H-W, Lo SK-F, Chan K-H, Poon VK-M, Chan W-M, Ip JD, Cai J-P, Cheng VC-C, Chen H, Hui CK-M, Yuen K-Y. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *Lancet (London, England)*. 2020:S0140-6736(0120)30154-30159.
5. Corman VM, Landt O, Kaiser M, Molenkamp R, Meijer A, Chu DK, Bleicker T, Brünink S, Schneider J, Schmidt ML, Mulders DG, Haagmans BL, van der Veer B, van den Brink S, Wijsman L, Goderski G, Romette J-L, Ellis J, Zambon M, Peiris M, Goossens H, Reusken C, Koopmans MP, Drosten C. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. *Eurosurveillance*. 2020;25:2000045.
6. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y, Wei Y, Xia Ja, Yu T, Zhang X, Zhang L. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet (London, England)*. 2020:S0140-6736(0120)30211-30217.
7. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z, Yu T, Xia J, Wei Y, Wu W, Xie X, Yin W, Li H, Liu M, Xiao Y, Gao H, Guo L, Xie J, Wang G, Jiang R, Gao Z, Jin Q, Wang J, Cao B. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. 2020.
8. Müller NL, Ooi GC, Khong PL, Zhou LJ, Tsang KWT, Nicolaou S. High-Resolution CT Findings of Severe Acute Respiratory Syndrome at Presentation and After Admission. *American Journal of Roentgenology*. 2004;182:39-44.
9. Goh JS, Tsou IY, Kaw GJ. Severe acute respiratory syndrome (SARS): imaging findings during the acute and recovery phases of disease. *J Thorac Imaging*. 2003;18:195-199.
10. Ajlan AM, Ahyad RA, Jamjoom LG, Alharthy A, Madani TA. Middle East respiratory syndrome coronavirus (MERS-CoV) infection: chest CT findings. *AJR Am J Roentgenol*. 2014;203:782-787.
11. Wong KT, Antonio GE, Hui DS, Lee N, Yuen EH, Wu A, Leung CB, Rainer TH, Cameron P, Chung SS, Sung JJ, Ahuja AT. Severe acute respiratory syndrome: radiographic appearances and pattern of progression in 138 patients. *Radiology*. 2003;228:401-406.

Figure legends

High-resolution CT manifestations of selected 4 cases with Corona Virus Disease 2019 (CORVID-19)

Case 1. 57-year-old male patient

1A, 1B. HRCT scan was performed on day of admission (8 days after the onset of illness). 1A shows a combined pattern of consolidations (blue arrow) and GGOs (yellow arrows) with air-bronchograms in both lobes. 1B shows areas of consolidation (blue arrow) in both lower lobes. 1C, 1D. Follow-up HRCT scan performed 10 days after admission (1C)(1D) show remission of abnormalities, with reduced extent and density of airspace opacification, GGOs (yellow arrows) and fibrosis (black arrow).

Case 2. 23-year-old male patient

2A, 2B. HRCT scan was performed on day of admission (16 hours after the onset of illness). (2A) (2B) show a subpleural distribution of GGOs (yellow arrows) in the middle and lower right lobe. 2C, 2D. Follow-up HRCT scans performed 3 days after admission (2C)(2D) show larger areas of mixed consolidations and GGOs (blue arrows) in the upper?? right lobe and both lower lobes.

Case 3. 50-year-old female

HRCT scan was performed on the day of admission (4 days after the onset of illness). (3A) (3B) show a subpleural distribution of GGOs (yellow arrow) and consolidations (blue arrows) in both lobes.

Case 4. 43-year-old female

HRCT scan was performed on day of admission (3 days after the onset of illness). (4A) (4B) show a subpleural distribution of GGOs (yellow arrow) in both lobes.

