Chest CT Findings of Coronavirus Disease 2019 (COVID-19)

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ABSTRACT

The aim of this study was to investigate the chest CT findings of coronavirus disease 2019 (COVID-19) from January to February 2020. CT features of six cases, confirmed by reverse transcription polymerase chain reaction (RT-PCR) with COVID-19 disease, were evaluated. Of the six patients, one patient had normal scan. One patient had ground glass opacity only, while the rest four patients mainly had ground glass opacity accompanied by consolidation. Moreover, air bronchogram, crazy paving and reversed halo sign could be seen in 5, 3 and 1 patient, respectively. Lesions in three patients were only located in the peripheral area, while of two patients, were mainly located in the peripheral area with involvement of the center along with bronchovascular bundles. While one patient had enlarged mediastinal nodes, no one had pleural effusion. CT can be used as the first choice for early diagnosis of COVID-19 pneumonia.

Key Words: Pneumonia, Lung CT scan, COVID-19, Coronavirus infection.

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patients, respectively. The lymphocyte count was normal in two patients, while decreased in four patients. The C-reactive protein was normal only in one patient, while increased in rest of five patients. The liver enzyme was normal in three patients, while increased in rest of three patients. The lactate dehydrogenase of all the six patients were increased.

Among the six patients, one patient showed no abnormal findings in chest CT imaging (Table I). One patient only had ground glass opacity (Figure 1A), while another four patients mainly had groundglass opacity accompanied by partial consolidation (Figure 1B and 1C). Moreover, air bronchogram without mucus plug could be seen in five patients (Figure 1A), one patient had reversed halo sign (Figure 1C), and three patients demonstrated crazy paving sign (Figure 1B-D). These lesions were located in the peripheral area under the pleura in three patients (Figure 1A-C), while mainly located in the peripheral area with involvement of the centre along bronchovascular bundles in two patients (Figure 1D-G). One patient had three lobes affected excepting right upper and middle lobe, while four patients had involvement of all the five lobes (Figure 1D-G). Only a single patient had single lesion within right upper lobe; whereas, the rest of the affected lobes demonstrated multiple lesions (Figure 1D-G). One patient had enlarged mediastinal nodes (Figure 1H); and no one had pleural effusion.

Table I: CT findings of six patients.

| Ground glass opacity and consolidation | Numbers (%) |
|---------------------------------------|-------------|
| Presence of ground glass opacity      | 1 (16.7%)   |
| Presence of ground glass opacity and consolidation | 4 (66.6%) |
| Reversed halo sign                     | 1 (16.7%)   |
| Crazy paving sign                      | 3 (50.0%)   |
| Air bronchogram                        | 5 (83.3%)   |
| Number of lobes involved               |             |
| Single lobe                           | 0 (0.0%)    |
| Two lobes                             | 0 (0.0%)    |
| Three lobes                           | 1 (16.7%)   |
| Four lobes                            | 0 (0.0%)    |
| Five lobes                            | 4 (66.6%)   |
| Frequency and lesions of lobe involvement |             |
| Right upper lobe                       | 4 (66.6%)   |
| Single lesion                         | 1 (16.7%)   |
| Multiple lesions                      | 3 (50.0%)   |
| Right middle lobe (multiple lesions)  | 4 (66.6%)   |
| Right lower lobe (multiple lesions)   | 5 (83.3%)   |
| Left upper lobe (multiple lesions)    | 5 (83.3%)   |
| Left lower lobe (multiple lesions)    | 5 (83.3%)   |
| Distribution                           |             |
| Peripheral                             | 3 (50.0%)   |
| Peripheral involving central          | 2 (33.3%)   |
| Other features                         |             |
| Enlarged mediastinal nodes             | 1 (16.7%)   |
| Pleural effusion                       | 0 (0.0%)    |
| Normal scan                            | 1 (16.7%)   |

From December 2019, the outbreak of an epidemic pneumonia in Wuhan, China, was ultimately found to be caused by a new BetaCoronavirus named as COVID-19 by the World Health Organization. This is the new member of large RNA coronavirus family that includes severe acute respiratory syndrome coronavirus (SARS-CoV), Middle-East respiratory syndrome coronavirus (MERS-CoV), and whose genome sequence is 85% similar to SARS-CoV, both can cause severe respiratory syndrome in humans. Therefore, early detection and diagnosis of COVID-19 is vital for disease treatment and control. Owing to its high sensitivity and convenience, chest CT imaging has become the primary tool for diagnosis of COVID-19 as compared with initial RT-PCR from swab samples because of limitations of sample collection and transportation and kit performance. Thus, in this study, six confirmed patients were searched to analyse CT features to detect and diagnose at early age for determining hospitalization and isolation.

Figure 1: Chest CT abnormal findings of the enrolled patients with COVID-19.

A: Multiple ground glass opacities with air bronchogram (short white arrows) distributed along peripheral subpleural regions; B, C: Crazy paving sign manifested by bilateral lower lobes ground glass opacities and interlobular septal thickening (long white arrows) accompanied by partial consolidation (long black arrows); C: Ground glass opacity with reversed halo sign (short white arrow) in the subpleural area of left lower lobe; D: Multiple ground glass opacities with crazy paving sign distributed along peripheral subpleural regions (long white arrows) and involvement of the center along bronchovascular bundles (short white arrows); E-G: Multiple ground glass opacities accompanied by partial consolidation diffused in the bilateral lobes; H: Mediastinal window demonstrated enlarged mediastinal nodes (short white arrows).

There were reports on CT imaging of COVID-19 in the past several months. CT findings overlapped with other viral pneumonia such as SARS, MERS etc. Nevertheless, COVID-19 still has its characteristic CT features. In this study, only one patient had three lobes including bilateral lower lobes affected, while four patients had all lobes affected. Furthermore, multiple lesions were demonstrated in all involved lobes except single lesion in a right upper lobe. Meanwhile, lesions distributed peripheral area under the pleura, and two patients involved the centre along bronchovascular bundles, but lesions still mainly located in the peripheral area. The physiopathological mechanism for above-mentioned imaging characteristics is still unsure. However, it is speculated that the release storm of inflammatory cellular cytokines plays a vital role in the COVID-19, and the diameter of lower lobe bronchus is relatively larger than that of upper and middle lobe. Moreover, the Coronavirus’s targeted cell may locate in the epithelium of respiratory bronchiole and pulmonary alveoli. In this study, ground glass opacity in five patients and accompanied by partial consolidation in four patients were observed. These five patients came to the hospital at early...
stage of COVID-19, when different degree of diffuse pulmonary alveoli injury with hyaline membrane formation, but little of exudation and edema in pulmonary alveoli. Partial consolidation could be seen in the center of some ground glass opacity resulted from the increase of inflammatory exudation in pulmonary alveoli. Then, with the progression of pulmonary interstitial infection and thickening, crazy-paving sign revealed in three patients. Fibrous stripe was rare in these six patients because they were all at the early stage of COVID-19, which often demonstrated at the recovery stage except combined with other primary pulmonary diseases. Air bronchogram without mucus plug seen in five patients could account for the symptom of nonproductive cough.

When the viruses invaded the lymphatic system, the mediastinal node enlarged through the pulmonary lymphatic drainage. Thus, one patient had enlarged mediastinal nodes. One patient had no abnormal findings in chest CT in the study, it is speculated that COVID-19 has an incubation period of 1-14 days, and symptoms occur prior to the imaging manifestations.

CT features of viral pneumonia have been well known. However, the features overlap among various viral organisms. COVID-19 should be differentiated from other viral pneumonia such as SARS, MERS, influenza virus, adenovirus etc. Especially for SARS and MERS, they have many similar CT features to COVID-19 because the causative viruses belong to the same family. Nevertheless, definite epidemical exposure history is vital for COVID-19. Meanwhile, COVID-19 should also be differentiated from other microorganisms including bacteria, chlamydia and mycoplasma.

In summary, CT findings of COVID-19 are mostly multiple ground glass opacities in the bilateral peripheral subpleural areas or involvement of center along bronchovascular bundles accompanied by partial consolidation, air bronchogram, reversed halo and crazy paving sign as reported by others. The presence of enlarged mediastinal nodes is an unusual finding.

ETHICAL APPROVAL:
The study was conducted after obtaining approval from the Hospital Ethical Committee.

CONFLICT OF INTEREST:
Authors declared no conflict of interest.

AUTHORS’ CONTRIBUTION:
WC, GF: Designed the study, interpreted data and drafted the manuscript.
JY, RL: Collected data and edited the manuscript.
BZ, LX: Analysed CT images and revised critically the manuscript.

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