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Case Report

Dynamic Chest CT Evaluation in Three Cases of 2019 Novel Coronavirus Pneumonia

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Abstract

A recent outbreak of pneumonia in Wuhan, China, was caused by the 2019 novel coronavirus (2019-nCoV). There have been some reports of imaging findings regarding the disease's characteristic features. Here, we report three cases of coronavirus disease 2019 (COVID-19) with dynamic pulmonary CT evaluation. The CT scan showed multiple regions of ground-glass opacities and patchy consolidation in COVID-19 patients and the CT scan was useful in tracking the progression or regression of COVID-19.

Keywords: 2019-Novel coronavirus pneumonia, Clinical characteristics, Coronavirus disease 2019, Dynamic evaluation, Chest computed tomography

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Introduction

In late 2019, a cluster of pneumonia occurred in Wuhan, Hubei Province, China, now known as the 2019 novel coronavirus (COVID-19), which has rapidly spread from Wuhan to other provinces of China and become a worldwide epidemic.[1,2] It is more likely to affect the elder with comorbidities. The most common clinical symptoms of the 2019-nCoV patients include fever, dry cough, myalgia, fatigue and dyspnea. Pulmonary computed tomography (CT) scan is a key diagnostic approach for patients suspected of COVID-19 at the early stage.[3] Furthermore, dynamic evaluation on chest CT can not only assess the patients' condition, but also guide appropriate treatment. Here, we report chest CT of three patients diagnosed with COVID-19 in Shaoxing People's Hospital, Shaoxing, China. The study was approved by the Institutional Ethics Board of Shaoxing People's Hospital, and consent was obtained from all patients.

Case Report

Case 1

A 31-year-old male with fever, cough and expectoration was admitted to the fever clinic of Shaoxing People's Hospital. He had a recent trip to Wuhan, and returned to Shaoxing, Zhejiang province, six days before hospital admission. The patient had a medical history of hypertension for three years. Physical examination was normal except for a fever of 38.4°C. Laboratory investigation demonstrated normal leukocyte count (3.9*10^9/L) and normal D-dimer concentration, reduced lymphocytes (0.98*10^9/L), elevated alanine transaminase (57.5U/L), and increased lactate dehydrogenase (256.2 U/L). Real-time fluorescence polymerase chain reaction (PCR) with the patient's sputum sample returned positive for the 2019-nCoV nucleic acid. Unenhanced chest CT showed patchy consolidation in left lower lobe and ground glass opacities (GGO) in right lower lobe of the subpleural area (Figure 1A). Neither pleural effusion nor lymphadenopathy was detected. The patient initially received antiviral therapy, antibiotics and febrifuge, which did not alleviate his symptoms. The follow-up chest CT scan, performed three days after the first scan, showed distribution of bilateral and multiple consolidation, progressive ground glass opacities, fibrous stripes, indicating enlarged lesions compared to the first CT scan (Figure 1B1-2). The patient was subsequently given respiratory support with high-flow nasal cannula (HFNC) and intravenous methylprednisolone (40 mg bid) to inhibit a cytokine storm and promote absorption of pulmonary infiltration. After five days of adjusted treatment, the patient's temperature became normal and the cough symptom was relieved. Chest CT scan revealed that consolidation and GGO had been absorbed, whereas punctate nodules and small area of fibrous stripes were still present (Figure 1C1-2).

Case 2

A 67-year-old female with fever, dry cough, myalgia and fatigue was admitted to the Shaoxing People's Hospital.

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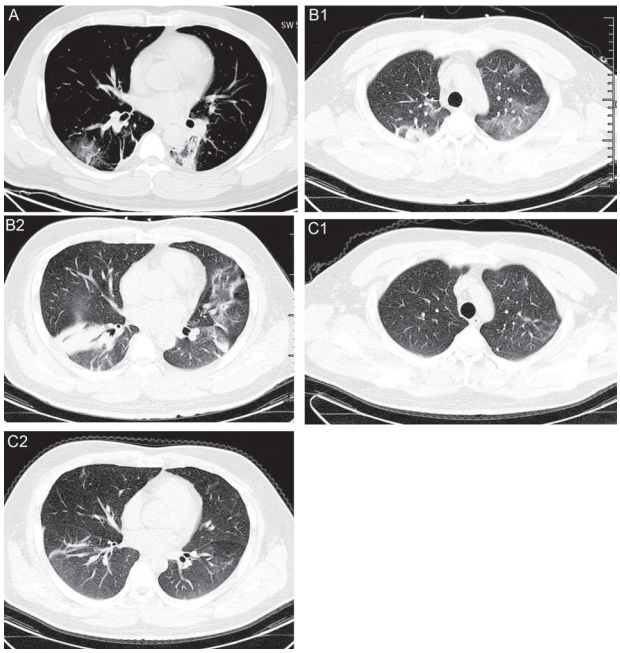

Figure 1. (A) Unenhanced chest CT showing patchy consolidation in the left lower lobe and a small region of subpleural ground glass opacity in the right lower lobe. **(B1-2)** Follow-up chest CT three days after initial treatment showing bilateral, multiple, enlarged consolidation and ground glass opacities compared with initial CT scan. **(C1-2)** Dynamic evaluation of chest CT five days after adjusted treatment showing that the lesions are almost absorbed.

She had a recent business trip to Wuhan, and had a history of good health without underlying diseases. On admission, her body temperature was 38.5°C and laboratory examination showed normal leukocyte count (3.9*10^9/L), lymphocytopenia (0.74*10^9/L), decreased platelets (88*10^9/L), moderately increased high-sensitivity C-reactive protein (57.56 mg/L), and mildly elevated lactate dehydrogenase (287.3 U/L). Arterial blood gas (ABG) analysis showed hypooxygenemia (PaO_2: 65 mm Hg) and normal $PaCO_2$. A definitive diagnosis of COVID-19 was made based on real-time fluorescence PCR. As shown in Figure 2, unenhanced chest CT scan showed multiple, bilateral, patchy, ground glass opacities with paving pattern (Figure 2A). Antiviral (Abidore) did not help to lower the patient's temperature or ease her breathing. Repeated chest CT performed four days later demonstrated multiple, enlarged consolidation, ground glass nodules, and ground glass nodules adjacent to the pleura (Figure 2B). The patient then received intravenous administration of methylprednisolone (40 mg qd), oral administration of γ-immunoglobulin and traditional Chinese medicine, and non-invasive positive pressure ventilation (NIPPV). Dynamic CT scan showed patchy consolidation and partly absorbed nodules, indicating the symptoms were relieved (Figure 2C).

Case 3

A 59-year-old male with high fever, fatigue and nausea

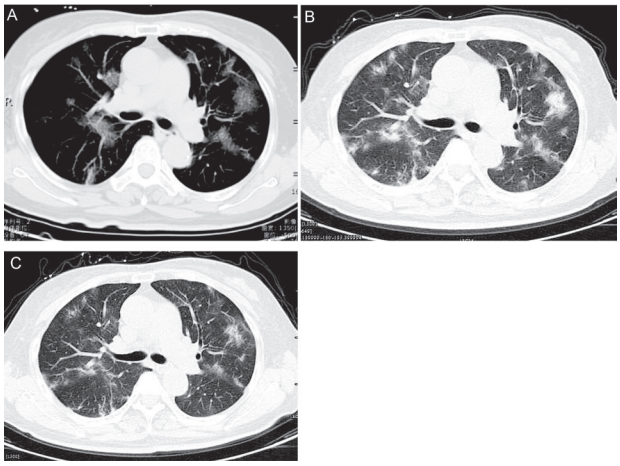

Figure 2. (A) Unenhanced chest CT showing bilateral patchy pure ground glass opacities. **(B)** Follow-up chest CT scan four days after initial treatment showing increased lesions, mixed ground glass opacities, ground glass nodules and local consolidation. **(C)** Dynamic chest CT scan five days after adjusted treatment showing patchy consolidation and nodule partly absorbed.

was admitted to the fever clinic of Shaoxing People's Hospital. He had not recently visited Wuhan, but had close contact with his wife who returned from Wuhan five days before his hospital admission; his wife was diagnosed with COVID-19. The man had a medical history of well-controlled diabetes mellitus. On admission, his highest temperature was 39.1°C, and his respiratory rate was 24 breaths per minute. Laboratory investigation showed normal leukocyte count (3.95*10^9/L), lymphocytopenia (0.91*10^9/L), mildly increased high-sensitivity C-reactive protein (57.56 mg/L), and increased erythrocyte sedimentation rate (26 mm/h). The 2019-nCoV was detected in his throat by real-time fluorescence PCR. Unenhanced chest CT revealed ground glass nodules in the right upper lobe and a region of patchy consolidation in the left lower lobe with subpleural distribution (Figure 3A1-2). After four days of treatment, repeated chest CT scan showed multiple, bilateral, diffusely enlarged subpleural ground glass opacity with interlobular septal thickening, crazy-paving pattern and local consolidation (Figure 3B1-2). His symptoms were not alleviated and he was short of breath. The patient was subsequently given intravenous methylprednisolone (40 mg bid), traditional Chinese medicine and NIPPV. Five days later, dynamic evaluation of chest CT showed that the lesions were partly absorbed with a region of remaining fibrous stripes and multiple local consolidations (Figure 3C1-2).

Discussion

The COVID-19 presents a major threat to public health. The deadly strain of coronavirus has now spread to almost every part of China, and thousands of cases have been confirmed in other countries.[4-6] As of March 3, 2020, a total of 78,631 people have been diagnosed with COVID-19

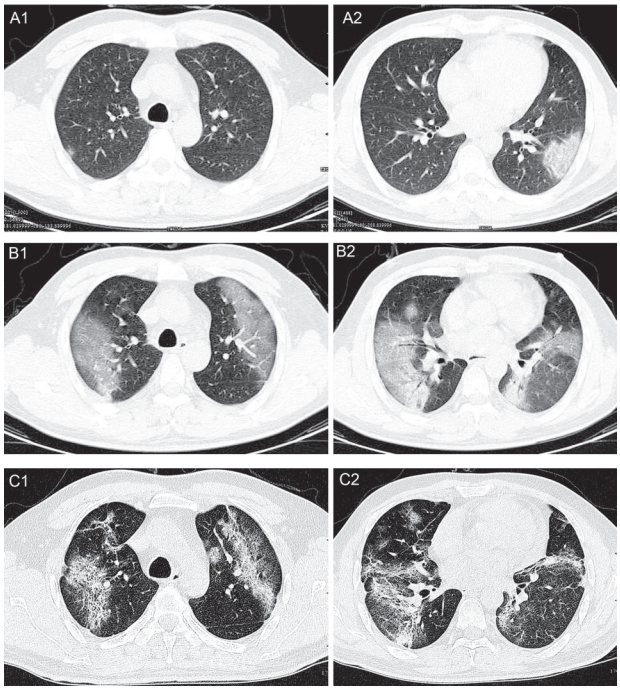

Figure 3. (A1-2) Unenhanced chest CT scan revealing a ground glass nodule in the right upper lobe and a region of patchy consolidation in the left lower lobe with subpleural distribution. **(B1-2)** Repeated chest CT four days after baseline chest CT showing multiple, bilateral, diffusely subpleurally distributed enlarged ground glass opacity with interlobular septal thickening and crazy-paving pattern, local consolidation of both lower lobes. **(C1-2)** Dynamic evaluation of chest CT five days after adjusted treatment showing the lesions partly absorbed with a region of fibrous stripes and multiple local consolidations remaining.

in China, among which 10 892 were severe cases, 2747 expired, and 32 920 were cured. Shaoxing, a city in Zhejiang province, also suffered from this pandemic. We report three cases with laboratory-confirmed COVID-19 admitted to our hospital. To our knowledge, only a few case series have been described in terms of the time course of lung changes using chest CT scan. The purpose of this study is to present dynamic evaluating on chest CT in the course of treatment. The clinical feature and laboratory findings of the patients are also described.

The source of COVID-19 was thought to be Chinese horseshoe bat, as the 2019-nCoV is 96% identical at the whole genome level to a bat coronavirus.[7] The transmission of the 2019-nCoV was thought to be mainly via droplets but may occur through direct and indirect contact.[8] The patient in Case 3 had not recently visited Wuhan, and it is very likely that he acquired COVID-19 through his wife who had recently returned from Wuhan. Similar to other reports, the most common symptoms of our cases were mild or moderate fever, dry cough, sputum, fatigue and myalgia. Less common symptoms were nausea, dyspnea and diarrhea.[9-10] The COVID-19 patients might be asymptomatic and easily misdiagnosed, and thus become an underlying source of infection.[11]

According to the laboratory findings, all three patients showed lymphocytopenia and mildly increased high-sensitivity C-reactive protein (CRP), which is consistent with viral infection. Procalcitonin (PCT) may rise secondary to bacterial sepsis. Furthermore, Huang et al[11] showed that increased amounts of cytokines (IL1B,IFNγ and IP10) in serum might activate Th1 cell response, which in turn leads to inflammation infiltration. Therefore, corticosteroids were initially used to treat patients with severe inflammation. Recent studies have found that compared to less-severe patients over 50 years of age, severe patients had higher neutrophil-to-lymphocyte ratio, predicting a poor prognosis in the early stage.

Chest CT scan is recommended to detect and track COVID-19, and chest radiography is not sensitive to minute lesions in the early stage of infection.[12,13] By now, a few studies have reported the chest CT features of COVID-19. Typical chest CT images demonstrate multiple, bilateral, ground glass opacity with patchy consolidation peripherally with subpleural distribution. Chest CT also shows slight thickening of adjacent pleura. Lung cavitation, pleural effusion and lymphadenopathy are rarely observed.[13] However, pathological features are the basis of these CT imaging changes. So far, there are only two reports on the pathological features of COVID-19. The 2019-nCoV is similar to SARS and MERS and its pathological changes are mainly targeted to both lungs, resulting in diffuse damage, edema, and transparent membrane formation of the lungs after invasion, presenting viral pneumonia changes mainly characterized by inflammatory cell infiltration dominated by mononuclear macrophages and lymphocyte exudation and alveolar epithelial damage. In the early stage, pulmonary edema, protein exudation, lung interstitial thickening, and infiltration of multinucleated giant cells and macrophages in alveolar cavity were observed, but the formation of transparent membrane was not obvious. Diffuse alveolar injury in both end-stage lungs accompanied by fibromyxoid exudate, pulmonary edema, exfoliation of alveolar epithelial cells, formation of transparent membrane, infiltration of lymphocytic interstitial inflammatory cells, viral cell changes characterized by macronucleus, amphiphilic granular cytoplasm and prominent nucleoli, and polynuclear giant cells in alveoli could be found.[14,15]

In the course of COVID-19, the lesion in the lung might be enlarged and the contralateral lung might be involved. By then, the patients may present with more severe symptoms such as continuous fever with high temperature, breathlessness, and hypoxia. As we present here, the patients' conditions deteriorated after the initial treatment, and dynamic evaluation of chest CT scan showed enlarged lesion compared to the initial CT scan. Pan et al[16] showed negative findings on CT scan at early stage while repeated chest CT found abnormalities in the lung. They reported that rapid growth of ground glass opacity, greater consolidation and increased pleural effusion indicated disease progression. Wu et al[17] reviewed chest

CT and clinical data of 80 confirmed patients and found that there is significant correlation between pulmonary inflammation, clinical symptoms, and laboratory tests. So, we would recommend dynamic evaluation of chest CT if COVID-19 is suspected or diagnosed.

In conclusion, the clinical manifestations of COVID-19 are nonspecific. Chest CT scan is the major diagnostic approach for COVID-19 and its feature includes multiple, bilateral, patchy consolidation and ground glass opacity with subpleural distribution. Dynamic observation of chest CT could help prompt diagnosis, assess patients' condition, monitor disease progression and adjust therapeutic strategy.

Authors' Contribution

XC and YC proposed the concept of the work. JuS and CZ designed the experiment and supervised all aspects of the work. SL and GP equally participated in data acquisitions and analysis. All authors contributed to writing the manuscript. JiS, XC and YC provided critical reviews in order to promote the manuscript. All authors read and approved the final manuscript.

Conflict of Interest Disclosures

The authors declare that they have no conflict of interest.

Ethical Statement

Informed consent was obtained from all the participants prior to enrolment. The study was approved by the Institutional Ethics Board of Shaoxing People's Hospital.

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