Imaging and Clinical Features of Patients with 2019 Novel Coronavirus SARS-CoV-2

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Abstract

Coronavirus disease 2019 (COVID-19) outbreak, first reported in Wuhan, China, has rapidly swept around the world just within a month, causing global public health emergency. In diagnosis, Chest CT examination plays an important role in the initial diagnosis of the novel coronavirus pneumonia. Multiple patchy ground glass opacities in bilateral multiple lobular with periphery distribution are typical chest CT imaging features of the COVID-19 pneumonia. chest computed tomography (CT) manifestations can supplement parts of limitations of real-time reverse transcription polymerase chain reaction (RT-PCR) assay. we aim to review the typical and relatively atypical CT manifestations with representative COVID-19 cases at our hospital, and hope to strengthen the recognition of these features with radiologists and help them make a quick and accurate diagnosis.

Keywords

Coronavirus Infections; Imaging Features; Computed Tomography.

1. Introduction

Coronavirus disease 2019 (COVID-19) is a major threat to the health of people worldwide. According to the diagnosis and treatment guidelines proposed by the National Health Committee of the People's Republic of China (7th Edition)[1], As of February 10, 2020, a total of 40,265 confirmed cases have been reported in China, with another 23,589 suspected cases, 909 fatal cases, and 3501 discharged patients. Moreover, more than 300 similar cases have been identified in other 24 countries. On December 30, 2019, WHO announced the event constituted a Public Health Emergency of International Concern (PHEIC), indicating that a big threat to global health has been posed by the novel coronavirus infections[2].

Chest computed tomography (CT) can intuitively demonstrate the lung lesions and its manifestations of COVID-19 pneumonia have been reported in many studies[3].Chest CT exams are useful in supplementary diagnosis of RT-PCR tests[4],evaluating disease stages and severity[5-7].

Chest CT plays an important role in timely detecting lung abnormalities, allowing for early treatment[8]. We aimed at describing clinical and CT imaging characteristics of 30 patients with SARS-CoV-2 infection and follow-up appearances of patients. We hope our findings will provide useful information for medical imagers to recognize the COVID-19 pneumonia and assess its evolution.

2. Materials and methods

2.1 Patients

The study was approved by our local institutional review board (IRB). Informed consent was waived because of the retrospective nature of the study and the use of anonymous clinical data.

Data were extracted from an institutional prospectively maintained database, including consecutive patients admitted to our Emergency Department, from January 21, 2020, to March 20, 2020. The clinical data analyzed were as follows: age, sex, exposure history, comorbid conditions, symptoms, and laboratory results.

2.2 Image acquisition and analysis

All included patients underwent baseline chest non-contrast enhanced CT in a designated hospital (Guizhou Provincial People's Hospital). An Optima CT680 scanner (GE Medical Systems, Milwaukee, WI) was used and set at 210 mA and 120 kV, with the minimum slice thickness of 1 mm. All images were analyzed by two senior chest radiologists with 15–20 years of experience, in a consistent manner. Image analysis, focused on the lesion features of each patient, included(a) multiple lobe involvement, (b) peripheral or perihilar distribution, (c) upper or lower zone distribution, (d) ground glass opacities (GGO) more than 50% of lung pattern (including crazy paving), (e) consolidation more than 50% of lung pattern, (f) solid nodules, (g) presence of cavitation, (h) ring halo sign, (i) lymphadenopathy (defined as lymph node with short axis > 10 mm), (l) pleural and (m) pericardial effusion. The alterations caused by underlying lung diseases (such as tuberculosis, lung cancer) were not included in this study. Thirty patients underwent a second chest CT after 1–5 days (mean 3.5 days). These images were evaluated for lesions' evolution by two senior radiologists, in a consistent manner. Changes in lung lesions were divided as no change, disease resolution, and disease progression.

2.3 Statistical analysis

Statistical analysis was performed using MATLAB version 2019 b (The Mathworks Inc, USA).

Table 1. Patient charactristics and laboratory results

	Patients(n=30)
Patient demographics	
Median age,years(range)	45(18-72)
Men	20(66.6%)
Women	10(33.3%)
Exposure history	
Exposure to Wuhan or infected patient	26(86.7%)
Unknown exposure	4(13.3%)
Comorbid conditions	
Hypertension	13(43.3%)
Diabetes	8(26.7%)
Cardiovascular disease	3(10.0%)
Chronic obstructive pulmonary disease	2(6.7%)
Tuberculosis	4(13.3%)
Malignancy	2(6.7%)
Others	17(56.7%)
Symptoms and signs	
Fever	26(86.7%)
Cough	21(70.0%)
Dyspnea	12(40%)
Fatigue weakness	10(33.3%)
Myalgia	8(26.7%)
Sore throat	9(30.0%)
Chills	7(23.3%)
Headache	4(13.4%)
Nausea	6(20.0%)
Vomit	7(23.3%)
Diarrhea	5(16.7%)
No obvious symptoms	6(20.0%)
Laboratory test	
C-reactive protein (mg/L; normal range 0–10)	
Increased	16(53.5%)
Decreased	0(0%)
Normal	15(50.0%)
Leucocytes ($\times 10^9$/L, normal range 3.5–9.5)	
Increased	3(10.0%)
Decreased	12(40.0%)
Normal	15(50.0%)
Positive for (SARS-CoV-2) nucleic acid test by Real-time PCR	30(100%)

3. Results

This study included 30 patients (20 men and 10 women; median age, 45 years (age range, 18–72 years). summarizes patients' clinical characteristics. Most patients had a history of exposure in Wuhan or to infected patients; exposure history was unknown in 4 (13.3%) patients. The majority of patients presented with fever and cough. Half of the patients hold comorbidities. Thirty-eight (53.5%) patients showed elevated C-reactive protein. Patients with decreased white blood cells were more than those with increased white blood cells. see Table 1.

Baseline chest CT showed abnormalities in 30 patients, and 17 (56.7%) patients had more than two lobes involved. More than half of the patients presented bilateral, multifocal lung lesions, with peripheral distribution. Lesions were inclined to distribute in the lower lobes. Of the 30 patients included, 11 (36.7%) had ground glass opacification, 6 (20%) had consolidation, and 9 (30%) patients presented with crazy paving pattern. Thirty-three (36.7%) patients had interlobular thickening, 12(40.0%) had combined linear opacities, 5(16.7%) showed air bronchogram sign, and 9(30%) presented adjacent pleura thickening. Pleural effusion, pericardial effusion, cavitation, thoracic lymphadenopathy, and pulmonary emphysema were uncommon imaging findings in these patients. see Table 2.

Table 2. Imaging findings of patients with SARS-CoV-2 at presentation

	Patients(n=30)
Distribution	
Periphery distribution	9(30.0%)
Bilateral involvement	13(43.4%)
Multifocal involvement	8(26.7%)
Particular sizes of lobes involved	
1	5(16.7%)
2	8(26.7%)
>3	17(56.7%)
Lobe of lesion distribution	
Left upper lobe	8(26.7%)
Left lower lobe	12(40.0%)
Right upper lobe	11(36.7%)
Right middle lobe	14(46.7%)
Right lower lobe	12(40.0%)
Bilateral upper lobes	9(30.0%)
Bilateral lower lobes	14(46.7%)
Patterns of the lesion	
Ground glass opacification	11(36.7%)
Consolidation	6(20.0%)
Crazy paving pattern	9(30.0%)
Cavitation	0(0%)
Other signs in the lesion	
Interlobular septal thickening	11(36.7%)
Linear opacities combined	12(40.0%)
Air bronchogram sign	5(16.7%)
Other findings	
Adjacent pleura thickening	9(30.0%)
Pleural effusion	2(6.7%)
Pericardial effusion	1(3.3%)
Lymphadenopathy	3(10.0%)
Pulmonary emphysema	1(3.3%)

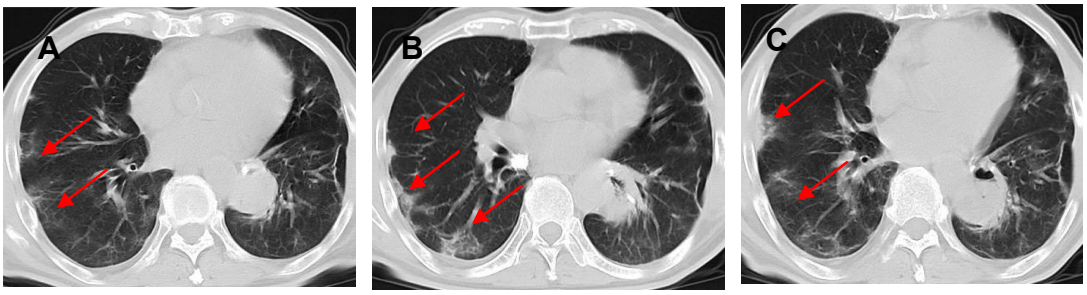

Fig. 1 A, male, 46 years old with fever and cough for 6 days. Axial chest CT shows chest CT showed multiple peripheral patchy ground glass opacities in bilateral multiple lobular and subsegmental with obscure boundary, B After 4 days, the follow-up CT scan showed enlarged lesions and increased density of the lesions compared with previous images, indicating disease progression (red arrows),C After 7 days, chest CT showed lesions absorption and disease resolution.

Fig. 2 A, female, 55 years old, with fever and cough for 7 days. Axial chest CT shows small bilateral areas of peripheral GGO with minimal consolidation; B After 5 days, the follow-up CT scan showed enlarged lesions and increased consolidation (red arrows),C After 6 days, chest CT showed lesions absorption and disease resolution.

4. Discussion

Infected patients predominantly presented with fever and cough. Notably, some patients (7%) were asymptomatic. These findings indicated that the absence of clinical symptoms cannot rule out the diagnosis of infection. Persons with a clear history of exposure to SARS-CoV-2, regardless of clinical symptoms, should be considered for medical observation, home isolation, and further examination. Similarly, patients with symptoms without a known history of exposure should undergo further examinations. Early recognition and isolation of COVID-19 patients is of crucial importance in controlling this outbreak, especially in those with false negative RT-PCR or without symptoms. Although bilateral GGO and consolidation were reported as the predominant imaging characteristics in COVID-19, chest CT manifestations can vary in different patients and stages[9]. In this paper, Our study showed some common CT imaging features in patients affected by SARS-CoV-2 pneumonia: bilateral, multifocal ground glass opacities, with peripheral distribution. Of note, more than half of the patients had multilobar involvement and lesions were more frequent in the lower lobes. Pleural effusion, pericardial effusion, cavitation, thoracic lymphadenopathy, and pulmonary emphysema were uncommon imaging findings in these patients. Imaging features of viruses' infections usually appear as multifocal ground glass opacities. In our study, the majority of patients showed multifocal involvement in the initial chest CT scan, and this finding is consistent with a recent report[10]. Since there is an incubation period after infection with the SARS-CoV-2 [11], a patient may not present any symptoms and imaging abnormalities during this period[12]. Few patients initially negative for SARS-CoV-2 nucleic acid test had bilateral ground glass opacities in chest CT scans[13]. After a few days, patients converted to positive for SARS-CoV-2 nucleic acid test by real-time PCR[14,15]. This points out that patient's history, clinical manifestations, imaging characteristics, and laboratory tests are all important elements in the diagnosis of the disease.

Our study had some limitations. First of all, we cannot demonstrate any prognostic role for chest CT, because we did not find any correlation between imaging and the course of the disease. Also, 30 patients with short-term follow-up chest CT showed disease progression. The imaging evaluation of disease progression is not complete, and we will collect more follow-up CT data to observe the evolution and outcome of the disease and provide more imaging information to be correlated with clinical findings.

5. Conclusion

Chest CT detects minor lung lesions in patients at an early stage of disease, demonstrating its utility in guiding the diagnosis. In a patient with a history of close contact with a SARS- CoV-2-infected patient, early manifestation of bilateral, multifocal, and peripheral ground glass opacities on a chest CT scan might be a sign of a 2019 novel coronavirus infection. Thus, chest CT is suggested as an important tool for SARS- CoV-2 infection diagnosis.

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References

[1] Liu, J. et al. Overlapping and discrete aspects of the pathology and pathogenesis of the emerging human pathogenic coronaviruses SARS-CoV, MERS-CoV, and 2019-nCoV. J Med Virol 92, 491-494, doi:10.1002/jmv.25709 (2020).

[2] Song, P. & Karako, T. COVID-19: Real-time dissemination of scientific information to fight a public health emergency of international concern. Biosci Trends 14, 1-2, doi:10.5582/ bst.2020. 01056 (2020).

[3] Kassem, M. N. E. & Masallat, D. T. Clinical Application of Chest Computed Tomography (CT) in Detection and Characterization of Coronavirus (Covid-19) Pneumonia in Adults. J Digit Imaging, 1-11, doi:10.1007/s10278-021-00426-5 (2021).

[4] Ai, T. et al. Correlation of Chest CT and RT-PCR Testing for Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. Radiology 296, E32-e40, doi:10.1148/ radiol. 2020200642 (2020).

[5] Francone, M. et al. Chest CT score in COVID-19 patients: correlation with disease severity and short-term prognosis. Eur Radiol 30, 6808-6817, doi:10.1007/s00330-020-07033-y (2020).

[6] Pan, F. et al. Time Course of Lung Changes at Chest CT during Recovery from Coronavirus Disease 2019 (COVID-19). Radiology 295, 715-721, doi:10.1148/radiol.2020200370 (2020).

[7] Xiong, Y. et al. Clinical and High-Resolution CT Features of the COVID-19 Infection: Comparison of the Initial and Follow-up Changes. Invest Radiol 55, 332-339, doi:10.1097/ rli. 0000000000000674 (2020).

[8] Claessens, Y. E. et al. Early Chest Computed Tomography Scan to Assist Diagnosis and Guide Treatment Decision for Suspected Community-acquired Pneumonia. Am J Respir Crit Care Med 192, 974-982, doi:10.1164/rccm.201501-0017OC (2015).

[9] Niu, R. et al. Chest CT features associated with the clinical characteristics of patients with COVID-19 pneumonia. Ann Med 53, 169-180, doi:10.1080/07853890.2020.1851044 (2021).

[10] Xu, X. et al. Imaging and clinical features of patients with 2019 novel coronavirus SARS-CoV-2. Eur J Nucl Med Mol Imaging 47, 1275-1280, doi:10.1007/s00259-020-04735-9 (2020).

[11] Heymann, D. L. Data sharing and outbreaks: best practice exemplified. Lancet 395, 469-470, doi:10.1016/ s0140-6736(20)30184-7 (2020).

[12] Harrison, A. G., Lin, T. & Wang, P. Mechanisms of SARS-CoV-2 Transmission and Pathogenesis. Trends Immunol 41, 1100-1115, doi:10.1016/j.it.2020.10.004 (2020).

[13] Salehi, S., Abedi, A., Balakrishnan, S. & Gholamrezanezhad, A. Coronavirus Disease 2019 (COVID-19): A Systematic Review of Imaging Findings in 919 Patients. AJR Am J Roentgenol 215, 87-93, doi:10.2214/ajr.20.23034 (2020).

[14] Li, D., Zhang, J. & Li, J. Primer design for quantitative real-time PCR for the emerging Coronavirus SARS-CoV-2. Theranostics 10, 7150-7162, doi:10.7150/thno.47649 (2020).

[15] Chaimayo, C. et al. Rapid SARS-CoV-2 antigen detection assay in comparison with real-time RT-PCR assay for laboratory diagnosis of COVID-19 in Thailand. Virol J 17, 177, doi:10.1186/s12985-020-01452-5 (2020).