Chest CT changes in COVID-19 patients with hypertension comorbidities

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Research Article

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Abstract

AIM

To summarize the chest CT and clinical features of COVID-19 pneumonia patients with hypertension comorbidities.

METHODS

The initial chest CT imaging and clinical data of 15 confirmed COVID-19 patients with hypertension comorbidities treated in our hospital were analyzed retrospectively from January 1, 2019 to February 14, 2020. The chest CT images and clinical data were reviewed and their relationship of the disease was analyzed.

RESULTS

Totally 15 COVID-19 patients diagnosed with hypertension comorbidities were included. In terms of clinical characteristics, 14/15 (93.3%) of patients had characteristics of clustering onset, and the positive rates of the first RT-PCR test and the initial CT were 80% and 93% respectively. The most frequent CT abnormality observed was ground glass opacity (GGO) (13/15, 86.7%), including patchy/ punctate GGO and large/multiple GGO. Most of the lesions were multiple, and 60% of them involved 4-5 lobes. Most patients present with bilateral CT onset (12,80.0%), and most present with subpleural distribution (10,66.7%). The average CT score is 13.7, and 40% of the patients exceeded 20 points.

CONCLUSION

The common chest CT findings in COVID-19 patients with hypertension comorbidities are GGO, most of which at present with bilateral CT onset and subpleural distribution. CT is indispensable in the diagnosis and evaluation of this global health emergency.

Introduction

Since the end of 2019, many cases of pneumonia associated with a novel coronavirus have been reported and it was named the 2019 novel coronavirus (2019-nCoV) initially[1]. Shortly, the World Health Organization (WHO) announced that the official name of the disease caused by the coronavirus is COVID-19 on February 12, 2020[2]. As of May 6, 2020, nearly 3.6 million cases of this infectious disease have been confirmed in more than 200 countries and regions[3]. As the number of cases continued to increase, this epidemic has become a global health emergency[4]. Some of these patients were also complicated by diseases other than COVID-19 pneumonia, such as COPD, hypertension, diabetes, and so on[5, 6]. These comorbidities may affect lung inflammation in these patients. Chest CT scan is a fast and effective way for the diagnosis of pneumonia[7, 8]. The typical radiographic imaging of COVID-19 pneumonia is ground-glass opacities, crazy paving, consolidation, irregular solid nodules and fibrous stripes[9-13]. Although previous studies have reported on COVID-19 pneumonia comorbidities, there was

no systematic description of the imaging performance of these patients. As a designated hospital for COVID-19 pneumonia, all 103 patients have been discharged except one died, including 5 imported cases. A total of 15 confirmed patients with COVID-19 pneumonia were included in the study, and they all had complications of hypertension. The clinical symptoms and pulmonary CT imaging features of them were analyzed and summarized, in order to better understand the early clinical symptoms and CT imaging findings of patients accompanied by hypertension.

Materials And Methods

Patients

Our institutional review board approved this retrospective study. Informed consent was waived as the study involved no potential risk to patients. The work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments. A total of 15 patients with hypertension comorbidities were confirmed from January 1, 2019 to February 2 2020. Their diagnosis criteria of COVID-19 infection were confirmed with a positive result to real-time polymerase chain reaction (RT-PCR) detection of SARS-CoV-2 nucleic acid with nasopharyngeal or oropharyngeal swab specimens. All these patients have an epidemiological history or corresponding clinical manifestations.

Image Acquisition

To avoid cross infection between patients and improve the convenience of clinical examination, all patients were scanned on 3 different machines according to the clinical requirements and the condition of the patient. The machine models were PET-CT uMI780, uCT 760, and KAIPU CT precision 32. All patients underwent non-enhanced CT plain scans. The scanning conditions were: 120KV, automatic mAs, layer thickness 1.0cm (PET-CT uMI780, uCT 760), 1.1cm (KAIPU CT precision 32), layer spacing 1.0cm (PET-CT uMI780, uCT 760), 0.7cm (KAIPU CT precision 32).

Imaging Evaluation

Two radiologists with 9 and 8 years of experience independently reviewed the CT images while they were blinded to the names and clinical data of these patients. For each of the 15 patients, the initial chest CT images were evaluated for the following characteristics: patchy/punctate GGO, large/multiple GGO, consolidation, reticulation /interlobular septal thickening, irregular solid nodules, fibrous stripes and no related lesions. Patchy/punctate GGO is defined as a single ground glass lesion less than 5 cm in diameter of each lobe, and large/multiple GGO is defined as a single lesion larger than 5 cm in diameter or multiple lesions in each lobe. Regarding the inconsistent results, the two parties reached an agreement through consultation.

CT score was used to evaluate the severity of the pneumonia. Each lobe is scored separately based on range and density. The range scoring rules of each lobe are as follows: score 0, 0% involvement; score 1,

1% to 25% involvement; score 2, 26% to 50% involvement; score 3, 51% to 75% involvement; score 4, 75% to 100% involvement. The density score is based on the average CT value of the lesion and is defined as follows: score 0, no lesions; score 1, the CT value between -799HU and -600HU; score 2, the CT value between -599HU and -400HU; score 3, the CT value between -399HU and -200HU; score 4, the CT value between -199HU and 0HU. The average CT value of each lung lobe is the average of the maximum and minimum values. The final total CT score obtained is the sum of range score and density score of each lung lobe. Each lobe has a final score between 0-8, so the final possible score is between 0-40. The inter-observer and intra-observer agreement of CT score measurement was analyzed by interclass correlation coefficient (ICC).

Statistical Analysis

All statistical analyses were performed by using SPSS statistical software (version 25, IBM). Categorical variables were described as frequency rates and percentages, and quantitative variables were described using mean (SD) or median (interquartile range, IQR) values.

Results

Characteristics and clinical manifestations

The clinical features of patients at different groups are shown in Table 1. A total of 15 infected patients (53-75 years, mean age, 63.4 years [SD, 6.7]) were included in the study, of which 6 were male (40.0%) and 9 were female (60.0%). Among them, there are a total of 14 cases (93.3%) of cluster incidence, 3 cases with diabetes, 1 case with heart disease and old tuberculosis respectively. 12 patients showed positive results at the first RT-PCR and 14 at the initial CT scanning. A total of 14 patients developed corresponding clinical symptoms, including 9 with fever, 6 with cough/ expectoration, 3 with fatigue, and 1 with dizziness/headache and chest tightness respectively, and no patients with abdominal pain/diarrhea, pharyngeal discomfort and myalgia. The average temperature of all the patients was 37.9 degrees [SD, 1.0]. In terms of clinical classification at admission, 2 are severe/ critical and 13 are mild/ordinary, 5 of which later developed into severe/ critical.

Chest CT findings

The initial CT features of patients are shown in Table 2 which were taken at admission. The imaging finding of GGO has a high incidence (13/15, 86.7%) including patchy/ punctate GGO and large/multiple GGO. In addition, there were 2 patients with consolidation, 3 patients with fibrous stripes, and 1 patient with irregular solid nodules and reticulation /interlobular septal thickening respectively. In terms of the number of lobes involved, 5 were involved in 1-3 lobes and 9 were involved in 4-5 lobes. Among them, 8 affected the right upper lobe, 9 affected the right middle lobe, the right lower lobe and the upper left lobe, 11 affected the lower left lobe. There were 12 patients with bilateral lung disease, and a total of 10 patients had lesions subpleural distribution. The average CT score of the patients was 13.7 points [SD,

9.0], of which 5 patients had 1-9 points, 3 patients had 10-19 points, and 6 patients scored more than 20 points.

Discussion

Some patients, especially elderly patients, with COVID-19 pneumonia have comorbidities, such as hypertension, diabetes mellitus and heart disease, etc., and a higher proportion of patients have hypertension[14]. There are many studies show that elderly patients with comorbidities are more likely to be infected with COVID-19. It is suggested that elderly patients with multiple comorbidities are more likely to have an impaired body function and weakened immune system and thus are more susceptible to the coronavirus. Like the general COVID-19 patients, the COVID-19 patients with hypertension comorbidities also have the following clinical symptoms: fever, cough, expectoration, fatigue, dizziness, chest tightness. But overall, patients are more likely to have fever, cough and expectoration at the time of onset. So, the patients can still be helped to early screen by these characteristics. But it is worth noting that we found that 1 patient who did not show symptoms at the time of onset. Therefore, it is inappropriate to judge whether a patient is infected with COVID-19 based on clinical symptoms alone[15]. In this study, the clinical classification of 5 patients changed from mild/ordinary to severe/ critical, which suggests that these patients are more likely to get more severe clinical typing, especially those patients with COVID-19 who have comorbidities[5, 16]. Impaired physical functions and a weakened immune system may make them more vulnerable to virus attacks, thereby accelerating the progression of the disease. For these elderly patients with comorbidities, clinicians need to pay special attention early and always pay attention to changes in the condition.

The CT feature of GGO is the most common CT manifestation of COVID-19 pneumonia. Chest CT of these patients not only showed patchy/ punctate GGO, but also showed large/multiple GGO. In addition, imaging features such as consolidation, fibrous stripes, irregular solid nodules and irregular solid nodules and reticulation /interlobular septal thickening also appeared, but their incidence is not high. For most patients, the number of lobes involved is 4-5, and most of them are bilaterally distributed, which may also indicate that the lung of these patients with comorbidities are more susceptible to viral infections[17]. In this study, the frequency of lobe involvement with the highest probability of disease was the left lower lobe, but there is no specificity.

In conclusion, in this study of 15 cases, we found that common chest CT changes in COVID-19 patients with hypertension comorbidities are GGO. Typical clinical and CT findings can help early screening of suspicious patient cases of COVID-19. According to the current diagnostic standard, laboratory test is the standard and formative assessment for the diagnosis of COVID-19 infection such as RT-PCR detection[18]. However, thanks to the convenience of the CT examination, it is still an essential and indispensable examination method when current laboratory tests are time consuming and fail to meet the needs of a growing number of infected people.

Declarations

Competing interests: The authors declare no competing interests.

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Tables

Table 1 Basic clinical data in COVID-19 patients with hypertension comorbidities [n (%)]

Variables	Total(n=15)
Sex	
Male	6(40.0%)
Female	9(60.0%)
Age	63.4(6.7)
Cluster onset	14(93.3%)
Diabetes mellitus	3(20.0%)
Heart disease	1(6.7%)
Old tuberculosis	1(6.7 %)
First RT-PCR positive	12(80.0%)
First CT positive	14(93.3%)
CT always negative	0(0.0%)
No symptoms	1(6.7%)
Fever	9(60.0%)
Cough and expectoration	6(40.0%)
Pharyngeal discomfort	0(0.0%)
Myalgia	0(0.0%)
Fatigue	3(20.0%)
Dizziness and headache	1(6.7%)
Chest tightness	1(6.7%)
Abdominal pain/Diarrhea	0(0.0%)
Temperature (°C)	37.9(1.0)
Clinical classification at admission	
Mild/Ordinary	13(86.7)
Severe/ Critical	2(13.3)
Highest clinical classification	
Mild/Ordinary	8(53.3)
Severe/ Critical	7(46.6)

Data are n (%), mean (SD)

Table 2. Initial CT Features in COVID-19 patients with hypertension comorbidities [n (%)]

Variables	Total(n=15)
Patchy/ Punctate GGO	13(86.7%)
Large/Multiple GGO	13(86.7%)
Consolidation	2(13.3%)
Reticulation /Interlobular septal thickening	1(6.7%)
Irregular solid nodules	1(6.7%)
Fibrous stripes	3(20.0%)
None lesions	1(6.7%)
Numbers of Lobes Affected	
0 Lobes	1(6.7%)
1-3 Lobes	5(33.3%)
4-5 Lobes	9(60.0%)
Frequency of lobe involvement	
Right upper lobe	8(53.3)
Right middle lobe	9(60.0)
Right lower lobe	9(60.0)
Left upper lobe	9(60.0)
Left lower lobe	11(73.3)
Bilateral lung disease	12(80.0%)
Subpleural distribution	10(66.7%)
CT score	13.7±9.0
CT score group	
0 score	1(6.7 %)
1-10 score	5(33.3%)
10-20 score	3(20.0%)
20- score	6(40.0%)

Data are n (%), mean (SD)

Figures

A

B

C

D

E

Figure 1

Axial non-enhanced chest CT in a 69-year-old male patient with a history of hypertension for 2 years. A. Chest CT at admission showed multiple subpleural GGO lesions in the bilateral lung. B. 3 days later, the follow-up CT image showed the scope of the lesion began to expand and the density began to increase. C. 5 days later, the lesions increased further with superimposed inter- and intralobular septal thickening

and consolidation. D. 9 days later, fibrous stripes began to appear in some lesions. E. After 17 days, The GGO was almost completely absorbed, replaced by fibrous stripes.

A

B

C

Figure 2

Axial non-enhanced chest CT in a 69-year-old male patient with a history of hypertension. A. The chest CT result at admission was negative. B. 5 days later, the follow-up CT image showed patchy GGO lesions in the left upper lobe subpleural (white arrow). C. After 15 days, the scope of the lesion expanded slightly (white arrow).