Comparison of initial HRCT features of COVID-19 pneumonia and other viral pneumonias

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Research

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Abstract

Background: Multicenter retrospective comparison of the first high-resolution computed tomography (HRCT) findings of coronavirus disease 2019 (COVID-19) and other viral pneumonias.

Methods: We retrospectively collected clinical and imaging data from 254 cases of confirmed viral pneumonia in 20 hospitals in Yunnan Province, China, from March 1, 2015, to March 15, 2020. According to the virus responsible for the pneumonia, the pneumonias were divided into non-COVID-19 (133 cases) and COVID-19 (121 cases). The non-COVID-19 pneumonias included 3 types: cytomegalovirus (CMV) (31 cases), influenza A virus (82 cases), and influenza B virus (20 cases). The differences in the basic clinical characteristics, lesion distribution, location and imaging signs among the four viral pneumonias were analyzed and compared.

Results: Fever and cough were the most common clinical symptoms of the four viral pneumonias. Compared with the COVID-19 patients, the non-COVID-19 patients had higher proportions of fatigue, sore throat, expectorant and chest tightness (all $p<0.000$). In addition, in the CMV pneumonia patients, the proportion of patients with combined acquired immunodeficiency syndrome (AIDS) and leukopenia were high (all $p<0.000$). Comparisons of the imaging findings of the four viral pneumonias showed that pulmonary lesions of COVID-19 were more likely to occur in the peripheral and lower lobes of both lungs, while those of CMV pneumonia were diffusely distributed. Compared with the non-COVID-19 pneumonias, COVID-19 pneumonia was more likely to present as ground-glass opacity (GGO), intralobular interstitial thickening, vascular thickening and halo sign (all $p<0.05$). In addition, in the early stage of COVID-19, extensive consolidation, fibrous stripes, subpleural lines, crazy-paving pattern, tree-in-bud, mediastinal lymphadenectasis, pleural thickening and pleural effusion were rare (all $p<0.05$).

Conclusion: The HRCT findings of COVID-19 pneumonia and other viral pneumonias overlapped significantly, but many important differential imaging features could still be observed.

Introduction

Coronavirus disease 2019 (COVID-19) broke out in Wuhan, China, in December 2019; the disease is highly infectious, has a long incubation period and is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1, 2]. COVID-19 spreads at an alarming rate. As of April 20, COVID-19 has spread to 211 countries worldwide, with more than 2.3 million confirmed patients and 164,976 deaths. Currently, COVID-19 has become an inevitable global health crisis.

Early studies have shown that almost all COVID-19 patients have pneumonia [3, 4]. However, at this time of year, pneumonias caused by other pathogens are also common [5–7]. Therefore, in this COVID-19 pandemic, the differential diagnosis of different viral pneumonias is difficult but is also important. Real-time reverse transcription-polymerase chain reaction (RT-PCR) is the gold standard for the diagnosis of viral pneumonia. However, recent reports have shown that the sensitivity of RT-PCR for the detection of COVID-19 is as low as 60–71% [8], and the high false negative rate limits the rapid identification of viral pneumonia by RT-PCR.

Currently, computed tomography (CT) can play an important role in the diagnosis and treatment of viral pneumonia [9–11]. Studies have shown that the typical CT findings of COVID-19 include ground-glass opacity (GGO) and partial consolidation in the peripheral areas of both lungs with a round shape and without cavities, pleural effusion and lymphadenopathy [12, 13]. After treatment, chest CT can detect the dynamic changes in COVID-19 [14, 15]. Other studies have shown that the imaging findings of viral pneumonias and bacterial pneumonias are different [9, 10]. However, little is known about the differences in imaging findings between COVID-19 and other viral pneumonias.

Therefore, the purpose of this study was to clarify the basic clinical features and potential differences in high-resolution computed tomography (HRCT) findings of COVID-19 and other viral pneumonias.

Materials And Methods

Patients

This retrospective study was approved by our institutional review board, and patient consent was waived. This multicenter study retrospectively analyzed patients who underwent chest CT for suspected viral pneumonia due to fever, fatigue or respiratory tract symptoms at 20 hospitals in Yunnan Province, China, from March 1, 2015, to March 15, 2020. RT-PCR assays were performed to identify influenza A virus, influenza B virus, respiratory syncytial virus, parainfluenza virus, adenovirus, SARS coronavirus, SARS-CoV-2, Epstein-Barr virus, measles virus, and other viruses from nasopharyngeal swabs or bronchoalveolar lavage fluid. The study only included pneumonia patients infected with one virus, and patients with multiple respiratory viruses or bacterial or fungal infections were excluded. A total of 351 viral pneumonia patients were diagnosed in this study. The further selection process for viral pneumonia patients is shown in Fig. 1. According to the clinical guidelines for COVID-19 [15], among the 121 COVID-19 patients, 22 were mild, 76 were moderate, 20 were severe, and 3 were critical. In addition, the study excluded one case of Epstein-Barr virus, two cases of herpes virus, one case of measles virus, two cases of varicella virus and one case of mumps virus. All patients were admitted within 4–7 days after the onset of acute symptoms. The patient's age, sex, history of exposure, and clinical symptoms (fever, cough, fatigue, dyspnea, sore throat, runny nose, expectoration, headache, muscle aches, chest tightness, chest pain, nausea and vomiting, diarrhea and no obvious symptoms), underlying diseases (hypertension, diabetes, coronary heart disease, liver disease, tumor, acquired immunodeficiency syndrome (AIDS) and leukopenia), hospital admission time and CT examination time were recorded. Patients completed the chest CT examination within 48 hours after admission. According to the virus found in the lungs, the patients were divided into four groups: cytomegalovirus (CMV), influenza A virus, influenza B virus and COVID-19. The number of cases from each hospital is shown in Table 1. All patients were from Yunnan Province, China.

Table 1
Hospital name and number of cases in this multicenter study

Hospital name	Total	CMV	Influenza A virus	Influenza B virus	COVID-19
Kunming Third People's Hospital	68	2	31	5	30
Yunnan Provincial Infectious Disease Hospital	46	27	8	0	12
Kunming First People's Hospital	29	0	18	11	0
The First People's Hospital of Zhaotong	22	0	4	1	17
Third People's Hospital of Yunnan Province	15	1	12	2	0
Xishuangbanna People's Hospital	13	0	3	1	9
Qujing First People's Hospital	12	0	0	0	12
Dali People's Hospital	11	0	0	0	11
Yuxi People's Hospital	10	0	0	0	10
Lijiang People's Hospital	6	0	0	0	6
Second People's Hospital of Yunnan Province	5	1	4	0	0
Chuxiong People's Hospital	4	0	0	0	4
Lancang First People's Hospital	3	0	0	0	3
First People's Hospital of Yunnan Province	2	0	2	0	0
Baoshan People's Hospital	2	0	0	0	2
Honghe People's Hospital	2	0	0	0	2
Pu'er People's Hospital	1	0	0	0	1
Qiaojia People's Hospital	1	0	0	0	1
Ruili People's Hospital	1	0	0	0	1
Total	254	31	82	20	121

Note: CMV, cytomegalovirus; COVID-19, coronavirus disease 2019. Data are number of patients.

Ct Protocol

HRCT examination: CT scanners with 16 or more detector rows (Siemens, Germany; Philips, the Netherlands; and GE, USA) were used. The patient was scanned in supine position while holding his or her breath after inhalation. The scanning range was from the thoracic inlet to the costophrenic angles. Scanning parameters:

detector collimation width 64 × 0.6 mm or 128 × 0.6 mm, tube voltage 120 kV, adaptive tube current, high-resolution algorithm reconstruction, reconstruction layer thickness 1 or 1.5 mm and layer spacing 1.5 mm.

Chest Ct Analysis

Three Chinese radiologists were blinded to the RT-PCR results, all patient information, and type of viral pneumonia. First, two experienced radiologists (Yilong Huang and Yuanming Jiang) in the cardiothoracic group independently read the radiographs. When their opinions were inconsistent, they discussed them and reached a consensus, which was reviewed and confirmed by the third senior radiologist in the cardiothoracic group (Bo He). The morphological signs of the first CT examination after admission were analyzed. The CT imaging evaluation [9, 10, 12, 17] included lesion distribution (peripheral, central), location (left upper lobe, left lower lobe, right upper lobe, right middle lobe and right lower lobe) and signs (GGO [ground-glass opacities], partial consolidation, multifocal consolidation, focal consolidation, fibrous stripes, septal thickening, intralobular interstitial thickening, subpleural lines, crazy-paving pattern, tree-in-bud, bronchial wall thickening, bronchiectasis, vascular thickening, air bronchogram, halo sign, mediastinal lymphadenectasis, pleural thickening and pleural effusion). The window width and level were set to 1600/-600 HU.

Statistical analysis

SPSS 25.0 software was used for statistical analysis. Count data are expressed as frequency, and measurement data are expressed as` x ± s. One-way analysis of variance (ANOVA) was used for age, which had a normal distribution, and the least significant difference (LSD) method was used for pairwise comparison. The distribution, location and signs of pulmonary lesions in different viral pneumonias were compared using χ2 or Fisher's exact probability method. The Z-test (Bonferroni method) was used for pairwise comparisons. $p < 0.05$ was considered statistically significant.

Results

1. Patient clinical characteristics

This study included 254 patients with viral pneumonia, including 121 COVID-19 patients and 133 patients with non-COVID-19 pneumonias (CMV, 31 cases; influenza A virus, 82 cases, influenza B virus, 20 cases). The mean age of the COVID-19 patients (42.88 ± 17.67) was lower than that of the influenza A patients(55.50 ± 18.46). Fifty-four (44.63%) COVID-19 patients were males, and 93 (69.92%) non-COVID-19 patients were males. All COVID-19 patients had a history of living in Hubei or had close contact with other COVID-19 patients. Five patients with influenza A had a history of poultry contact. Among the four viral pneumonias, fever and cough were the most common clinical symptoms, and the highest proportion was found in the influenza A patients ($p < 0.000$). Compared with the COVID-19 patients, the non-COVID-19 patients had higher proportions of fatigue, sore throat, expectoration and chest tightness, while the COVID-19 patients were more likely to be asymptomatic, and the differences were statistically significant (all $p < 0.000$). Compared with the other viral pneumonia patients, the CMV pneumonia patients had higher proportions of AIDS and leukopenia (all $p < 0.000$). Table 2 shows the clinical characteristics of the included patients.

Table 2
Basic clinical characteristics of 253 patients with viral pneumonia

Clinical characteristics	CMV(n = 31)	Influenza A virus(n = 82)	Influenza B virus(n = 20)	Non-COVID-19(n = 133)	COVID-19(n = 121)	P value
Age average	41.55 ± 10.69	55.50 ± 18.46*	40.85 ± 18.75	50.05 ± 18.27*	42.88 ± 17.67	0.000
Age range	28–76	6–93	6–72	6–93	3–79	
Gender						0.000
Male	26 (83.87%)*	56 (68.29%)*	11 (55.00%)	93 (69.92%)*	54 (44.63%)	
Female	5 (16.13%)*	26 (31.71%)*	9 (45.00%)	40 (30.08%)*	67 (55.37%)	
Epidemiological history						
Travel/residence history in Hubei	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	98 (80.99%)	
Close contact with patients	0 (0.00%)	16 (19.51%)	2 (10.00%)	18 (13.53%)	23 (19.01%)	
Exposure to infected poultry	0 (0.00%)	5 (6.10%)	0 (0.00%)	5 (3.76%)	0 (0.00%)	
Symptoms						
Fever	22 (70.97%)	72 (87.80%)*	16 (80.00%)	110 (82.71%)*	60 (49.59%)	0.000
Cough	20 (64.52%)	75 (91.46%)*	8 (40.00%)	103 (77.44%)*	53 (43.80%)	0.000
Fatigue	12 (38.71%)*	32 (39.02%)*	5 (25.00%)	49 (36.84%)*	17 (14.05%)	0.000
Difficulty breathing	3 (9.68%)	6 (7.32%)	1 (5.00%)	10 (7.52%)	3 (2.48%)	0.371
Sore throat	0 (0.00%)	23 (28.05%)*	2 (10.00%)*	25 (18.80%)*	12 (9.92%)	0.001
Runny	4 (12.90%)	11 (13.41%)	1 (5.00%)	16 (12.03%)	8 (6.61%)	0.420
Expectorant	10 (32.26%)*	32 (39.02%)	8 (40.00%)*	50 (37.59%)	18 (14.88%)	0.000

Note: CMV, cytomegalovirus; AIDS, acquired immune deficiency Syndrome; COVID-19, coronavirus disease 2019. Continues data are expressed as mean ± SD, and categorical data are presented as n (%). *, compared with COVID-19, significance was considered when $P < 0.05$.

Clinical characteristics	CMV(n = 31)	Influenza A virus(n = 82)	Influenza B virus(n = 20)	Non-COVID-19(n = 133)	COVID-19(n = 121)	P value
Headache	1 (3.23%)	4 (4.88%)	1 (5.00%)	6 (4.51%)	7 (5.79%)	0.980
Muscle ache	0 (0.00%)	6 (7.32%)	1 (5.00%)	7 (5.26%)	9 (7.44%)	0.581
Chest tightness	21 (67.74%)*	4 (4.88%)	7 (35.00%)	32 (24.06%)*	9 (7.44%)	0.000
Chest pain	0 (0.00%)	2 (2.44%)	1 (5.00%)	3 (2.26%)	3 (2.48%)	0.864
Nausea and vomit	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (1.65%)	0.352
Diarrhea	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (0.83%)	0.698
No obvious symptoms	0 (0.00%)	0 (0.00%)*	0 (0.00%)	0 (0.00%)*	15 (12.40%)	0.000
Basic disease						
Hypertension	3 (9.68%)	28 (34.15%)*	10 (50.00%)*	41 (30.83%)*	9 (7.44%)	0.000
Diabetes	2 (6.45%)	19 (23.17%)*	2 (10.00%)	23 (17.29%)*	7 (5.79%)	0.003
Coronary heart disease	1 (3.23%)	2 (2.44%)	1 (5.00%)	4 (3.01%)	3 (2.48%)	0.976
Liver disease	6 (19.35%)	3 (3.66%)	2 (10.00%)	11 (8.27%)	2 (1.65%)	0.003
Malignant tumor	1 (3.23%)	0 (0.00%)	0 (0.00%)	1 (0.75%)	0 (0.00%)	0.221
AIDS	22 (70.97%)*	0 (0.00%)	0 (0.00%)	22 (16.54%)*	0 (0.00%)	0.000
Leukopenia	6 (19.35%)*	0 (0.00%)	0 (0.00%)	6 (4.51%)	0 (0.00%)	0.000

Note: CMV, cytomegalovirus; AIDS, acquired immune deficiency Syndrome; COVID-19, coronavirus disease 2019. Continues data are expressed as mean ± SD, and categorical data are presented as n (%). *, compared with COVID-19, significance was considered when $P < 0.05$.

2. Distribution and location of the pulmonary lesions of COVID-19 and other viral pneumonias

Thirty-three COVID-19 patients were negative on the first CT examination. Figure 2 shows the comparisons of the distribution and location characteristics of pulmonary lesions found on the first CT examinations of CMV, influenza A virus, influenza B virus, non-COVID-19 and COVID-19 patients. The results showed that there were no lesions in the central lung alone in the COVID-19 patients. The proportion of peripheral lesions in the COVID-19 patients was significantly higher than that of the patients with other viral pneumonias (all $p <$ 0.000), and the pulmonary lesions of CMV pneumonia were mainly distributed in the peripheral and central

lung. Regarding the pulmonary lesions in COVID-19, influenza A virus and influenza B virus, more were found in the left and right lower lobes than in other lung lobes ($p < 0.05$). However, in the CMV pneumonia patients, there was no significant difference in the number of lesions found in the different lung lobes; however, more CMV patients than patients with other viral pneumonias had lesions in the left upper lobe, right upper lobe, and right middle lobe, and the differences were statistically significant ($p < 0.05$).

3. Chest CT findings of viral pneumonia

The first CT images of pulmonary lesions in CMV, influenza A virus, influenza B virus, Non-COVID-19 and COVID-19 were compared (Table 3). Compared with Non-COVID-19 pneumonias, COVID-19 was more likely to present as GGO (96.59% vs 45.86%, $p < 0.001$), intralobular interstitial thickening (63.64% vs 20.30%, $p < 0.001$), vascular thickening (55.68% vs. 5.26%, $p < 0.001$) and halo signs (59.09% vs 15.04%, $p < 0.001$). In the early stage of COVID-19, extensive consolidation (7.95% vs 39.85%, $p < 0.001$), fibrous stripes (15.91% vs 34.59%, $p = 0.002$), subpleural lines (7.95% vs 24.81%, $p < 0.001$), crazy-paving pattern (0.00% vs 15.04%, $p = 0.002$), tree-in-bud (1.14% vs 28.57%, P < 0.001), mediastinal lymphadenectasis (14.29% vs 1.14%, $p < 0.001$), pleural thickening (59.40% vs 38.64%, $p = 0.014$) and pleural effusion (25.56% vs 0.00%, $p < 0.001$) were rare. Figure 3–6 demonstrates CMV, Influenza A virus, Influenza B virus, and COVID-19 cases.

Table 3
Comparison of CT findings of different viral pneumonia

CT findings	CMV(n = 31)	Influenza A virus(n = 82)	Influenza B virus(n = 20)	Non-COVID-19(n = 133)	COVID-19(n = 88)	P value
Main features						
GGO	8 (25.81%)*	41 (50.00%)*	12 (60.00%)*	61 (45.86%)*	85 (96.59%)	0.000
Partial consolidation	22 (70.97%)*	42 (51.22%)	10 (50.00%)	74 (55.64%)	34 (38.64%)	0.022
Consolidation						
Multifocal consolidation	14 (45.16%)*	33 (40.24%)*	6 (30.00%)	53 (39.85%)*	7 (7.95%)	0.000
Focal consolidation	10 (32.26%)	15 (18.29%)	6 (30.00%)	31 (23.31%)	22 (25.00%)	0.539
Fibrous stripes	6 (19.35%)	30 (36.59%)*	10 (50.00%)*	46 (34.59%)*	14 (15.91%)	0.002
Interstitial changes						
Septal thickening	14 (45.16%)	29 (35.37%)	7 (35.00%)	50 (37.59%)	30 (34.09%)	0.853
Intralobular interstitial thickening	7 (22.58%)*	15 (18.29%)*	5 (25.00%)*	27 (20.30%)*	56 (63.64%)	0.000
subpleural lines	3 (9.68%)	27 (32.93%)*	3 (15.00%)	33 (24.81%)*	7 (7.95%)	0.000
Crazy-paving pattern	11 (35.48%)*	7 (8.54%)	2 (10.00%)*	20 (15.04%)*	0 (0.00%)	0.000
Other features						
Tree-in-bud	2 (6.45%)	28 (34.15%)*	8 (40.00%)*	38 (28.57%)*	1 (1.14%)	0.000
Bronchial wall thickening	6 (19.35%)	17 (20.73%)	2 (10.00%)	25 (18.80%)	12 (13.64%)	0.643
Bronchiectasis	23 (74.19%)*	19 (23.17%)	6 (30.00%)	48 (36.09%)	23 (26.14%)	0.000
Vascular Thickening	2 (6.45%)*	4 (4.88%)*	1 (5.00%)*	7 (5.26%)*	49 (55.68%)	0.000
Air bronchogram	14 (45.16%)*	14 (17.07%)	3 (15.00%)	31 (23.31%)	11 (12.50%)	0.002

Note: CMV, cytomegalovirus; GGO, ground-glass opacities; COVID-19, coronavirus disease 2019. Continues data are expressed as mean ± SD, and categorical data are presented as n (%). *, compared with COVID-19, significance was considered when P < 0.05.

CT findings	CMV(n = 31)	Influenza A virus(n = 82)	Influenza B virus(n = 20)	Non-COVID-19(n = 133)	COVID-19(n = 88)	P value
Halo sign	0 (0.00%)*	12 (14.63%)*	8 (40.00%)	20 (15.04%)*	52 (59.09%)	0.000
Mediastinal lymphadenectasis	10 (32.26%)*	9 (10.98%)	0 (0.00%)	19 (14.29%)*	1 (1.14%)	0.000
Pleural Thickening	20 (64.52%)	46 (56.10%)	13 (65.00%)	79 (59.40%)*	34 (38.64%)	0.014
Pleural effusion	7 (22.58%)*	22 (26.83%)*	5 (25.00%)*	34 (25.56%)*	0 (0.00%)	0.000

Note: CMV, cytomegalovirus; GGO, ground-glass opacities; COVID-19, coronavirus disease 2019. Continues data are expressed as mean ± SD, and categorical data are presented as n (%). *, compared with COVID-19, significance was considered when $P < 0.05$.

Discussion

COVID-19 is threatening human health and safety worldwide. Considering the similarity in outbreak time and clinical manifestations between COVID-19 and other viral pneumonias, this study systematically analyzed the differences in first chest CT findings between COVID-19 and other viral pneumonias. Our study found that although it is difficult to completely differentiate COVID-19 from other viral pneumonias, COVID-19 still has some unique CT features.

This study included 254 patients with confirmed viral pneumonia. The main clinical manifestations of all patients were fever and cough. However, the incidence of fever and cough in COVID-19 patients was low, which was consistent with the results of Zhao et al [18– 19]. This may be related to the low virulence of SARS-CoV-2. In this study, 15 patients (12.40%) showed no obvious clinical symptoms, and 33 patients (27.27%) had negative CT findings, which was consistent with the results of Guan et al. [20]. However, the patients' RT-PCT results were still positive for SARS-CoV-2, indicating that they were still infectious and should be isolated for observation and receive antiviral treatment. It is worth noting that patients with AIDS and leukopenia were more prone to developing CMV pneumonia.

The periphery of the lower lobes of both lungs was the most common area of lesions in COVID-19 and influenza pneumonias, which is consistent with the results of previous studies [17]. However, we found that a high proportion of COVID-19 lesions occurred in the peripheral area, while CMV pneumonia was usually diffusely distributed in both lungs. This study systematically analyzed and compared the CT findings of

COVID-19 and other viral pneumonias. We found that GGO was more common in COVID-19 than in other viral pneumonias, and multifocal consolidation was more common in other viral pneumonias, a result that was consistent with previous studies [17, 19]. To the best of our knowledge, studies comparing microscopic signs between COVID-19 and other viral pneumonias are still rare. Intralobular interstitial thickening, vascular thickening and halo signs were more likely to occur in COVID-19 than other viral pneumonias, and fibrous stripes, subpleural lines, crazy-paving pattern, tree-in-bud, pleural effusion and mediastinal lymphadenectasis occurred less frequently in COVID-19 than in other viral pneumonias. This may be related to the slower development of COVID-19 than other viral pneumonias [19]. It is worth noting that tree-in-bud was observed in 35.29% of influenza pneumonia cases, and similar results were observed by Shiley et al. [21], but almost no tree-in-bud was observed in COVID-19. Compared with other viral pneumonias, CMV pneumonia often presents as characteristic bronchiectasis, and immunocompromise is an important risk factor. In previous studies, it has been called “AIDS associated bronchiectasis” [22]. With this information combined with the clinical data, radiologists can better identify the type of viral pneumonia [23].

This study has some limitations. First, although we tried our best to collect the clinical and imaging data of patients with viral pneumonia in Yunnan Province, the number of confirmed cases of adenovirus, measles virus, herpes virus and other viruses was relatively small, but the differences in imaging signs among them are very interesting and will be studied in the future. Second, most of the included CMV pneumonia patients had AIDS, which is likely to cause a selection bias regarding other CMV pneumonia patients. Third, different populations, such as infants, children and elderly adults, may be susceptible to different viruses, and their signs of pulmonary lesions on imaging might be different. Because of the sample size, we did not perform a subgroup analysis for age. In future studies, more efforts should be made to determine the differences in the imaging characteristics of different populations.

In summary, the analysis and comparison of the chest CT findings of COVID-19 and other viral pneumonias showed that the chest CT findings partially overlapped, but many significant imaging features could still be observed, which is helpful for the early differential diagnosis of COVID-19 and the development of more accurate clinical diagnosis and treatment strategies.

Abbreviations

COVID-19: the coronavirus disease 2019;

HRCT: high-resolution computed tomography;

CMV: cytomegalovirus

AIDS: acquired immunodeficiency syndrome

GGO: ground-glass opacity

SARS-CoV-2: syndrome coronavirus 2

RT-PCR: Real-time reverse transcription-polymerase chain reaction

CT: computed tomography

ANOVA: One-way analysis of variance

LSD: least significant difference

Declarations

Ethics approval and consent to participate: This research was carried out in accordance with the ethical standards established by our institutional committee. This was a retrospective study approved by our institutional review board. This study was also informed consent of all patients was obtained.

Consent for publication: not applicable

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

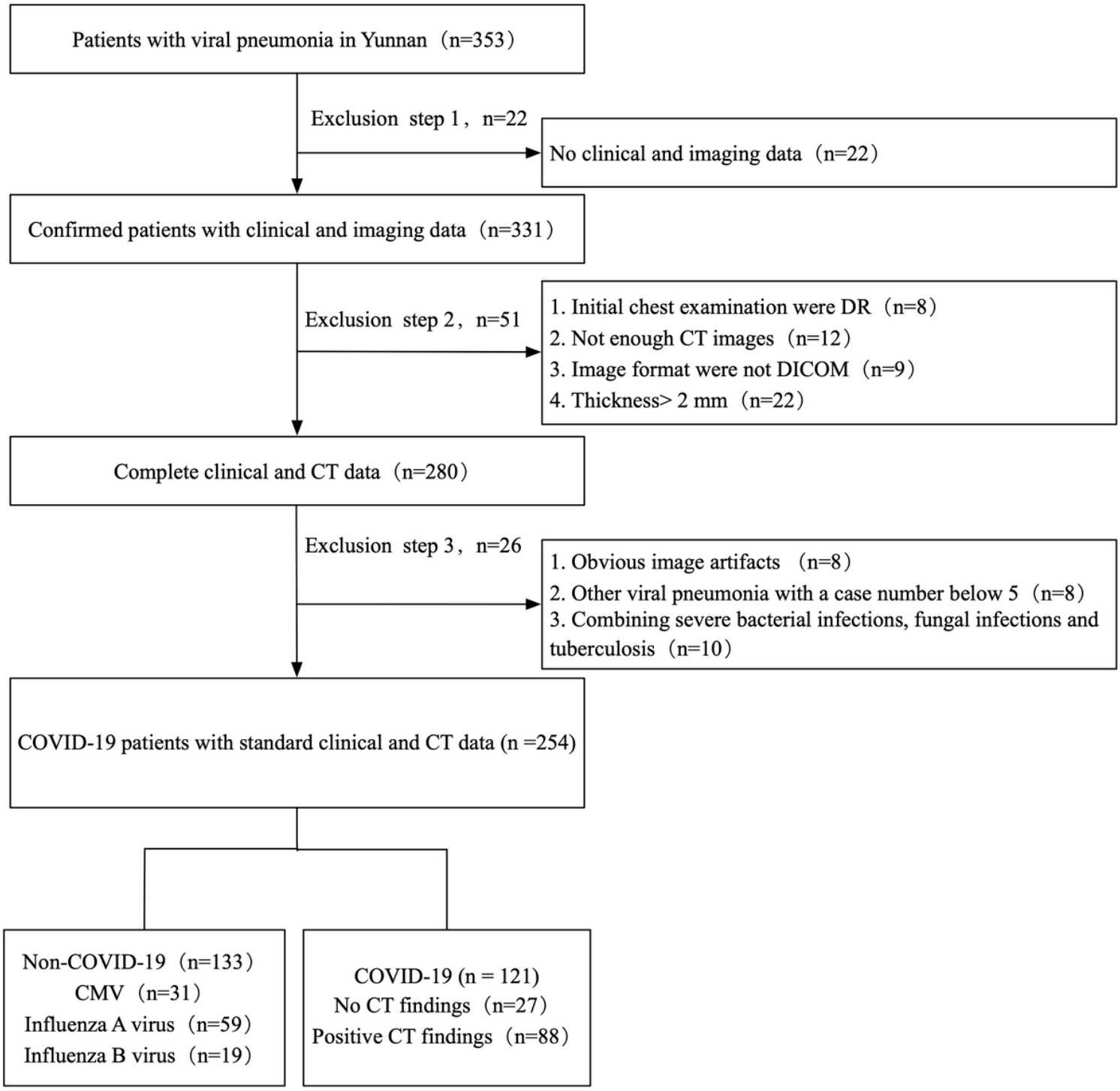

Figure 1

Flow diagram of the study design and the participants included in the analysis

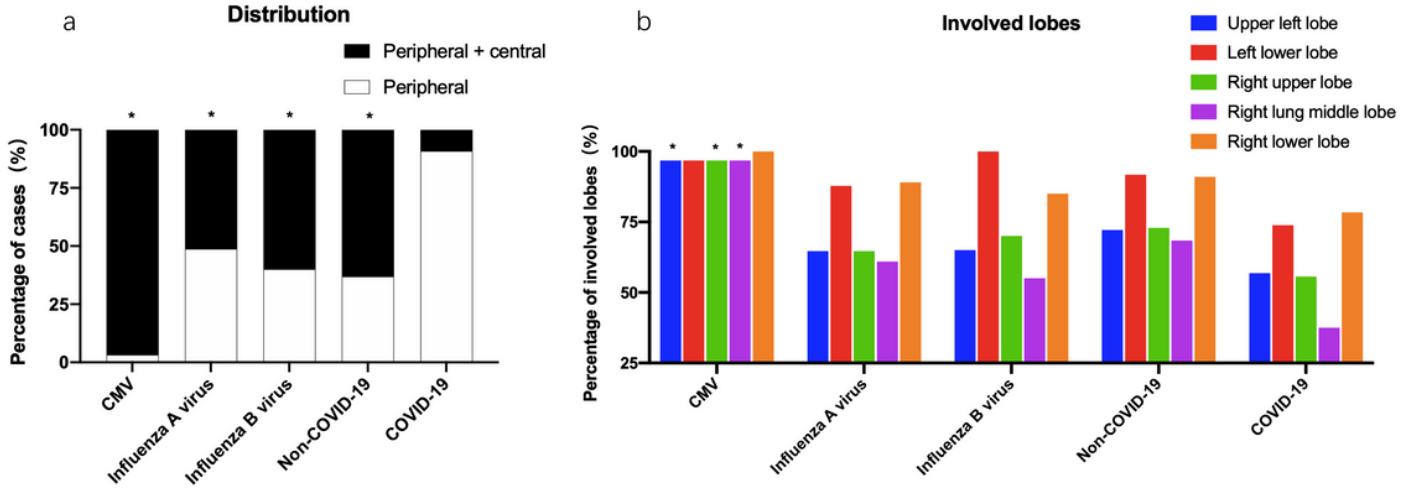

Figure 2

Distribution and location of COVID-19 pneumonia and other viral pneumonias(a) lesion distribution; (b) lesion location. Data are reported as percentages; * P<0.05 vs COVID-19 pneumonia.

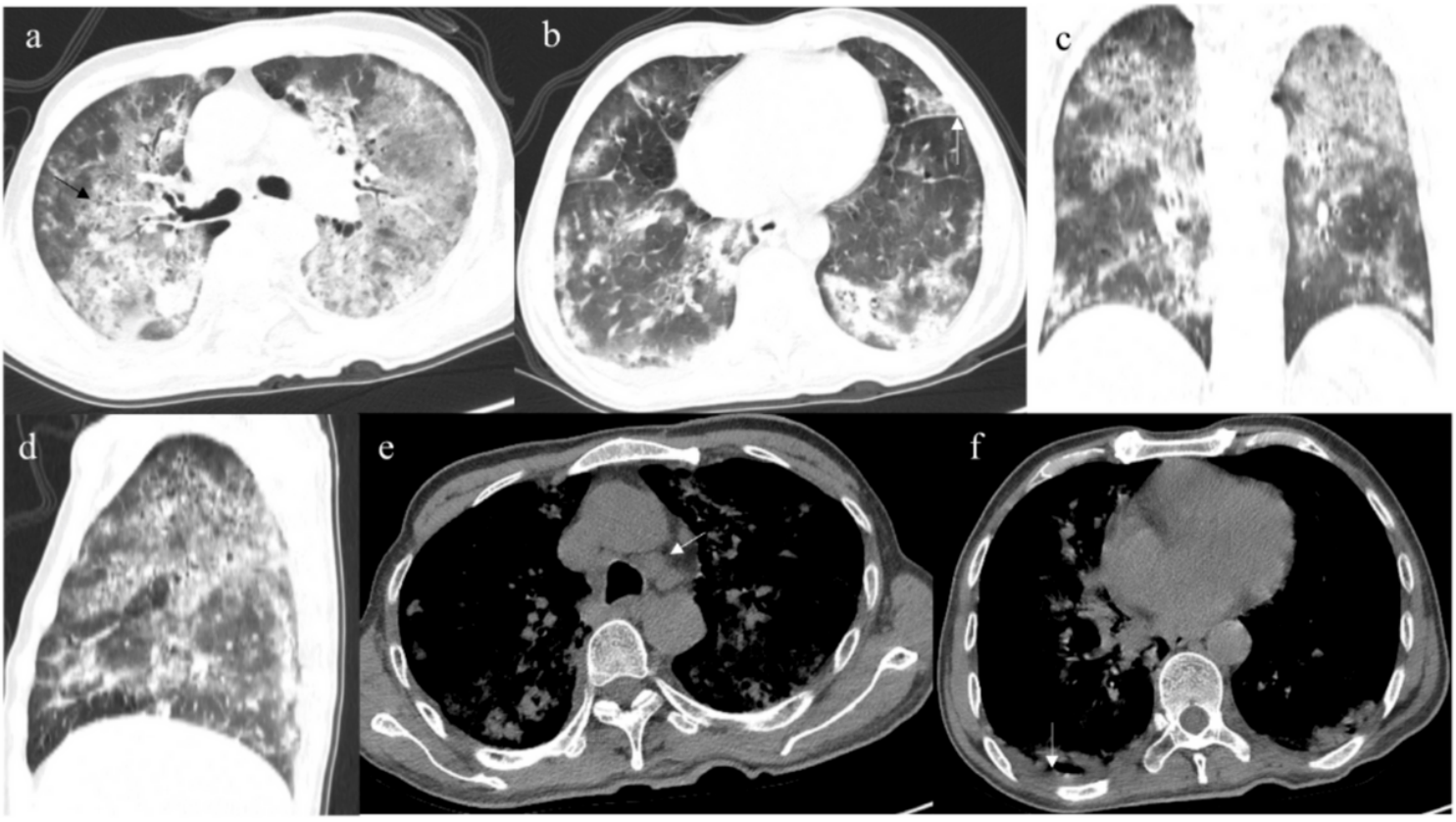

Figure 3

Chest CT findings of CMV pneumonia Fig 3a-f: Male, 54 years old, CMV pneumonia combined with AIDS and leukopenia. Diffuse GGO and multifocal consolidation in both lungs (Fig 3a-f), left intralobular interstitial thickening (Fig 3b white arrow), bronchiectasis (Fig 3a black arrow), mediastinal lymphadenectasis (Fig 3e

white arrow), left pleural effusion (Fig 3f white arrow). Fig 3a-b, e-f, axial view; Fig 3c, coronal view; Fig 3d, sagittal view.

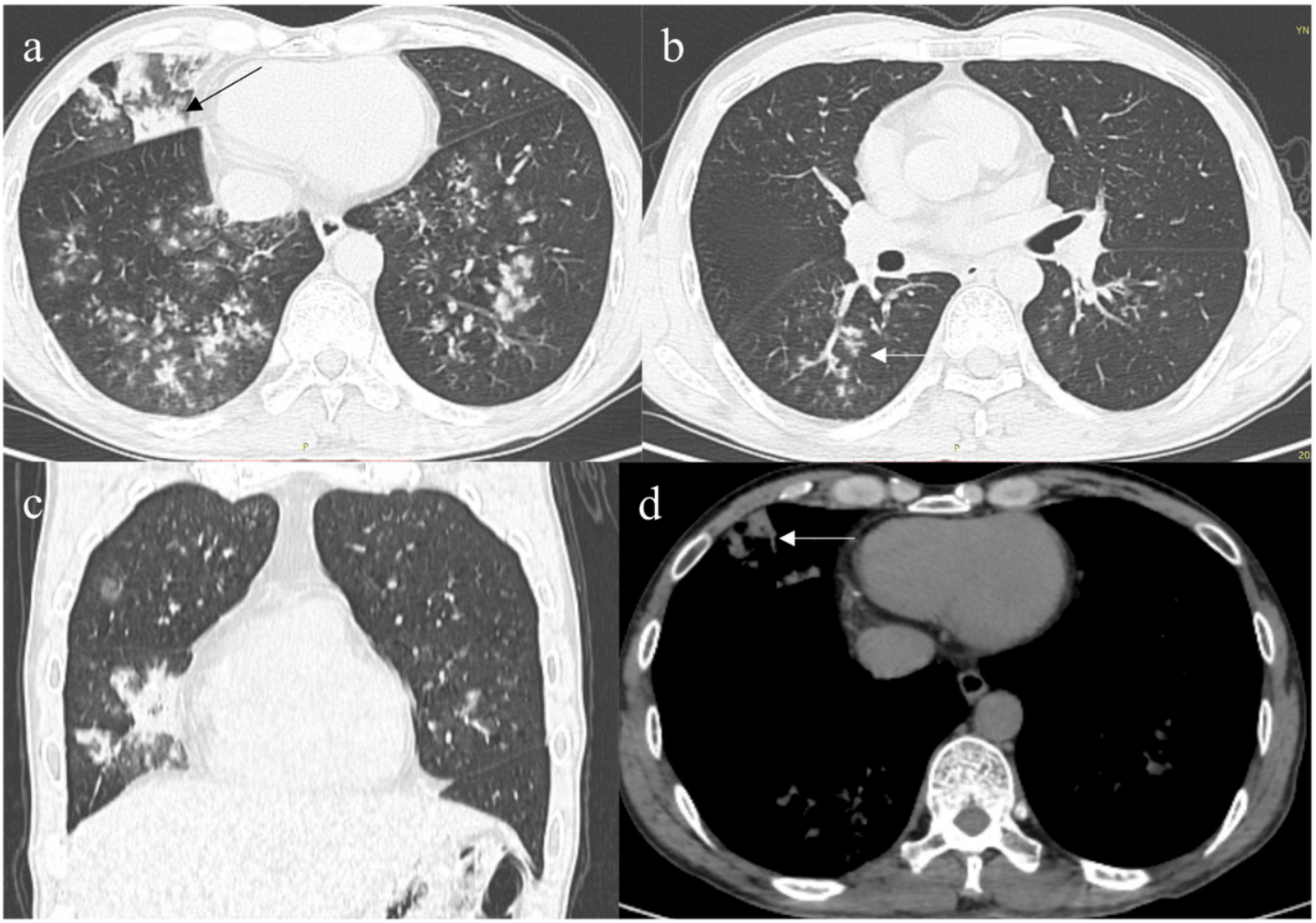

Figure 4

Chest CT findings of influenza A pneumonia Fig 4a-d: Male, 44 years old, influenza A pneumonia, H1N1 infection. Multifocal GGO, partial consolidation and consolidation in both lungs (Fig 4a-d), tree-in-bud (Fig 4b white arrow). Fig 4a, d show the consolidation in right middle lobe (arrow). Fig 4c, coronal view.

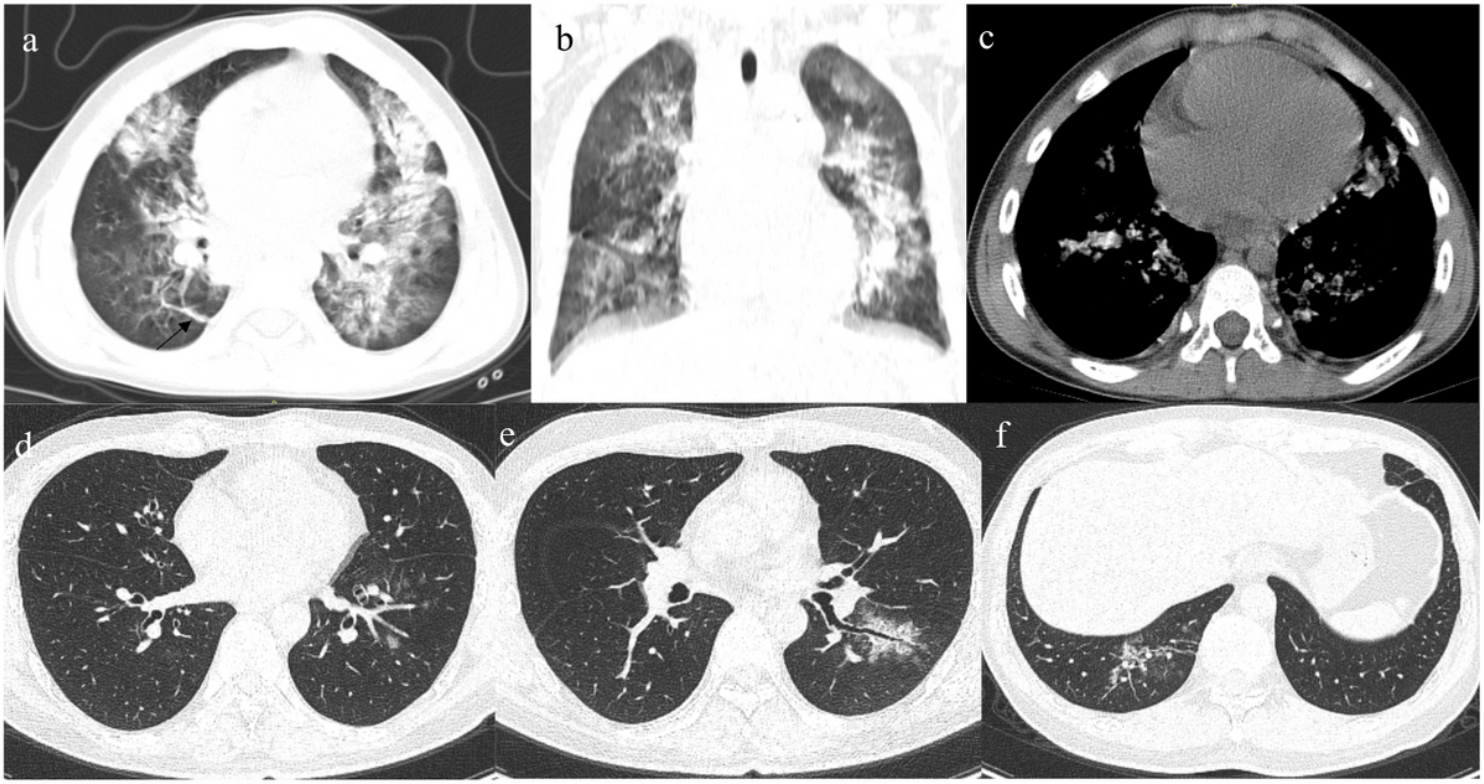

Figure 5

Chest CT findings of influenza B pneumonia Fig 5a-c: Male, 6 years old, influenza B pneumonia. Multifocal GGO with partial consolidation in both lungs (Fig 5a-c), parenchymal band (Fig 5a black arrow), air bronchogram, pleural thickening, pleural effusion. Fig 5a-c, axial view. Fig 5d-f: Male, 39 years old, influenza B pneumonia. Multifocal GGO and tree-in-bud in lower lobes of both lungs (Fig 5d), bronchial wall thickening (Fig 5e), partial consolidation and parenchymal band (Fig 5f). Fig 5d-f, axial view.

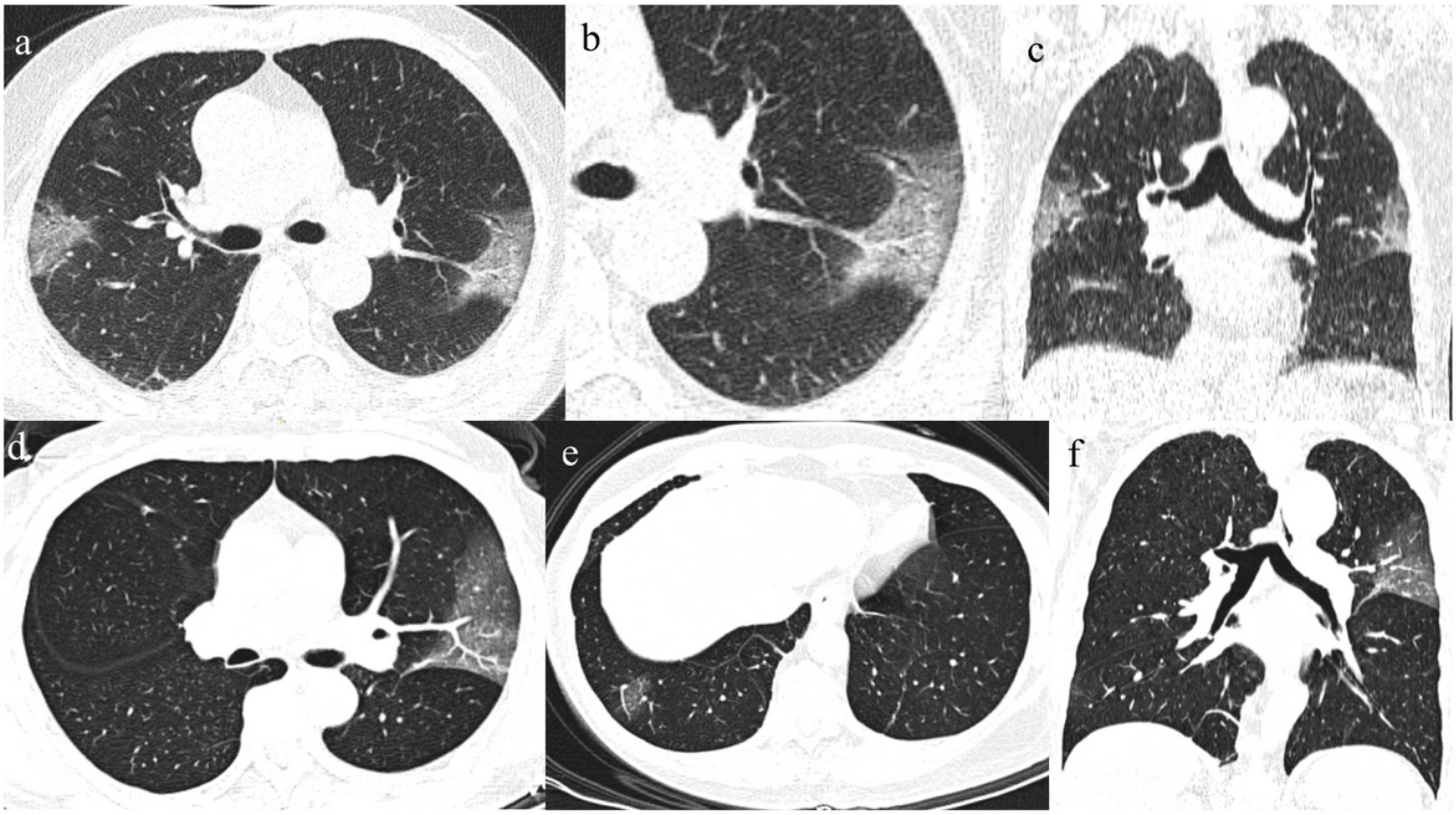

Figure 6

Chest CT findings of COVID-19 pneumonia Fig 6a-c: Female, 63 years old, COVID-19. Multifocal GGO in both lungs (Fig 6a-c), vascular thickening (Fig 6b), intralobular interstitial thickening (Fig 6b), pleural thickening (Fig 6c). Fig 6a-b, axial view; Fig 6c, coronal view. Fig 6d-f: Female, 66 years old, COVID-19. Multifocal GGO in both lungs (Fig 6 d-f), intralobular interstitial thickening (Fig 6d), vascular thickening (Fig 6d-e), pleural thickening (Fig 6a, f). Fig 6d-f, axial view; Fig 6f, coronal view.