ORIGINAL ARTICLE

Common and Uncommon Imaging Appearances of COVID-19 Pneumonia in Young and Middle-Aged Group and Elderly Group

Alireza Mahmoudabadi [1], Hamed Masoumi [1], Mohammad Keshtkar [1*], Arash Azhideh [2], Hamidreza Haghighatkhah [3]

[1] *Department of Medical Physics and Radiology, Faculty of Medicine, Gonabad University of Medical Sciences, Gonabad, Iran*

[2] *The Functional Neurosurgery Research Center, Shahid Beheshti University of Medical Sciences, Tajrish Sq, Tehran, Iran*

[3] *Department of Radiology, Shohadae Tajrish Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran*

*Corresponding Author: Mohammad Keshtkar
Email: keshtkar.dmohammad@yahoo.com

Received: 14 February 2021 / Accepted: 25 March 2021

Abstract

Purpose: In this study, we retrospectively evaluated chest Computed Tomography (CT) imaging manifestations of the patients with Coronavirus Disease 2019 (COVID-19) to simplify prompt early diagnosis of disease and speed up needed actions for infected patients.

Materials and Methods: Totally, 75 patients who laboratory confirmed COVID-19 pneumonia were enrolled in this study. CT images, demographic and some clinical data of all patients were collected and analyzed retrospectively. Furthermore, for comparison, the patients were divided into two groups as follows: the young and middle-aged group (< 60 years old) and the elderly group (≥ 60 years old).

Results: Based on the evaluation of CT images, 33 patients (44%) showed Ground-Glass Opacity (GGO), 15 patients (20%) showed consolidation, 24 patients (32%) showed mixed GGO and consolidation, 2 patients (2.6%) had bronchial wall thickening, 10 patients (13.3%) had a crazy paving sign, 35 patients (46.6%) had air bronchogram and, 7 patients (9.3%) had cavitation and 2 patients (2.6%) had a tree in the bud. CT images of 3 patients (4%) were normal. In terms of out of lung changes, lymphadenopathy was observed in one patient (1.3%), pleural effusion in 12 patients (16%), and pericardial effusion in 2 patients (2.6%). Lesions were found predominantly in the peripheral (57.3%) and the lower lung region (60%).

Conclusion: CT images of the COVID-19 patients showed various aspects, mainly GGO, consolidation, mixed GGO and consolidation, and air bronchogram. Lesion distribution was predominantly in lower lung region, bilateral and peripheral. Pleural effusion and multiple lobe involvement were significantly higher in the elderly group than that of the young and middle-aged group.

Keywords: Chest; Computed Tomography; Coronavirus Disease 2019; Imaging Manifestation.

DOI: https://doi.org/10.18502/fbt.v8i2.6516

Frontiers in BIOMEDICAL TECHNOLOGIES

1. Introduction

After December 2019, several patients have discovered "new viral pneumonia" that was initially associated with admission to the Huanan Seafood Market, Wuhan, China [1]. It has suggested a novel coronavirus, which has the potential to affect humans and is called COVID-19 [2, 3]. From February 7, 2020 to April 21, 2020, 2,501,898 cases have been infected with COVID-19 pneumonia and 169,859 people around the world have died from this disease [4].

The genome of Coronaviruses is a symmetrical nucleocapsid consisting of a sequence of ribonucleic acids and a set of ribosomes. This type of nucleocapsid is rare in viruses with positive-sense and is more common in viruses with negative-sense [5].

This is the seventh generation of corona viruses and like other coronavirus pneumonia such as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), COVID-19 can also cause Acute Respiratory Distress Syndrome (ARDS). COVID-19 is also capable of inducing brain damage and modifying consciousness. This potentially neuroinvasive COVID-19 was not commonly documented in infected patients [6-9]. Fever, sore throat, dry cough, and shortness of breath are the most frequent health signs; such non-specific signs include fatigue, stomach aches, exhaustion, and a lack of sense of smell and taste [10].

Because of the lack of dedicated therapeutic drugs and preventive vaccinations for the 2019 novel coronavirus disease, early identification of the disease is crucial and the infectious person is easily isolated from the healthy population [11]. Diagnosis is made for respiratory or blood samples using Reverse Transcriptional Polymerase Chain Reaction (RT-PCR) or gene sequencing. RT-PCR test is a significant predictor of evidence of infection in the hospital, but due to shortcomings in sample processing, storage, kit efficiency and kit error, the accuracy of accurate confirmed RT-PCR findings for throat swab samples in the initial tests was approximately 30 to 60 % [12].

As a standard imaging technique for diagnosing pneumonia, High Resolution Computed Tomography (HRCT) scanning is reasonably easy to do and can lead to a rapid diagnosis. In this case, it might be useful to detect COVID-19 by chest CT [13]. Radiologists should be aware of the diagnostic characteristics of COVID-19 infection in CT scanning images [14, 15]. Lengthy and false-negative outcomes of RT-PCR in the current public health scenario suggest that many COVID-19 patients may not be detected promptly and will not receive appropriate care. Because of the extremely infectious existence of the virus, these patients increase disease breakout [16].

Some early authors have identified imaging variations on chest radiography as healthcare clinicians, epidemiologists, virologists, phylogeneticists, and others collaborate with public health authorities and decision-makers to identify the pathogenesis of infection and monitor the transmission of disease [17]. Chest CT can be considered a key instrument for the ongoing identification of COVID-19 in outbreak regions [18]. Hence, in this study, we retrospectively analyzed chest CT imaging manifestations of COVID-19 disease patients to facilitate prompt early detection of disease and speed up the measures required for infected patients. On the other hand, it seems that the elderly and people with chronic underlying diseases not only show more clinical symptoms, but also develop more severe pneumonia, which makes them more difficult to treat. Thus, we further compared clinical symptoms and CT signs for two groups.

2. Materials and Methods

2.1. Patients

The study was accepted by the ethical review committee and, owing to the retrospective nature of the study, the informed consent of patients was forgiven. The patients were enrolled in a hospital, from March 10, 2020, until May 5, 2020. All patients confirmed to have an RT-PCR test for COVID-19 infection. CT photos, demographic and some clinical data of all patients were gathered and retrospectively analyzed for this study. In addition, the patients were divided as follows into two groups: young and middle-aged (< 60 years of age) and elderly (60 years of age).

2.2. CT Scanning Technique and Parameters

CT scanning was conducted using one of the following scanners: 16-slice Somatom Sensation Scanner (Siemens, Germany) and Single Slice Equilibrium Scanner (Siemens, Germany). All patients with unenhanced CT scan and spiral protocol were scanned in the supine position. The scanning parameters were as follows: tube voltage

110 and 130 kVp, tube current-time product 50-90 mAs for balance single-slice scanner, and tube current was adjusted by an automatic exposure control system (CARE Dose 4D) for 16-slice Somatom Sensation scanner, pitch 1.5 and 1.6, reconstructed slice thickness 5 mm.

2.3. Image Interpretation

Two radiologists (5 and 10 years of experience) examined and interpreted all CT images. They also called for compromise in the event of any dispute. Both lung and mediastinal window settings were tested for the CT images. For the numerous changes in the thoracic area, the radiologists analyzed the images as follows: (1) lung lesion aspects: GGO, consolidation, mixed GGO and consolidation, mad paving sign, air bronchogram, cavitation, increased bronchial wall thickening, vascular perforator sign; (2) distribution of lung lesions: affected lung (unilateral or bilateral), transverse distribution (central, peripheral and non-transverse), craniocaudal distribution (predominantly of the upper lung, predominantly of the lower lung or not of craniocaudal tendency), and lobar involvement (3) out of lung changes: lymphadenopathy, pleural effusion, pericardial effusion or other lesions.

2.4. Statistical Analysis

All data were imported and analyzed using SPSS software (version 23). Clinical and CT findings were provided as numbers and percentages. Comparison between two groups was performed by chi-square or Fisher exact test. P values of less than 0.05 were considered to be statistically significant.

3. Results

3.1. Clinical Findings

Totally, this study included 75 patients (mean age, 58.43 ± 19.57 years old; range 20-90 years) who confirmed COVID-19 pneumonia in the laboratory. Demographic and clinical characteristics are listed in Table 1.

The number of men and women who were enrolled was 36 (48 %) and 39 (52 %), respectively. As for the first symptoms, fever was observed in 55 patients (73.3%), cough in 49 patients (65.3%), muscle pain in 8 patients (10.6%), and shortness of breath in 48 patients (64%). Five patients showed no initial symptoms. One patient had diabetes, two had hypertension, and two had chronic kidney disease regarding the history of other diseases.

Table 1. Demographic and clinical features of COVID-19 patients

Parameter	Value
Sex	
Men	36 (48%)
Women	39 (52%)
Age (year)	
Mean	58.43
Standard deviation	± 19.57
Range	20-90
Symptoms	
Fever	55 (73.3%)
Cough	49 (65.3%)
Muscle pain	8 (10.6%)
Shortness of breath	48 (64%)
No obvious symptoms	5 (6.6%)
History of other Diseases	
Diabetes	1 (1.3%)
Hypertension	2 (2.6%)
Chronic kidney disease	2 (2.6%)

3.2. CT Findings

Various manifestations of COVID-19 patients were noted on CT images. Assessment of changes in CT images in pulmonary lesion aspects indicated that 33 patients (44%) had GGO, 15 patients (20%) had consolidation, 24 patients (32 %) had mixed GGO and consolidation, 2 patients (2.6 %) had bronchial wall thickening, 10 patients (13.3 %) had crazy paving signs, 35 patients (46.6 %) had air bronchogram, 7 patients (9.3 %) had air bronchogram. CT images were normal for 3 patients (4 %). Lymphadenopathy in one patient (1.3%), pleural effusion in 12 patients (16%), and pericardial effusion in 2 patients (2.6%) were observed in terms of out of lung changes (Table 2).

Table 2. Results of CT findings

CT Manifestations	Patients (n=75)
Pulmonary Lesion Aspect	
GGO	33 (44%)
Consolidation	15 (20%)
Mixed GGO and Consolidation	24 (32%)
bronchial wall thickening	2 (2.6%)
Crazy paving sign	10 (13.3%)
Air bronchogram	35 (46.6%)
Cavitation	7 (9.3%)
Tree in bud	2 (2.6%)
Normal CT	3 (4%)
Right/Left Distribution	
Right lung predominant	25 (33.3%)
Left lung predominant	13 (17.3%)
Equivalent in both lung	34 (45.3%)
Craniocaudal Distribution	
Upper lung predominant	4 (5.3%)
Lower lung predominant	45 (60%)
No craniocaudal tendency	23 (30.6%)
Transverse Distribution	
Central	3 (4%)
Peripheral	43 (57.3%)
No transverse tendency	26 (34.6%)
Lung Region Distribution	
Unilateral	13 (17.3%)
Bilateral	59 (78.6%)
Dispersity Distribution	
1	7 (9.3%)
≥ 2	17 (86.6%)
Out of Lung Changes	
Lymphadenopathy	1 (1.3%)
Pleural effusion	12 (16%)
Pericardial effusion	2 (2.6%)
Lobar Involvement	
Right Upper Lobe (RUL)	32 (42.6%)
Right Middle Lobe (RML)	43 (57.3%)
Right Lower Lobe (RLL)	64 (85.3%)
Left Upper Lobe (LUL)	39 (52%)
Left Lower Lobe (LLL)	53 (70.6%)

In 59 patients (78.6 %), both lungs were infected while unilateral involvement was noted in 13 patients (17.3 %). Of these 13 patients, 10 patients involved right lung, and 3 patients involved left lung. Lesions were found mainly in the peripheral (57.3 %) and lower lung (60 %) regions. Predominantly right lung was observed in 25 patients (33.3 %), predominantly left lung in 13 patients (17.3 %) and equivalent involvement in both lungs in 34 patients (45.3 %). Viruses infected the right upper lobe in 32 patients (42.6%), the right middle lobe in 43 patients (57.3%), the right lower lobe in 64 patients (85.3%), the left upper lobe in 39 patients (52%), and the left lower lobe in 53 patients (70.6%). Figure 1 and 2 show some CT images of the patients (Table 2).

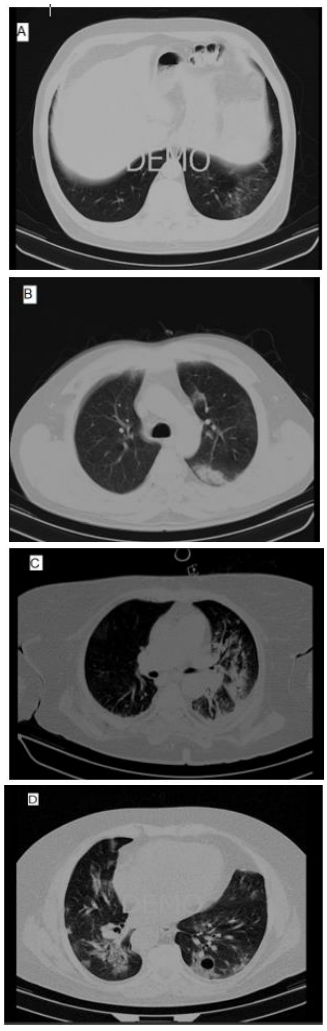

Figure 1. (A) A CT image of a 37-year-old shows peripheral ground-glass opacities in left lower lobe. (B) A CT image of a 49-year-old man shows peripheral consolidation in left upper lobe. (C) A CT image of 63-year-old woman shows air bronchogram in left lung. (D) A CT image of 67-year-old man shows a cavitation in left lung

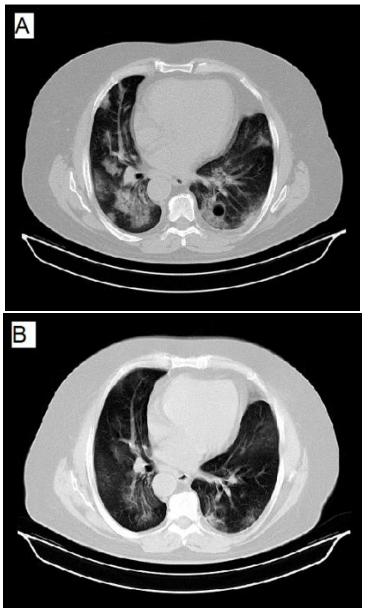

Figure 2. Two CT images of a 63-year-old woman at different times. (A) CT scan was performed one day after admission showing a cavity in the lower left lung. (B) CT scan was performed 19 days after admission showing that lesions surrounding cavity reabsorbed and the size of cavity was reduced

3.3. Comparison between Two Groups

Comparison of clinical symptoms and CT manifestations between the two groups is summarized in Table 3. There was no significant difference in two-group clinical symptoms ($P > 0.5$), with one exception for cough that was significantly higher for the elderly ($P < 0.05$). There were no significant differences within the two groups in GGO, consolidation, mixed GGO, and consolidation and air bronchogram. In the elderly group, pleural effusion and multiple lobe involvement were considerably higher than that in the young and middle-aged group ($P < 0.05$).

4. Discussion

Pneumonia's high virulence power has confronted the world with global concerns. Current information, early diagnosis, and prompt separation of the infected from the healthy population are the most efficient ways of combating this pandemic [11]. Currently, the RT-PCR test is a first-line screening tool for COVID-19 pneumonia, but this procedure requires time and has some other problems [12].

Patient CT images showed various aspects, including GGO, consolidation, combined GGO and consolidation, and air bronchogram. The distribution of lesions was predominantly in lower, bilateral, and peripheral lung regions. In the elderly group, pleural effusion and involvement of multiple lobes is statistically higher than that of the young and middle-aged group. CT imaging with a high sensitivity detection of lung lesions and precisely as rapid inspection can be seen as an appropriate alternative to RT-PCR scanning.

In our analysis, mean patient age was 58.43 years old, which may indicate mainly COVID-19 contaminated elderly. There was no significant gender gap, as well. These results are consistent with research by Shi *et al.* [19].

Table 3. Comparison of two groups with regard to clinical symptoms and CT manifestations

Variable	Group 1 (Young and Middle-Aged) (n=32)	Group 2 (Elderly) (n=40)
Clinical Symptoms		
Fever	27	28
Cough	19	30
Muscle pain	3	5
Shortness of breath	19	29
CT Manifestations		
GGO	18	15
Consolidation	6	9
Mixed GGO and Consolidation	10	14
Multiple lobe involvement	18	36
Pleural effusion	2	10
Air bronchogram	13	22

In evaluating and examining the CT characteristics of 62 cases of COVID-19 pneumonia in China, researchers observed that cases more commonly presented as multiple lesions on the original CT scan (83.9 %); nevertheless, 16.1 % of cases existed as single lesions, and 70.0 % of those cases occurred in the lower right lung lobe [20]. In moderate instances, the visual trend of multifocal peripheral ground glass or mixed illumination of predominance in the lower lung is extremely suggestive of COVID-19 throughout the first week of disease onset. Nevertheless, after testing positive for COVID-19, certain patients can present with a typical chest finding [21].

In our sample, the most common clinical symptoms of contaminated patients were fever (73.3 %), cough (65.3 %), and shortness of breath (64 %). These signs are seen in patients with low infection in the respiratory tract [22]. Hence these signs can be used for improved screening in COVID-19 pneumonia cases. Interestingly, all three patients with no apparent signs had irregular CT scans of the lung, indicating that in this situation, CT scans would help rapidly detect people in infectious households and patients at high risk. Most patients (86.6 %) had multiple lesions, but 9.3 % of patients had one lesion in the first CT scan, based on the dispersity distribution of lesions. This could be due to varying periods between first developing signs and hospital referrals. It should be remembered that for all patients the first CT scan was performed 0-1 day after the date of admission.

Our findings revealed that activity in the right lobe (85.3 %) was more prominent in line with other studies [19, 20, 23]. This may be related to the peculiar anatomical properties of the lobe on the right bottom. The right lower lobe bronchus is narrow and erect, making it more vulnerable to invasion by viruses. In terms of transverse and craniocaudal distribution, activity was reported primarily in the lower lung region (60%) and peripheral area (57.3%), in line with previous studies [19, 20, 24], and also consistent with the signs of SARS and MERS [25].

An Italian analysis showed the usual form of COVID-19 pneumonia was peripheral ground-glass opacity with multilobe and subsequent intervention, longitudinal spread, and subsegmental vessel enlargement (> 3 mm). Chest CT was highly adaptive (97%) but lower in precision (56%) [26].

Various CT improvements were observed in patients with COVID-19 pneumonia; GGO (44%), consolidation (20%), mixed GGO and consolidation (32%), bronchial wall thickening (2.6%), mad paving sign (13.3%) and air bronchogram (46.6%), along with other research [19, 20, 23] and also consistent with SARS and MERS [20]. The development of a high proportion of GGO and elements of aggregation shows that COVID-19 induces damage to both the lung interstitium and parenchyma. Invasion by more viruses can increase the opacity by GGO lesions, which can appear as insane signs of paving. Air bronchogram refers to oxygen-filled bronchi surrounded by airless lung, as a result of contraction of the lungs. In addition, viruses may invade bronchial cells and cause inflammation which tends to thicken bronchial walls.

In our sample, cavitation was found in 7 patients (9.3 %), although in other studies this was unusual [24]. Cavitation has vanished in the time span of treatment in three patients with a follow-up CT scan. Figure 2 displays CT photographs of a 63-year-old woman one day after admission and 19 days after entry. Figure 2B shows that the opacities around cavitation have been reabsorbed, and the extent of cavitation has been, which, showing treatment success. Cavitation, as an unusual symptom of CT in COVID-19 pneumonia, requires further study with a larger sample population.

In our research, in accordance with other studies, lymphadenopathy (1.3 %) and pericardial effusion (2.6 %) were unusual features of CT [19, 24].

In the last CT scan, i.e. after beating COVID-19, pericardial effusion in all two patients was disappeared, indicating myopericarditis consistent with COVID-19. We found 12 patients with pleural effusion (16 %), and these patients were in the advanced COVID-19 pneumonia process. This indicates that pleural effusion, consistent with Heshui Shi [19] and Huang *et al.* [27] can occur in extreme COVID-19 pneumonia.

Some comparisons between COVID-19 pneumonia and SARS and MERS in terms of lesion distribution and CT aspects enable physicians to closely examine clinical signs and specific types of changes in CT pictures, such as pleural effusion, vascular changes [20], and so on.

Consolidation and air bronchogram were higher in aged population patients as compared to two cohorts, but not statistically important. In addition, pleural effusion and multiple lobe involvement were significantly higher in the elderly population, which could be due to increased

susceptibility of the elderly to COVID-19 infection, which may indicate disease severity. Although our results showed that only cough was significantly higher in elderly group, Jia Cao *et al.* [28] reported that fever, cough, and weakness were significantly higher in elderly group. Also they reported that GGO was significantly higher in young group, which is not in consistent with our findings. These discrepancies may be related to different sample sizes (75 patients in our study versus 183).

5. Conclusion

Patient CT images showed various aspects, including GGO, consolidation, combined GGO and consolidation, and air bronchogram. The distribution of lesions was predominantly in lower, bilateral, and peripheral lung regions. In the elderly group, pleural effusion and involvement of multiple lobes are statistically higher than that of the young and middle-aged group.

Ethical Approval

The study was approved by the regional ethical committee of Gonabad University of Medical Sciences (IR.GMU.REC.1399.010).

References

1- C. Huang *et al.*, "Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China," *The Lancet*, vol. 395, no. 10223, pp. 497-506, 2020.

2- N. Zhu *et al.*, "A novel coronavirus from patients with pneumonia in China, 2019," *New England Journal of Medicine*, 2020.

3- Q. Li *et al.*, "Early transmission dynamics in Wuhan, China, of novel coronavirus–infected pneumonia," *New England Journal of Medicine*, 2020.

4- M. Roser, H. Ritchie, and E. Ortiz-Ospina, "Coronavirus Disease (COVID-19)–Statistics and Research," *Our World in Data*, 2020.

5- A. R. Fehr and S. Perlman, "Coronaviruses: an overview of their replication and pathogenesis," *in Coronaviruses: Springer*, pp. 1-23, 2015.

6- A. Filatov, P. Sharma, F. Hindi, and P. S. Espinosa, "Neurological complications of coronavirus disease (covid-19): encephalopathy," *Cureus*, vol. 12, no. 3, p. e7352, 2020.

7- Y. C. Li, W. Z. Bai, and T. Hashikawa, "The neuroinvasive potential of SARS-CoV2 may play a role in the respiratory failure of COVID-19 patients," *Journal of medical virology*, 2020.

8- R. L. Graham, E. F. Donaldson, and R. S. Baric, "A decade after SARS: strategies for controlling emerging coronaviruses," *Nature Reviews Microbiology*, vol. 11, no. 12, pp. 836-848, 2013.

9- W. H. Organization, "Novel coronavirus (2019-nCoV)," *Situation report*, vol. 28, 2020.

10- W. Wang, J. Tang, and F. Wei, "Updated understanding of the outbreak of 2019 novel coronavirus (2019-nCoV) in Wuhan, China," *Journal of medical virology*, vol. 92, no. 4, pp. 441-447, 2020.

11- G. O. o. N. H. Committee, "Notice on the issuance of a program for the diagnosis and treatment of novel coronavirus (2019-nCoV) infected pneumonia (trial revised fifth edition)," ed, 2020.

12- Y. Yang *et al.*, "Laboratory diagnosis and monitoring the viral shedding of 2019-nCoV infections," *medRxiv*, 2020.

13- M. Chung *et al.*, "CT imaging features of 2019 novel coronavirus (2019-nCoV)," *Radiology*, p. 200230, 2020.

14- S. Kooraki, M. Hosseiny, L. Myers, and A. Gholamrezanezhad, "Coronavirus (COVID-19) outbreak: what the department of radiology should know," *Journal of the American college of radiology*, 2020.

15- A. Mahdavi *et al.*, "Radiologic Management of COVID-19: Preliminary Experience of the Iranian Society of Radiology COVID-19 Consultant Group (ISRCC)," *Iranian Journal of Radiology*, no. In Press, 2020.

16- H. Xu *et al.*, "Analysis and Prediction of False Negative Results for SARS-CoV-2 Detection with Pharyngeal Swab Specimen in COVID-19 Patients: A Retrospective Study," *MedRxiv*, 2020.

17- A. Bernheim *et al.*, "Chest CT findings in coronavirus disease-19 (COVID-19): Relationship to duration of infection," *Radiology*, p. 200463, 2020.

18- T. Ai *et al.*, "Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases," *Radiology*, p. 200642, 2020.

19- H. Shi *et al.*, "Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study," *The Lancet Infectious Diseases*, 2020.

20- W. Zhao, Z. Zhong, X. Xie, Q. Yu, and J. Liu, "Relation between chest CT findings and clinical conditions of coronavirus disease (COVID-19) pneumonia: a multicenter study," *American Journal of Roentgenology*, vol. 214, no. 5, pp. 1072-1077, 2020.

21- W. Yang *et al.*, "Clinical characteristics and imaging manifestations of the 2019 novel coronavirus disease (COVID-19): A multi-center study in Wenzhou city, Zhejiang, China," *Journal of Infection*, 2020.

22- R. Nijman, M. Thompson, M. van Veen, R. Perera, H. Moll, and R. Oostenbrink, "Derivation and validation of age and temperature specific reference values and centile charts to predict lower respiratory tract infection in children with fever: prospective observational study," *Bmj*, vol. 345, 2012.

23- S. Zhou, Y. Wang, T. Zhu, and L. Xia, "CT features of coronavirus disease 2019 (COVID-19) pneumonia in 62 patients in Wuhan, China," *American Journal of Roentgenology*, vol. 214, no. 6, pp. 1287-1294, 2020.

24- X. He, J. Zheng, J. Ren, G. Zheng, and L. Liu, "Chest high-resolution computed tomography imaging findings of coronavirus disease 2019 (Covid-19) pneumonia," *International Journal of Radiation Research*, vol. 18, no. 2, pp. 343-349, 2020.

25- P. Zhou *et al.*, "A pneumonia outbreak associated with a new coronavirus of probable bat origin," *nature*, vol. 579, no. 7798, pp. 270-273, 2020.

26- D. Caruso *et al.*, "Chest CT features of COVID-19 in Rome, Italy," *Radiology*, p. 201237, 2020.

27- H. Lu, H. Rui, Y. Pengxin, W. Shaokang, and X. Liming, "A correlation study of CT and clinical features of different clinical types of 2019 novel coronavirus pneumonia," *Chin J Radiol*, vol. 54, pp. E003-E003, 2020.

28- J. Cao, J. Zhou, Q. Long, G. Ling, and X. Liao, "Clinical and Imaging Features of Novel Coronavirus Pneumonia in the Elderly Compared with Young and Middle-Aged Individuals," *Iranian Journal of Radiology*, vol. 17, no. 4, 2020.