

Chest CT imaging features of critically ill COVID-19 patients

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Abstract

Objectives To analyze the findings of computed tomography (CT) imaging in critically ill patients diagnosed with coronavirus disease 2019 (COVID-19).

Methods This retrospective study reviewed 60 critically ill patients (43 males and 17 females, mean age 64.4 ± 11.0 years) with COVID-19 pneumonia who were admitted to two different clinical centers. Their clinical and medical records were analyzed, and the chest CT images were assessed to determine the involvement of lobes and the distribution of lesions in the lungs between the patients who recovered from the illness and those who died.

Results Patients were significantly older in the death group (10/60, 16.67%) than in the recovery group (50/60, 83.33%) ($p=0.044$). C-reactive protein (CRP) (67.9 ± 50.5 mg/L) was significantly elevated in the death group as opposed to the recovery group ($p < 0.001$). The neutrophil-to-lymphocyte ratio (NLR) was higher in the death group when compared with the recovery group ($p=0.030$). Involvement of five lung lobes was found in 98% of the patients, with medial or parahilar area involvement observed in all the death patients. Ground-glass opacities (97%), crazy-paving pattern (92%) and air bronchogram (93%) were the most common radiological findings. Presence of emphysema was more prevalent in the death group than in the recovery group (30% vs 2%, $p=0.011$).

Conclusions The degree of lung involvement and lesion distribution with dominance in the medial and parahilar pulmonary areas were more severe in the death patients than in those who recovered. Patient's age, emphysema, CRP and NLR could be combined with CT to predict the disease outcomes.

Introduction

From early December 2019, coronavirus disease 2019 (COVID-19), which is caused by the novel coronavirus (2019-nCoV), has rapidly spread from Wuhan to other regions of China and countries around the world. According to the World Health Organization (WHO) report, by 2 March 2020, there were 88948 confirmed cases globally, including 79968 in China, and 3043 deaths worldwide [1].

Management of critically ill patients is important to reduce the mortality of COVID-19. In China, the reported incidence of critical illness in COVID-19 patients was 17.7% in Wuhan, 10.4% in the Hubei province, and 7.0% in areas outside the Hubei province [2]. These figures necessitate attention since the incidence of critical illness among the Chinese medical staff afflicted with COVID-19 was 14.6% [2]. According to a recent study by Guan et al. who reported the clinical characteristics of COVID-19 in China through an analysis of 1099 patients, 173 (15.7%) had severe disease with a mortality of 8.1%, which was significantly higher than that in the non-severe patients (0.1%) [3]. The mortality of critically ill COVID-19 patients in China was between 38.5% and 49.0% [2, 4, 5]. Thus, it is imperative to recognize both the clinical and imaging characteristics, thus achieving superior patient management.

Recently, several studies have reported chest computed tomography (CT) imaging features and changes during recovery in COVID–19 pneumonia patients without acute respiratory distress syndrome [6–13]. The common conclusion arising from these investigations is that CT is a useful imaging modality in the diagnostic evaluation of abnormal lung changes in the patients [11, 12, 14, 15]. However, CT manifestations in critically ill patients have not been described in literature. Hence, the purpose of this study was to analyze the chest CT findings in a group of critically ill COVID–19 pneumonia patients with the aim of determining the clinical and imaging features that can be used to predict the future disease outcome.

Materials And Methods

Patients

We retrospectively reviewed the medical records of 60 critically ill COVID-19 pneumonia patients who were admitted to a hospital in Wuhan, Hubei province, and another in Huaihua, Hunan province, between 9 January 2020 and 19 February 2020. Non-contrast chest CT examinations were performed in all the patients. They were diagnosed by the local Centre for Disease Control and Prevention (CDC) (Hubei and Hunan Provinces) by using the real-time reverse-transcription–polymerase-chain-reaction (RT-PCR) assay with samples of bronchoalveolar lavage, endotracheal aspirate, nasopharyngeal swab, or oropharyngeal swab. According to the criteria for clinical severity of confirmed COVID-19 pneumonia (Table 1) [16], the patients of severe and critical type were defined as being critically ill. All CT scans were performed within 24 h for patients who met the clinical severity criteria. No exclusion criteria were applied since the selection criteria were strictly followed to include only the severely ill patients.

Table 1: Criteria for determining Clinical Severity of COVID-19 Pneumonia [16]

Types	Findings
Mild	Mild clinical symptoms [fever <38°C (quelled without treatment), with or without cough, no dyspnea, no gasping, no chronic disease] No imaging findings of pneumonia
Moderate	Fever, respiratory symptoms, imaging findings of pneumonia
Severe	Meet any of the followings: a. Respiratory distress, RR≥30 times/min b. SpO ₂ <93% at rest c. PaO ₂ /FiO ₂ ≤300 mmHg * Patients showing a rapid progression (>50%) on CT imaging within 24-48 hours should be managed as severe
Critical	Meet any of the followings: a. Respiratory failure, need mechanical assistance b. Shock c. “Extra pulmonary” organ failure, intensive care unit is needed

RR: respiratory rate; SpO₂: oxygen saturation; PaO₂: partial pressure of oxygen;
FiO₂: fraction of inspired oxygen

Patient characteristics including age, gender, clinical symptoms, time course of the symptoms before admission, medical history, laboratory results and outcomes were recorded. Furthermore, neutrophil-to-lymphocyte ratio (NLR) was calculated. Owing to the retrospective and urgent nature of the data collection (both clinical and imaging data), ethical approval and informed consent were waived since this study did not involve any potential risk to the patients.

Chest CT Examinations

Of the 60 cases, 55 were obtained from WuGang General Hospital (Wuhan, Hubei Province), and the CT scans were performed on a 64-slice scanner (SOMATOM Definition AS+, Siemens, Healthineers, Erlangen, Germany) with a slice thickness of 8 mm. The remaining 5 cases were gathered from the First Affiliated Hospital of Hunan University of Medicine (Hunan Province) on a GE Lightspeed 16-slice CT scanner (GE Medical Systems, Milwaukee, Wis) with 1.3-mm-thick transverse slices. All the examinations were conducted with the patients in a supine position under single breath-hold at the end of inspiration. The tube voltage was 120 kVp, and automatic tube current modulation was used. All CT images were reconstructed with filtered back projection (FBP) algorithm with a matrix size of 512 × 512.

Chest CT Evaluation

The CT images were independently reviewed by two cardiothoracic radiologists (having 20 years and 7 years of experience in the field), and the final decisions were reached by consensus. The following CT characteristics were recorded: (a) involvement of the pulmonary lobes and distribution of the lesion, (b) presence of lesion in terms of imaging appearances, such as ground-glass opacities (GGO), consolidation, and linear opacities, (c) accompanying signs such as crazy-paving pattern, air bronchogram and margin of the lesion, (d) presence of underlying lung disease such as emphysema, fibrosis and calcification, (e) presence of other abnormalities, including pleural effusion, pericardial effusion and thoracic lymphadenopathy.

To further assess the abnormalities in CT images, the following parameters were analyzed: unilateral or bilateral lungs involved; number of lobes involved; number of peripheral or subpleural areas (peripheral 1/3), intermediate area (mid 1/3) and medial or parahilar region (medial 1/3) involved; degree of lung involvement; and consolidative degree of the lesions. Degree of involvement and consolidation were classified as none (0%), minimal (1%–25%), mild (26%–50%), moderate (51%–75%) or severe (76%–100%), which were recorded by assigning scores of 0, 1, 2, 3 and 4, respectively.

The terms of abnormal imaging appearances were defined according to the guidelines provided by the Fleischner Society [17]. GGO opacity was defined as hazy increased lung density, with indistinct margins of bronchus and pulmonary vessels. Consolidation was defined as increased pulmonary parenchymal attenuation, with the margins of the bronchus and the pulmonary vessels being obscured. Crazy-paving pattern was defined as GGO opacity combined with reticulation or/and interlobular septal thickening. An air bronchogram is an air-filled bronchus seen clearly with low density on a background of GGO or consolidation opacity. The margin of the lesion was defined as sharp or blurred. Thoracic lymphadenopathy was defined as the short-axis dimension of lymph node ≥ 10 mm.

Statistical Analysis

The data were analyzed using SPSS 25.0 (SPSS, Inc., Chicago, IL, USA). The continuous variables were expressed as mean \pm standard deviation (SD). The comparison of discrete variables between the recovered and death groups was done by using X^2 test with continuity correction. The continuous variables were compared using Mann-Whitney U test. The differences were considered statistically significant at $p \leq 0.05$.

Results

Patient Characteristics

Of the 60 patients, 43 were males (71.7%), and their mean age was 64.4 ± 11.0 years. Patients in the death group were older than those in the recovery group by an average of 7 years. The mean time between

symptoms onset to admission was 8.9 ± 5.0 days (Table 2). Hypertension (37%) was the most common comorbidity in these critically ill patients, followed by coronary heart disease (23%). Fever (83%) and cough (77%) were the most common symptoms, followed by phlegm (55%), fatigue (55%) and loss of appetite (47%). C-reactive protein (CRP) (67.9 ± 50.5 mg/L) was elevated in all the patients, but it was significantly greater in the death group than in the recovery group ($p < 0.001$). Similarly, the NLR ratio was significantly higher in the death group when compared with the recovery group ($p = 0.03$).

Table 2. Demographics and clinical characteristics of patients with critically ill COVID-19

Characteristics					P
		All patients	Recovered Patients	Death patients	
		n = 60	n = 50	n = 10	
Gender	Male	43(72%)	36(72%)	7(70%)	1.000
	Female	17(28%)	14(28%)	3(30%)	1.000
Age (Y)		64.4±11.0	62.6±11.0	70.6±9.1	0.044
Time course of symptoms before hospital (d)		8.9±5.0	8.9±4.9	8.9±5.5	0.920
Comorbidity	Hypertension	22(37%)	18(36%)	4(40%)	1.000
	Coronary Heart Disease	14(23%)	11(22%)	3(30%)	0.891
	COPD	6(10%)	4(8%)	2(20%)	0.564
	Peptic Ulcer	9(15%)	8(16%)	1(10%)	1.000
	Stroke	6(10%)	4(8%)	2(20%)	0.564
	Diabetes	9(15%)	5(10%)	4(40%)	0.052
	Signs and symptoms	Fever	50(83%)	41(82%)	9(90%)
	Cough	46(77%)	38(76%)	8(80%)	1.000
	Phlegm	33(55%)	28(56%)	5(50%)	1.000
	Shortness of breath	27(45%)	23(46%)	4(40%)	1.000
	Myalgia	6(10%)	6(12%)	0(0%)	0.564
	Fatigue	33(55%)	29(58%)	4(40%)	0.486
	Headache and Dizziness	3(5%)	3(6%)	0(0%)	1.000
	Sore throat	1(2%)	1(2%)	0(0%)	1.000
	Loss of Appetite	28(47%)	24(48%)	4(40%)	0.908
	Nausea and Vomit	5(8%)	4(8%)	1(10%)	1.000
	Diarrhea	8(13%)	7(14%)	1(10%)	1.000
	Highest Temperature	38.6±0.7	38.6±0.7	38.7±0.7	0.723
	Heart Beat (bpm)	86.5±14.3	87.2±15.2	83.2±9.3	0.471

	Breath (bpm)	20.3±3.3	19.8±2.7	22.2±4.6	0.185
	Systolic Blood Pressure (mmHg)	114.4±21.7	111.7±22.7	126.6±9.5	0.017
	Diastolic Blood Pressure (mmHg)	84.4±25.8	87.1±27.7	72.7±7.6	0.279
Laboratory results	CRP (mg/L)	67.9±50.5	63.0±50.4	110.8±26.3	<.001
	WBC count (10 ⁹ /L)	6.7±3.6	6.3±3.3	9.6±5.3	0.030
	LYM count (10 ⁹ /L)	0.81±0.52	0.83±0.53	0.61±0.43	0.108
	NEUT count (10 ⁹ /L)	5.6±3.7	5.2±3.4	8.6±5.1	0.056
	PaO ₂ (mmHg)	78.5±28.9	80.3±28.2	62.5±34.6	0.160
	SO ₂ (%)	92.7±14.2	93.4±14.2	84.0±15.6	0.006
	NLR	9.7±9.5	8.4±7.5	18.7±16.6	0.030

COPD-chronic obstructive pulmonary disease, CRP: C-reactive protein, WBC-white blood cell, LYM-lymphocyte, NEUT-neutrophils, NLR-neutrophil-to-lymphocyte ratio.

Ten patients died in this study cohort, establishing the mortality of critically ill COVID-19 pneumonia patients to be 16.67%. The condition of the remaining 50 patients improved, and they were discharged from the hospitals. No significant difference was found in gender, time course of symptoms prior to hospitalization, and comorbidity between the recovery and death groups.

CT Findings

Bilateral lungs were involved in all the patients. Almost all the 60 patients (98%) exhibited involvement of all 5 lobes, while only 4 lobes were involved in 1 patient. In the death group, the lesions included the peripheral, intermediate, and medial areas for all the patients. Medial or parahilar area involvement was highly prevalent in the death group (recovery patients: 27/50, 54%; death patients: 10/10, 100%, p=0.018) (Fig 1). The degree of lung involvement was more severe in the death group (recovery patients: 2.0±0.7; death patients: 3.3±0.5, p<0.001), with no significant difference in the consolidative degree of the lesions (recovery patients: 1.6±1.1; death patients: 1.5±1.4, p=0.662) (Table 3).

Table 3. CT findings in critically ill COVID-19 pneumonia patients

Imaging characteristics					P
		All patients	Recovered group	Death group	
		n = 60	n = 50	n = 10	
Involvement and distribution	Bilateral lungs involved	60(100%)	50(100%)	10(100%)	NA
	4 lobes involved	1(2%)	1(2%)	0(0%)	1.000
	5 lobes involved	59(98%)	49(98%)	10(100%)	1.000
	Peripheral area involved	60(100%)	50(100%)	10(100%)	NA
	Intermediate area involved	52(87%)	42(84%)	10(100%)	0.396
	Medial area involved	37(62%)	27(54%)	10(100%)	0.018
	Degree of lung involvement	2.2±0.9	2.0±0.7	3.3±0.5	<.001
	Consolidative degree of lesions	1.6±1.1	1.6±1.1	1.5±1.4	0.662
Presence of Lesion Types	GGO	58(97%)	48(96%)	10(100%)	1.000
	Consolidation	41(68%)	35(70%)	6(60%)	0.804
	Linear Opacities	13(22%)	13(26%)	0(0%)	0.161
Accompanied Signs	Crazy-paving Pattern	55(92%)	45(90%)	10(100%)	0.676
	Air Bronchogram	56(93%)	46(92%)	10(100%)	0.817
	Clear Margin	12(20%)	10(20%)	2(20%)	1.000
	Blur Margin	59(98%)	49(98)	10(100%)	1.000
Underlying Lung Diseases	Emphysema	4(7%)	1(2%)	3(30%)	0.011
	Fibrosis	1(2%)	1(2%)	0(0%)	1.000
	Calcification	13(22%)	10(20%)	3(30%)	0.779
Other Abnormalities	Pleural Effusion	15(25%)	12(24%)	3(6%)	1.000
	Pericardial Effusion	2(3%)	2(4%)	0(0%)	1.000

GGO appearances were noted in 97% of the patients (Fig. 2), with consolidation in 68% and linear opacities in 22% (Fig 3). There was no significant difference between the recovery and death patients in the lesion types. Crazy-paving pattern (92%) and air bronchogram (93%) were discernable in almost all the patients (Fig. 4 and 5). The margin of the lesions was blurred in 98% of the patients and clear in only 20% (Fig. 6). No significant difference was noticed between the recovery and death patients in the presence of the above-mentioned signs.

The presence of emphysema was more common in the death group (recovery patients: 2%; death patients: 30%, $p=0.011$). Only 1 (2%) patient exhibited fibrosis in the CT images. Calcified lesions were found in 22% of the patients. Pleural effusion was evident in 25% of the patients and pericardial effusion in 3%. Lymphadenopathy was not found in any of the patients.

Discussion

In this study, we focused on the analysis of basic clinical information, comorbidity, symptoms, laboratory results, clinical outcomes and CT findings in 60 critically ill COVID-19 pneumonia patients. This investigation is different from the previous ones which had included different categories of COVID-19 patients and compared mild with moderate or severe, severe with non-severe, and intensive care unit (ICU) with non-ICU patients [2, 18-21]. Of the 60 patients in our study, 10 (16.67%) died; thus, the mortality rate is similar to the 15% that was reported by Huang et al. [4] but much higher than the 1.4% for all the patients and 8.1% for the severe patients as documented by Guan et al. [3]. However, most of the patients (93.6%) remained in the hospital in the study by Guan et al.; therefore, the clinical outcomes were unknown at the time of publication despite the analysis of a large sample size. The mortality rate in our cohort is lower than the 38.5 and 49% that was reported in China [2, 4, 5, 22]. The low mortality recorded in these investigations could have been due to enrolment with the exclusion of critically ill COVID-19 patients. It could also have been due to the fact that not all the patients received CT scans within 24 h, considering the emergency of the situation.

Since the outbreak of COVID-19, several studies are available in literature and some of them have focused on the description of chest imaging features [6-15, 18-21, 23]. Typical chest CT findings include GGO and consolidation, which are seen in most of the patients, while other findings include crazy-paving pattern, interlobular thickening and linear opacities. These reported findings are based on patients with mild and moderate disease. However, there is a lack of information about analyzing the imaging features in severely ill patients. In such a context, our study has uniquely presented the imaging findings regarding the involvement and distribution patterns in critically ill or severe COVID-19 pneumonia patients. In the mild and moderate types of patients, only few pulmonary lobes were involved according to the previous studies (1-3 lobes involvement: 29-44.4%; 4 lobes involvement: 11.1-19%; 5 lobes involvement: 38-44.4%) [6, 7]. However, in this study of the critically ill patients, involvement of all 5 lobes was observed in 98% of the patients. A larger proportion of intermediate (87%) and medial (62%) areas was involved in our

recruited critically ill patients, which was in contrast with the predominant peripheral involvement in the mild and moderate patients [7, 11, 13, 24]. Among the critically ill patients in this study, the mean degree of lung involvement was 2.2 ± 0.9 with a range of 0-4, which represents nearly 50% of the lung field being involved. In the death group, the mean score was 3.3 ± 0.5 , indicating a higher degree of lung involvement. In the research by Chung et al. [7], a total of the lung severity scores of mild and moderate patients were calculated and a summation of each lobe score (with similar 0-4 scales) was performed to determine the degree of involvement of the lung field. Their results showed that the mean total lung severity score was 9.9 in a range of 0-20. Our results aid in predicting the extent of disease in these critically ill patients by analyzing the degree of lung involvement based on chest CT images.

According to the MuLBSTA scoring system [25], multilobular infiltrates, lymphocyte $\leq 0.8 \times 10^9/L$, bacterial coinfection, acute-smoker, quit-smoker, hypertension and age ≥ 60 years are the mortality risks for viral pneumonia. In this work, although 5 lobes were infiltrated in most patients, medial or parahilar area involvement and the degree of lung involvement were significantly higher in the death group. Involvement range and degree might be the potential risk predictors on CT images in the COVID-19 pneumonia patients. Our patient sample is different from those in other studies as we evaluated the clinical and imaging features in the critically ill patients with pneumonia. Since emphysema was more common in the death group, it could be hypothesized that an underlying lung disease may also affect the clinical outcome. Furthermore, patients with low lymphocyte count, hypertension and old age appeared more frequently in the death group.

The NLR was identified as the independent risk factor for predicting critical illness in the COVID-19 pneumonia patients, with 3.13 serving as a good cut-off value [26]. In this research, the average NLR of the 60 patients was 9.7 ± 9.5 , which is significantly higher than the recommended value of 3.13. Moreover, the NLR was significantly higher in the death patients (nearly double the value of the recovery group), indicating its potential to predict not only critical illness but also death in the severely ill patients.

Despite numerous reports on COVID-19 being available in literature, to our knowledge, only the clinical factors or imaging features associated with disease severity have been documented [27, 28]. For instance, Liu et al. analyzed 78 COVID-19 pneumonia patients, focusing only on the clinical factors with regard to their effects on disease progression [27]. In their group, 11 patients demonstrated deterioration of the situation, while 67 exhibited improvement or stabilization. Akin to our findings, patient age, CRP, pre-existing conditions such as smoking history and respiratory failure, albumin, and maximum body temperature on admission were identified as the factors responsible for COVID-19 progression. Li et al. compared 25 critically ill COVID-19 pneumonia patients with 55 ordinary patients in terms of their clinical and CT imaging features [28]. In addition to the common CT imaging findings associated with COVID-19 patients, they used the CT scores to determine the diagnostic value of this technique in differentiating these two situations. Older age, comorbidities, increased CRP and neutrophil ratio, decreased lymphocytes and higher CT scores were directly related to severe or critical illness. These findings, along with ours, further confirm the value of these combined factors in assisting clinical-decision making while evaluating the disease severity for prediction of outcomes.

Some limitations exist in this study. First, this was a preliminary description of the CT findings in critically ill COVID-19 pneumonia patients. The sample size was relatively small owing to the strict selection criteria applied to these patients. Thus, further studies with the inclusion of more cases should be conducted so that robust conclusions could be drawn. Second, as the CT follow-up scans were done at different clinical sites, only the first scan taken within 24 hours of critical illness onset was described in this work. Change of chest CT findings in critically ill patients, including the recovery and death process, can provide additional information for clinical outcome prediction and management assessment. Besides, we did not follow-up on the recovered patients. A recent research reported that some recovered patients may still be carriers of the virus [29]. Therefore, long-term follow-up of these patients is necessary, which should be the focus of future research. Lastly, no autopsy was performed in the death patient group. Upon comparison with the pathological results, additional and a more precise interpretation of the CT image signs will be available in the future work.

In conclusion, this study involving critically ill COVID-19 patients has revealed that ground-glass opacities, crazy-paving pattern and air bronchogram represent the most common findings, with more of the pulmonary lobes involved in the patients. Medial and intermediate area involvements in the lungs were more often seen in the death group than in the recovery group. Additionally, some clinical and laboratory factors such as patient age, co-existing emphysema, CRP and NLR could be used to predict the disease outcomes as they were significantly higher in the patients who succumbed to the disease than in those who recovered from it. Follow-up of the recovery patients is necessary to confirm whether they continue to harbor the virus despite the absence of clinical symptoms.

Abbreviations

CDC	Centre for disease control and prevention
COPD	Chronic obstructive pulmonary disease
CT	Computed tomography
COVID-19	Coronavirus disease 2019
CRP	C-reactive protein
FiO ₂	Fraction of inspired oxygen
GGO	Ground glass opacities
ICU	Intensive care unit
LYM	Lymphocyte
NEUT	Neutrophils

NLR	Neutrophil-lymphocyte ratio
PaO ₂	Partial pressure of oxygen
RR	Respiratory rate
RT-PCR	Reverse-transcription–polymerase-chain-reaction
SD	Standard deviation
SpO ₂	Oxygen saturation
WBC	White blood cell
WHO	World Health Organization

Declarations

Funding information

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Conflict of interest

The authors declare no conflict of interest in this work.

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Figures

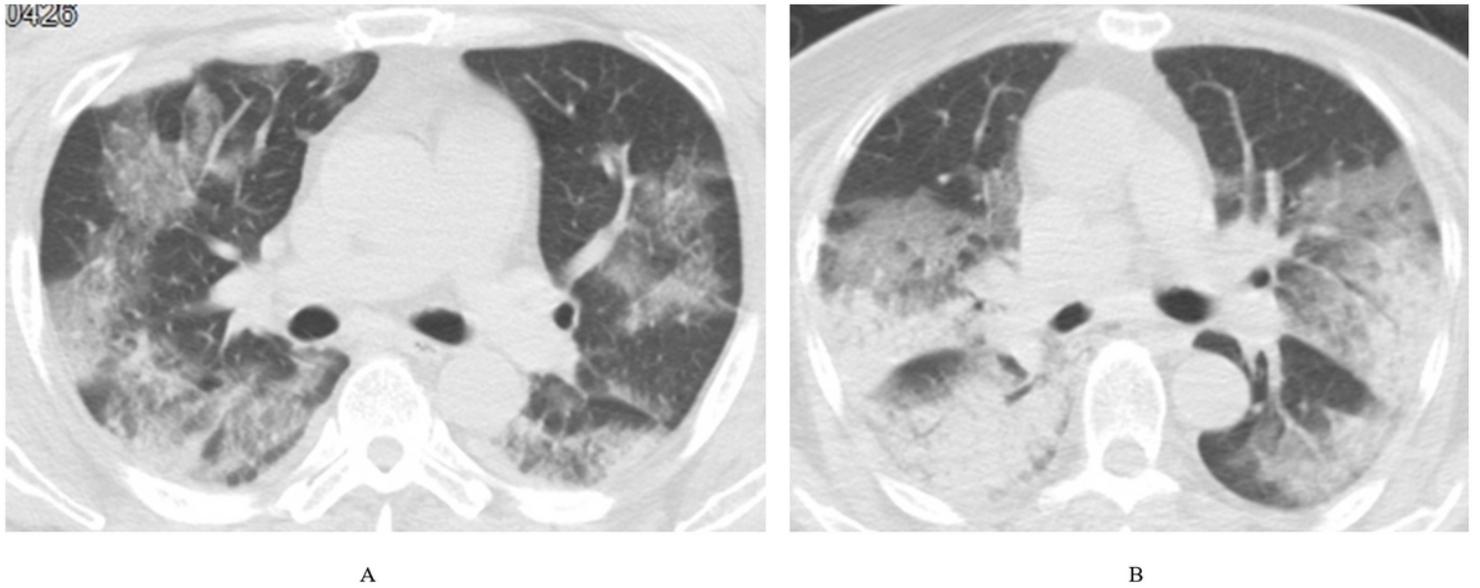


Figure 1

Lesion distribution in the lung fields of critically ill patients with COVID-19. A: A 53-year-old male critically ill COVID-19 patient whose symptoms improved and was discharged from the hospital after treatment. CT shows the lesions infiltrating the peripheral and intermediate lung fields, with a lung involvement degree of 26-50% and lesion consolidation degree of 1-25%. B. A 77-year-old female critically ill patient with COVID-19 who eventually died. Peripheral, intermediate, and medial areas were seen to be simultaneously involved on CT, with lung involvement and lesion consolidation degrees of 51%-75%.

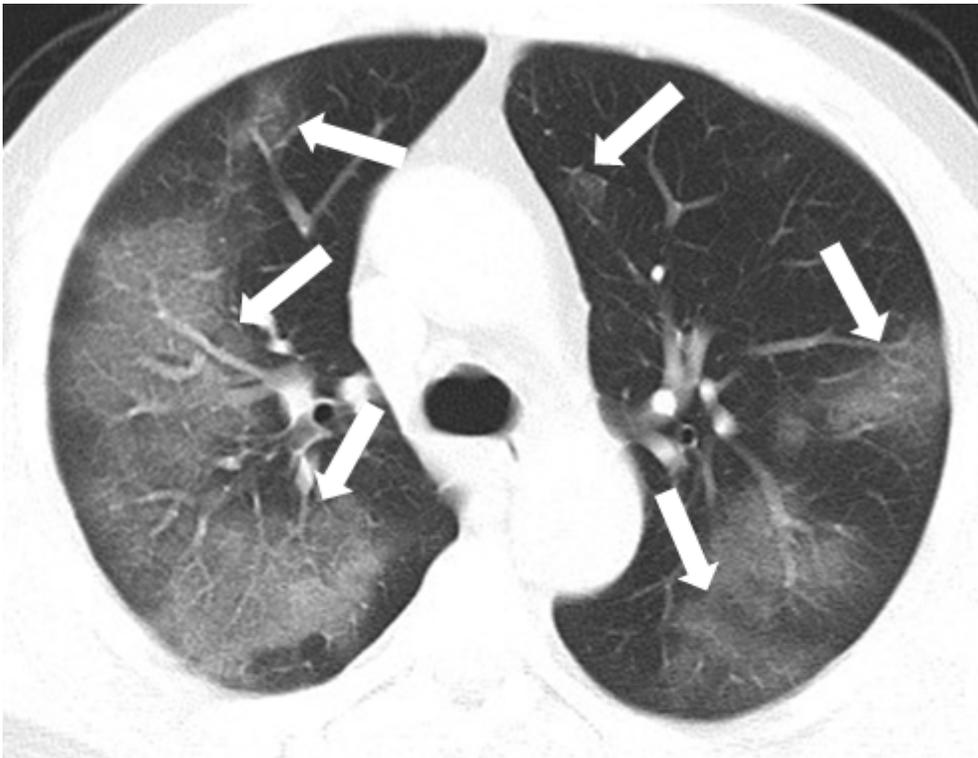
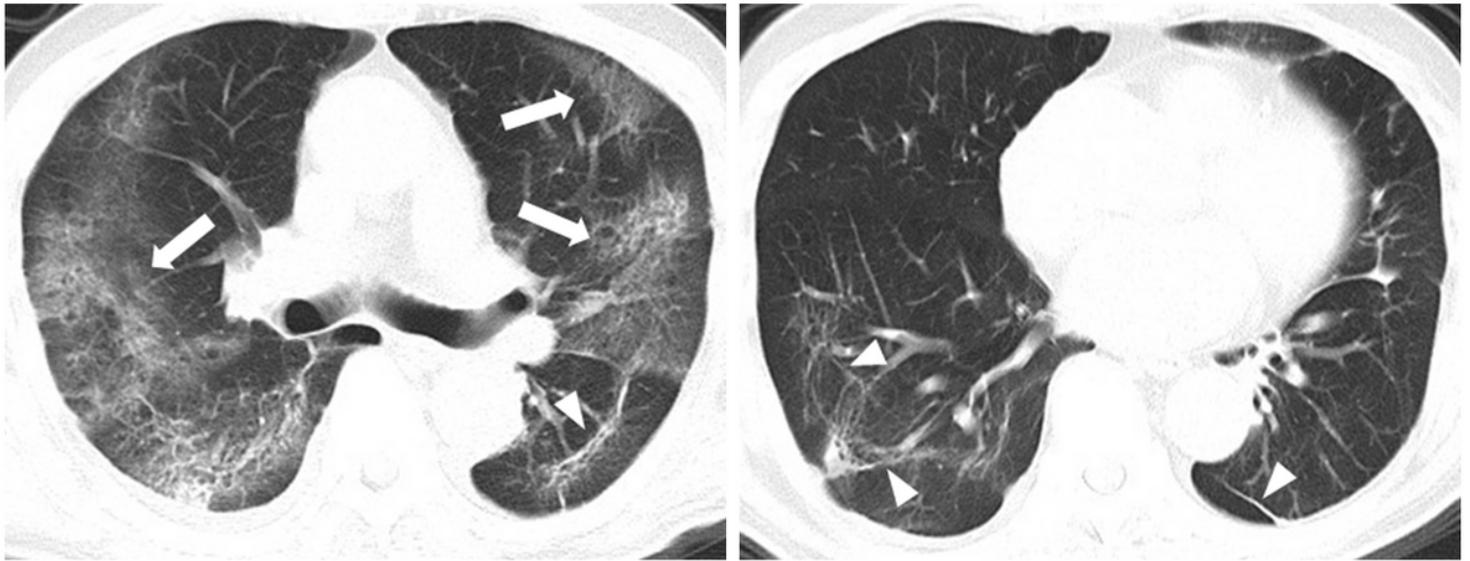


Figure 2

A 52-year-old male critically ill patient with COVID-19 who recovered after treatment. Multiple pure GGO lesions were seen in the peripheral and intermediate lung fields (arrows) on the CT image. GGO: ground glass opacities.



A

B

Figure 3

A 77-year-old male critically ill COVID-19 patient who recovered after treatment. GGO (arrows in A) and linear opacities (arrowheads in B) are presented in the same patient on the CT images. GGO: ground glass opacities.

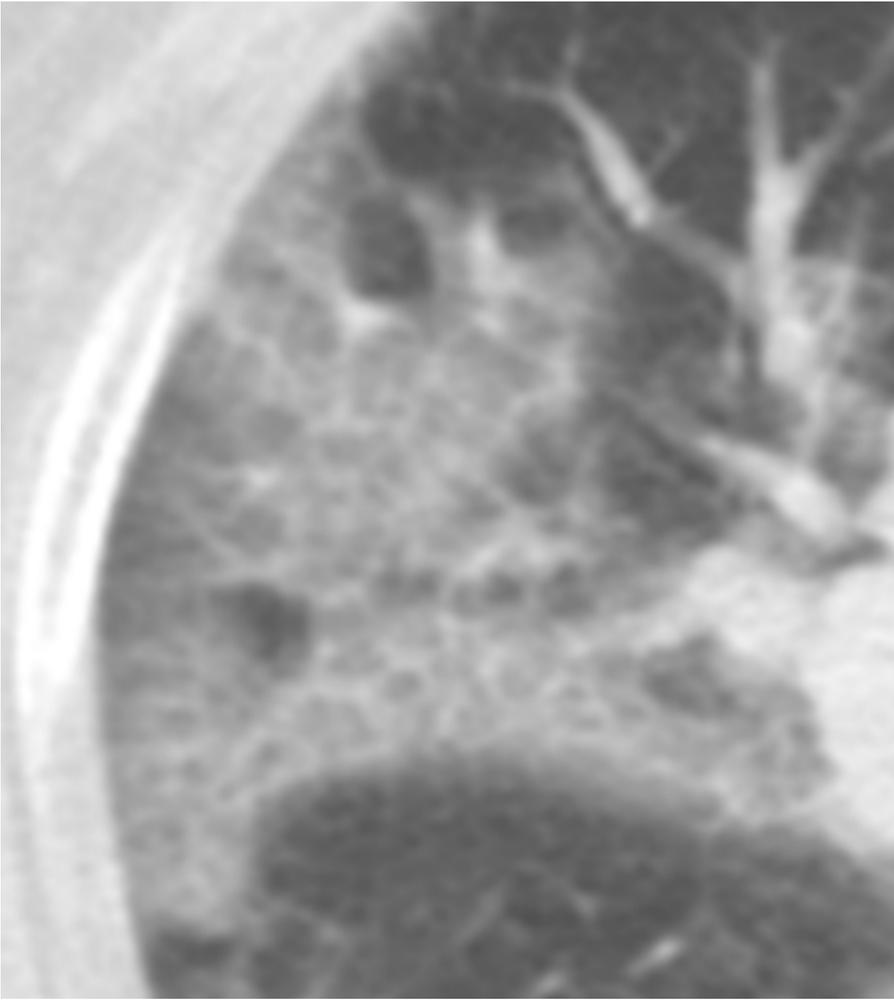


Figure 4

Crazy-paving pattern in a 65-year-old female critically ill COVID-19 patient in the recovery group. A typical crazy-paving pattern is visualized on the CT image.

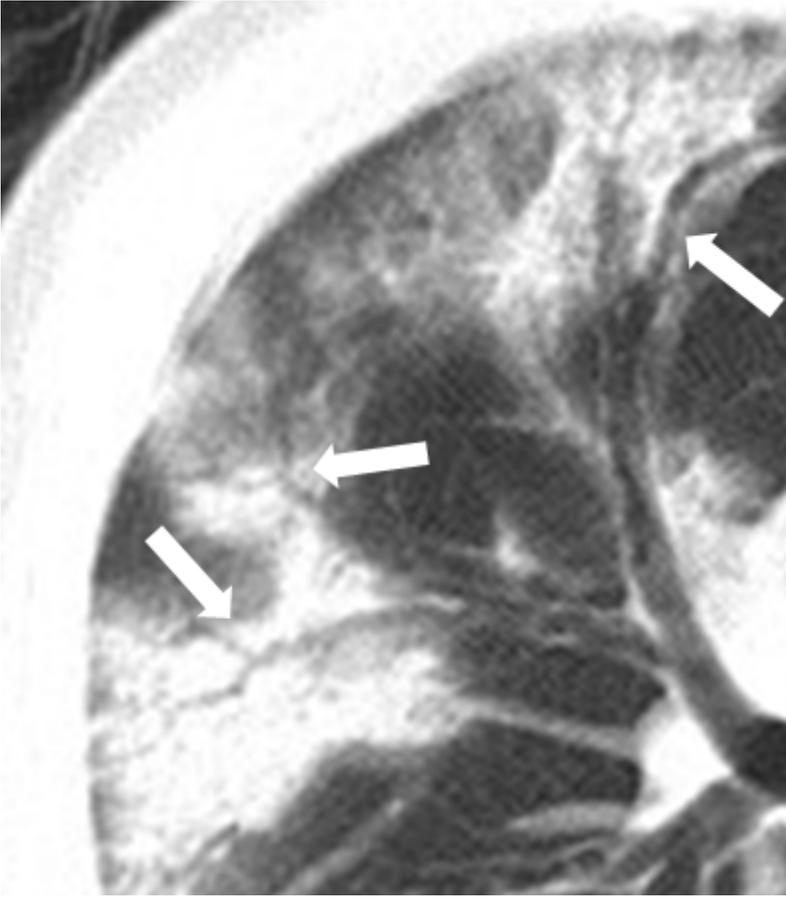
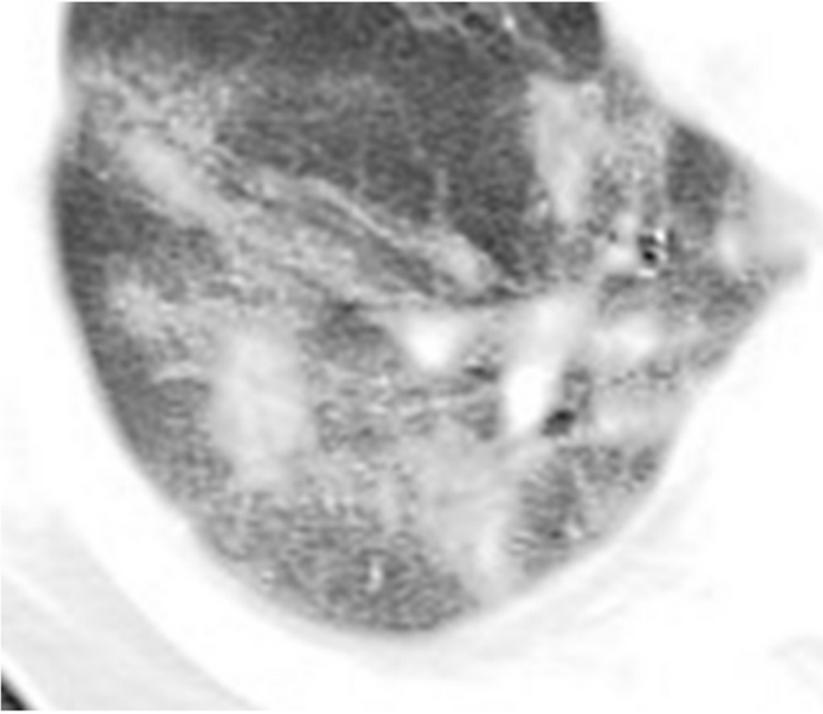
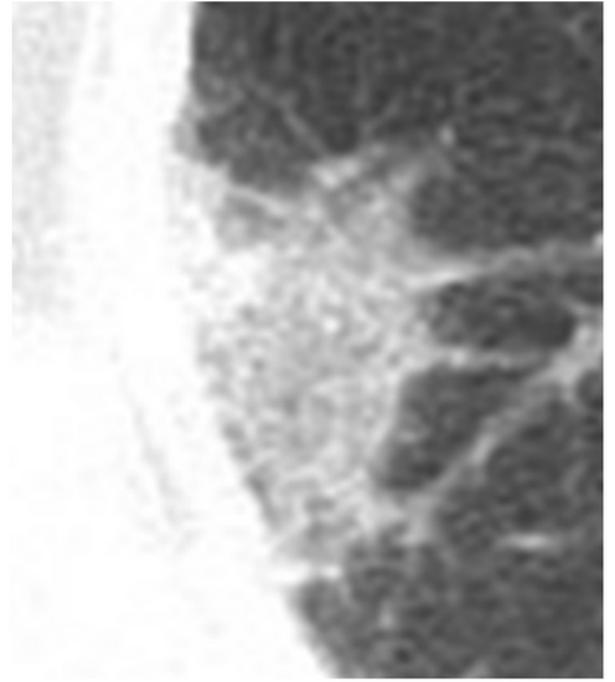


Figure 5

Air bronchogram appearance in a 73-year-old male critically ill COVID-19 patient in the recovery group. Multiple bronchogram signs are seen in the GGO and consolidation lesions (arrows). GGO: ground glass opacities.



A



B

Figure 6

GGO opacity with different margins in a 78-year-old male critically ill COVID-19 patient in the recovery group. A: GGO opacity with blurred margin; B. GGO opacity with clear margin; GGO: ground glass opacities.