

CT Exhibiting the Lung Lesions of Dynamic Changes and Volume Quantification of COVID-19

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Abstract

CT examination can clearly distinguish the lung lesions of corona virus disease 2019 (COVID-19), which can be followed up with CT over time. To exhibit the lesions and measure their volumes are beneficial to find the prognosis of patients and adjust the plans of clinical treatment.

Keywords: COVID-19; Lung lesions; Volume measurement; CT; Follow up

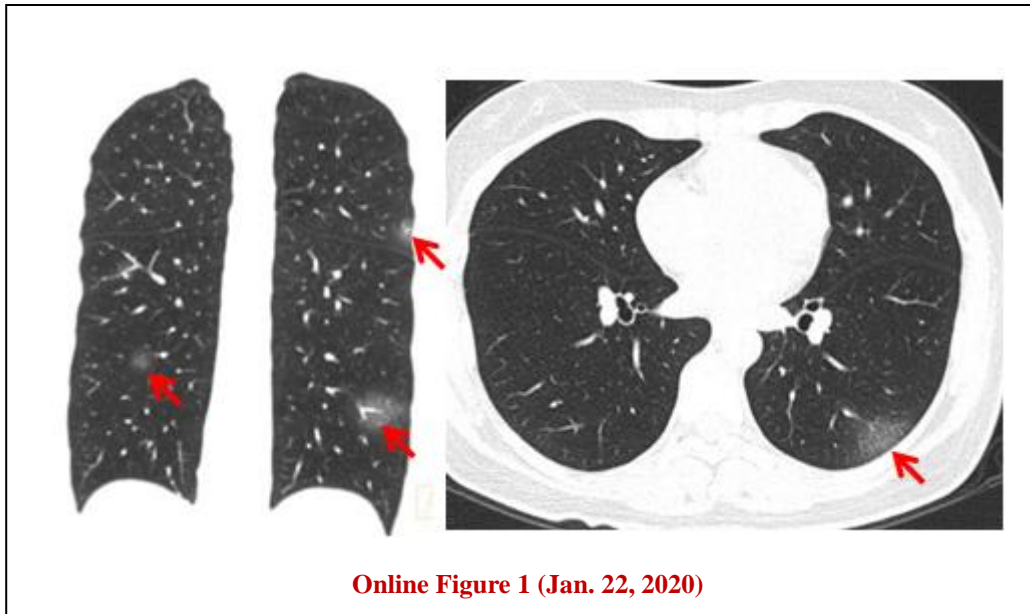
Introduction

In December 2019, the corona virus disease 2019 (COVID-19) was launched in Wuhan, China and spread rapidly to the whole country. Radiological diagnosis of COVID-19 has important clinical value, and CT of chest can clearly show the presence, size and change of lesions [1,2]. In this paper, the patient with COVID-19 was reported with CT follow up in detail.

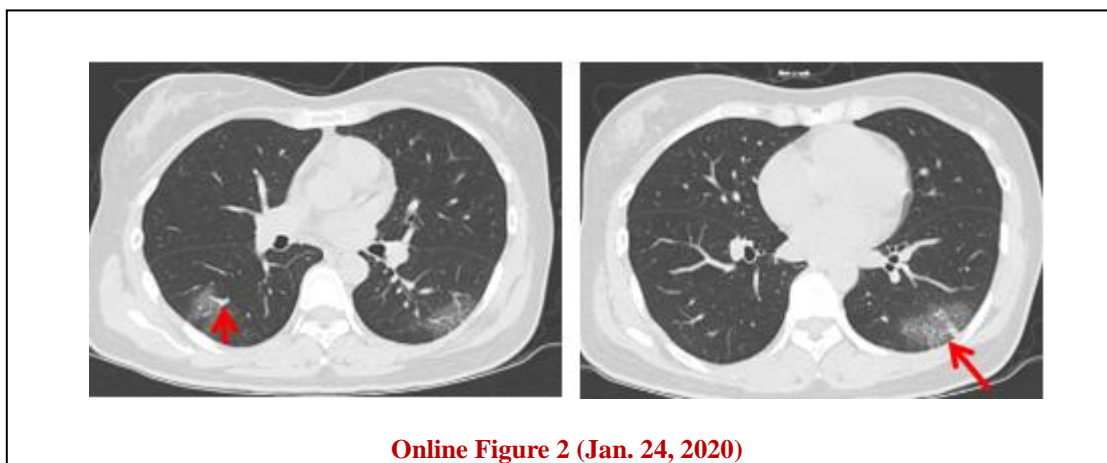
Table 1: Clinical data of patient (Female, 32-year-old) on Jan 22, 2020.

DATA	CONTENTS
Chief complaint	Patient had fevered for 1 day, with cough.
Present medical history	Patient fever with unknown cause one day ago, and the temperature was 39°C in maximum. She was with cough, nasal congestion and runny nose, but no chest distress, no fear of cold, no headache, no joint muscle pain.
Previous medical history	There was no chronic obstructive pulmonary disease, no hypertension, no coronary heart disease, no diabetes.
Epidemiological history	Patient was from Wuhan (the center of COVID-19 outbreak) to Xiamen, China on Jan. 18, 2020, During staying in Wuhan, she denied the contact history of febrile patients. History of drug allergy: not found.
Physical examination	T: 37.4°C, she is clear mind, no congestion in pharynx. There was no swelling of bilateral tonsils, the breath sounds in both lungs were accentuated without obvious coarse crackles. The abdominal wall is soft without tenderness.
Laboratory examination	Routine blood test: leukocyte (4.40×10^9 G/L and lymphocyte (1.19×10^9 G/L) counts were normal, C-reactive protein increased (21.93 mg/L, normal range, 0-10 mg/L).
diagnosis and treatments	Clinical diagnosis: the fever of unknown origin, viral pneumonia? Patient received the treatments of antiviral drugs (lopinavir and abidol), anti-inflammatory drugs (moxifloxacin hydrochloride) and interferon (recombinant human interferon α -2b). Other contents see the figure caption over time.

CT Findings of Lungs Lesions of Patient with COVID-19 and Clinical Data as Follows (in Chronological Order)

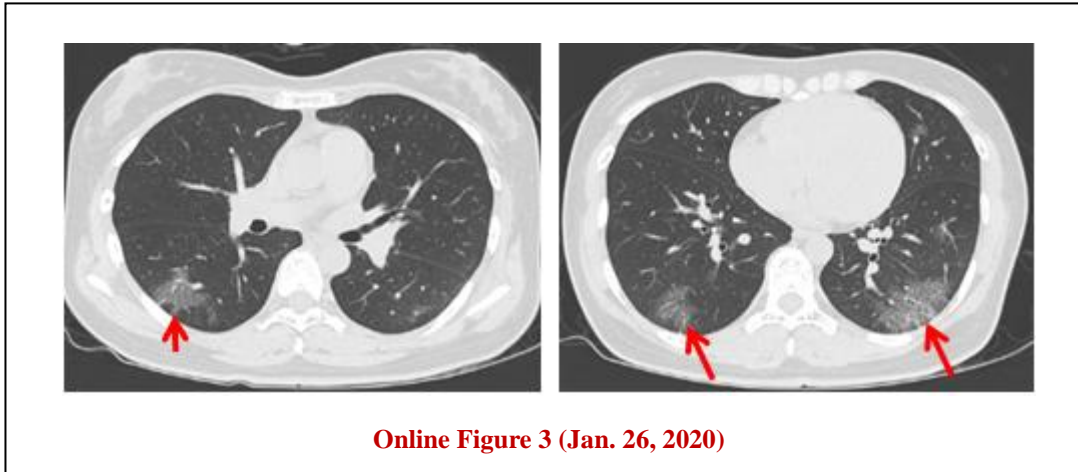


CT examination on the day of admission: showing the multiple small and thin ground-glass opacity (GGO, see the 4 arrows) in peripheral zone of both lungs. Clinical data: Patient with fever (39°C in maximum temperature) for 1-day, paroxysmal cough and runny nose, without phlegm. The oxygen partial pressure decreased (44.0 mmHg, normal range 83.0-108.0 mmHg/L), oxygenated hemoglobin decreased (80.7%, normal range 92.0-98.0%), deoxyhemoglobin increased (18.6%, normal range 0.0-5.0%). Physical examination: breath sounds in both lungs were accentuated without obvious coarse crackles. Clinical diagnosis: the fever of unknown origin, virus pneumonia?

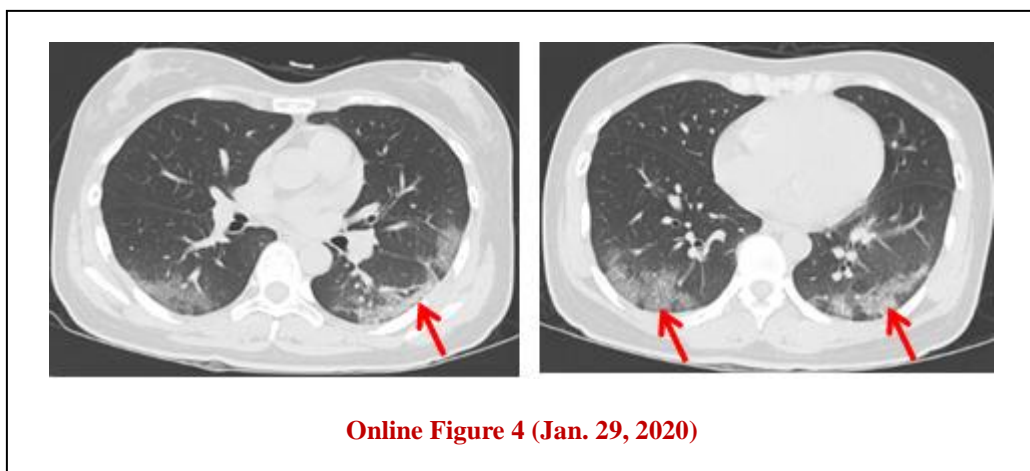


The second CT examination showed that the original lesions became more and larger (see the long arrow) than the admission CT, with GGO and thickened blood vessels (see the short arrow) in the focus area. Clinical data: patient treated with antiviral drugs (lopinavir and abidol), anti-inflammatory drugs (moxifloxacin hydrochloride,

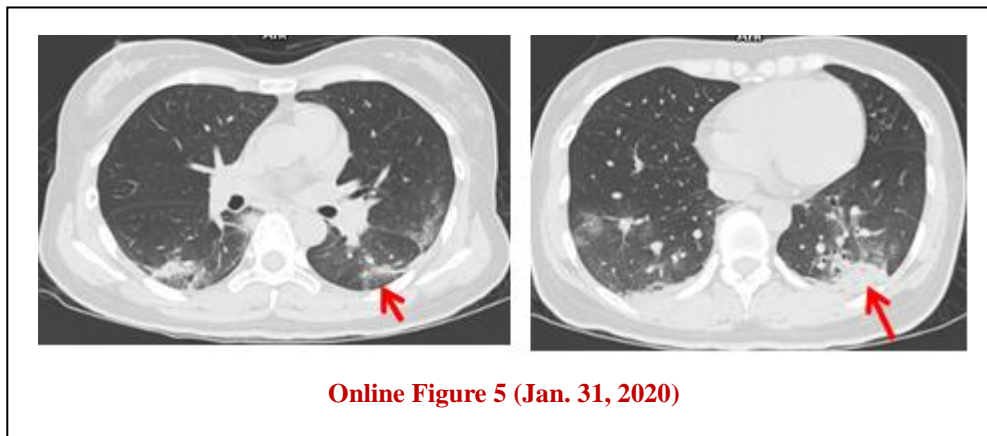
methylprednisolone), interferon (recombinant human interferon α -2b), oxygen inhalation, infusion and symptomatic supports. The patient was still with low fever, 4 times of diarrhea and slightly nausea. Physical examination: T: 37.8°C, P: 112 times/min, R: 30 times/min, BP: 87/58 mmHg; both of lungs were without obvious coarse crackles. Terminal oxygen saturation in 98% (intranasal oxygen inhalation with 2L/min), oxygenation index decreased in 260.



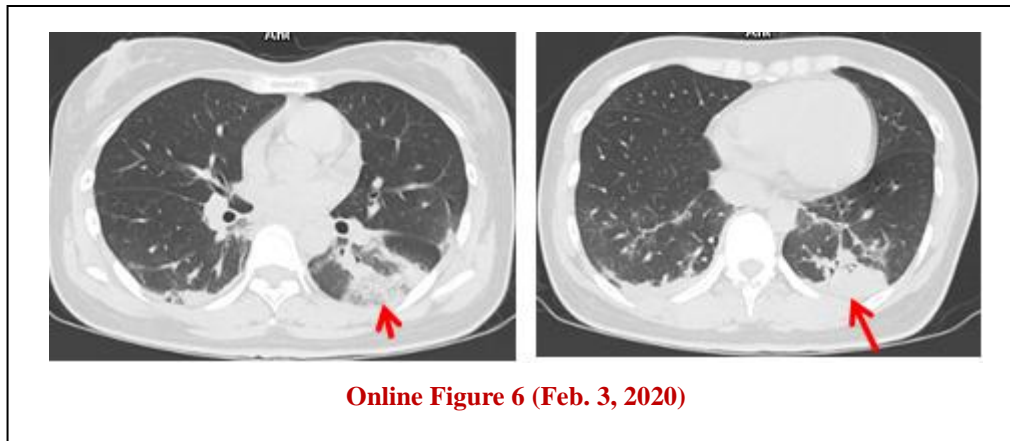
The third CT examination showed that the focus continued to become more and larger than those of the last, with a change from GGO to crazy-paving pattern (see the long red arrow), and thickened inter-lobular septum (see the short arrow). Clinical data: The patient had no fever, still Light cough without phlegm or diarrhea. Physical examination: vital signs were normal; breath sounds in both lungs were clear without coarse crackles. Re-examination of blood gas analysis (intranasal oxygen inhalation with 2L/min): PH: 7.41, PCO₂: 36.9 mmHg, PO₂: 87 mmHg. Clinical diagnosis: COVID-19 (Severe type), Laboratory-confirmed SARS-CoV-2 infection by real-time RT-PCR (Jan. 24, 2020; Jan. 25, 2020).



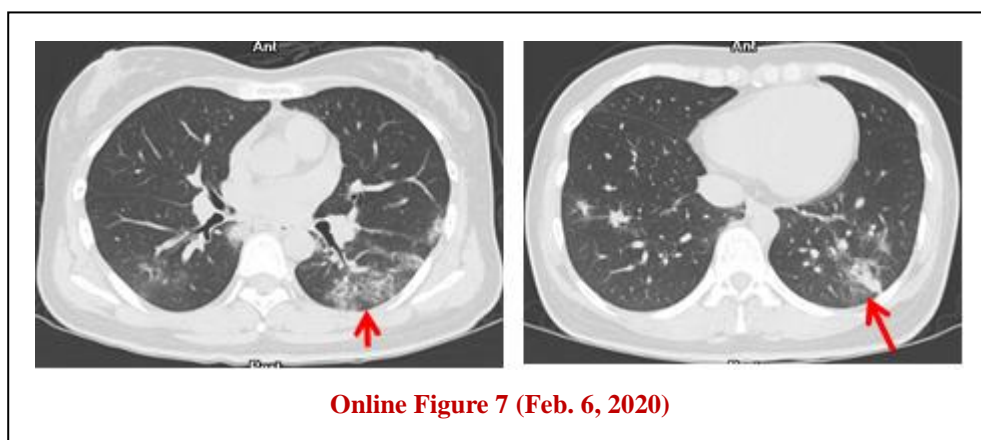
The fourth CT examination: the lesions of lungs continued to become more and larger than those of the third, with obvious crazy-paving patterns (see the 3 arrows). Clinical data: the patient had fever (38.4°C in maximum temperature) again with light cough, but still no phlegm, chest tightness or breath shortness. Terminal oxygen saturation was over 98% with continuous intranasal oxygen inhalation with 2L/min. Physical examination: P: 80 times/min, R: 20 times/min, BP: 111/80 mmHg; breath sounds in both lungs were clear without coarse crackles. Examination of blood gas analysis: PH: 7.429, PCO₂: 39.1 mmHg, PO₂: 72 mmHg, oxygenation index decreased in 248.



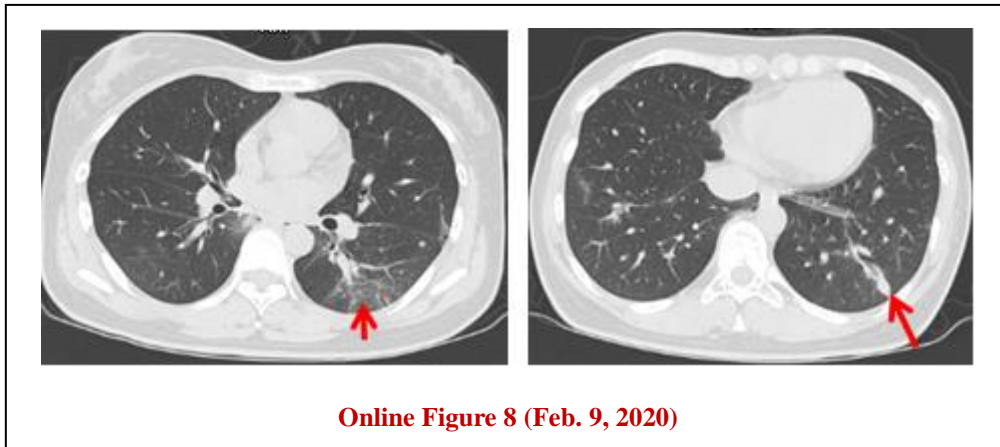
The fifth CT examination: multiple GGO were absorbed and become smaller (see the short arrow) than those of the fourth, with shadows of fiber cord and consolidation (see the long arrow). Clinical data: the patient had a fever occasionally (38.4°C in maximum temperature) with light cough, still no phlegm, chest tightness or breath shortness. Terminal oxygen saturation was over 97% with continuous intranasal oxygen inhalation with 2L/min. Physical examination: P: 82 times/min, R: 20 times/min, BP: 102/53 mmHg; breath sounds in both lungs were clear without coarse crackles. Routine blood test: WBC 3.29×10^9 G/L, N 71.6 %, L 12.8 %, Hb 123 G/L and PLT 170×10^9 G/L. PCT <0.05 mg/ml. Treatments of antivirus drugs and intranasal oxygen inhalation still remained.



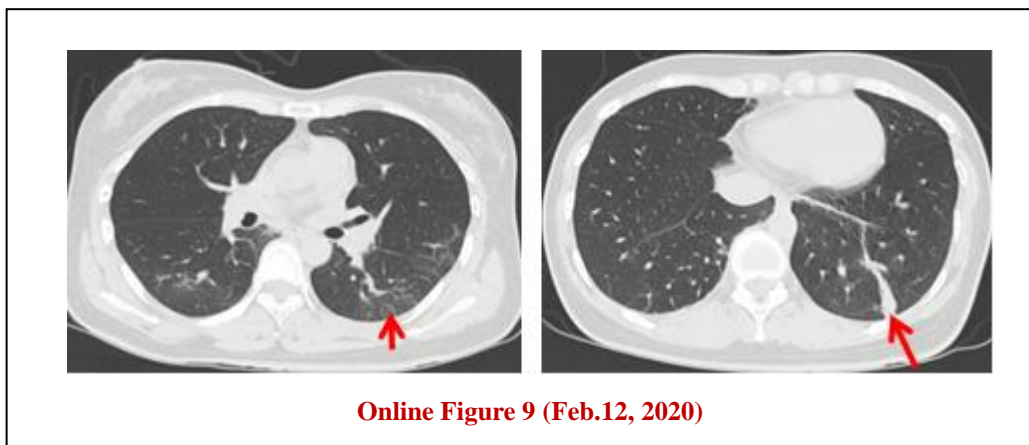
The sixth CT examination: there were more shadows of consolidation (see the long arrow) than those of the fifth, with mixed lesions of GGO and consolidation (see the short arrow). Clinical data: the patient had a low fever (37.8°C in maximum temperature) with moderate cough and a little chest tightness, with no phlegm. Physical examination: P: 78 times/min, R: 20 times/min, BP: 115/53 mmHg; breath sounds in both lungs were clear without coarse crackles. Examination of blood gas analysis (intranasal oxygen inhalation with 2L/min): PH: 7.441, PCO₂: 42 mmHg, PO₂: 170 mmHg. Oxygenation index: 314. SARS-CoV-2 infection was positive by real-time RT-PCR (Feb. 3, 2020).



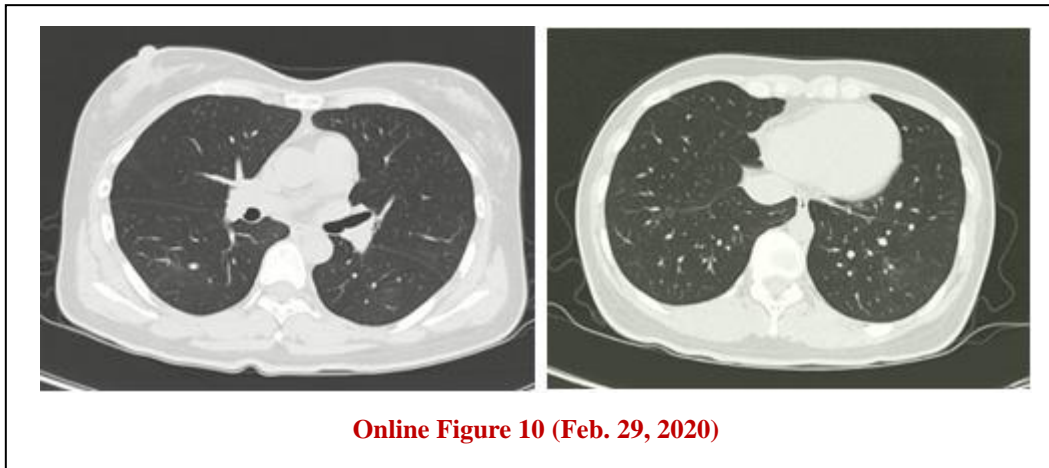
The seventh CT examination: the shadows of consolidation were absorbed and became less (see the long arrow) than those of the sixth, and GGO (see the short arrow) were seen. Clinical data: The patient had no fever, but had a paroxysmal cough and a little chest tightness, still no phlegm, pectoralgia or palpitation. Physical examination: vital signs were normal; breath sounds in both lungs were clear without coarse crackles. Re-examination of routine blood test: WBC 3.44×10⁹ G/L, N 50.3 %, L 33.4 %, Hb 116 G/L, PLT 262×10⁹ G/L. Examination of blood gas analysis (no intranasal oxygen inhalation): PH: 7.453, PCO₂: 38.6 mmHg, PO₂: 68 mmHg. SARS-CoV-2 infection was positive by real-time RT-PCR (Feb. 6, 2020).



The eighth CT examination: the lesions of GGO and consolidation continued to be absorbed and become less and smaller (see the short arrows) than that of the seventh, and the fibre cord or lobular atelectasis (see the long arrow) were seen. The patient had no fever, but occasionally had a paroxysmal cough, no phlegm, no pectoralgia and palpitation. Physical examination: vital signs were normal; breath sounds in both lungs were clear and no coarse crackles. Treatments of antiviral drugs and intranasal oxygen inhalation had been kept. SARS-CoV-2 infection was positive by real-time RT-PCR (Feb. 9, 2020).



The ninth CT examination: the lesions continued to be absorbed and became smaller (see the short arrow) than those of the eighth, with clear edges of fiber cord or/and lobular atelectasis (see the long arrow). Clinical data: the patient had no fever with occasionally mild cough, still no phlegm, pectoralgia or palpitation. Physical examination: vital signs were normal; breath sounds in both lungs were clear without coarse crackles. SARS-CoV-2 infection was negative three times by real-time RT-PCR (Feb.12, 13, 15, 2020). Until Feb.16, 2020, the patient was discharged.



Online Figure 10 (Feb. 29, 2020)

The tenth CT examination (after discharge): the lesions continued to be absorbed and basically disappeared. Clinical data: the patient recovered well and came back to hospital for CT Re-examination according to the doctor's instructions.

AI Calculation About the Lesions Data of COVID-19

The AI method was developed by YITU (Shanghai, China) with using the technique of lungs quantitative analysis. The quantification data of lesions such as the shape, scope and density were obtained. AI can give the diagnosis suggestions and prognosis evaluation (Figure 1). CT abnormalities were classified according to density as GGO (-700 to -500 HU), mixed abnormalities (-500 to -200 HU) and consolidation (-200 to +60 HU). The proportion of lesions volume in the bilateral lung, left and right lung was shown in Figure 2-4.

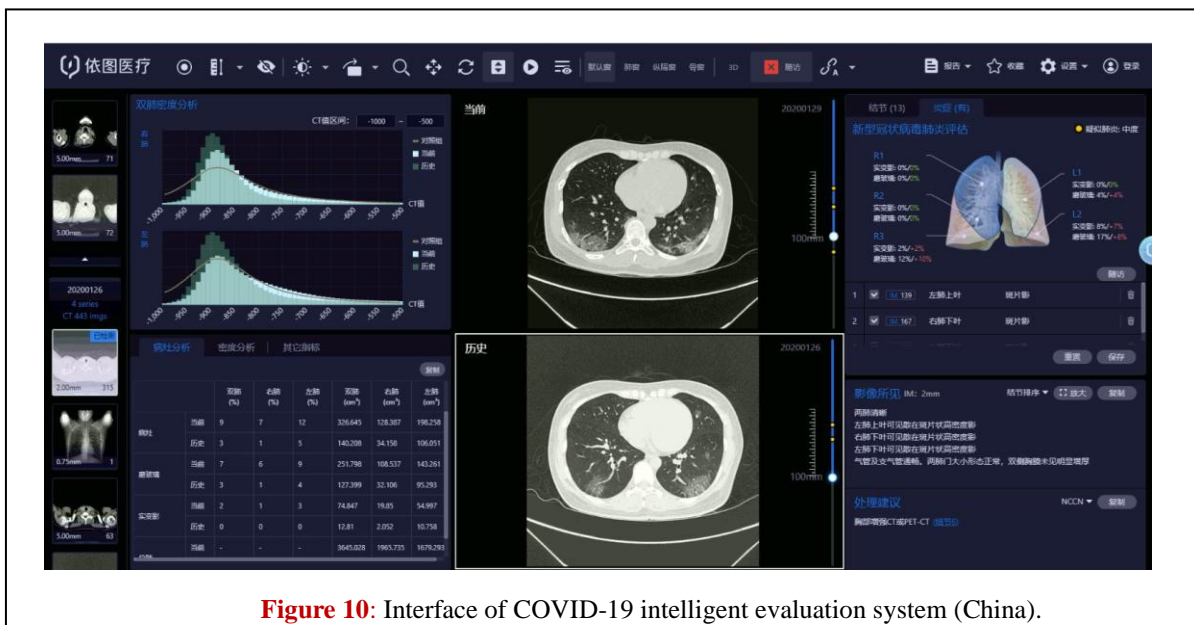
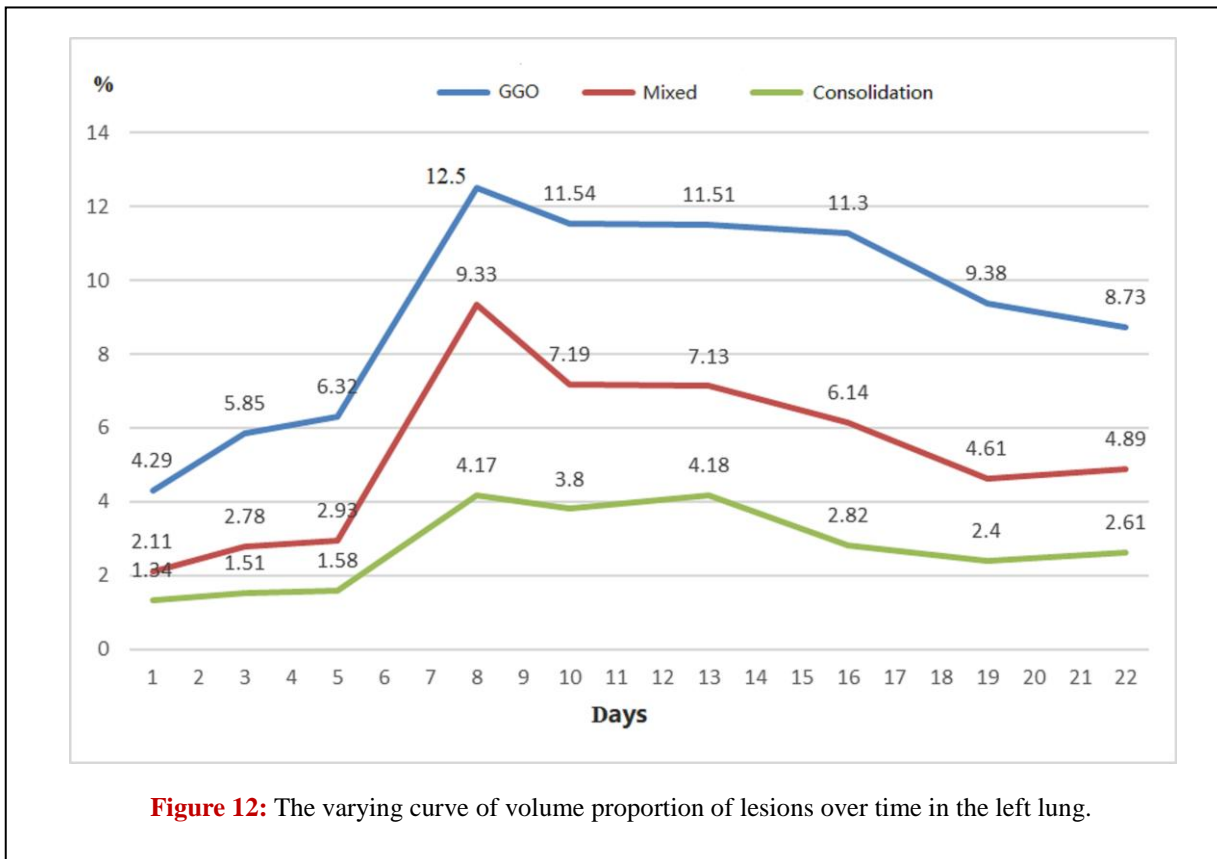
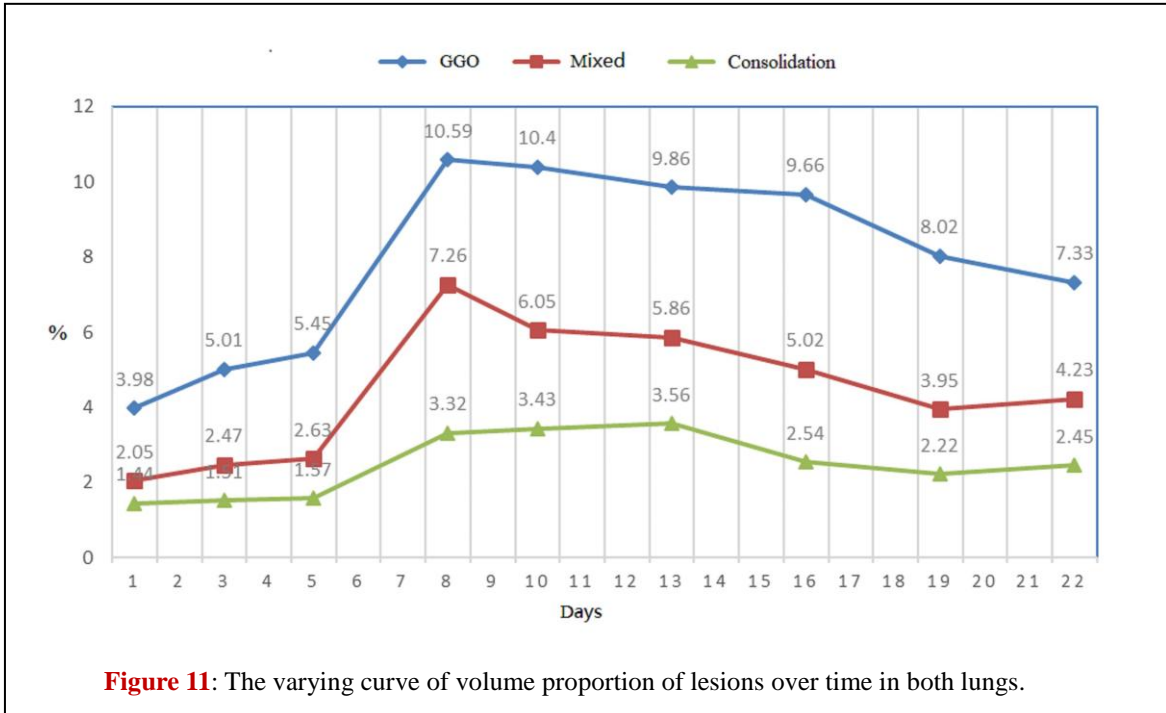
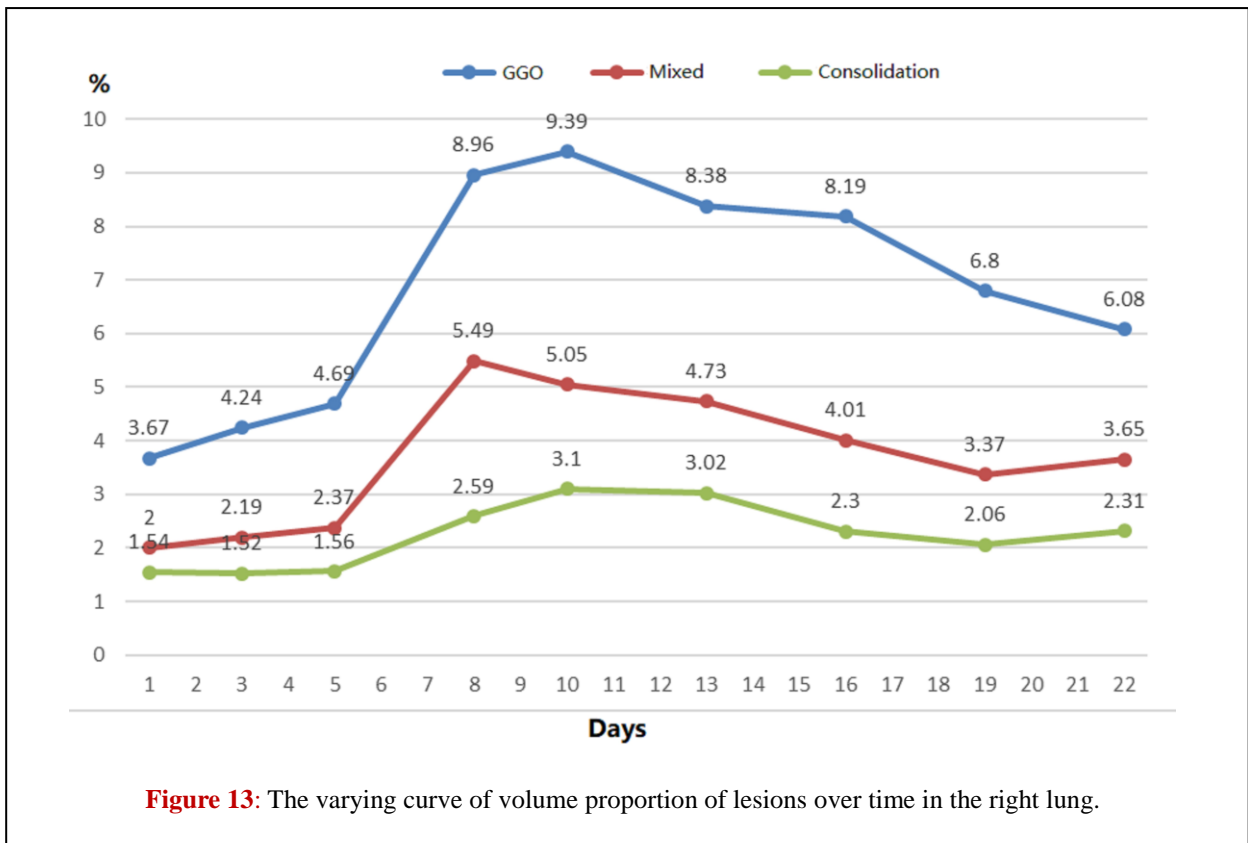


Figure 10: Interface of COVID-19 intelligent evaluation system (China).





Discussion

In this paper, CT images of patient with COVID-19 were sequentially observed over time. The lesions of lungs were found with some GGO in both lungs, which gradually increased, enlarged and became to the consolidation, then lesions were gradually absorbed, diminished and their density became light, finally formed a little fibrosis or disappeared. Quantitative analysis of lesions was shown by AI with the volume-time curve, on which the peak volume of lesions can be found on the 8th day after onset of disease, and the volume of GGO is the most, that of the mixed is the second and the consolidation is the least. When lesions entered the absorption stage, the volume of lesions gradually decreased. The change of lesions and volumes are clearly shown over time, it is beneficial to find the prognosis of patients and adjust the plans of clinical treatment [4,5].

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