Diagn Interv Radiol 2021; 27: 692–693

LETTER TO THE EDITOR

Rapid progression of COVID-19 pneumonia to extensive fibrosis assessed with 3D volumetric CT

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Dear Editor,

We read with great interest the article entitled "CT findings of COVID-19 in follow-up: comparison between progression and recovery" by Guan et al. (1) in the journal of *Diagnostic and Interventional Radiology*. In addition to the findings in this article, we would like to contribute to this article by emphasizing the development of lung fibrosis in COVID-19 pneumonia.

In COVID-19 pneumonia outbreak, CT has played an important role in the evaluation of lung lesions as well as the extent of lung involvement. The most common CT findings, ground-glass opacities and consolidations, are seen in early stages of the disease, while fibrosis typically occurs in the absorption stage of the disease, more than 14 days after the onset of symptoms and with a prevalence of 17%–20% (2). Fibrosis that is associated with severe lung injury is regarded as the coexistence of the findings of interstitial thickening, traction bronchiectasis, clusters of subpleural cystic airspaces, and decrease in lung volume. While fibrosis has been suggested to point to recovery and good prognosis, others suggested that it is a predictor for poor prognosis (2).

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) can affect both type II pneumocytes and pulmonary endothelial cells by showing interaction with its receptor, angiotensin-converting enzyme II. Injury of type II pneumocytes can cause pulmonary fibrosis, while the injury of endothelial cells can cause vascular complications in COVID-19 disease (3). The possible mechanisms of lung damage by SARS-CoV-2 include a cytokine release syndrome induced by viral antigen, pulmonary toxicity induced by drugs, and acute lung injury due to mechanical ventilation induced by high airway pressure and hyperoxia (4). Approximately 40% of patients with COVID-19 progress to acute respiratory distress syndrome (ARDS), and 20% of the patients with ARDS are severe (4). The risk factors for pulmonary fibrosis in COVID-19 pneumonia are advanced age, disease severity (associated with comorbidities such as hypertension, diabetes, and coronary artery disease and laboratory findings of lymphopenia, leukocytosis, and elevated lactate dehydrogenase), prolonged stay in intensive care unit and mechanical ventilation, smoking, and chronic alcoholism (5).

Combet et al. (3) reported a case with COVID-19 pneumonia progressing to pulmonary fibrosis with a predominant pattern of honeycombing. In our example of COVID-19 pneumonia, CT images show rapid progression of ground-glass opacities to extensive lung fibrosis in a patient with emphysema and under treatment of COVID-19, and volume-rendered three-dimensional (3D) reconstruction images demonstrate significant volume loss corresponding to more than a half of the initial lung volume (Fig.). Lung volume loss can be quantitatively demonstrated with 3D volumetric CT. The limitations of 3D volumetric CT can be minimized by obtaining CT scans with thinner slice thickness and breathing instruction protocols (6).

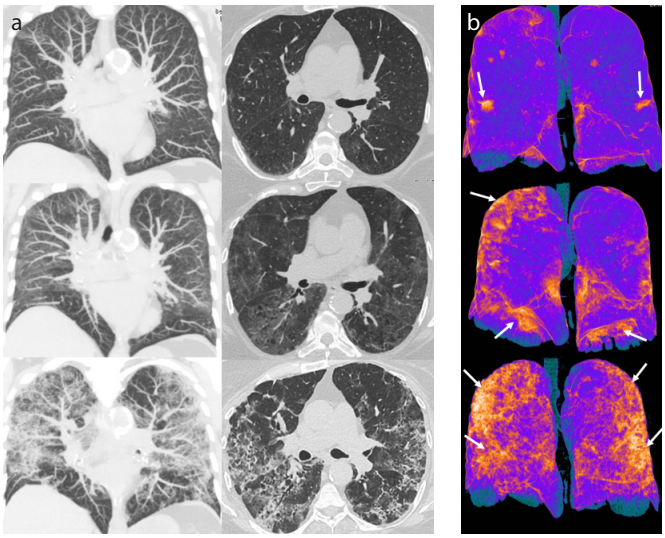

Figure. a, b. A 65-year-old woman presented with dry cough for 1 day and had a positive result of the reverse transcriptase polymerase chain reaction assay for COVID-19. She had one week of favipiravir therapy at home, and on day 7, she was hospitalized with fever and shortness of breath for 2 days. During her one week of stay at the hospital she received treatment with nasal oxygen, intravenous corticosteroid, and inhaled salbutamol, which progressively increased her oxygen saturation from 82% to 96%. Three consecutive, unenhanced chest CTs were performed with 1-week intervals (at diagnosis, at admission to the hospital on day 7, and 2 weeks after the onset of the initial symptoms). Coronal maximum intensity projection images and axial images in panel **(a)** show underlying emphysema and peripheral ground-glass opacities progressing to extensive fibrosis. Volume-rendered 3D images in panel **(b)** show progressive lung volume losses *(arrows)*. The total lung volume decreased from 3812 cm^3 to 2924 cm^3 and then to 1704 cm^3.

In conclusion, it should be considered that fibrosis may rapidly occur despite early treatment of COVID-19 pneumonia, and the assessment of the lung volume loss using 3D volumetric CT is important in the management of patients during the course of the disease as well as on follow-up.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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Received 24 December 2020; accepted 6 January 2021.

Published online 6 April 2021.

DOI 10.5152/dir.2021.21105

You may cite this article as: Guneyli S, Hekimsoy I, Altinmakas E, Savas R. Rapid progression of COVID-19 pneumonia to extensive fibrosis assessed with 3D volumetric CT. Diagn Interv Radiol 2021; 27: 692–693