



Atypical CT Pattern in COVID-19 Infection: Are Lung Cavitations Really Uncommon?

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Abstract

The standard for diagnosis of SARS-CoV-2 virus is reverse transcription polymerase chain reaction test, but chest CT may play a complimentary role in the diagnostic algorithm. A diversity of interesting CT imaging features was found but lung cavitations or abscess were described as rare pattern, and for this reason labeled as atypical. In this study we describe six confirmed cases of COVID-19 subjects which developed lung cavitations, out of 45 studied patients (13.3%). CT scan was performed on average 27 days after admissions, and all the patients have been previously intubated. Our findings are remarkable because lung cavitations in COVID-19 patients have been described very rarely so far.

Keywords: Lung cavitation; COVID-19; CT; SARS-CoV-2

Introduction

Coronavirus Disease 2019 (COVID-19), a highly infectious disease caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), was firstly reported in Wuhan, Hubei Province, China, and rapidly spreads to other domestic cities and countries beyond China [1,2]. On January 30th, 2020, the World Health Organization (WHO) declared this ongoing outbreak as a global public health emergency and raised the risk of COVID-19 to very high at the global level on February 28th, 2020 [3]. The standard for diagnosis of SARS-CoV-2 virus is Reverse Transcription Polymerase Chain Reaction (RT-PCR) test, but chest CT may play a complimentary role in the diagnostic algorithm for the early detection (early suspicion) of COVID-19 pneumonia (in conjunction with clinical presentation, blood gas analysis and 6-minute walking time test) [4,5]. CT examination is of great significance not only in diagnosing COVID-19 but also in monitoring disease progression and evaluating therapeutic efficacy [6]. The most frequently reported CT lesions in the literature are crazy paving pattern, reticular pattern, air bronchogram, airway changes, pleural changes, vascular enlargement and reversed halo sign. Bilateral distribution with or without consolidation in posterior and peripheral lungs segments was the cardinal hallmark of COVID-19 [7,8]. A diversity of interesting CT imaging features was found but lung cavitation or abscess was considered as rare pattern. In this study we describe six confirmed cases of COVID-19 which developed lung cavitation and represent the first case series reported in literature.

Patients and Methods

From March 22nd until April 26th, 2020, 116 adult patients admitted to Sub-intensive care unit named COVID Emergency unit in Fatebenefratelli Hospital Milan. Forty-five patients underwent lung CT scan (38.7%). All scans were performed without intravenous contrast with the patient in the supine position during end-inspiration. In six patients we found lung cavitation areas which represented 13.3% of our study sample; in these patients CT scan was done 27 days on average after admissions.

Case Series

Case 1

A 65-year-old male went to the emergency room for persistent hyperpyrexia (>38°C) associated with cough and dyspnea. Laboratory results showed normal counts of white blood cells count

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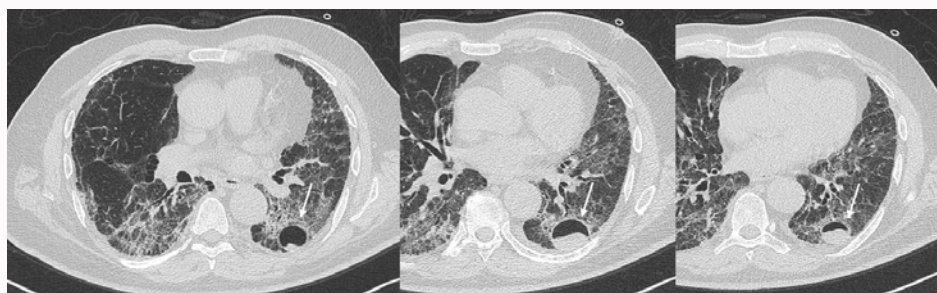


Figure 1: Axial thin-sections unenhanced CT scan show diffuse bilateral confluent and predominantly linear ground-glass opacities with a pronounced peripheral and posterior distribution and in lower left lobe a cavitated area with mucoid component in the context (arrows).

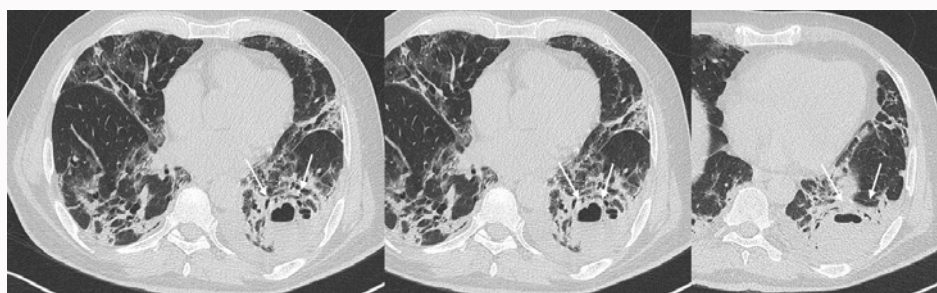


Figure 2: Axial thin-sections unenhanced CT scan show organizing pneumonia areas with diffuse alveolar damage, subpleural opacities with thickening of bronchial segmentations and sub-segmentations and concomitant traction bronchiectasis and in lower left lobe an excavated area up to 4 cm in maximum diameter (arrows).



Figure 3: Axial thin-sections unenhanced CT scan show patchy ground glass opacities with underlying reticulation and multiple inflammatory areas, some of which with an excavated component especially in right lower lobe (arrows).

($6.19 \times 10^9/L$, normal range 4.19 to 9.35), and increased C-Reactive Protein (CRP), lactate dehydrogenase, D-dimer and fibrinogen values (160 mg/L, normal range 0 to 5; 447 U/L, normal range 135 to 225; 5144 ng/ml; >700 mg/dl normal range 270 to 470; respectively). Patient was initially treated with non-invasive ventilation with CPAP helmet. Considering worsening of respiratory exchanges and clinical conditions was intubated 9 days after hospital admission and rapidly extubated after 4 days. Chest CT scan performed 24 days after his hospital admission (Figure 1) showed centrilobular and panlobular emphysema, bilateral patchy ground glass opacities and lower left lobe cavitated area with mucoid component in the context. Homolateral pleural was also reported. QuantiFERON-TB Gold test and routine tests were performed in order to exclude fungal and bacterial superinfection were negative.

Case 2

A 59-year-old male presented with cough and fever. Laboratory results showed normal white blood cells count ($5.65 \times 10^9/L$), decreased albumin (24 g/L), increased CRP, lactate dehydrogenase,

D-dimer and fibrinogen values (296 mg/L, 302 U/L, 11222 ng/ml, 507 mg/dl; respectively). The patient was treated with non-invasive ventilation with helmet continuous positive air pressure. However, for the progressive worsening of respiratory exchanges and clinical conditions the patient was intubated 3 days after hospital admission. Chest CT scan performed one month after his hospital admission (Figure 2) showed bilateral inter and intra lobular interstitial thickening, diffuse inflammatory involvement, bronchiectasis and concomitant lower left lobe excavated area up to 4 cm in maximum diameter. Homolateral pleural effusion with dysventilation of the adjacent lung parenchyma was also evident. QuantiFERON-TB Gold test and routine tests were performed in order to exclude fungal superinfection were negative. Bacterial culture of sputum was positive for *Enterobacter aerogenes*.

Case 3

A 52-year-old male presented to the emergency room for fever, cough, and chest pain. Laboratory results showed normal white blood cells count ($7.65 \times 10^9/L$), decreased albumin (29 g/L), increased

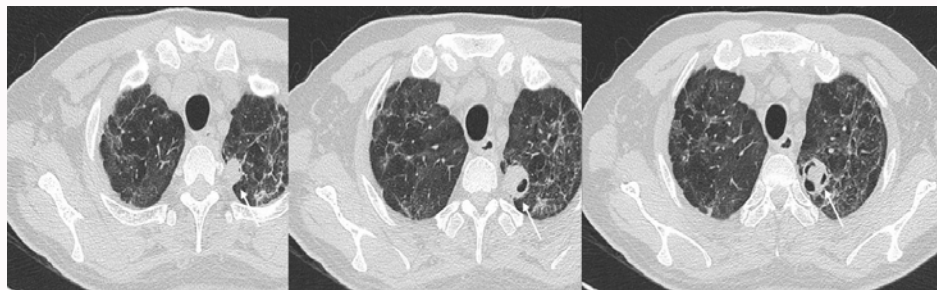


Figure 4: Axial thin-sections unenhanced CT scan show multiple patchy ground glass opacities with underlying reticulation and in left upper lobe a parenchymal alteration central excavation of 22 mm × 24 mm and craniocaudal extension of about 28 mm (arrows).

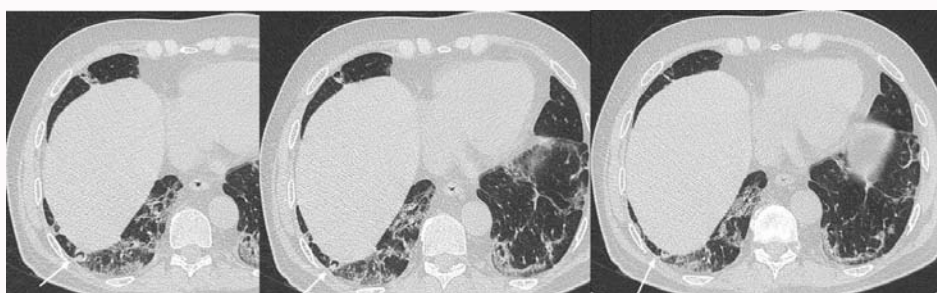


Figure 5: Axial thin-sections unenhanced CT scan show reticular thickening with symmetrical distribution and craniocaudal gradient. In right lower lobe we described concomitant centimetric excavated alterations (arrows).

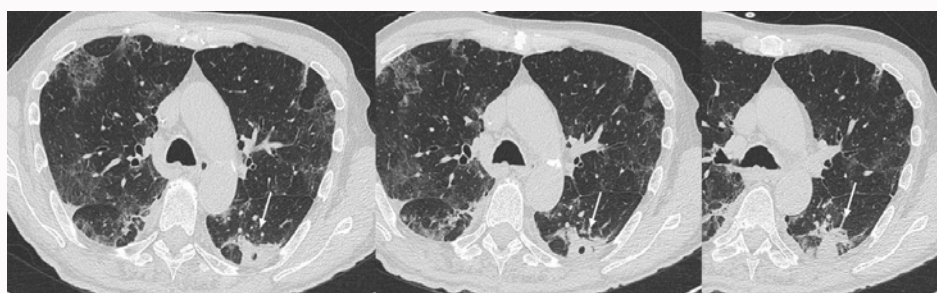


Figure 6: Axial thin-sections unenhanced CT scan show bilateral consolidation areas and cavitations in left lower lobe (arrows).

CRP, lactate dehydrogenase, D-dimer and fibrinogen values (104 mg/L, 501 U/L, 3154 ng/ml, 681 mg/dl; respectively). The patient was intubated one day after hospital admission and was admitted in COVID emergency unit after 21 days in the intensive care unit. Chest CT scan performed one month after his hospital admission (Figure 3) showed patchy ground glass opacities, prevalent in upper lobes. In lower lobes multiple inflammatory areas, some of which with an excavated component, especially in right lower lobe. QuantiFERON-TB Gold test and routine tests were performed in order to exclude fungal superinfection were negative. Bacterial culture of sputum was positive for *Enterobacter aerogenes*, *Enterococcus faecalis* and *Pseudomonas aeruginosa*.

Case 4

A 53-year-old male went to the emergency room for fever and dyspnea. Laboratory results showed increased white blood cells count ($17.13 \times 10^9/L$), CRP, lactate dehydrogenase, D-dimer and fibrinogen values (226 mg/L, 825 U/L, 12043 ng/ml, >700 mg/dl; respectively) and decreased albumin (23 g/L). The patient was intubated one day after hospital admission and was admitted in COVID Emergency

Unit after 23 days in the intensive care unit. Chest CT scan performed 40 days after his hospital admission (Figure 4) revealed in left upper lobe a parenchymal alteration central excavation of 22 mm × 24 mm and craniocaudal extension of about 28 mm. Peripheral and peri-bronchial consolidation with diffuse ground glass opacities, thickening of bronchial segmentations and sub-segmentations and concomitant traction bronchiectasis. Stable negativity of blood cultures, QuantiFERON-TB Gold test and specific tests excluded fungal or bacterial superinfection.

Case 5

A 68-year-old male went to the emergency room for fever and dyspnea. Laboratory results showed normal white blood count cells ($9.24 \times 10^9/L$) and albumin (41 g/L), and increased CRP, lactate dehydrogenase, D-dimer and fibrinogen values (173 mg/L, 733 U/L, 3487 ng/ml; >700 mg/dl; respectively). The patient was intubated one day after hospital admission and rapidly extubated after 4 days. CT performed 18 days after his hospital admission (Figure 5) showed reticular thickening with symmetrical distribution and craniocaudal gradient. These findings were more represented in lower lobes and in

right lower lobe we described two concomitant centimetric excavated alterations. QuantiFERON-TB Gold test and routine tests were performed in order to exclude fungal and bacterial superinfection and were negative.

Case 6

A 70-year-old male went to the emergency room for fever, cough and dyspnea. Laboratory results showed normal white blood cells count and D-dimer ($5.97 \times 10^9/L$ and 428 ng/ml; respectively) and increased CRP, lactate dehydrogenase and fibrinogen values (259 mg/L, 448 U/L and 663 mg/dl; respectively) and decreased albumin (22 g/L). The patient was intubated 4 days after hospital admission and was admitted in COVID Emergency Unit after 15 days in the intensive care unit. CT performed 22 days after his hospital admission (Figure 6) showed extensive peripheral predominant ground-glass opacities. Bilateral consolidation areas and cavitation in left lower lobe. Pericardial and bilateral pleural effusion was also described. QuantiFERON-TB Gold test, microbiological tests were negative except a sputum sample positive for *Pseudomonas aeruginosa*.

Conclusion

The variety of the findings in COVID-19 has been categorized in the consensus documents from American College of Radiology/ Society of Thoracic Radiology/Radiological Society of North America [5]. The typical features are peripheral bilateral and rounded ground glass opacities, and reverse halo sign of organizing pneumonia. Atypical features include isolated consolidations, tree-in-bud opacities and smooth interlobular septal thickening with pleural effusion, and cavitations, that have been reported very rarely [9]. A larger number of reports on imaging findings in COVID-19 diseases are present in literature and probably new imaging patterns may emerge in the future. The size and type of CT abnormalities may be related to a more severe pulmonary involvement and longer hospitalization and can vary in different patients and stages. In this paper, we reported a case series of patients with pulmonary cavitations which represented the 13.3% of our cohort. This result can be interpreted as a late CT manifestation of COVID-19 disease, not rare in patients that have been intubated. This conclusion is supported by the timing of CT examinations in our patients, performed later than previous cases reported in literature (27 days on average after admission). Bacterial superinfections

cannot be excluded as a possible cause of the cavitations we observed, but the germs we isolated were all opportunistic hospital-acquired pathogens, very common in ventilated intensive-care unit patients and rarely causing lung excavations [9,10]. This case series, with its representative pictures, is remarkable because lung cavitation in COVID-19 patients has been described very rarely so far [8-10].

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