Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Clinical Imaging 69 (2021) 72–74

Contents lists available at ScienceDirect

Clinical Imaging

journal homepage: www.elsevier.com/locate/clinimag

Cardiothoracic Imaging

Target-shaped combined halo and reversed-halo sign, an atypical chest CT finding in COVID-19

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ARTICLE INFO

Keywords:
COVID-19
Severe acute respiratory syndrome coronavirus 2
Tomography, X-ray computed
Lung diseases

ABSTRACT

Typical chest CT findings in COVID-19 have been described as bilateral peripheral ground glass opacities, with or without consolidation. Halo sign and reversed halo sign have been reported as atypical imaging findings in this disease. However, to the best of our knowledge, combined presence of these signs has never been reported before. Herein, we present a COVID-19 patient with numerous atypical target-shaped, combined halo and reversed halo pulmonary lesions, in the absence of any other underlying disease.

1. Introduction

The first clinical case of coronavirus disease 2019 (COVID-19) was reported in Wuhan city, China. To date (May 14, 2020), 4,248,389 patients have been infected, with 292,046 deaths reported worldwide [1].

Clinical symptoms of COVID-19 are non-specific and include fever, cough, myalgia, or fatigue. Less common symptoms are diarrhea, nausea, headache, sputum production, and hemoptysis. Approximately, half of the patients experience dyspnea during disease progression [2]. The predominant chest CT findings in COVID-19 have been described as bilateral and peripheral ground glass opacities, with or without consolidation. Lymphadenopathy, pleural effusion, and lung cavitation were less common imaging features [3]. Previous studies have reported the halo and reversed halo signs as less frequent findings in patients with COVID-19 [3–7]. The halo sign describes a nodule or mass surrounded by ground glass opacity. The reversed halo (Atoll) sign is defined as a crescent or complete ring of consolidation, surrounding a focal area of ground glass opacity [8].

In this case report, we present unusual chest CT findings in a confirmed COVID-19 patient, who has recovered well after experiencing respiratory distress symptoms.

2. Case presentation

The patient was a 49-year-old, apparently healthy and non-smoker man, without any underlying disease. He was a taxi driver and in frequent contact with passengers. On March 13, he first presented with fever, dyspnea, and nausea. After four days, respiratory symptoms progressed, and he was admitted to the hospital with tachypnea and low peripheral oxygen saturation (temperature: 38.3 °C, heart rate: 96/min, respiratory rate: 26/min, SpO2 = 85%).

He was immediately given respiratory support with supplemental oxygen (8 L/min O_2 using face mask), with clinical suspicion of COVID-19. Primary laboratory workups demonstrated a significant increase in CPK and LDH and positive CRP (Table 1). The diagnosis of COVID −19 was confirmed using nasopharyngeal sample RT-PCR, which was positive for SARS-CoV2. Blood culture tests yielded negative results after 24, 48, 72 h.

Baseline chest CT was obtained on the first day of admission, showing diffuse non-rounded multifocal consolidations and air-bronchograms in both lungs, with confluent appearance in both lower lobes. There were several target-shaped reversed halo configurations with central round dense consolidation, which were described as combined halo and reversed halo signs (maximum size of 33 × 24 mm) coexisting on the same study (Fig. 1, Supplement video file). A small amount of pleural effusion was noted in the right hemithorax. No lymphadenopathy, pericardial effusion, collapse, or cavitary changes were found.

The patient was started on multidrug treatment with hydroxychloroquine (400 mg/OD), oseltamivir (75 mg/BD), ribavirin (400 mg/BD), levofloxacin (500 mg/OD), and naproxen (500 mg/BD). He

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https://doi.org/10.1016/j.clinimag.2020.06.038
Received 16 May 2020; Received in revised form 16 June 2020; Accepted 26 June 2020
Available online 02 July 2020
0899-7071/

Table 1
Laboratory results at the time of admission

	Result	Reference range
WBC, C/μL	7100	4000–10,000
Neutrophils, %	63.4%	49.0–74.0
Lymphocytes, %	33.1%	26.0–46.0
RBC, $\times 10^6$C/μL	5.02	4.4–6.2
Hemoglobin, g/dL	15.1	13.2–16.5
Hematocrit, %	45.3	41.5–53.0
Platelets, $\times 10^3$C/μL	290	130–450
Na, mEq/L	137.0	135–145
K, mEq/L	4.0	3.5–5.5
Urea, mg/dL	38.3	15–50
Creatinine, mg/dL	1.02	0.7–1.4
LDH, U/L	572 ↑	< 480
CPK, U/L	527 ↑	< 196
ESR 1 h, mm/h	57 ↑	0–15
CRP, mg/L	9 ↑	< 6
PT, s	13.5	13.5–18
PTT, s	27	24–34
Blood culture, 24, 48, 72 h	Negative	

WBC: white blood cell, RBC: red blood cell, Na: sodium, K: potassium, LDH; lactate dehydrogenase, CPK: creatine phosphokinase, ESR: erythrocyte sedimentation rate, CRP: C-reactive protein, PT: Prothrombin time, PTT: partial thromboplastin time.

responded well to treatment. His fever resolved within 48 h and his respiratory symptoms subsided in 5 days of hospitalization. He did not require endotracheal intubation or ICU admission. The patient was discharged after one week with stable vital signs, and his SpO2 was 95%.

Four weeks after disease onset, a follow-up CT scan (Fig. 2) showed complete clearance of consolidations. Diffuse round pure ground glass opacities were seen in both lungs without intra- or inter-lobular septal thickening. Scar formation, cavitation, atelectasis, or lymphadenopathy were absent.

3. Discussion

In this study, we reported a COVID-19 patient with an unusual chest CT finding of combined halo and reverse halo signs coexisting on the same study, who recovered rapidly after multidrug treatment.

Alveolar edema and hemorrhage may create the halo sign, while the reversed-halo sign may be formed by the organization and resolution of alveolar exudates [9]. Although these findings are not specific, they are highly suggestive for early stages of opportunistic invasive fungal infections (e.g. aspergillosis, mucormycosis) in immunocompromised patients. They might be seen in immunocompetent individuals in other conditions such as non-fungal endemic infections, cryptogenic organizing pneumonia, vasculitis, and neoplastic and inflammatory diseases [8]. The Reversed Halo sign in invasive fungal infections appears as one or more large lesions; while in endemic infections (e.g. tuberculosis), lesions have a bilateral and asymmetric appearance with ground glass opacities, centrilobular nodules, or consolidations [10]. The multilobular, peripheral target-shaped findings in our COVID-19 patient were unlikely due to fungal co-infection, given lack of history of immunodeficiency, short disease course, and the resolution of consolidations without any antifungal treatment.

Bernheim et al. reported that the frequency of uncommon chest CT findings, including the reversed halo sign, increases in the later stages of COVID-19 progression [11]. There are no adequate data to explain the pathophysiology of the combined lesions in our patient. The coexistence of both halo and reversed halo signs could be an atypical presentation in COVID-19. To the best of our knowledge, this imaging feature has never been described before.

This case report provides information for future secondary articles

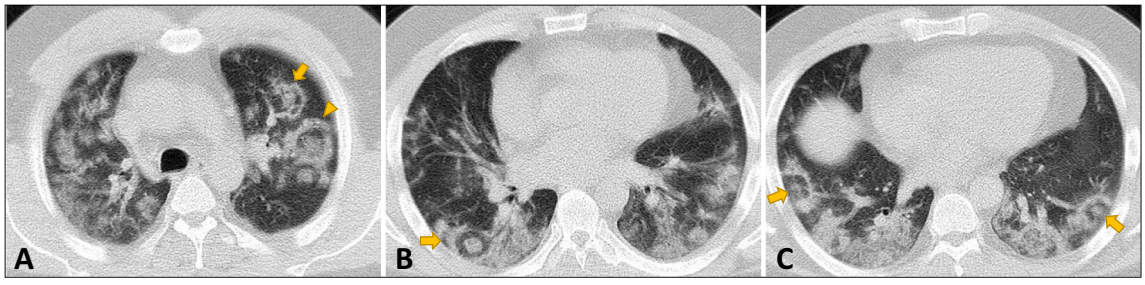

Fig. 1. Baseline chest CT displaying multilobar peripheral consolidations with mixed configuration of 'reversed halo' and 'halo' signs. This appearance was embedded in areas of consolidation. The described patterns were seen in the anterior and apicoposterior segments of the left upper lobe with a maximum size of 33 × 24 mm (arrowhead) (A). Another well visualized peripheral halo consolidation and central round nodule was seen in the posterior segment of the right lower lobe (28 × 18 mm) (B). Two additional areas of peripheral complete halo and central nodular opacity were seen in the lateral segment of the right lower lobe and lateral segment of the left lower lobe, measuring 29 × 21 mm and 25 × 15 mm, respectively (C).

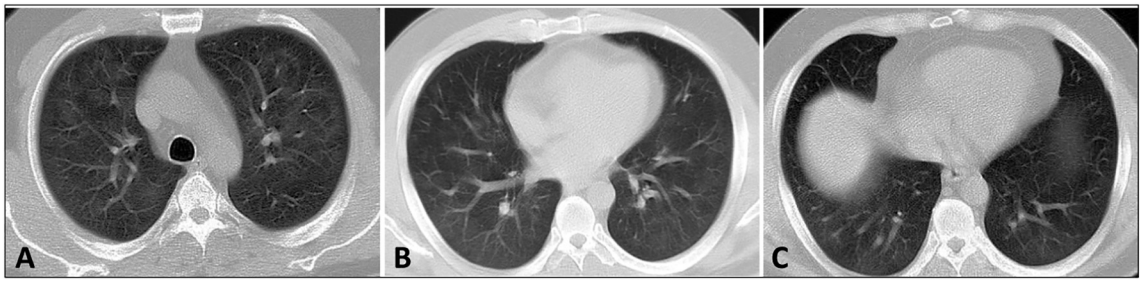

Fig. 2. Follow-up CT-scan, after 4 weeks of disease onset, showing diffuse multifocal patchy pure ground-glass opacities in both lungs, without consolidation. Significant clearance of lung fields in left upper lobe (A), right lower lobe (B), and bilateral lower lobes (C) is evident compared to the baseline. The patient denied any symptoms on the follow-up exam.

and systematic reviews. We advocate reporting unusual presentations of COVID-19 patients. Future studies on this data should be warranted better understand the pathophysiology and different characteristics of this newly emerged disease.

A video of axial CT images is available as an online appendix. Supplementary data to this article can be found online at https://doi.org/10.1016/j.clinimag.2020.06.038.

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