



Differences and Similarities between the Double Halo Sign, the Chest CT Target Sign and the Reversed Halo Sign in Patients with COVID-19 Pneumonia

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To the Editor,

We read with great interest the well-written letter to the editor of Poerio et al. [1], who reported a case of COVID-19 pneumonia that presented on CT examination with the halo sign, reversed halo sign (RHS), and an atypical feature that they named the “double halo sign” (DHS). The authors characterized the DHS as an RHS surrounded by an additional peripheral ground-glass halo (identical to the “halo sign”), which gives these lesions a peculiar target-like appearance [1].

The halo sign and RHS are nonspecific tomographic signs that have been described in patients with several

infectious and noninfectious diseases [2], and were recently reported in patients with COVID-19 pneumonia [3,4]. A recent study [3] showed that the RHS may present two different morphological appearances in patients with COVID-19 infection: the traditional RHS, defined as a focal rounded area of ground-glass opacity surrounded by a more or less complete ring of consolidation [4,5], and the reticular RHS, characterized by low attenuation areas inside the halo, with or without reticulation, suggestive of pulmonary infarction [6].

Other authors have reported the observation of a tomographic sign similar to the DHS described by Poerio et al. [1] in patients with COVID-19, characterized by peripheral ring-like opacities and a central nodular ground-glass opacity [7,8]. The authors named this sign the chest CT “target sign” and noted that the ring-like opacities are suggestive of an organizing pneumonia reaction pattern [6]. They also suggested that the central nodular opacity may reflect the presence of perivascular inflammation or may represent focal enlargement of the pulmonary artery. Despite its morphological distinctiveness, the target sign is often misinterpreted as the RHS [9].

We retrospectively reviewed the chest CT studies of 34 adult patients with COVID-19 pneumonia, confirmed by reverse transcriptase polymerase chain reaction, who were examined in two tertiary hospitals in Brazil. Images were obtained in the late phase of the disease (> 12 days after symptom onset) [10]. RHS was observed in three (8.8%) patients, and the target sign was identified in four (11.8%) patients. Multiple target signs were observed in three of the latter patients, and a solitary sign was observed in one patient. In all the target sign cases, areas of consolidation and ground-glass opacity were also observed. In three of the four patients, the periphery of the target sign was complete and the sign had a polygonal instead of a more rounded or oval appearance (Fig. 1A), as commonly seen in the RHS. Regarding the central nodularity of the target sign, contrast-enhanced CT studies showed that the central region was composed of vessels in some cases, but had no relationship with vascular structures in others (Fig. 1B, C). In addition, the density was compatible with ground-glass opacity (ranging from -200 to -500 Hounsfield units).

Detailed analysis of the peripheral wall of the target sign is more significant than the analysis of central nodular opacity.

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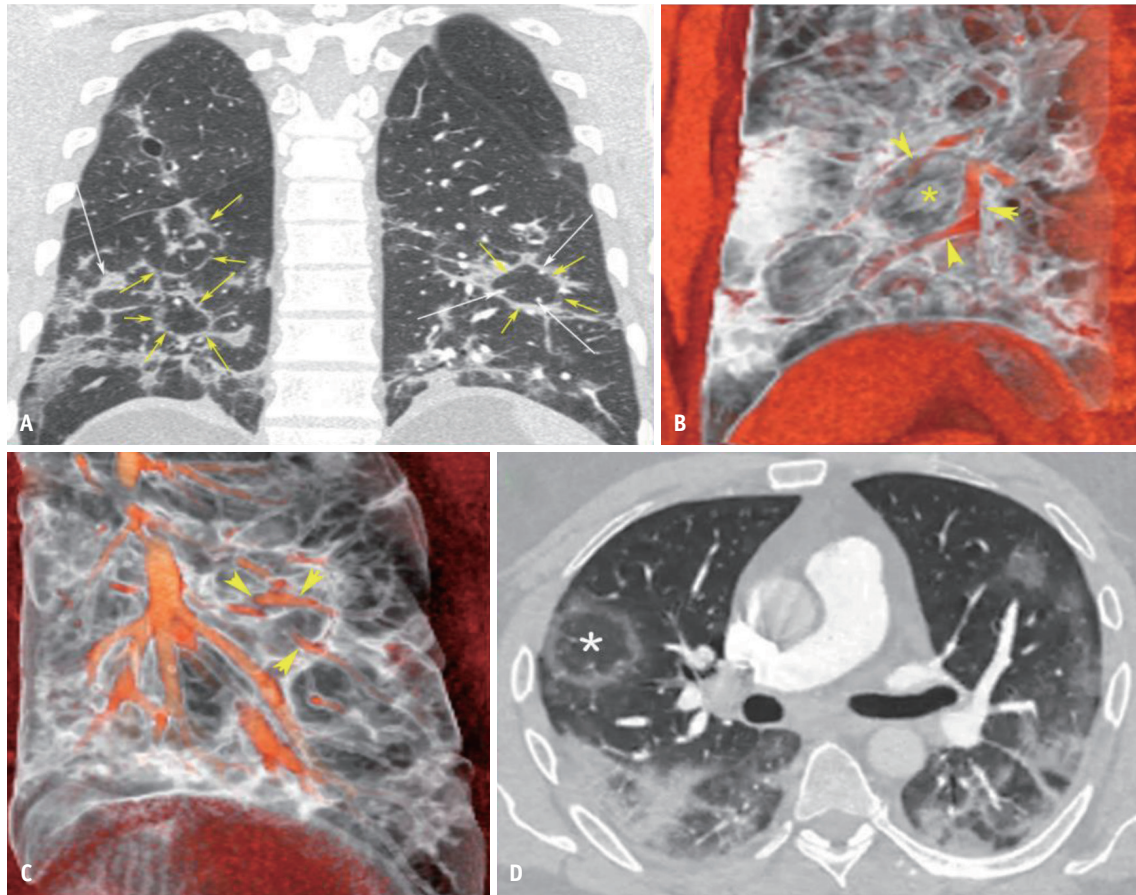


Fig. 1. Target sign and reversed halo sign on chest CT in a COVID-19 patient.

A. Coronally reconstructed chest CT image showing bilateral areas of ground-glass opacity, most with a polygonal peribular distribution (yellow arrows). The target sign is seen on the right lung, with central density (white arrows). Another polygonal peribular opacity is seen on the left lung (yellow arrows), with vessels inside it (white arrows). **B.** 3D reconstruction of the target sign on the right lung showing the absence of vessels in the center (asterisk); the vessels have a peripheral course (arrowheads). **C.** 3D reconstruction of the polygonal opacity on the left lung, demonstrating the presence of vessels inside it (arrowheads). **D.** A reversed halo sign is seen in the right lung (asterisk). Note the rounded aspect of the lesion. 3D = three-dimensional

In patients with multiple adjacent target signs, the signs share external walls, creating a polygonal appearance. This pattern is not seen in patients with multiple RHSs, which generally have rounded or oval boundaries (Fig. 1D). The polygonal target sign structures are considered to represent the peribular pattern, a characteristic finding of organizing pneumonia [11]. This pattern is characterized by thick, irregular polygonal or arcade-like opacities distributed mainly around the inner surface of the secondary pulmonary lobule. It was present in 57% of 21 patients with pathologically confirmed organizing pneumonia [11] and in 22.2% of 36 adult patients with organizing pneumonia studied by Faria et al. [12]. A recent pathological study demonstrated that patients in the late phase of COVID-19 pneumonia, especially critically ill patients who require mechanical ventilation, may develop secondary organizing pneumonia [13], as with other viral respiratory diseases, including influenza [14].

In conclusion, more important than the differentiation between the RHS, the target sign, and the DHS is the recognition of the signs' common etiopathogenesis; all the signs likely have the same significance and represent organizing pneumonia. This information is important because steroid use, although not routinely recommended in the early phase of COVID-19 pneumonia, might play a role in the late phase of the disease, when organizing pneumonia is suspected. Subsequent pathological studies may help confirm this suspicion, which could have important therapeutic implications.

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Response

RE: Differences and Similarities between the Double Halo Sign, the Chest CT Target Sign and the Reversed Halo Sign in Patients with COVID-19 Pneumonia

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Dear Editor,

We read the paper "Differences and Similarities between the Double Halo Sign, the Chest CT Target Sign and the Reversed Halo Sign in Patients with COVID-19 Pneumonia" [1] with great interest. We thank the authors for their quote, and we are grateful for the opportunity to comment on it.

We really appreciated the discussion about the shape of the sign and, specifically, the fact that the relief of a polygonal shape rather than a rounded or oval appearance could help to identify this sign and to differentiate it from the classical reversed halo sign (RHS). In our case, the shape of the double halo sign (DHS) was polygonal and not rounded [2], and this feature could be very useful.

We also agree that a detailed analysis of the peripheral wall of this sign is more significant than the analysis of the central component. For this reason, we would emphasize that in our case, the outer rim of the DHS was constituted of a more or less uniform ground-glass opacity, a feature that seems to be appreciable also in this paper (Fig. 1A) and in other works about the chest CT target sign [3,4]. As we stated in our article, we strongly believe that this feature is indicative of vascular damage of pulmonary microcirculation, mainly found in the acute phase of disease, associated with a polygonal shaped

ring consolidation indicative of organizing pneumonia. This hypothesis would be consistent with what has been reported in studies based on pathological findings [5, 6], and with the literature concerning the CT analysis of vascular involvement in patients with COVID-19 pneumonia [7,8]. In this scenario, the value of the central vascular density should not be overlooked because it could have the same explanation.

In conclusion, we think that the DHS and the chest-CT target sign are not different signs, but the same pattern described from different points of view. Moreover, we absolutely agree with the authors that this sign as well as the classic RHS, is probably indicative of organizing pneumonia, information that could have important implications both in the clinical management in the acute/subacute phase of the disease and during the follow-up.

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