

Significance of various pulmonary and extrapulmonary abnormalities on HRCT of the chest in scleroderma lung

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Abstract

Patients with systemic sclerosis (SSc) are routinely investigated with high-resolution computed tomography (HRCT) chest for early detection and accurate characterization of complicating interstitial lung diseases. Though the primary aim of HRCT is to delineate the burden of pulmonary involvement and to characterize the nature of fibrosis to potentially help guide management, it provides an opportunity to evaluate extrapulmonary manifestations, particularly the dilated pulmonary artery, esophageal dilatation, and pericardial abnormalities which have their own clinical significance. The aim of this article is to discuss the significance of various pulmonary and extrapulmonary abnormalities that may be identified on HRCT chest of SSc patients.

Key words: Ground-glass opacity; HRCT Chest; lung fibrosis; pulmonary hypertension, systemic sclerosis

Introduction

Systemic sclerosis (SSc) is a chronic multisystem autoimmune disorder that involves the skin and several internal organs. Depending on the extent of cutaneous involvement, the disease is classified into diffuse cutaneous (dcSSc) and localized cutaneous (LcSSc) forms. Among the potential organ involvements, the lung has a very important bearing on the prognosis of these patients. Pulmonary involvement and related complications is the largest driver of morbidity and mortality in SSc.^[1] Interstitial lung disease (ILD) and pulmonary hypertension (PH) are the two most important complications which are also the leading cause of morbidity and mortality. Over 90% of SSc patients have evidence of ILD at autopsy and 40% of SSc patients demonstrate abnormal pulmonary function tests.^[2]

According to the contemporary standard clinical practice, patients of SSc are routinely investigated with high-resolution CT (HRCT) chest for screening of ILD. The aim of this article is to describe the findings that should be sought on HRCT chest of these patients and to discuss the significance of these findings.

Table 1 lists the various abnormalities that may be present in HRCT chest of SSc patients.

Lung Parenchymal Abnormalities

HRCT chest is now a well-established and reliable imaging tool to detect and characterize ILD in SSc.^[3,4] Classically, the disease initially affects the subpleural, posterior, and dependant aspects of the lungs. The pattern of ILD in SSc is similar to that seen in the idiopathic nonspecific interstitial pneumonitis (NSIP).^[5,6]

Ground-glass Opacity

Ground-glass opacity (GGO) is defined as hazy increase in lung parenchymal opacity with preservation of bronchial and vascular markings [Figure 1A and B].^[7] This is the most common abnormality seen on HRCT chest in cases of SSc.

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In previously published series,^[8,9] GGO has been reported to be from 66 to 93% cases and was seen as an isolated abnormality in 7-22% cases.

Since GGO, by definition, results from volume averaging of lung morphological abnormalities that are too small to be clearly resolved by HRCT, GGO can represent both presence of inflammatory cells filling the alveoli (alveolitis) and early fine fibrosis.^[10]

Shah *et al.* followed a cohort of SSc patients for a mean follow-up period of 27 months and found that out of 27 patients with GGO at presentation, only 2 patients showed significant improvement. None of the three patients with isolated GGO at presentation showed any improvement on follow-up. They suggested that GGO in SSc is most commonly associated with irreversible disease.

Similar observations were made by Remy-Jardin *et al.*^[11] who suggested that in the absence of significant honeycombing, the severity of GGO may represent a useful indicator of lung damage in SSc. In their series, in all but one patient, honeycombing was seen to develop

within areas of GGO on initial CT scan, with concurrent resolution of GGO.

These observations are opposite to the conclusions drawn by other researchers^[12] that GGO is a good predictor of response to treatment in fibrosing alveolitis. This likely reflects high likelihood that the GGO in SSc is more likely to represent fine fibrosis rather than alveolitis.

As a result, GGOs cannot be reliably used to predict active inflammation and potentially reversible disease. In addition, GGO does not show an association with peak pulmonary artery pressures as measured by echocardiography.^[8]

Lung Fibrosis and Honeycombing

Fibrosis is manifested by the presence of interlobular septal thickening, intralobular septal thickening, traction bronchiectasis, and bronchiolectasis [Figure 1B and C]. Honeycombing represents end-stage irreversible lung fibrosis and is defined as clustered air-filled cysts with well-defined walls [Figure 1D].^[7]

In our previously published series, features of lung fibrosis without honeycombing were present in 72% cases and honeycombing was present in 17% cases. In the presence of these features, likelihood of irreversible disease increases. Presence of lung fibrosis and honeycombing are significantly associated with PH.^[8] Thus, presence and extent of lung fibrosis and honeycombing are important poor prognostic features.

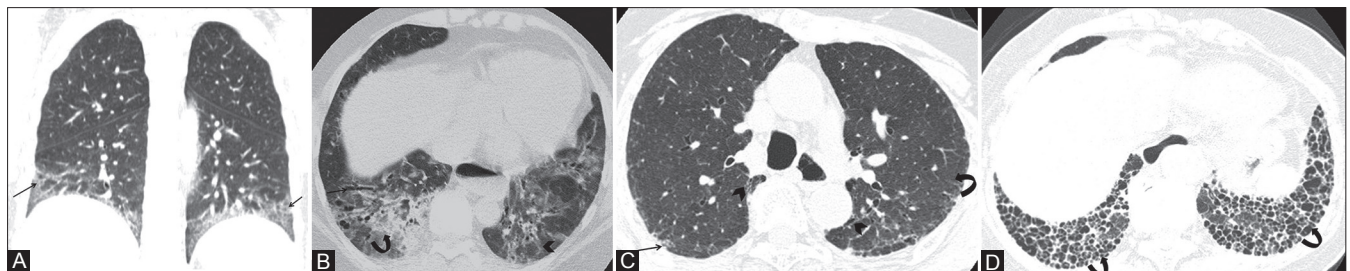
In a recent study by Tashkin *et al.*^[13] the degree of lung fibrosis on baseline CT was found to be a useful predictor of progression of fibrosis and worsening pulmonary function when untreated.

Goh *et al.*^[14] have proposed a simple semi-quantitative staging system to classify the SSc patients with limited and extensive disease, which has an important bearing on the prognosis. The authors found that there was a remarkable difference in the clinical outcome between those having ILD

Table 1: Various abnormalities which may be found in HRCT chest of systemic sclerosis patients

Lung parenchymal abnormalities	Ground glass opacity Lung fibrosis and honeycombing Small centrilobular nodules (Follicular Bronchiolitis)
Pleural Disease	Subpleural micronodules Pseudoplaques Diffuse pleural thickening
Pericardial Abnormalities	Pericardial effusion Diffuse pericardial thickening Thickening of anterior pericardial recess
Dilated pulmonary artery	
Dilated esophagus	
Mediastinal lymphadenopathy	

HRCT: High-resolution computed tomography



Figures 1 (A-D): (A) Coronal reformatted image of HRCT chest at lung window image displaying ground-glass opacity in bilateral lung bases. (B) Axial image of HRCT chest at lung window displaying ground-glass opacity and changes of fibrosis as manifested by traction bronchiectasis and septal thickening in bilateral lung bases. (C) Axial image of HRCT chest at lung window at the level just above carina depicting intralobular and interlobular septal thickening with traction bronchiolectasis in bilateral (left > right) upper lobes posteriorly. (D) Axial image of HRCT chest lung window at the level of lung bases showing bilateral honeycombing

involving <20% lung volume and those with involvement of >20% lung volume.

Small Centrilobular Nodules (Follicular Bronchiolitis)

Though nodules are not prominent HRCT features of scleroderma lung, however, small parenchymal nodules have been reported which probably represent focal lymphoid hyperplasia.^[15]

Pleural Disease

The manifestations of the pleural disease may be in the form of subpleural micronodules, pseudoplaques, and diffuse pleural thickening. Confluent subpleural micronodules (<7 mm in width) are called pseudoplaques. In a previous study by Remy-Jardin *et al.*^[11] the subpleural micronodules were seen in 89% cases and diffuse pleural thickening in one-third of the cases.

Pericardial Abnormalities

Fischer *et al.*^[16] reported an abnormal pericardium in 59% patients of SSc. The pericardial abnormalities include pericardial effusion, thickened pericardium, and thickened anterior pericardial recess [Figure 2A and B]. Pericardial thickness was measured using total pericardial score which is the sum of pericardial thickness at four points: Anterior, posterior, right lateral, and left lateral positions at a level midway between the aortic root and diaphragm. Total pericardial score >8 mm is considered abnormal. The sagittal dimension of anterior pericardial recess is measured anteriorly between the ascending aorta and main pulmonary artery and >10 mm is considered abnormal.^[17]

Patients of scleroderma with pericardial abnormalities are more likely to have coexistent PH and higher median

right ventricular systolic pressure. Of the pericardial abnormalities discussed above, the total pericardial score is the best individual predictor of PH.

Exact pathogenesis of these pericardial abnormalities is not known. Probably increased right atrial pressure contributes to the development of pericardial effusion via direct drainage of some cardiac veins into the right atrium. Alternatively, pericardial fluid accumulation may be a passive transudative process resulting from increased pulmonary artery pressure.

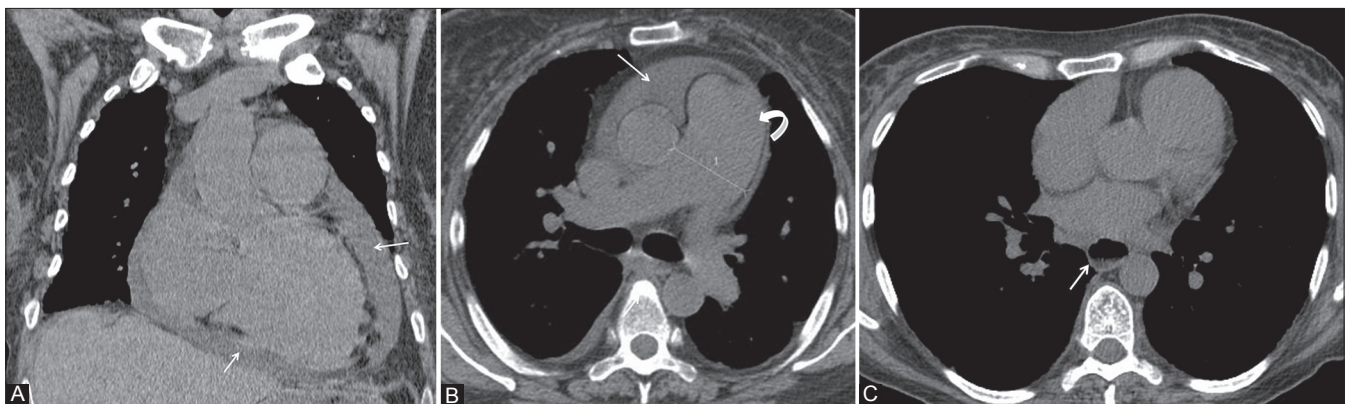
Esophageal Dilatation

Esophageal dilatation [Figure 2C] is defined by luminal coronal diameter of >9 mm of the infra-aortic esophagus.^[18] The prevalence of esophageal dilatation varies from 58 to 80% in different series.^[18-20] A case control study done by Vonk *et al.*^[19] revealed that the presence of esophageal dilatation on HRCT chest in ILD patients suggests a diagnosis of SSc with sensitivity of 63% and specificity of 88%. There is also good agreement between HRCT-detected dilated esophagus and esophageal dysmotility either detected with esophageal transit scintigraphy^[21] or with barium radiography.^[19]

Though the dilated esophagus has no correlation with the extent of HRCT-determined ILD and total lung capacity,^[19,20] interestingly, patients of SSc who have dilated esophagus on HRCT chest have significantly lower diffusion capacity for carbon monoxide and higher peak pulmonary artery pressures suggesting that these patients tend to have more severe pulmonary vascular disease.^[20]

Dilated Pulmonary Artery

Main pulmonary artery diameter (MPAD) is measured at its widest dimension at the level of its bifurcation on an axial supine scan [Figure 2B]. Dilated (>29 mm) pulmonary



Figures 2 (A-C): (A) Coronal reformatted image of non contrast CT of chest at mediastinal window displaying pericardial effusion in a patient of systemic sclerosis and pulmonary hypertension. (B) Axial image of non contrast CT chest at mediastinal window at the level of bifurcation of main pulmonary artery. A line has been drawn to represent the method to measure MPA diameter. Also note the fluid-filled dilated anterior pericardial recess. (C) Axial image of non contrast CT of chest at mediastinal window at the level of inferior pulmonary veins show dilated esophagus with air-fluid level

artery has been reported to suggest PH.^[22] Though a few studies have suggested that in presence of significant burden of lung fibrosis, MPAD does not correlate well with peak pulmonary artery pressure,^[23,24] in patients with SSc, MPAD shows statistically significant positive correlation with peak pulmonary artery pressures. Similarly, the ratio of MPAD and aortic diameter also correlates well with the peak pulmonary artery pressure; however, the normalized MPAD (MPAD/BSA) does not show statistically significant correlation with peak pulmonary artery pressure.^[8]

Mediastinal Lymphadenopathy

Enlarged mediastinal nodes on HRCT chest have been reported in 60% of patients of SSc by Bhalla *et al.*^[18] In this series, enlarged lymph nodes were most frequently seen in station 7. The nodal enlargement corresponds to reactive change on histopathology when biopsy is performed.^[25]

Conclusion

The primary goals of chest imaging in SSc patients are early detection and characterization of ILD, to evaluate for reversibility and any response to therapy. HRCT chest is the well-established gold standard imaging investigation used for this purpose. However, careful evaluation for extrapulmonary manifestations of SSc should also be done on HRCT chest as these findings may help to detect PH and visceral involvement in otherwise asymptomatic patients.

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