Pulmonary changes findings in patients with systemic sclerosis by high resolution computed tomography

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Abstract

This study was done to assess the ability of high resolution computed tomography (HRCT) in detecting the early signs of pulmonary involvement in patients with systemic sclerosis (SSc). The chest in ten patients with established diagnosis of SSc according to American College of Rheumatology criteria for classification of systemic sclerosis-1980 were examined by conventional chest x-ray (CXR) at Tikrit teaching hospital,(2007-2008) . After that, each patient was subjected to chest HRCT. The finding in HRCT imaging seen in nine patients (90%), while only five patients (50%) showed an abnormality on conventional CXR suggestive of an interstitial lung disease and/or chronic pulmonary fibrosis. The HCRT findings were distributed among the reticular and nodular structures (70%), decreased opacity (70%) and other accompanying lesions seen in (60%) of patients. No one of the examined group showed a sign of increased opacity which include the sign of ground glass appearance. HRCT scanner considered a worthfull imaging modality in all patients with SSc, especially at an early stage of the disease as the management of the pulmonary complication in such patients is more effective when applied early.

Key Word: HRCT, Systemic sclerosis, pulmonary complications.

Introduction

Systemic sclerosis (SSc) is a disease which affects many of body systems but is primarily characterized by thickening and tightening of the skin. Women are affected more than men with a ration of 3:1 and the dominant age group is between 20-50 years [1,2]. Lung disease is a frequent manifestation in patients with systemic sclerosis (70%) and had replaced renal disease as the leading cause of mortality [3].

Lung involvement independent of cardiac and/or renal disease is clearly associated with decreased survival [4]. The two major types of pulmonary disease in systemic sclerosis are interstitial lung disease [5] (ILD) and pulmonary hypertension [6]. Fibrosis of pulmonary parenchyma is a well defined feature of SSc, which results in significant impairment of lung function and pulmonary disease is a contributing cause of death in a significant number of patients [7]. Prognostic factors of poor outcome for lung disease which have been reported include; male sex [4], presence of lung involvement early in the disease [4,8,9], severe Raynaud's phenomenon [3] and cigarette smoking [4].

In SSc there will be wide spread small vessel vasculopathy and fibrosis, which occur in the setting of immune system activation and autoimmunity, distinguish SSc from other connective tissue diseases. [10]

SSc pulmonary fibrosis is morphologically indistinguishable from idiopathic pulmonary fibrosis (IPF), but the fibrosis of SSc usually developed over a more protracted course [11]. More recently, prospective studies of lung biopsies in patients with interstitial lung disease due to SSc suggest that pathological pattern of lung involvement was more frequently of non specific interstitial pneumonia (NSIP) than that of usual interstitial pneumonia (UIP) [12]

The pathogenesis of SSc lung disease is poorly understood. Researches

on pulmonary involvement in SSc largely emphasize two theories: the vascular and the immunologically mediated inflammatory theories, although these factors probably act together to induce pulmonary fibrosis [13].

During the last two decades, high resolution CT of the lungs has developed into a mature technique for the evaluation of diffuse pulmonary parenchymal abnormality. At its simplest, high resolution CT is a sampling tool that combines 1-2 mm thin collimation CT images with high spatial frequency reconstruction algorithm to generate images that show exquisite lung detail. The technique of high resolution CT for diffuse lung disease was initially described by Tode et al from Kyoto University in 1982 [14].

Several recent publications had strengthened the fact that a systematic approach to the HRCT pattern is of great importance and allows for a mean diagnostic accuracy ranging between 57 and 95% depending on the study group and the disease entity [14].

The aim of the study is to evaluate the efficacy of high resolution CT imaging of the lungs to detect early involvement in patients with SSc.

Patients and Methods

Between January 2007 and October 2007, 10 patients (9 females and 1 male) who were admitted to the Rheumatology department and carefully diagnosed as having SSc according to the American College of Rheumatology criteria for classification of systemic sclerosis-1980 [1] were subjected to conventional chest X-ray and high resolution CT for the lungs (most of these patients were admitted for reasons not related to respiratory complaints).

CT scan study as well as CXR was done at Tikrit teaching hospital. The CXR and HRCT films were evaluated by two radiologists at two different intervals. All patients were lied in supine position and the chest was examined with 2mm collimation and 6 mm table increment to include from the apices to the base of the lungs with multiple breath holding in full inspiration with a few section taken with breath holding in full expiration at the lung bases with 2mm slice thickness and 2 mm interval.

Kvp about 140, MAS = 120 with scan time 20-30 seconds and a window level (-300) – (-400), window width (1500-1600), matrix of 512 pixels with a field of view of about 35-40cm. Statistical analysis was done by using Chi square formula with P value = 0.05.

Results

Ten patients were subjected to this study, 9 of them were females and only one patient was male (a ratio of 9:1). The age ranged between 14-59 years with a mean of 31 years. Two patients had localized form and 8 out of ten were having systemic form of SSc.

Five patients (50%) as seen in table (3), showed abnormalities on conventional chest X-ray in the form of an interstitial pulmonary disease and/or chronic pulmonary fibrosis; most of these signs were in the form of decrease in lung volume and diffuse bilateral reticulo-nodular shadowing and sometimes even honeycomb lesions in the lower lobes.

The findings on HRCT discovered in nine patients (90%), can be summarized as follow: see table (3)

1. Reticulonodular structures seen in seven patients (70%) and these include:
   a. Septal lines (smooth, irregular, nodular)
   b. Honeycomb
   c. Bronchovascular thickening
   d. Nodular abnormalities (milliary, centrilobular, perilymphatic).
2. Decreased opacity seen in seven patients (70%) and these include:
   a. Cystic lesion

b. Emphysema (air trapping)
c. Mosaic alteration

3. Accompanying lesions seen in 6 patients (60%) and these include
   a. Linear opacities
   b. Parenchymal bands
   c. Architectural distortion

Of the ten patients examined, no one showed a feature of increased opacity.

Discussion

Pulmonary disease occurs in a significant number of patients with systemic sclerosis and is second in frequency as a visceral complication only to esophageal involvement. Diagnosis of lung disease in its earliest stage is critical because it enables the prompt institution of therapy aimed at halting disease progression. Fortunately, modern techniques such as high resolution CT scan [15], 99m Tc-DTPA scanning and the analysis of broncheoalveolar lavage fluid (BAL)[16,17] have begun to make this possible. There is also evidence that genetic markers HLA-DR_3/DR_{52}[18,19] specific antibodies (Sc1-70 anti-U_3 RNP, anti-topoisomeras I and antihiston antibodies) and African-American race may help identify of presentation those patients who are more susceptible to SSc lung disease [20-24].

A single HRCT finding is frequently non specific but the combination of the various HRCT findings together with their anatomic distribution can suggest the most probable diagnosis [23]. An accurate interpretation of HRCT scans requires a detailed understanding of normal lung anatomy and of pathological alterations in normal lung that occur in the presence of disease [25] and with the recognition of the artifacts and the potential interpretive and cognitive pitfalls in the approach to HRCT image as this is so important to avoid confusion of artifacts with real lung disease and other misinterpretation. The HRCT has a sensitivity of 95% and a specificity approaching 100% in detecting diffuse lung disease [26,27] in comparison to conventional chest X-ray which had an overall sensitivity of 80% and specificity of 82% for detection of diffuse lung disease [28].

The present study shows that female to male ratio (9:1) is seems to be higher in comparison with a known ratio (3:1) [2] and this perhaps related mainly to the shortage of the included samples, while the age distribution showed to fall within the same range of age as that mention in previous study [2] & inspite of that the age seem to be unrelated to the incidence of the disease, as its seen in table (5) ,were p-value = 0.07.

The duration of illness is apparently different from patient to other, but in spite of that, the pulmonary changes of SSc seems to be unrelated to this factor and as it is seen from table (1), the duration of illness among the studied group ranged from (1yr-17yrs) and the HRCT imaging findings were discovered in most of them. The p value was 0.37 which is not significant.

The present study showed that HRCT scan finding among the studied group is not a uniform one and it differs from one patient to another irrespective to the age, sex or to the duration of the illness. These signs mainly showed in form of decreased opacification (70%) and/or reticular and nodular shadowing (70%) and only 60% of them showing signs of linear opacification, parenchymal bands with other architectural distortion, while no one showed signs of increased opacification, were one of most important sign falls which is ground glass opacity. Although ground glass pattern is not a specific sign of DILD as further developed, there is considerable interest in demonstrating its presence on HRCT images in patients with suspected or known DILD because it often reflects mild parenchymal alteration, unsuspected on the radiographs and it may provide

information about disease activity, therapy as well as prognosis [28]. The paucity in number of patients and/or technical fault may lie behind the absence of this sign in this study.

Another possible reason may arise from either difficulty or impossibility in distinguishing between patterns of normal lungs intermingled with areas of ground glass attenuation from a pattern of areas of abnormally low attenuation against normal lung, in the presence of mild heterogenicity distributed gradients of density in the lung parenchyma [25]. In spite of that, and from the statistical point of view, the p-value for HRCT findings was highly significant (0.003).

Collectively, the signs detected on HRCT scanner were seen in about 90% of patients and this percentage seems to be approximate to the percentage shown by Warrick JH et al [29] which was about 91% and Kips JC [30] where the study documented the finding in about 90% of patients, while Lifortson et al [31] found that HRCT scanner can detect early pulmonary changes in 70-90% of patients with SSc and only 70% of patients with SSc showed early pulmonary changes on HRCT imaging as mentioned by Wells et al [32].

This variability in percentage may be in fact related to the limited type of the present study and for the technical causes in form of, e.g. the machine type and the efficiency of the technicians, in addition to that the type of patients included and their ability in obeying the order regarding the holding of inspiration.

The finding on conventional X-ray seen in about 50% of patients and this finding showed to be unrelated to the age of patients but it has a high relation to the duration of illness where the findings were more frequent in patients with long history of illness.

By comparing the detective ability of HRCT scanner with that of the CXR, as we see in table (3) where the p value = 0.05 which is significant , we found that CXR is not as an accurate imaging modality as that of HRCT regarding discovering of early signs of pulmonary involvement in patients with SSc, with 100% sensitivity and 30% specificity for HRCT imaging , so that CXR should be used only as an initial screen to detect established findings and/or to rule out the possibility of secondary infection or aspiration because of esophageal involvement [33]. This result seems to be in approximately similar to that done by Charge JH et al [26] where he found that chest radiograph is abnormal in about 25-50% of patients with established disease, also Harrison NK et al [33] found that HRCT scans are frequently abnormal in asymptomatic patients with systemic sclerosis who have normal chest radiograph and CXR is an insensitive indicator of fibrosing alveolitis. Schurawitzki et al [26] found evidence suggesting usual interstitial pneumonia (UIP) in 90% (21 out of 32) of patients with progressive SSc using HRCT. Radiographic findings were definitely positive in 39% and absolutely normal in 35% of the same group.

The signs of irreversible pulmonary fibrosis seen on HRCT include subpleural lines, honey combing and parenchymal bands [29]. HRCT evidence of alveolitis, though sensitive, is not 100% specific [34], in comparison with BAL which is sensitive and specific method, although invasive, to detect alveolitis in early stage of lung disease [34].

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Table (1) The distribution of patients according to age, sex and duration of illness

Sex of patients	Age of patients	No. of patients	Duration of illness (mean)
Female	10-19	1(1%)	2 yrs
	20-29	2(2%)	4 yrs
	30-39	4(4%)	19yrs
	40-49	2(2%)	8.5yrs
Male	50-59	1(1%)	7 yrs

Table (2) The distribution of patients according to HRCT findings

No. of patients	Reticular & nodular structures	Increased opacity	Decreased opacity	Accompanying lesions
9	7	0	7	6
100%	70%	0	70%	60%

P = 0.003

Table (3) Comparison between HRCT and conventional chest X-ray findings

No. of patients	HRCT findings	X-ray findings
9	+ve	-
5	-	+ve

P = 0.05

Table (4) The distribution of patients according to the duration of illness

Duration of illness (yrs)	No. of patients
1-5 yrs	4
> 5 yrs	6

P= 0.07

Table (5) The distribution of patients according to age

Age (yrs)	No. of patients
10-39 yrs	7
40-59 yrs	3

P = 0.37

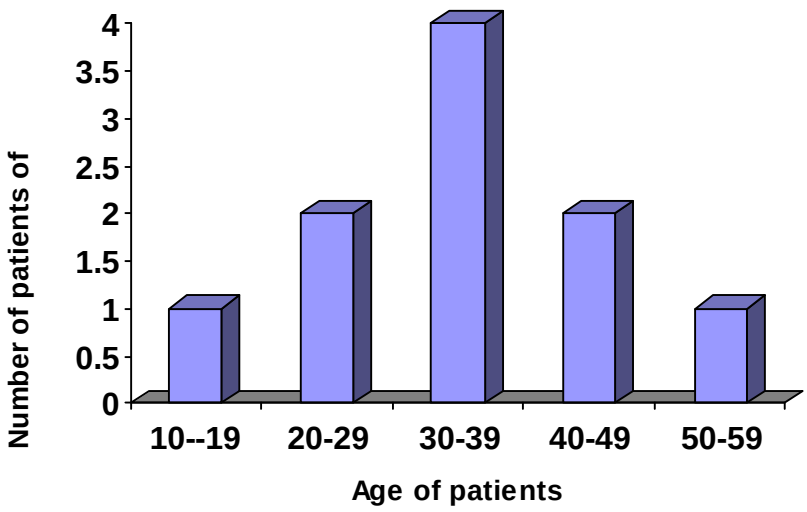

Figure (1) The distribution of patients according to age group