

## Oxygen-Enhanced MRI vs. Thin-Section CT: Capability for Pulmonary Functional and Disease Severity Assessments in Patients with Connective Tissue Diseases

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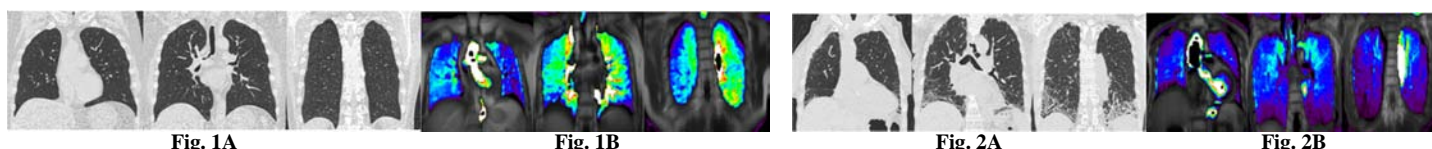
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**Introduction:** Interstitial lung disease (ILD) is described as a heterogeneous group of parenchymal lung disorders that share common radiologic, pathologic, and clinical manifestations. Currently, ILD is subdivided into idiopathic interstitial pneumonia, idiopathic pulmonary fibrosis (IPF) as one subset, and diffuse parenchymal lung diseases, which may be secondary to a variety of exposures to occupational or environmental hazards or can complicate several connective tissue diseases (CTDs). According to the previous epidemiologic and radiologic studies, the American Thoracic Society-European Respiratory Society classification of ILD has provided a useful new template for classifying thin-section CT and pathologic features which can also be applied to CTDs. Thin-section CT as well as pulmonary function tests, the serum markers are utilized for diagnosis, disease severity assessment and therapeutic effect evaluation of ILD associated with CTD. In contrast to morphological approach using thin-section CT, pulmonary functional MR imaging has been suggested as new approach for assessment of pulmonary diseases since 2000. As pulmonary functional MR imaging, various techniques including oxygen-enhanced MR imaging (O<sub>2</sub>-enhanced MRI) can be suggested as useful for assessment of regional morphological and functional changes in various pulmonary diseases. In addition, it has been proposed that O<sub>2</sub>-enhanced MRI can assess regional ventilation, alveolocapillary gas transfer of molecular oxygen, oxygen uptake per respiratory cycle and airflow limitation (1, 2). However, none of these studies have examined the quantitative and qualitative capabilities of O<sub>2</sub>-enhanced MRI for evaluation of pulmonary functional loss and disease severity, and compared with that of evaluation by means of thin-section CT. We hypothesized that O<sub>2</sub>-enhanced MRI has the potential to quantitatively and qualitatively evaluate pulmonary functional loss and disease severity as well as thin-section MDCT in CTD patients with ILD. The purpose of the study presented here was thus to prospectively and directly compare capability of O<sub>2</sub>-enhanced MRI and thin-section CT to pulmonary functional loss and disease severity assessments in CTD patients with ILD.

**Materials and Methods:** 36 CTD patients with ILD (23 men and 13 women, mean age, 63.9 years, age range 41-76 years) and nine CTD-patients without ILD (five men and three women, mean age, 62.0 years, age range 43-75 years) underwent thin-section CT, O<sub>2</sub>-enhanced MRI, and pulmonary functional measurements. Serum KL-6 levels of all patients were also assessed. On O<sub>2</sub>-enhanced MRI, the T1-weighted images were continually collected by means of a respiratory synchronized half-Fourier acquisition centrally-reordered inversion recovery single-shot turbo spin-echo (HASTE) pulse sequence at 1.5 T scanners. All O<sub>2</sub>-enhanced MR images were expressed as the percentage change between the oxygen-enhanced and baseline images, and the mean relative enhancement ratio (MRER) for each subject was determined as the average of the relative enhancement ratio measured from regions of interest (ROIs) drawn over both lungs on the coronal section. Disease severity of CTD in each subject was determined from serum KL-6 level and semi-quantitatively assessed as CT-based disease severity by using visual scoring system according to past literatures (3). To evaluate the difference between normal subjects and CTD patients with ILD on CT- and MR-based indexes, Student's t-tests were performed. To determine the capability for pulmonary functional loss assessment and disease severity evaluation, MRER was correlated with the results of pulmonary functional test, CT-based disease severity and serum KL-6 level in all subjects and only CTD patients with ILD. In addition, CT-based disease severity was also correlated with pulmonary functional test and serum KL-6 level in all subjects and only CTD patients with ILD.

**Results:** Representative case is shown in Figure 1 and 2. CT-based disease severity and MRER of CTD patients had significant difference with those of normal subjects (p<0.05). Correlations of MRER with results of pulmonary function test, CT-based disease severity and serum KL-6 level and that of CT-based disease severity with results of pulmonary function test and serum KL-6 level in all subjects and only CTD patients are shown in Table 1. In all subjects, MRER and CT-based disease severity had significant and moderate correlations with %FEV<sub>1</sub>, %VC and serum KL-6 (0.60<r<0.71, p<0.05). In addition, MRER and CT-based disease severity had significant and good correlations with %DL<sub>CO</sub>/V<sub>A</sub> (MRER: r=0.79, p<0.05; CT-based disease severity: r=0.76, p<0.05). Moreover, MRER had significant and moderate correlation with CT-based disease severity (r=0.56, p<0.05). In only CTD patients with ILD, MRER and CT-based disease severity had significant and moderate or fair correlations with %FEV<sub>1</sub>, %VC and serum KL-6 (0.32<r<0.63, p<0.05). In addition, MRER had significant and good correlations with %DL<sub>CO</sub>/V<sub>A</sub> (r=0.75, p<0.0001). Moreover, MRER had significant and moderate correlation with CT-based disease severity (r=0.42, p<0.05).

**Conclusion:** O<sub>2</sub>-enhanced MRI was found to be as useful as thin-section CT for pulmonary functional loss and disease severity assessments of CTD patients with ILD.



**Figure 1.** 42-year-old male CTD patient without ILD

A: Thin-section CT on coronal planes (L to R: ventral to dorsal) show no abnormality within both lungs, and CT-based disease severity was assessed as 0. B: O<sub>2</sub>-enhanced MRI on coronal planes (L to R: ventral to dorsal) shows slightly heterogeneous, but generally homogeneous oxygen-enhancement within lungs. MRER was 0.33.

**Figure 2.** 56-year old male MCTD patient with ILD

A: Thin-section CT on coronal planes (L to R: ventral to dorsal) show traction bronchiectasis and fibrotic changes with remodeling of secondary lobules, and CT-based disease severity was assessed as 20. B: O<sub>2</sub>-enhanced MRI on coronal planes (L to R: ventral to dorsal) shows slightly heterogeneous, but generally homogeneous oxygen-enhancement within lungs. MRER was 0.08.

**Table 1.** Correlations among all parameters in all patients and only CTD patients with ILD.

	All CTD patients				CTD patients with ILD			
	CT-based disease severity		MRER		CT-based disease severity		MRER	
	r	p value	r	p value	r	p value	r	p value
%FEV <sub>1</sub>	0.68	p<0.0001	0.65	p<0.0001	0.33	0.046	0.61	p<0.0001
%VC	0.7	p<0.0001	0.69	p<0.0001	0.6	0.0001	0.62	p<0.0001
%DL <sub>CO</sub> /V <sub>A</sub>	0.76	p<0.0001	0.79	p<0.0001	0.53	0.0008	0.75	p<0.0001
CT-based disease severity	N/A	N/A	0.56	p<0.0001	N/A	N/A	0.42	0.01
Serum KL-6	0.6	p<0.001	0.64	p<0.0001	0.54	0.0007	0.61	p<0.0001

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