Pulmonary Thin-Section 3D MR Imaging with Ultra-Short TE: Comparison of Capability for Radiological Findings Assessment with Thin-Section CT

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Introduction: When magnetic resonance (MR) imaging was first implemented, many investigators were interested in this new technique for not only brain, but also other areas including chest. As a result, from the 1980s to the early 1990s, MR imaging was tested to evaluate different lung diseases as well as mediastinal, pleural and cardiac diseases by many physicists and radiologists. MR imaging was concluded that it could not play as substitution for computed tomography (CT) because MR systems, sequences and other applications at that time were very primitive and limited for obtaining adequate image quality within an appropriate examination time. Although state of the art pulmonary MR imaging can provide functional and morphological information in some cardiopulmonary diseases, lung MR imaging is still one of the most challenging fields for MR imaging. In this situation, pulmonary 3D MR imaging with ultra-short TEs has been suggested as useful for T2* measurement in COPD and interstitial lung disease due to connective tissue diseases (1-4). In addition, a few investigators have demonstrated the potential of pulmonary 3D MR imaging with ultra-short TE (UTE-MRI) for demonstration of lung structures and functions (5-7). However, to the best of our knowledge, no direct comparison of capability for radiological finding assessment has been made between UTE-MRI at 3T system and thin-section CT (TS-CT) in patients with various pulmonary diseases.

We hypothesized that UTE-MRI has a potential to evaluate radiological findings as well as TS-CT. The purpose of this study was directly compare the capability of UTE-MRI for evaluation of radiological findings with TS-CT in patients with various pulmonary diseases.

Materials and Methods: Thirty-two consecutive patients (19 men and 13 women; mean age 71 years) with various pulmonary diseases underwent TS-CT and UTE-MRI at 3T MR system (Vantage Titan 3T, Toshiba Medical Systems Corporation, Otawara, Tochigi, Japan). All TS-CT examinations were performed at an area-detector CT system (Aquilion ONE, Toshiba), and all UTE-MRI examinations were performed by respiratory-gated 3D radial UTE pulse sequence (TR 4.0 ms/ TE 192 μs, flip angle 5 degree, 1×1×1 mm^3 voxel size). Then, all radiological finding assessment on TS-CT and UTE-MRI were performed by two board certified chest radiologists with more than 10 years experience. As visual assessment, depictions of pulmonary vasculature from lobar to secondary lobule level, bronchi from trachea to sub-segmental level, ground-glass opacity, honeycomb, traction bronchiectasis, micro-nodule, nodule, bulla and emphysematous change were visually assessed by means of a 5-point visual scoring system on a per segment basis on both modalities. Aneurysm, pleural and/ or pericardial effusions, pleural thickening or tumor, lymphadenopathy were also evaluated using a 5-point visual score on a per patient or station basis.

To determine inter-observer agreement of TS-CT and UTE-MRI, κ statistics and $\chi 2$ tests were performed. To compare the capabilities of UTE-MRI for lung parenchyma and mediastinum structure depiction and each radiological finding assessment with TS-CT, each inter-modality assessment was evaluated by κ statistics and $\chi 2$ test. P value less than 0.05 was considered as significant in this study.

Results: Representative case is shown in Figure 1. Inter-observer agreement of TS-CT (κ=0.83, p<0.0001) and UTE-MRI (κ=0.81, p<0.0001) were also evaluated almost perfect. Inter-modality assessments between TS-CT and UTE-MRI are shown in Table 1. Intra-modality agreements of lung and mediastinal structure depictions (lung: κ=0.79, p<0.0001; mediastinum: κ=0.81, p<0.0001) were assessed as substantial or almost perfect. All intra-modality agreement of radiological findings (0.84≤κ≤1.00, p<0.0001) except pulmonary emphysema were determined as almost perfect, and that of emphysema (κ=0.42, p<0.001) as moderate.

Conclusion: On 3T MR system, pulmonary thin-section MRI with ultra-short TE (UTE-MRI) has a potential to assess lung anatomy and morphological changes as well as thin-section MDCT in patients with various pulmonary diseases.

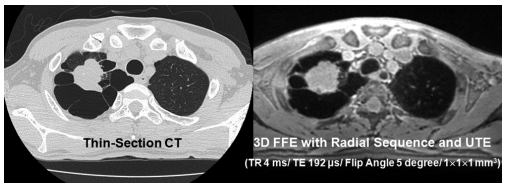

Figure 1. 58-year old male with squamous cell carcinoma, pulmonary emphysema and bullae. TS-CT and UTE-MRI shows lung cancer as nodule, bullae and pulmonary emphysema. All radiological findings as well as lung and mediastinal structures are clearly demonstrated on both modalities.

Table 1. Inter-modality agreement assessment between TS-CT and UTE-MRI.

		κ value	p value
Normal structure visualization	**Pulmonary vessels**	0.81	p<0.0001
	Trachea, bronchus and Bronchi	0.79	p<0.0001
Radiological findings	**GGO**	0.89	p<0.0001
	Nodule	0.93	p<0.0001
	Micronodules	0.88	p<0.0001
	Honeycomb	0.84	p<0.0001
	Traction bronchiectasis	0.87	p<0.0001
	Emphysema	0.42	p<0.001
	Aortic aneurysm	1.00	p<0.0001
	Pleural or pericardial effusion	1.00	p<0.0001
	Pleural thickneing	1.00	p<0.0001
	Pleural tumor	1.00	p<0.0001
	Lymph adenopathy	1.00	p<0.0001

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