Non-Contrast-Enhanced Pulmonary MR imaging: Comparison of Capability for Nodule Screening between 1.5T and 3.0T MR Systems

K. Matsumoto[1], Y. Ohno[1], H. Koyama[1], M. Nogami[1], D. Takenaka[1], Y. Onishi[1], N. Aoyama[2], H. Kawamitsu[2], T. Araki[3], and K. Sugimura[1]

[1]Department of Radiology, Kobe University Graduate School of Medicine, Kobe, Hyogo, Japan, [2]Division of Radiology, Kobe University Hospital, Kobe, Hyogo, Japan, [3]Department of Radiology, University of Yamanashi, Japan

INTRODUCTION: Detection of pulmonary nodule, lung cancer screening and metastases surveillance are widely performed by chest radiograph and/ or multidetector-row CT (MDCT) in routine clinical practice. Although higher detection rate and diagnostic capability of MDCT are considered as the major advantage, higher radiation exposure than chest radiograph is also considered as the fundamental problem. In addition, academic and social interest to radiation induced cancer development on CT examination is increasing in the world. Since 1997, several investigators have suggested that pulmonary MR imaging on 1.5T MR system has potential for nodule detection as substitution to CT (1-3). Currently, the clinical use of 3.0T MR systems is expanding from neuro MR imaging into body imaging (4, 5). Although prolonged T1 relaxation time, higher SAR level, stronger chemical shift artifact and higher sensitivity to B1 inhomogeneity are considered as main problems on 3.0T MR systems, 3.0T MR system has the advantages as follows: better S/N ratio, higher spatial resolution, possibility for reduction of scan time and easier clinical application of MR spectroscopy than 1.5T MR system. However, a few literatures reported the capability for assessment of pulmonary abnormalities on 3.0T MR system (6-8). To the best of our knowledge, no one directly compare the capability of non-contrast-enhanced (non-CE) pulmonary MRI for pulmonary nodule detection between 1.5T and 3.0T MR systems. We hypothesized that 3T MR system have better potential for pulmonary nodule detection than 1.5T MR system. The purpose of this study was to prospectively and directly compare the capability of non-CE pulmonary MR imaging on 3.0T MR system for nodule detection than that on 1.5T MR system.

MATERIALS AND METHODS: 40 consecutive patients (20 men, 20 women, age range 44-82 years; mean age, 66.4 years) with 73 pulmonary nodules detected on chest radiographs and/or CT underwent pulmonary non-CE MR imaging on 1.5 T (Achieva 1.5T, Philips Healthcare, Best, the Netherlands) and 3.0T (Achieva 3.0T, Philips). All nodules were divided into malignant (n=39) and benign (n=34) nodules according to the results of pathological examinations. As pulmonary non-CE MR imaging, Black-Blood T1-weighted (TR: 1<R-R>, TE_{eff} : 8-10ms) , T2-weighted (TR: 2-3<R-R>, TE_{eff} :80-100ms) and short tau inversion recovery (STIR) (TR: 2<R-R>, TE_{eff} : 8-10ms) turbo spin-echo (SE) imaging were obtained on both systems. On STIR turbo SE imaging, TI s were 165ms and 215ms on 1.5T and 3.0 T systems. Respiratory gating technique was used at 3T scanner, and breath-hold technique was used at 1.5T scanner. For determination of the detection capability of nodule on both systems, two chest radiologists assessed the probability of presence of each nodule by using a 5-point visual scoring system. Interobserver agreements of all sequences on both systems were assessed by Kappa analysis. To statistically compare the detection capability of pulmonary nodules on all sequences on both systems, ROC analyses were performed. Finally, the detection rates of overall nodule, malignant nodule and benign nodule were statistically compared by using McNemar's test. A p value less than 0.05 was determined as statistically significant.

RESULTS: Representative case is shown in Figure 1. Interobserver agreements of all sequences in each nodule group were substantial or almost perfect. Results of ROC analysis and McNemar's test in each group are shown in Table 1. In overall nodule group, area under the curve (Az) of T1WI on 3.0T MR system was significantly larger than that of T1WI and T2WI on 1.5T MR system (p<0.05). In benign nodule group, Az of T1WI on 3.0T MR system was significantly larger than that on 1.5T MR system (p<0.05). Although detection rate of each sequence on 3.0T MR system was better than that on 1.5T MR systems, there was no significant difference between each other (p>0.05).

CONCLUSION: Non-CE pulmonary MR imaging on 3.0 T MR system has better potential for pulmonary nodule detection than 1.5 T MR system. Pulmonary nodule detection on 3.0T MR system can be utilized for malignant nodule detection as well as 1.5 T MR system.
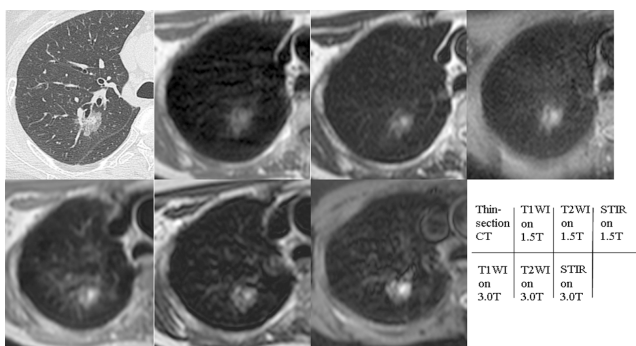

Figure 1. 67-year old female with bronchioalveolar Carcinoma.

Thin-section CT demonstrates partly-solid nodule in the right upper lobe, On 1.5T system, nodule was demonstrated as low signal intensity on T1WI, and intermediate signal intensity with high intensity on T2WI and STIR. On the other hand, this nodule was demonstrated as intermediate intensity with very high intensity on T1WI, T2WI and STIR on 3.0T system.

Table 1. Results of ROC analysis and McNemar's test in each group.

Group		1.5T			3.0T		
		T1WI	T2WI	STIR	T1WI	T2WI	STIR
Overall nodule	Az	0.93*	0.94*	0.95	0.98	0.97	0.96
	Detection rate	89%	90%	91%	93%	93%	90%
		(65/73)	(66/73)	(67/73)	(68/73)	(68/73)	(66/73)
Malignant nodule	Az	0.96	0.95	0.97	0.99	0.99	0.99
	Detection rate	95%	92%	95%	97%	97%	97%
		(37/39)	(36/39)	(37/39)	(38/39)	(38/39)	(38/39)
Benign nodule	Az	0.89*	0.92	0.93	0.97	0.94	0.93
	Detection rate	82%	88%	82%	88%	88%	82%
		(28/34)	(30/34)	(28/34)	(30/34)	(30/34)	(28/34)

*: Significant difference with T1WI on 3.0 T MR system (p<0.05).

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