Pulmonary MRI vs. Thin-section MDCT: Capability for Nodule Detection and Diagnosis and for Assessment of Influence to Survival

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Introduction: Multi-detector row CT (MDCT) has been utilized for nodule detection and diagnosis, although it has been sometimes difficult to distinguish malignant from benign nodules by using only radiological findings. In an attempt to find a solution for this problem, several investigators have assessed the utility of dynamic CT, dynamic magnetic resonance imaging (MRI) and positron-emission tomography (PET) or integrated and/or co-registered PET/CT for this purpose. However, X-ray exposure and side effects of contrast-media may be major drawbacks in this setting. Therefore, several investigators have reported the capability of pulmonary MR imaging (MRI) for nodule detection as compared with CT, and tried to demonstrate possibility for substitution to CT since 1997(1-5). However, these studies were adapted CT as gold standard, and no direct comparison between pulmonary MRI and thin-section MDCT have been reported. We hypothesized that pulmonary MRI has potential for detect and diagnose pulmonary nodules without significant degradation of detection rate for malignant nodules, diagnostic accuracy and survival rate, when compared with MDCT. The purpose of our study was to compare capability for nodule detection and diagnosis and for affection to survival between pulmonary MRI and thin-section MDCT.

Materials and Methods: One hundred sixty-one consecutive patients (110 male patients, 51 female patients; mean age, 66.5 years; age range 29 – 84 years) with 200 pulmonary nodules (PNs) equal to or less than 30 mm in diameter were enrolled in this study. All patients prospectively underwent thin-section MDCT, non-CE MRI (T1WI, T2WI and STIR), bronchoalveolar lavage, microbiologic examination, and pathological examination of specimens, which were obtained by transbronchial or percutaneous biopsy, resection at thoracotomy or video-assisted thoracic surgery, and/or follow-up CT. Nodule diameter was defined as the largest diameter on CT scans obtained with a lung window setting or respected specimens. The standard reference was defined as consensus of two chest board radiologists and a board pulmonary pathologist based on the results of initial and more than 2-year follow-up CT, microbacterial and/ or pathological examinations. All PNs were classified into two groups: malignant PNs (n=103) and benign PNs (n=97). As non-CE MRI, axial ECG-gated T1WI (TR 1 <R-R> ms/ TE 15 ms/ 2NEX), axial ECG- and respiratory-gated T2WI (TR 2-3 <R-R> ms/ TEeff 90 ms/ ETL 8/ 4 NEX) and STIR turbo spin-echo (TSE) imaging (TR 3600-5000ms/ TEeff 15 ms/ TI 150 ms/ ETL 5) were performed by using 1.5-T superconducting magnet (Intera T-15, Philips Medical Systems, Best, The Netherlands) and a body coil. Other parameters were as follow; FOV 350-400mm, 205-256×256 matrix, 410-512×512 reconstruction matrix, 5-8 mm contiguous section thickness. All initial CT examinations of initial examination were performed with a 4-detector row system (Somatom Plus 4 Volume Zoom; Siemens Medical Solution, Forchheim, Germany). The scan parameters of the 4-detector row MDCT examination were field of view 300–350 mm, 512 × 512 matrix, 4 × 1.0 mm or 16×0.5 mm collimation, 0.94-1.5 beam pitch, 0.5 s/rotation, 120 kVp and 110 effective mAs (330 mA) and all CT data were reconstructed to yield a thin-section CT of the entire lung with 1.0 mm contiguous section thickness. To determine the capabilities of pulmonary MRI and thin-section MDCT for nodule detection, two chest radiologists were independently assessed the presence and absence of pulmonary nodules in random order by means of 5-point visual scoring system. The scale ratings were as follow: 1, definitely negative; 2, probably negative; 3, equivocal; 4, probably positive; and 5, definitely positive. Then, the final score in each nodule was made by consensus of two readers. For qualitative assessment of pulmonary MRI, all MR images were independently interpreted by the same two chest radiologists and each pulmonary nodule was evaluated with the following five-point visual scoring system. The probability was evaluated by using a five-point visual scoring system as follows: 1, the signal intensity of pulmonary nodule was marked lower than the right rhomboid muscle or almost equal to lung parenchyma; 2, the signal intensity of pulmonary nodule was lower than that of the muscle; 3, the signal intensity of pulmonary nodule was equal to that of the muscle; 4, the signal intensity of pulmonary nodule was slightly higher than that of muscle; and 5, the signal intensity of pulmonary nodule was markedly higher than that of the muscle. Then, the final score in each detected nodule was made by consensus of two readers. To determine the diagnostic capability on thin-section MDCT, the probability of malignancy in each nodule was assessed by using a 5-point scale according to the past literature (6). To compare capability for nodule detection and diagnosis and influence to survival between pulmonary MRI and thin-section MDCT, ROC analyses were performed. Then, detection rate and diagnostic accuracy were compared by using McNemar's test. Finally, mean survival time of patients with malignant nodule detected and diagnosed by using best MR sequence was compared with that of patients detected and/or diagnosed on thin-section MDCT by using the Kaplan-Meier method followed by log-rank test.

Results: Detection rate of thin-section MDCT and non-CE MRI are shown in Table 1. Athough the overall detection rate and that of benign nodule of each MR sequence (82.5%) was significantly lower than that of MDCT (97.0%, $p<0.05$), that of malignant nodules showed no significant difference between MDCT and each MR sequence ($p>0.05$). Feasible threshold values, area under the curvea (Aza), sensitivities, specificities and accuracies of MDCT and each sequence are shown in Table 2. There were no significant differences among Azs ($p>0.05$). Specificity and accuracy of T1WI and T2WI were significantly lower than that of MDCT ($p<0.05$). Survival curves of lung cancer cases detected and diagnosed by MDCT and STIR are shown in Figure1. On comparison of mean survival times between MDCT (55.4 months) and STIR (55.5 months), there was no significant difference between them (p=0.95).

Conclusion: Pulmonary MRI has similar potential for diagnosis and no influence on survival periods, although overall detection rate and that of benign nodule of pulmonary MRI were significantly lower than those of thin-section MDCT.

Table 1. detection rate of pulmonary nodule of MDCT and each sequence at non-CE MRI.

	MDCT	T1WI	T2WI	STIR
Az	0.99	0.91*	0.91*	0.91*
Overall detection rate (%)	97.0 (194/200)	82.5* (165/200)	82.5* (165/200)	82.5* (165/200)
Detection rate of malignant nodules (%)	100.0 (103/103)	96.1 (99/103)	96.1 (99/103)	96.1 (99/103)
Detection rate of benign nodules (%)	93.8 (91/97)	68.1* (66/97)	68.1* (66/97)	68.1* (66/97)

*: significant difference with MDCT.

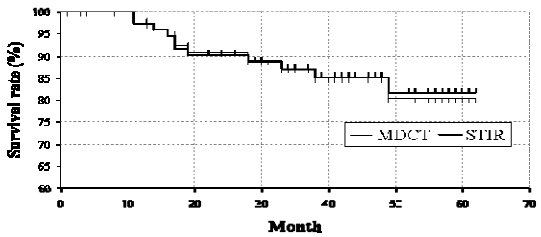

Figure 1. Survival curves of detected and diagnosed on MDCT and STIR.
There were no significant difference of survival periods between CT and STIR (p=0.95).

Table 2. Azs, feasible threshold values, sensitivities, specificities and accuracy accuracies of MDCT and each sequence at non-CE

	Az	Feasible threshold values	Sensitivity (%)	Specificity (%)	Accuracy (%)
MDCT	0.78	4	76.7 (79/103)	75.2 (73/97)	76 (152/200)
T1WI	0.74	2	84.4* (87/103)	57.7* (56/97)	71.5* (143/200)
T2WI	0.74	3	77.7 (80/103)	64.9* (63/97)	71.5* (143/200)
STIR	0.8	4	80.6 (83/103)	73.2 (71/97)	77 (154/200)

* ; significant difference with MDCT

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