Diffusion-weighted MR imaging of pulmonary lesions: Effectiveness of apparent diffusion coefficient quantification and lesion-to-spinal cord signal intensity ratio in the lesion characterization

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PURPOSE / INTRODUCTION: Lung cancer is among the leading causes of death worldwide. The characterization of pulmonary nodules or masses by noninvasive methods is a major concern for radiologists and clinicians. Diffusion-weighted MR imaging (DWI) exploits the microscopic random mobility of water protons, and help characterization of lesions because Brownian motion of water molecules causes phase dispersion resulting in attenuation of the measured signal intensity at DWI. The signal loss can be quantified by calculating the apparent diffusion coefficient (ADC). Unlike benign lesions, the movement of water molecules in malignant tumors is restricted due to increased cellularity and less extracellular space resulting in a decreased ADC value. Recently, lesion-to-spinal cord signal intensity ratio (LSR) was reported to be more accurate than ADC quantification on DWI.

The purpose of this study was to prospectively compare the diagnostic performance of ADC with that of LSR in differentiating malignant from benign lung lesions on DWI by using histopathology or clinical follow-up as the reference standard.

MATERIALS AND METHODS: The institutional review board approved the research protocol, and written informed consent was obtained from all patients. Forty-seven consecutive patients (36 men, 11 women; mean age, 54 years; range, 17-81 years) with 62 pulmonary lesions suspicious for lung cancer on computed tomography underwent MR imaging at 1.5-T. DWI was performed during free breathing using a single-shot echo-planar (SSEPI) MR imaging sequence with b values (b: diffusion factor) of 0 and 600 sec/mm^2. Apparent diffusion coefficient maps were reconstructed for all patients and diffusion of water molecule in each lesion was quantitatively measured by a minimum ADC. The LSR signal intensity was measured on the same DWI section with a diffusion gradient of 600 sec/mm^2. A region of interest of the same size as that placed on the spinal cord was positioned on the lesion. Imaging results were correlated with histopathologic findings (39 lesions) or imaging follow-up (23 lesions). Mann-Whitney U test was used to compare the ADC value and LSR between lung cancer and benign lesions. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the diagnostic performances of ADC and LSR in the differentiation of benign lesions and lung cancer, and to find the cutoff value.

RESULTS: There were 42 malignant (33 primary tumor, 9 metastases) and 20 benign lesions. The mean ADC values (x10^{-3} mm^2/sec) were 1.45+/-0.33 for malignant tumors, and 2.4+/-0.69 for benign lesions ($p<0.001$). The mean LSR for lung cancer was 1.24 +/- 0.78 and for benign lesions was 0.55 +/- 0.57 ($p<0.001$). The area under the ROC curve for ADC (0.931; 95% confidence interval: 0.868-0.993) was greater than that for LSR (0.801; 95% confidence interval: 0.675-0.926). For benign/malignant discrimination, ROC curve showed threshold value of ADC to be1.78x10^{-3} mm^2/sec and that of LSR to be 0.42. Using these cutoff values, ADC showed higher accuracy than LSR (Table 1).

Parameter	Cutoff value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
ADC (mm^2/sec)	1.78x10^{-3}	86 (36/42)	95 (19/20)	97 (36/37)	76 (19/25)	89 (55/62)
LSR	0.42	86 (36/42)	60 (12/20)	82 (36/44)	67 (12/18)	77 (48/62)

NPV = negative predictive value, PPV = positive predictive value

DISCUSSION / CONCLUSION: Diffusion-weighted MR imaging of lung is feasible and should be incorporated into routine chest MR imaging protocols. Apparent diffusion coefficient was more effective than LSR for the differentiation of malignant and benign lung lesions.