Pulmonary Nodule/Mass Assessment by Computed Diffusion-Weighted Imaging with High b-Value: How to Improve the Detection and Differentiation Capability with Acquired Diffusion-Weighted Imaging

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Introduction: The application of MRI to lung cancer analysis has been a relatively recent development, and the growth in this field has been rapid (1). In particular, diffusion weighted MR imaging (DWI) has been applied in a clinical setting and DWI is paid to attention in the field of the assessment of pulmonary nodules and masses. Computed diffusion-weighted imaging (cDWI) is the newly proposed method, and this technique has been applied recently. cDWI is based on the method to generate DWI with arbitrary b values from really acquired DWIs (aDWIs) with some different b values. cDWI reportedly allows higher b value images to be obtained with a good signal intensity ratio because it can suppress background noise while maintaining the original lesion signal (2). However, there are no major reports regarding pulmonary nodule/mass assessment by means of cDWI. Therefore, the purpose of this study was to directly and prospectively compare capabilities for pulmonary nodule/mass detection and differentiation of malignant from benign lesions among cDWI and aDWI.

Materials and Methods: Institutional review board approval and written informed consent were obtained. Ninety-seven patients (mean age; 69.1 years) with 121 pulmonary nodules/masses (mean diameter; 28.9 mm) were enrolled and underwent DWI by 1.5T MR system. Then, cDWI with b value at 1,000 s/mm^2 ($cDWI_{1000}$) were computationally generated from aDWIs with b values at 0 and 500 s/mm^2 by our propriety software. To evaluate detection capability of DWI, aDWIs with b values at 500 s/mm^2 ($aDWI_{500}$) and 1,000 s/mm^2 ($aDWI_{1000}$) and $cDWI_{1000}$ were visually assessed by means of 5-points scoring system. For quantitative diagnosis of pulmonary lesion, lesion to spinal cord ratio (LSR) on each DWI was calculated. Detection and differentiation capability were compared among these data sets by McNemar's test.

Results: According to pathological and/or follow up examinations, 97 malignant and 24 benign lesions were diagnosed. The detection rate of $aDWI_{500}$ (99.2%) was significantly higher than that of $aDWI_{1000}$ (92.6%, $p<0.05$), however no significant difference with that of $cDWI_{1000}$ (96.7%, $p>0.05$). Regarding differentiation capabilities, the result of differentiation capability is shown in Table 1. There was no significant difference among $aDWI_{500}$, $aDWI_{1000}$, and $cDWI_{1000}$ ($p>0.05$). However, the sensitivity and accuracy of $aDWI_{500}$ with $cDWI_{1000}$ were significantly higher than those of $aDWI_{500}$ and $aDWI_{1000}$ ($p<0.05$). The representative case is shown in Figure 1.

Conclusion: Computed DWI was useful technique, and the combination of $aDWI_{500}$ with $cDWI_{1000}$ would be better to choose in clinical practice for the evaluation of pulmonary nodules/masses.

(References) *1. Koyama H, et al. J Thorac Imaging 2013;28(3):138-150, 2. Blackledge MD, et al. Radiology 2011;261(2):573-581*

Table 1. Diagnostic capability of pulmonary lesions

	FTV	Sensitivity	Specificity	Accuracy
$aDWI_{500}$	1.0	72.6 %* (70/97)	62.5 % (15/24)	70.3 %* (85/121)
$aDWI_{1000}$	0.9	73.2 %* (71/97)	66.7 % (16/24)	71.9 %* (87/121)
$cDWI_{1000}$	1.8	78.5 % (76/97)	62.5 % (15/24)	75.2 % (91/121)
$aDWI_{500}$ with $cDWI_{1000}$	1.0, 2.0	80.4 % (78/97)	62.5 % (15/24)	76.9 % (93/121)

**; significant difference with $aDWI_{500}$ with $cDWI_{1000}$ by McNemar's test*

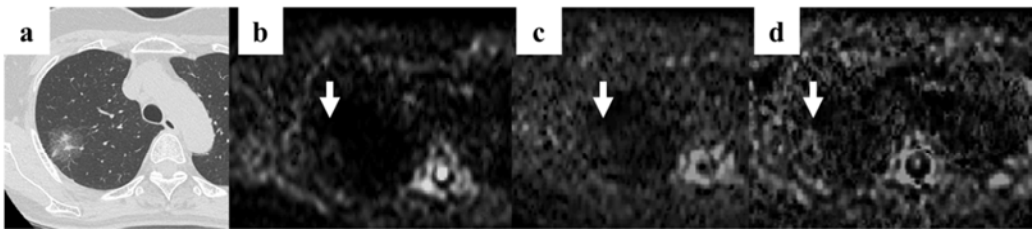

Figure 1. A 74-year-old female patient with adenocarcinoma in the right upper lobe. *(a) CT shows a nodule in the right upper lobe. (b) aDWI with a b value of 500 s/mm^2 shows slightly high signal intensity; the score of detection assessment is 4 and the LSR is 0.59. This assessment identified the nodule as benign. (c) Signal intensity shown at aDWI with a b value of 1,000 s/mm^2 was slightly high or equal to lung parenchyma; the score of detection assessment is 3 and the LSR is 0.53. This assessment identified the nodule as benign. (d) cDWI with a b value of 1,000 s/mm^2 also shows high signal intensity; the score of detection assessment is 4 and the LSR is 3.06. This assessment identified the nodule as malignant.*