

Evaluation of Optimal Timing for Diffusion Weighted MR Imaging to Assess Early Tumor Response of Lung Cancer after Stereotactic Body Radiotherapy

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Target Audience: Clinical radiologists who engage in pulmonary imaging or radiotherapy for lung cancer

Background and Purpose

Lung cancer is a fatal malignant neoplasm and provides the first leading cause of cancer death¹. Annually, approximately 220,000 new cancer cases and 157,000 deaths are estimated in the United States¹. In order to overcome such disappointing prognosis, a variety of treatment options have been applied. Stereotactic Body Radiotherapy (SBRT) has been recognized to be a promising treatment especially for patients who are medically or technically unfit for surgery or who refuse surgery. According to the previous studies, apparent diffusion coefficient (ADC) value of lung cancer calculated from diffusion-weighted imaging (DWI) has a potential for predicting early tumor response or predicting prognosis for patients who underwent radiotherapy^{2,3}. However, it has not been fully discussed appropriate timing for ADC to assess tumor response. Thus, the purpose of our study is to evaluate the optimal timing of DWI in lung cancer after SBRT.

Materials and Methods

Our study population included 15 patients with pathologically proven non-small lung cancer (age 70-86, 11 males, 4 females) who underwent SBRT (48-60Gy/4-8fr.). Transverse DWI of the lung cancer using a 1.5T MR scanner (Avanto, Siemens Healthcare, Erlangen, Germany) utilizing prospective acquisition correlation (PACE) and echo planar imaging (EPI) techniques (EPI factor = 96) was prospectively performed at pre, three, six, nine, and twelve months after SBRT. Scan parameters for DWI were: field-of-view (FOV) 320mm, matrix 96x128, number of slices 24, TR 27463.-12030.4msec, TE 72-79msec, slice thickness 4.0mm and five excitations. All DWI was acquired with MPG pulses along three directions (x, y, and z axes) with three different b-factors (0, 500, and 1000 s/mm²). Subsequently, ADC maps were automatically calculated from a series of diffusion-weighted images. The ADC values of lung cancer (pre, three, six, nine, and twelve months after SBRT), were measured on ADC map images by a single observer. Three different circular regions of interest (ROIs) were manually placed on the tumor. The average of these three ADC values was regarded as the ADC value of the tumor. Patients underwent follow-up examinations, including chest radiograph, chest CT or measuring tumor marker at regular intervals and were divided into two groups: group A (patients without any signs of local recurrence; n=12) and group B (patients with local recurrence; n=3). The median follow up period was 21.2months. Obtained serial ADC values were compared between two groups.

Results

Initial clinical T-staging of the tumor was T1a in four, T1b in six and T2a in five lesions. ADC values (mean±SD, x10⁻³mm²/s) of group A were 1.04±0.14, 1.55±0.27, 1.75±0.18, 1.69±0.17, 1.65±0.18 for pre, three, six, nine, and twelve months after SBRT, respectively. Those of group B were 1.09±0.09, 1.11±0.18, 1.07±0.20, 1.29±0.30, 1.51±0.55, respectively. Post-therapeutic ADC values of group B were lower than those of group A, although those of these two groups were similar prior to SBRT. Especially, ADC value of group B was significantly lower than those of group A at six months after SBRT (p=0.012), whereas no significant difference of ADC values could be found between the two groups at pre, three, nine, and twelve months after SBRT.

Discussion

Our study indicated that DWI at six months after SBRT seemed the best timing for assessing tumor response to SBRT. After SBRT, ADC value of the tumor tends to be gradually increased possibly because cell membrane damage and tumor necrosis caused by the cytotoxic effect of SBRT. Considering ADC values of the two groups became closer at 9 or 12 months after SBRT, ADC values later than 6 months might be influenced by other pathological conditions including edema and inflammation.

Conclusion

DWI has a potential to monitor early response to SBRT and is preferably performed at 6 months after SBRT.

References

1. Jamal A, et al. CA Cancer J Clin 2010;60:277-300
2. Chang Q, et al. Clin Imaging 2012;36:98-103
3. Ohno Y, et al. AJR 2012;198:75-82

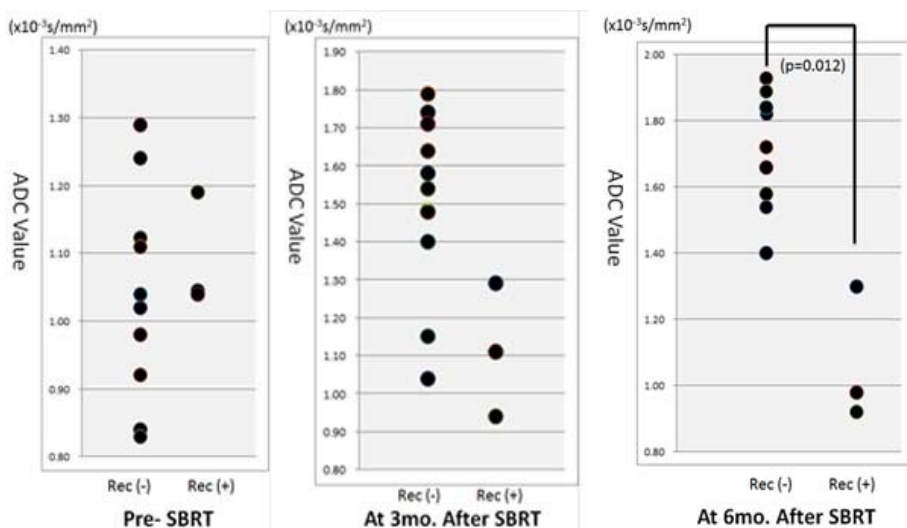


Figure: Comparison of the ADC values of lung

cancer between two groups (patients without recurrence and with recurrence) prior to, at 3 months after, and at 6 months after SBRT.

At 6 months after SBRT, ADC values of group with recurrence are significantly lower than those of group without recurrence.

Note that there are considerable overlaps between ADC values of these two groups at pre-SBRT and 3 months after SBRT.