ADC value and Diffusion Tensor Imaging of Prostate Cancer; Therapeutic changes with Heavy Ion Charged Particle Radiation Therapy

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INTRODUCTION

The usefulness of diffusion weighted image (DWI) and apparent diffusion coefficient (ADC) values has been reported for detecting prostate cancer (Pca), as Pca shows lower ADC values than normal regions of the prostate (1, 2). However, the combination of several pulse sequences is needed for more accurate diagnosis. Diffusion tensor imaging (DTI) is a new, promising technique for assessing the prostate (2). Although a normal prostate generally shows a symmetrical and concentric form, it is suspected that the structure will show deformities if Pca exists. In this study, we assessed the changes of ADC values and DTI between pre- and post-radiation.

MATERIALS AND METHODS

Nine patients with Pca (age range 61-75) and one healthy volunteer were analyzed. Diagnosis was confirmed by needle biopsy. All patients underwent heavy ion charged particle therapy and four patients received simultaneous hormone therapy. MR examinations were performed on Philips Gyroscan Intera 1.5T or Intera Achieva 1.5T Nova Dual with sensitivity encoding technique (SENSE). Follow-up study was done for all patients for three to nine months after therapy. MR imaging protocols were fast spin echo T2-weighted images (TR/TE = 3738/120 msec), diffusion weighted images (single-shot EPI, TR/TE 2761/96 msec, matrix size = 128×128) and diffusion tensor imaging (MPGs of 6 axes, b = 0, 700 s/mm^2, fifteen acquisitions per MPG direction). Regions at the contralateral side of the tumor were selected for evaluation of intact inner gland (IG) and peripheral zone (PZ). ADC value and fraction anisotropy (FA) of intact IG, PZ and Pca were calculated, respectively. Changes in values between pre- and post-radiation were assessed. Statistical analysis was performed with a paired t-test. A P value <0.01 was considered significant to avoid type 1 errors in the multiplicity of statistical analysis.

RESULTS AND DISCUSSION

The prostate of a healthy volunteer showed no deformity and the tensor structure was symmetrical (Fig. 1). DT images of a patient showed structural deformities at the lesion, and improvement in these deformities after radiation therapy (Fig. 2). The ADC value of Pca also showed significant differences between pre- and post-radiation (P<0.01) (Fig. 3), but FA of Pca and ADC and FA of intact IG and PZ showed no significant differences between pre- and post-radiation. In the comparison of Pca with intact IG and PZ, the pre-radiation ADC values of Pca-IG and Pca-PZ showed significant differences (P<0.01) (Fig. 3), but FA of Pca-IG and Pca-PZ did not. At post-radiation, significant differences had disappeared. ADC values and FA of Pca and intact IG had increased after the therapy. FA of intact PZ had also increased, but ADC values of intact PZ had decreased.
The ADC value has the potential to distinguish Pca from intact IC and PZ for prior to radiation therapy. The ADC value of Pca increases after radiation therapy, becoming close to those of intact IG and PZ. FA is not useful for distinguishing Pca because of the overlaps among Pca, intact IG and PZ. Although DTI is not indispensable for the diagnosis by itself, it is able to show changes in the prostatic structure. These results may help to estimate the prediction of the effect of radiation therapy.

REFERENCES

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2 Shinha S and Shinha U. Magn Reson Med 2004; 52; 530-537.

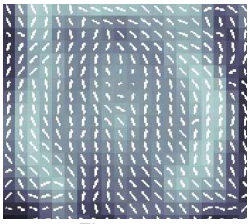

Figure1

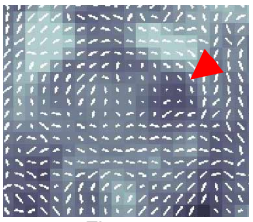

Figure2a

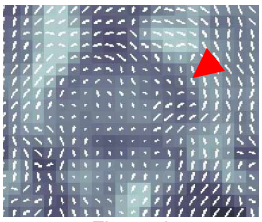

Figure2b

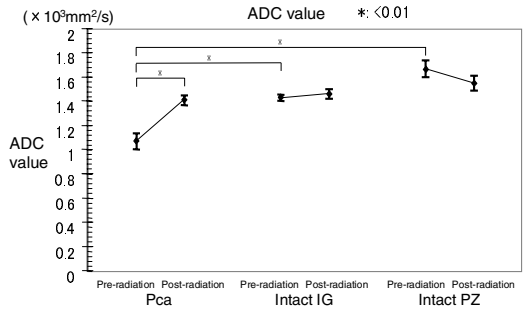

Figure3a

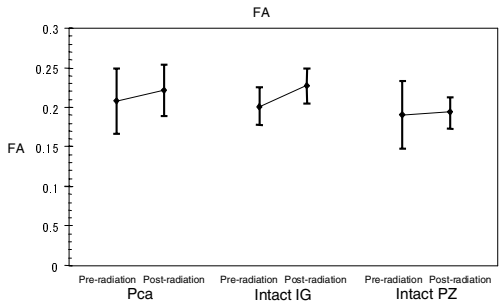

Figure3b

Figure1: Diffusion tensor imaging (DTI) of a healthy volunteer. The prostate shows no deformity and the tensor structure is symmetrical.
Figure2: DTI of a patient with prostate cancer. (a) Pre-radiation image of the prostate. Prostate cancer exists in the left peripheral zone. DTI reveals deformity at the lesion (arrowhead). (b) Post-radiation image of the prostate. The deformity at the lesion is improved after radiation therapy (arrowhead).
Figure3: (a) Apparent diffusion coefficient (ADC) value and (b) Fraction anisotropy (FA) of prostate cancer (Pca), intact inner gland (IG) and peripheral zone (PZ) between pre- and post-radiation. Asterisks indicate a significant difference (P<0.01).