DIFFUSION TENSOR IMAGING ANALYSIS OF OPTIC RADIATION BY READOUT-SEGMENTED ECHO-PLANAR IMAGING

Yamada Hirofumi[1], Yamamoto Akira[1], Okada Tomohisa[1], Kanagaki Mitsunori[1], Kasahara Seiko[1], Sawada Takeshi[1], Morimoto Emiko[1], Sakamoto Ryo[1], Okuchi Sachi[1], and Togashi Kaori[1]
[1]*Department of Diagnostic Imaging and Nuclear Medicine, Kyoto University, Kyoto, Kyoto, Japan*

Background and Purpose

The optic radiation is the greatest concerned region in the whole brain with characteristic anatomical distribution. Diffusion tensor imaging (DTI) study investigating internal signal intensity of the optic radiation has been scanty. It is difficult to investigate DTI parameters of fine structures such as the optic radiation by widely-used single shot echo planar imaging (SS-EPI) because of its limited spatial resolution. Readout-segmented echo planar imaging (RS-EPI) has been recently introduced to obtain distortion-free images with high resolution and reduced blurring from T2* signal decay compared to SS-EPI [1, 2]. We implemented RS-EPI DTI on 9 volunteers at 3T MR scanner with 32-channel head coil and evaluated the DTI parameters of the optic radiation.

Materials and Methods

RS-EPI DTI was acquired from nine healthy volunteers using a 3T MR scanner (MAGNETOM Trio, A Tim System, Siemens Healthcare, Erlangen, Germany; Version B17 with a 32-channel head coil) after obtaining written informed consent. For RS-EPI DTI, the following parameters were used; TR=5000 ms; TE1/TE2=64/102 ms; matrix=194 x 194; field-of-view (FOV)=180 mm; voxel size = 0.9mm x 0.9mm x 3.0mm; slices = 10; readout segments = 15 (for full k-space, segments were omitted from reconstruction for partial k-space comparison); echo spacing = 0.32ms; scan time = 10.47mins); section thickness = 3.0 mm. DTI protocol was performed with 1 image at b = 0 and 12 images at b = 1000 s/mm^2 in 12 independent directions. Diffusion tensor calculation and image analysis were performed by DTIstudio software version 3.0.3 (H. Jiang, S. Mori; Department of Radiology, Johns Hopkins University). Eigenvalue 1(EV1) as parallel diffusivity, radial diffusivity (RD), fractional anisotropy (FA), apparent diffusion coefficient (ADC) and color map images were calculated. Regions of interest (ROIs) were defined in the internal sagittal stratum, the external sagittal stratum, the inferior longitudinal fasciculus (ILF) and tapetum. Examples of ROI setting are shown on below Figure 1 with corresponding anatomic atlas. The mean EV1, RD, FA, ADC of the internal sagittal stratum and the external sagittal stratum were compared using a paired t-test.

Results

The parameters calculated in the present study are shown on Table 1. In our ROI-based analysis, on the slices obtaining the splenium of the corpus callosum the mean FA values of the external sagittal stratum were significantly higher and the mean RD values and ADC values of the external sagittal stratum were significantly lower than those of the internal sagittal stratum, while there was no significant difference in the mean EV1 between the external sagittal stratum and the internal sagittal stratum.

Discussion and Conclusion

The present study has demonstrated significant difference of DTI parameters between external sagittal stratum and internal sagittal stratum by RS-DTI. There were several reports about MR signal intensity of internal structure of optic radiation in present studies[3-5]. Our data are consistent with those findings. In our study the external sagittal stratum showed lower RD and higher FA than the internal sagittal stratum. In previous studies using mice, authors suggest EV1 reflects axonal condition and RD reflects myelination [6, 7]. Hence, it is supposed that our observation suggests the difference of radial diffusivity between the internal sagittal stratum and the external sagittal stratum is stronger than that of axial diffusivity, which may mean myelination affects difference of structure more strongly than axonal density.

In conclusion, internal structure of the optic radiation is different between the internal layer and the external layer, which was revealed by analyzing RS-DTI parameters. Our findings may be useful for evaluating multiple sclerosis, neuromyelitis optica, amyotrophic lateral sclerosis and other white matter diseases.

References

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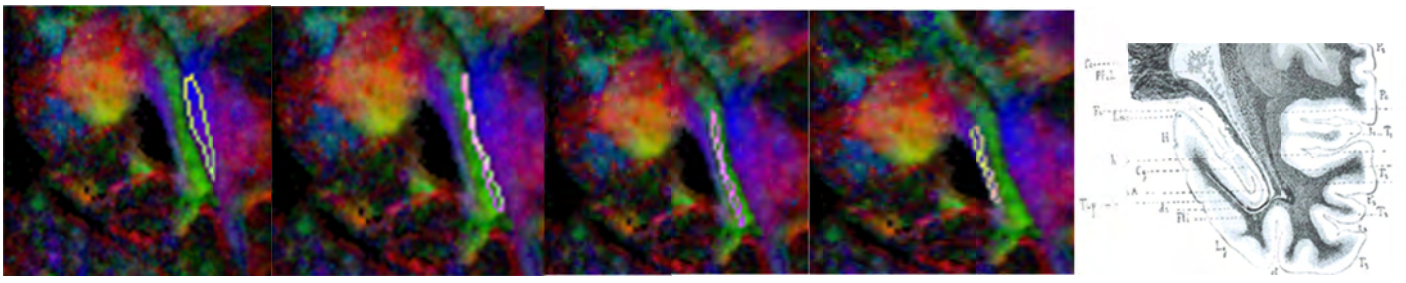

Figure 1
Examples of ROI setting and anatomic atlas. From left the ILF, the external sagittal stratum, the internal sagittal stratum, the tapetum.

	FA	ADC	RD	EV1
External sagittal stratum	0.693	0.56	0.46	1.68
Internal sagittal stratum	0.658	0.61	0.52	1.66
P-value	0.0083	0.0198	0.0083	0.5588

Table 1
The mean DTI parameters calculated on the slices obtaining splenium of corpus callosum