

Differences in diffusional changes of the optic pathways between Multiple Sclerosis and Neuromyelitis Optica using Diffusional Kurtosis Imaging

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Target audience: Radiologists, Neurologists, researchers of diffusion MRI, residents/fellows & techs.

Purpose: Diffusional kurtosis imaging (DKI) is an extension of diffusion tensor imaging (DTI) that enables simultaneous quantification of Gaussian and non-Gaussian diffusion in the brain¹. The purpose of this study is to evaluate differences in diffusional changes of the optic pathways between multiple sclerosis (MS) and neuromyelitis optica (NMO) using a new method, diffusional kurtosis imaging (DKI).

Methods: Six patients with known NMO, eight patients with known MS, and seven healthy volunteers participated in this study. Diffusion-weighted images were obtained on a 3T MR imager (Achieva; Philips Healthcare) by using a spin-echo echo-planar imaging sequence with 3 diffusion weightings ($b = 0, 1000, \text{ and } 2000 \text{ s/mm}^2$) along 20 diffusion-encoding directions. Diffusion metric maps were calculated by using the free software dTV II.FZRx (Image Computing and Analysis Laboratory, Department of Radiology, The University of Tokyo). Fractional anisotropy (FA) and apparent diffusion coefficient (ADC) maps of the conventional model and mean kurtosis (MK) maps were computed. The optic tracts and optic radiation of patients and controls were analyzed using a tract-specific analysis. The figure1 shows an example of tractography of the optic pathway.

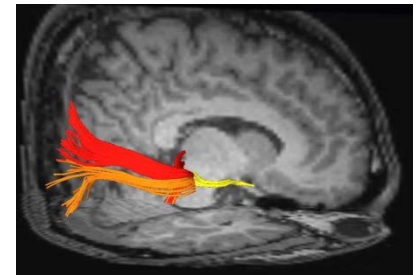
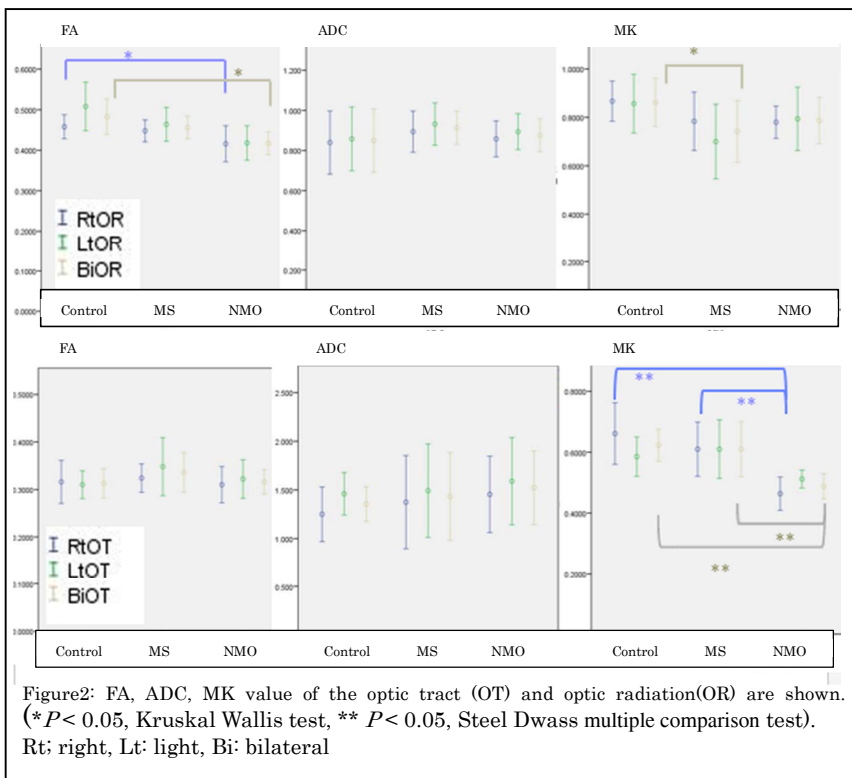


Figure1: Tract-specific analysis of the optic tract (yellow) and radiation (red).

Results: The MK, FA, and ADC of the bilateral optic radiation and tract are shown in the table. ($*P < 0.05$, Kruskal Wallis test, $**P < 0.05$, Steel Dwass multiple comparison test) The MK in the bilateral optic tract was significantly lower in the NMO group than in the MS group $**$. The MK was significantly lower in the bilateral optic radiation of MS patients than of controls $*$. The MK in the right and bilateral optic tract was significantly lower in NMO patients than in controls $**$. The mean FA in the right and bilateral optic radiation was also significantly decreased in NMO patients $*$. These results are shown in the Figure 2.



Discussion:DKI sensitively detected abnormalities in optic tract in NMO patients. NMO is a debilitating autoimmune central nervous system disease that causes severe attacks to the optic nerves and spinal cord². NMO-immunoglobulin G targeting AQP4 has been observed in the optic tract. Our results may reflect these pathological changes. DKI may be a more precise biomarker of optic tract damage in differentiation between MS and NMO patients compared to DTI metrics (FA and ADC).

Conclusion:DKI may be a more sensitive biomarker to differentiate between MS and NMO than conventional diffusional evaluations, such as diffusion tensor imaging. Each disease produces distinctive diffusional abnormalities of the optic pathways.

References: 1. Jensen JH, Helpern JA, Ramani A, et al. Diffusional kurtosis imaging: the quantification of non-gaussian water diffusion by means of magnetic resonance imaging. *Magn Reson Med.* 2005;53:1432-1440. 2. Wingerchuk DM, Lennon VA, Lucchinetti CF, et al. The spectrum of neuromyelitis optica. *Lancet Neurol.* 2007;6 :805-15.