

Detection of microstructural changes of nigra-striatum dopaminergic neurons in Parkinson's disease using high resolution DWI

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Target audience: Researchers and clinicians investigate the microstructural changes of brain tissue in Parkinson's disease using diffusion metrics.

Introduction: There are clinical proofs that the different clinical subtypes of Parkinson's disease (PD) have a different clinical course. Based on neuropathological findings, Jellinger depicted a model of different projections of nigral dopaminergic neurons to striatal structures for the PD subtypes¹. According to the paper, the akinetic-rigid type shows severe cell loss in the ventrolateral part of the substantia nigra zona compacta that projects to the posterior putamen. Eggers et al. have reported that PD subtypes show a different pattern of dopamine transporter single photon emission computed tomography binding in accordance with neuropathological findings². The purpose of our study is to detect and clarify microstructural changes of nigra-striatum dopaminergic neurons between akinetic-rigid and tremor-dominant PD by using high resolution diffusional kurtosis imaging (DKI) analysis.

Methods: 11 patients with akinetic-rigid type and 8 patients with tremor-dominant type were recruited. High resolution DWI data were obtained with a 3T MR scanner (Achieva, Philips Healthcare) using zoomed echo planar imaging (EPI) sequence. The scan parameters were: TR/RE = 4000/80 ms; intra-slice resolution = 0.98×0.98 mm; thickness = 5mm; b values = 0,1000, and 2000 s/mm²; motion-probing gradient directions = 32 directions; and $\delta / \Delta = 13.3/45.3$ ms. The map of fractional anisotropy (FA), mean diffusivity (MD) and mean kurtosis (MK) were generated (Figure 1). Regions of interest (ROIs) were manually drawn in "anterior putamen", "posterior putamen", and "caudate head", in reference to b0 images.

Statistical analysis was Mann-Whitney U test. A Bonferroni correction was applied, and setting level of significance at $P < 0.006$.

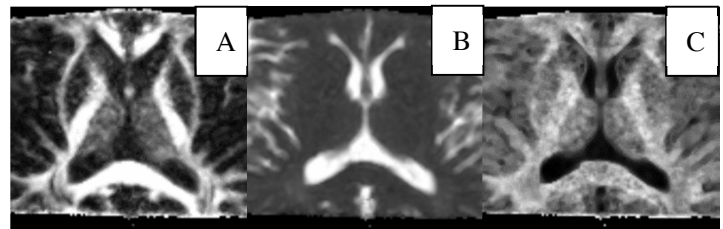


Figure 1. Diffusion metric maps calculated from high resolution DWI data. (A) Fractional anisotropy map, (B) Mean diffusivity map, and (C) Mean kurtosis map.

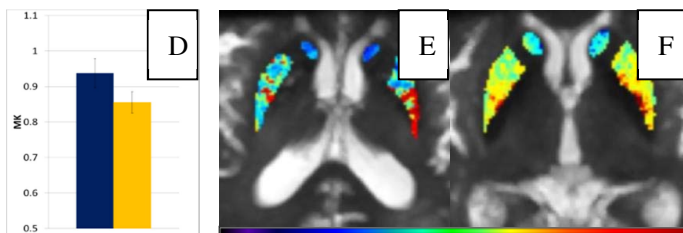


Figure 2. (D) The bar chart shows MK value. Blue bar is akinetic-rigid type, and yellow bar is tremor-dominant type. (E) MK value in basal striatum in patients with akinetic-rigid type. (F) MK value in basal striatum in patients with tremor-dominant type.

Result: MK value in the contralateral posterior putamen were significantly higher in patients with akinetic-rigid type than in patients with tremor-dominant type (Figure 2).

Discussion: The finding that MK value in the contralateral posterior putamen were significantly higher in patients with akinetic-rigid type is consistent with neuropathological model were depicted by Jellinger.

Conclusion: High resolution DKI using zoomed EPI sequence can detect and clarify microstructural changes of nigra-striatum dopaminergic neurons between akinetic-rigid and tremor-dominant PD.

Reference:

1. Jellinger KA. Post mortem studies in Parkinson's disease—is it possible to detect brain areas for specific symptoms?. J Neural Transm Suppl. 1999;56:1-29.
2. Eggers C, Kahraman D, Fink GR, et al. Akinetic-rigid and tremor-dominant parkinson's disease patients show different patterns of FP-CIT single photon emission computed tomography. Movement Disorders. 2011;26(3):416-23.