

Longitudinal DTI Study in Parkinson's Disease

Ling Ling Chan^{1,2}, Helmut Rumpel¹, Kia Min Ng², Chooi Sum Yeoh¹, and Eng King Tan^{2,3}

¹Singapore General Hospital, Singapore, Singapore, ²Duke-NUS Graduate Medical School, Singapore, Singapore, ³National Neuroscience Institute, Singapore

Target audience

Clinicians, Radiologists, MR Physicists and Researchers

Purpose

There is a need for an imaging marker to help evaluate progression in patients with Parkinson's disease (PD), a common neurodegenerative disease. Current published studies are mainly cross sectional in design and there have been no longitudinal Diffusion Tensor Imaging (DTI) studies in PD. Utilizing a longitudinal follow-up methodology, we investigated the rate of decline in FA ($\Delta\text{FA}/\Delta t$) and apparent diffusion coefficient (ADC) ($\Delta\text{ADC}/\Delta t$) in PD patients and controls.

Methods

We recruited study subjects prospectively over a 5 year period. All subjects underwent DTI imaging at baseline and 5 years later using identical MR protocol. We measured the FA and ADC values in the caudate, putamen, thalamus and substantia nigra, with the frontal white matter as a reference. We evaluated the rate of change in FA or ADC in PD and controls using both univariate and multivariate analysis models.

Results

We included 98 subjects (46 PD patients and 52 controls) who gave informed consent to participate in the study. We found an increased FA and ADC in all the studied brain regions except frontal white matter (for FA). The rate of change ($\Delta\text{FA}/\Delta t$) was significantly different in the putamen ($p=0.03$) and thalamus ($p=0.03$). The values in the substantia nigra were also significantly different between PD and controls. The rate of change ($\Delta\text{ADC}/\Delta t$) in the putamen ($p=0.01$) and in the frontal WM ($p=0.008$) were also significantly different between the 2 study groups.

Discussion

The increased FA in PD over time was unexpected and possibly related to iron deposition. The greater rate of change in the DTI values in PD compared to controls suggest progression of pathology in PD and hence the rate of change may be a potential imaging marker of disease progression. Correlation of the rate of change with clinical severity will need to be carried out in future studies.

Conclusion

This is the first long term longitudinal DTI study demonstrating an increase in FA values in the SN in PD compared to controls, with a corresponding significantly larger $\Delta\text{FA}/\Delta t$ in PD. The rate of DTI changes over time may be useful as potential imaging markers of disease progression.

References

1. Cochrane CJ, Ebmeier KP. Diffusion tensor imaging in parkinsonian syndromes: A systematic review and meta-analysis. *Neurology* 2013;80(9):857-864.
2. Péran P, Cherubini A, Assogna F, et al. Magnetic resonance imaging markers of Parkinson's disease nigrostriatal signature. *Brain* 2010;133(11):3423-3433.
3. Pfefferbaum A, Adalsteinsson E, Rohlfing T, et al. Diffusion tensor imaging of deep gray matter brain structures: Effects of age and iron concentration. *Neurobiol Aging* 2010;31(3):482-493.
4. Chan LL, Rumpel H, Yap K, et al. Case control study of diffusion tensor imaging in Parkinson's disease. *J Neurol Neurosurg Psychiatry* 2007;78(12):1383-1386.