

Validation of reduced Fractional Anisotropy measures in the Substantia Nigra of Parkinson's Patients using DAT Imaging

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Introduction

Parkinson's Disease (PD) is a progressive neurodegenerative condition resulting from the death of the dopamine containing cells of the substantia nigra (SN). It has been demonstrated that fractional anisotropy (FA) measures derived from high resolution diffusion tensor imaging (DTI) in the SN are reduced in de novo PD [1,2,3]. This work aims to validate this technique using dopamine transporter (DAT) imaging, which is currently considered the gold standard diagnostic imaging technique in PD, and to investigate correlation between FA measured in the SN and the specific/non-specific binding ratio measured in the striatum.

Methods

DTI datasets were acquired for twenty newly diagnosed PD subjects using a high resolution DTI protocol at 3-Tesla on a GE Signa HD system with 8-channel head coil. The datasets were used to create multiple parametric maps from which region of interest (ROI) analysis was performed in the SN, and FA measures recorded. ROIs were placed in three regions within the SN, labelled rostral, middle and caudal, with a reference region placed in the cerebral peduncle (CP) (see figure 1). DTI analysis was performed using DTIStudio [4]. In addition, DAT imaging was performed on the same patient group, using a dedicated neuro-SPECT scanner, and radioligand uptake measured throughout the striatum. The clinical diagnosis of PD was confirmed with the DAT imaging, and statistical correlation between FA in the SN and radioligand uptake in the striatum was then investigated.

Results

Two of the twenty patients clinically diagnosed with PD by a movement disorders specialist were shown not to have PD after undergoing DAT imaging. Using the eighteen remaining patients FA measures in the SN were shown to be reduced when compared with published normal control data [1]. The two patients shown not to have PD also demonstrated reduced FA (see table 1). Contrary to previous studies we found no significant difference in the mean FA measured in the rostral, middle or caudal region among the PD patients.



Figure 1: ROI placement on B0 image

	Rostral	Middle	Caudal	CP
Mean (SD)	0.43 (0.07)	0.41 (0.06)	0.41 (0.07)	0.71 (0.05)
NoPD1	0.35	0.44	0.4	0.76
NoPD2	0.29	0.26	0.4	0.68
Published Normal Mean	0.53	0.51	0.57	0.75

Table 1: FA measures in PD subjects and controls

There was no significant correlation found between the mean specific/non-specific binding ratios in the striatum and the measured FA values in any of the three regions in the SN.

Conclusion

The diagnosis of idiopathic PD can be difficult [5] and is complicated by the fact that other conditions have similar clinical presentations. This study confirms that FA measured in the SN is reduced in patients with PD and thus it has the potential to act as a diagnostic marker. However, further work is required to improve the technique, with further investigation required in clinically similar patient groups such as patients with Parkinson's plus syndromes, non-degenerative tremor disorders and drug induced Parkinsonism. This study highlights the value of DAT imaging in excluding PD from patients exhibiting classic PD symptoms and suggests that there may not be a direct correlation between FA measures in the SN and disease severity as measured by striatal binding ratios.

References

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