Cognitive Impairment in Parkinson's Disease: Preliminary DTI Findings

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Introduction

Cognitive impairment adds a significant burden to Parkinson's disease (PD) patients, with many of them (possibly up to 80%) progressing to frank dementia. Increased appreciation and understanding of cognitive heterogeneity and the progression of cognitive decline in PD are among the highest priorities facing researchers today(1,2). Establishing relevant markers is fundamental to identifying patients at risk of dementia and for targeted treatment and prevention of this important non-motor characteristic of PD. This pilot study investigated whether the apparent diffusion coefficient (ADC) and fractional anisotropy (FA) could be such markers.

Method

Diffusion tensor MRI data were acquired from 12 patients with varying degrees of cognitive impairment. A GE 1.5T scanner was used, with a single shot 2D spin echo EPI acquisition and TE/TR = 90ms/10s. Data were acquired axially with a matrix of 128×128×30 covering a field of view of 240mm×240mm×150mm, with 25 uniformly distributed gradient directions, with a *b*-value of 1000 s/mm^2, and 3 acquisitions with no diffusion weighting (total acquisition time 4 min 40s). The diffusion tensor was fitted using singular value decomposition weighted according to the SNR of each measurement. From the diffusion tensor at each voxel, the frame-independent ADC and fractional anisotropy (FA) were calculated. Statistical Parametric Mapping(3) was used to normalize each brain to a standard template, followed by voxel-wise t-tests of the correlation between ADC and the neuropsychological variable being considered. Similar tests were then done for FA. Those voxels showing statistically significant correlations were displayed on a standard brain map. The *p* value used in the significance tests was 0.05, and multiple comparisons were allowed for using the false discovery rate (FDR) correction (4).

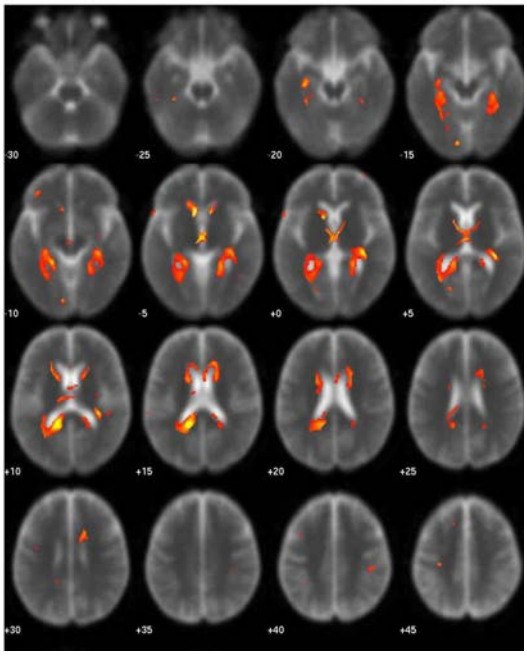

Figure 1. Regions of statistically significant correlation (using p<0.05 and FDR correction) between ADC and TotNP in Parkinsonian patients.

Results

Scores using 5 domains of neuropsychological tests that are sensitive to cognitive decline (executive function, working memory, visuoperception, nonverbal problem solving, and verbal memory) were used to produce a summarised measure, called the Total Neuropsychological (TotNP) score. Positive correlations were observed between ADC and the TotNP score (Figure 1). The higher the TotNP score, the higher the overall cognitive impairment. Correlations between ADC and the TotNP score were most apparent for periventricular regions, the medial temporal lobe and thalamus. FA was less sensitive than ADC; while some correlation with the TotNP score was apparent, it did not reach statistical significance.

Discussion

A high TotNP score indicates a worsening cognitive performance. Increased ADC is an indicator of neuronal damage(5). The regions of positive correlation between these variables, shown in Figure 1, represent where ADC is marking physical damage associated with progressive cognitive decline. These results indicate that ADC may be a particularly sensitive marker of worsening cognition in PD patients and may help identify those patients with mild cognitive impairment who are at risk of subsequent dementia. With PD being primarily a grey matter disease, FA is unlikely to be a suitable marker, and our results support this hypothesis. A larger study is planned to confirm and extend the findings presented here.

References

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