

Voxel Based Diffusion Tensor Imaging and Diffusion Tensor Tractography for the Evaluation of Cognitive Functioning in Parkinson's Disease

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BACKGROUND

PET has identified a PD-cognitive pattern (PDCP), including hypometabolism of the prefrontal and parietal association areas and hypermetabolism of the cerebellar vermis and dentate nuclei. We investigated whether Parkinson's disease (PD) cognitive declines are accompanied by neuroanatomic changes in these regions and their connecting white matter tracts using Diffusion Tensor Imaging (DTI).

DTI estimates myelination *in vivo*. White matter tracts restrict the movement of water molecules, which tend to move faster along nerve fibers rather than perpendicular to them. Fractional anisotropy (FA) is determined by the thickness of the myelin sheath and of the axons. Apparent diffusion coefficient (ADC) is the average magnitude of the diffusion. Axial diffusivity (AD) is the primary direction (x).

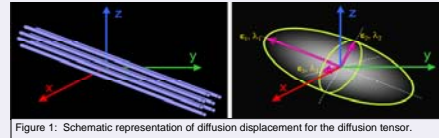


Figure 1: Schematic representation of diffusion displacement for the diffusion tensor.

METHODS

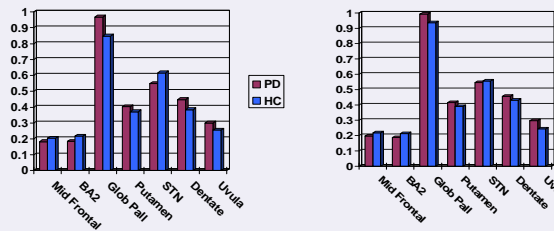
Table 1: Demographics		
	PD n=6	HC n=6
Gender	67/33	50/50
Age	67.5 (4.3)	62.7 (7.2)
Education	12.8 (2.9)	15.7 (2.3)
H&Y off	2.0 to 3.0	NA

1. Voxel-based diffusion tensor imaging (VB-DTI): FA and ADC for left and right cortical, subcortical and cerebellar areas.
2. DTI tractography (DTI-T): FA, ADC, and AD for right and left anterior (RAIC, LAIC) and posterior limbs (RPIC, LPIC) of the internal capsule.
3. Comprehensive Neuropsychological evaluation

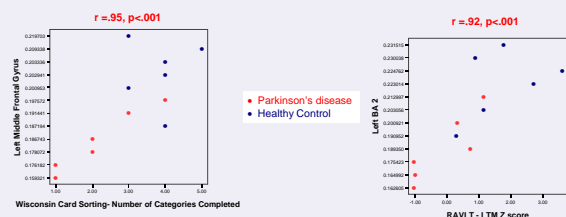
RESULTS: VB-DTI

- In PD patients compared to HC, the left middle frontal gyrus, left somatosensory white matter and left subthalamic nucleus showed significantly decreased FA.
- The left globus pallidus, left putamen, and bilateral cerebellar uvula demonstrated increased FA.
- ADC was significantly increased in the left cerebellar dentate for the PD patients.

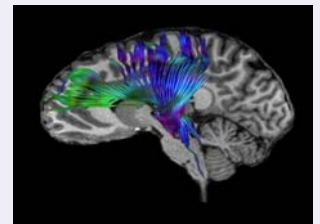
Figure 2a and b: Left and Right Hemisphere FA for PD and HC



- For the PD patients, lower FA in the left middle frontal gyrus was positively correlated with executive functioning impairment.
- For the PD patients, lower FA in the left somatosensory area was positively correlated with long-term verbal memory impairment.

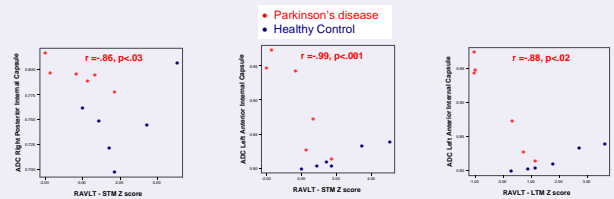


RESULTS: DTI-T

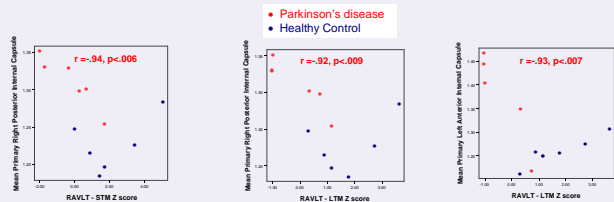


	ADC			AD		
	PD	HC	p	PD	HC	p
RPIC	.80 (.01)	.07 (.03)	.01	1.31 (.03)	1.23 (.04)	.002
LPIC	.81 (.04)	.77 (.03)	.07	1.34 (.05)	1.26 (.04)	.01
RAIC	.90 (.09)	.83 (.04)	.11	1.35 (.10)	1.27 (.05)	.10
LAIC	.90 (.07)	.81 (.03)	.01	1.35 (.10)	1.27 (.03)	.05

- ADC was negatively correlated with verbal short-term (RPIC and LAIC) and long-term memory (LAIC only) scores for the PD patients.



- AD was also significantly higher for PD patients versus HC, and was negatively correlated with verbal short-term (RPIC) and long-term memory (RPIC and LAIC) for the PD patients.



CONCLUSIONS

1. VB-DTI results suggest changes in PDCP associated areas, including left middle frontal gyrus, left parietal association area, and bilateral cerebellum. Frontal and parietal changes are related to executive functioning and verbal memory performance.
2. Decreased integrity of RPIC and LAIC tracts was associated with lower scores on verbal short- and long-term recall.
3. Analyses suggest that PD-related cognitive dysfunction is accompanied by microstructural changes in cortical areas and their connecting white matter pathways.
4. Future research will incorporate larger sample sizes and analyses between cognitive impaired versus intact PD patients.