Mean diffusivity correlates with executive function in patients with hypertension: a diffusion tensor study

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Introduction

Hypertension is associated with white matter lesions (1) and with cognitive impairment (2). Diffusion tensor imaging (DTI) is a novel imaging technique that allows the study of tissue microstructure. Damage to white matter tracts would be expected to lead to a reduction in fractional anisotropy (FA) and an increase in mean diffusivity (MD). A hypothesis explaining cognitive impairment in patients with hypertension is that white matter tract damage leads to disruption of cortical-subcortical and cortical-cortical connections (3). The aims of this pilot study were to determine if there are detectable abnormalities in normal appearing white matter and in the thalamus of asymptomatic hypertensive subjects and, if so, to assess whether they correlate with cognitive function.

Methods

20 hypertensive subjects (hypertension defined as self-reported use of anti-hypertensive medication) were compared to 11 normotensive subjects. Hypertensive subjects were excluded if they had end-organ damage or history of neuro-psychiatric disease. All subjects had magnetic resonance imaging and a 30-minute neuropsychological battery. MRI was performed on a 1.5T GE Signa MR scanner. Conventional axial T2-weighted and axial FLAIR sequences were performed. For DTI, an echoplanar imaging sequence with TE 84.5msec and TR 2000msec was used. Regions of interest were placed over normal appearing white matter of the periventricular region and centrum semiovale, and in the thalamus (Figure 1) from which mean FA and MD values were obtained.

Results

There was no significant difference between the baseline characteristics (age, sex and educational level) of the hypertensive subjects and the controls apart from pre-morbid IQ (101 in hypertensives cf 111 in controls; $p<0.05$). Lesion volume determined from FLAIR images was greater in hypertensive subjects (1737mm^3 cf 138mm^3, $p<0.005$). For all regions, FA was lower and MD higher in hypertensive subjects. However, this difference reached significance only in the thalamus (Table 1). As duration of hypertension increased there was a trend towards an increase in MD and a decrease in FA; this did not reach significance. The controls performed significantly better on a number of cognitive tests than the hypertensive subjects. In hypertensives, DTI parameters from the thalamus correlated with executive function (correlation between MD and Trail Making B-A - rho=0.45, $p<0.05$; Figure 2).

	Fractional anisotropy (sd)			Mean diffusivity (sd) $mm^2/s \times 10^{-3}$		
	Hypertensive	Control	p value	Hypertensive	Control	p value
Thalamus - all	0.24 (0.03)	0.26 (0.03)	0.088	0.78 (0.07)	0.74 (0.05)	0.050
Thalamus - left	0.24 (0.03)	0.27 (0.02)	0.043	0.78 (0.06)	0.74 (0.06)	0.049
Thalamus - right	0.25 (0.03)	0.26 (0.02)	0.313	0.78 (0.08)	0.75 (0.04)	0.080

Table 1 Result of t-test comparing mean of DTI parameters between two groups in the thalamus . The p values are based on normalised (by reciprocation(4)) data. Red denotes $p \leq 0.05$.

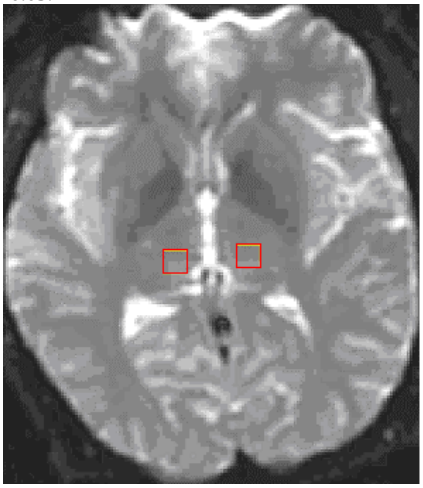

Figure 1 Axial T2 derived from echo planar imaging showing placement of regions of interest in the thalamus.

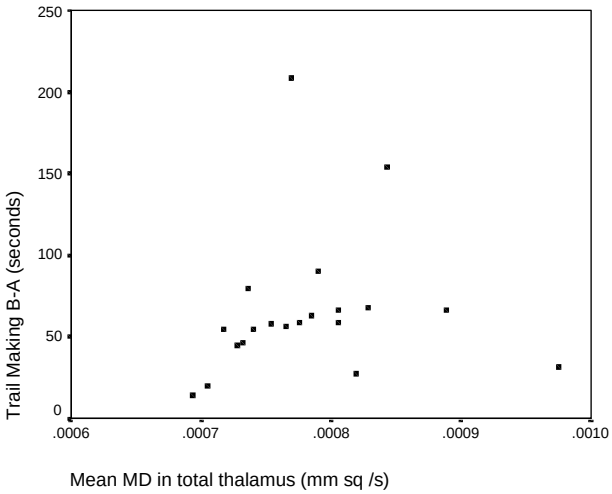

Figure 2 Correlation between mean diffusivity of thalamus and a task of executive function (Trail Making B-A) in hypertensive patients.

Conclusion

The DTI data revealed structural changes in patients with hypertension compared to controls. These changes were most significant in the thalamus. Mean diffusivity in the thalamus correlated with executive function. A possible explanation for this finding is degeneration of circuits involving the thalamus in hypertensives. Further work is required to verify this hypothesis. Improved correlations might be achieved by increasing the sample size and addressing the heterogeneity of the hypertensive subjects.

References

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