Assessment of Deep Grey Matter Atrophy in Clinically Isolated Syndrome (CIS) using 7 Tesla MR Imaging

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Objectives: To detect and measure atrophy of the deep grey matter (DGM) structures in a cohort of CIS patients using 7T MRI, and to investigate the correlation between DGM atrophy and clinical disability.

Background: Compared to MS, much less is known about the extent of regional grey matter atrophy in CIS and their correlation with disability measures. High-field MRI allows for more precise segmentation and volumetric measurements of small-scale structures in the brain, such as the DGM nuclei.

Design/Methods: 20 CIS patients and 11 controls were scanned using a 7T Philips Achieva MRI, obtaining a 3D-MPRAGE sequence (0.6mm^3 resolution; TE = 5.8ms; TR = 15ms; TI = 1051ms, acquisition time 12:05 mins) and T1 maps with inversion times of 150, 300, 500, 800, 1200, 1800 and 2500 ms (1.25mm^3 resolution; TR = 6.9ms; TE = 3.2ms; 14:07 mins). Locally developed software, Neuroi (CR Tench) was used to semi-automatically segment the bilateral thalamus, caudate and putamen on a high-contrast T1 sequence, and to acquire the volumes of each region which were subsequently normalised for total brain volume. Disability (EDSS) and fatigue (FSS) scores were obtained in the CIS group.

Results: Significant reduction in thalamic and caudate volumes were detected in CIS patients with fatigue compared to non-fatigued patients and controls (p=0.01 and p=0.002 respectively for the thalamus, p=0.02 and p=0.03 respectively for the caudate). In the CIS group, thalamic and caudate volumes correlated directly with fatigue (r=-0.59, p=0.004 and r=-0.55, p=0.009 respectively) and with EDSS (r=-0.61, p=0.003 and r=-0.47, p=0.03 respectively).

Conclusion/relevance –Regional gray matter atrophy is present in CIS patients and detectable at higher MRI field strengths, whereby high spatial resolution and longer absolute T1 recovery times allow for more accurate tissue characterisation. Our findings support a relationship between DGM atrophy, fatigue and EDSS, and demonstrate the extent of neurodegeneration which may precede clinically definite MS.