T1 Relaxometry of the thalamus in Clinically Isolated Syndrome using 7 Tesla MRI

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Background: Grey matter (GM) pathology has been shown to develop relatively early in multiple sclerosis (MS), affecting both cortical and subcortical structures. Minimally-disabled patients with early MS have evidence of thalamic abnormality, correlating with fatigue (Niepel et al 2006). Progressive cortical GM atrophy was observed in CIS patients who later converted to clinically definite MS (Dalton et al 2004). T1 relaxation time is a quantitative MRI measure sensitive to tissue damage where it becomes abnormally prolonged. Demyelination, oedema, gliosis, axonal and neuronal loss can cause the abnormal shift in T1 relaxation values, even if the tissues appear normal on imaging. This may bear clinical significance in terms of predicting disease conversion in CIS patients and long-term disability in MS.

Objective: To utilise the increased signal to noise ratio and spatial resolution available at ultra high field MR to measure T1 relaxation times of the thalamus in a group of CIS patients.

Methods: 14 subjects (9 CIS patients and 5 controls) were included. Of the patients, 6 were male and 3 female, mean age 34.8 years, mean time from presentation to scan 24.7 months (range 7 months to 4 years 8 months). Images were produced using a 7T Philips Achieva system equipped with a head only volume RF transmit coil and a 16 element dome shaped receive coil. Scan protocol included a 3D-MPRAGE sequence (0.6 mm isotropic resolution; 192 x 163 x 96 mm^3 FOV; TE=5.9 ms; TR=13 ms; TFE shots=149;160 slices; TI=1051 ms; SENSE factor = 2) and a 2D multi-slice FLAIR sequence (0.6 mm isotropic resolution;192 x 163 x 72 mm^3 FOV; TE= 100 ms; TR=1500 ms; 36 slices; TI= 2800). T1 maps were derived using data acquired with a modified version of the MPRAGE sequence, giving a 200x170x73 mm^3 FOV and 1.25 mm isotropic voxel size. 7 inversion times were used, i.e. 150, 300, 500, 800, 1200, 1800, 2500 ms. The region of interest, the bilateral thalamus, was delineated semi-automatically on a high-contrast MPRAGE image using locally developed software (Neuroi, CRT). From this the total thalamic volume for each subject was obtained and a binary mask created to extract the thalamus on the T1 maps. The median T1 value of the thalamus was later calculated for each subject.

Results: Preliminary results are as follows: Mean T1 relaxation time of the thalamus in the control group was 1561 ms (SD 63 ms) and in the CIS group 1510 ms (SD 121 ms). The mean thalamic volume in the control group was 9418 mm^3 (SD 945 mm^3) and in the CIS patients 8968 mm^3 (SD 2018 mm^3). The differences observed in the CIS and control groups did not show statistical significance.

Conclusions: 7 Tesla MRI can be used to generate high contrast 3D-MPRAGE images suitable for performing T1 relaxometry on deep grey matter structures in CIS/MS. Our initial results suggest no significant difference between the thalamic T1 relaxation times and volume in CIS patients using this method. The study is on-going.