Deep Gray Matter Atrophy as an MRI Metric of Physical and Cognitive Impairment in patients with Multiple Sclerosis

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Objective:

To investigate the role of deep gray matter (dGM) atrophy in determining physical and cognitive impairment (CI) in patients with Multiple Sclerosis (MS).

Background:

Previous studies have shown that dGM structures may be affected in MS. Particularly, thalamus involvement was disclosed using different MRI and histopathology techniques [1]. Nevertheless, the magnitude of dGM pathology in MS is still unclear and so its role in determining physical and cognitive impairment. Previous studies using low resolution MRI or incomplete neuropsychological evaluation (NE) have showed that thalamic atrophy may occur in MS patients and could be linked to some extent to CI. To provide further insights to this issue we acquired a high-resolution MRI datasets at 3.0T and tested MS patients with an extensive MS-specific neuropsychological evaluation (i.e. Minimal Assessment of Cognitive Function in MS or MACFIMS) [2].

Design/Methods:

Twenty-four MS patients, and 24 healthy volunteers (HVs) matched for age, gender and education level (see Table below) underwent: (1) clinical examination with assessment of physical impairment by the Expanded Disability Status Scale (EDSS); (2) MACFIMS; and (3) 3.0 T brain MRI with a 3D T1-weighted high-resolution image (matrix=256x256, FOV=250x250 mm, thickness=1mm, TR=7.5ms, TE=3.0ms, TI=725ms, FA=6°). Clinical examination and MACFIMS were done within the same month (1 to 4 weeks). The Freesurfer software tool, version 3.0.5, was used to automatically segment dGM structures (Thalamus and Basal Ganglia = Pallidum + Caudate + Putamen) (see Figure below) [3]. Results were visually inspected by two investigators as to evaluate the accuracy of the segmentation process. A *t*-test compared Th-vol and BG-vol measurements between patients and HVs. A linear-regression analysis was used to investigate the relation between Th-vol and BG-vol and scores of EDSS and selected MACFIMS components.

	MS patients	HVs	*p* value
N	24 (20 RRMS-4 SPMS)	24	-
F/M	17/7	17/7	-
Age (y) (range)	45.3 (19-57)	45.0 (18-60)	n.s.
Education Level (y)	15.5 ± 2.2	16.6 ± 3.2	n.s.
Disease duration (y)	12.4 ± 8.0	-	-
EDSS	2.3 ± 1.8	-	-
Th-vol (mm^3)	11465 ± 1634	12890 ± 1787	0.006
BG-vol (mm^3)	19408 ± 1888	20096 ± 2706	n.s.

Table: Subjects's Demographics and Results

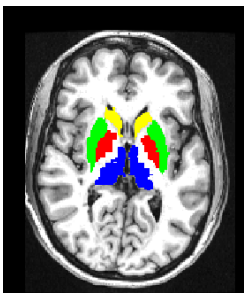

Figure: Segmentation
Blue: Thalamus
Red: Pallidum
Green: Putamen
Yellow: Caudate

Results:

Th-vol was significantly reduced in patients with respect to HVs (see Table above). Although reduced in patients, BG-vol. was not significantly different between the two groups. Significant correlations were identified between Th-vol and EDSS score ($p = 0.01$; $r = -0.249$) and tests measuring information processing speed, spatial learning and memory as well as visual-spatial ability ($p < 0.05$, $r = 0.409$ to 0.638). BG-vol was significantly correlated with the EDSS score ($p = 0.005$, $r = -0.556$) and with the test measuring spatial learning and memory ($p < 0.05$; $r = 0.440$ to 0.545).

Conclusion/Relevance:

In MS patients, dGM atrophy plays an important role in either physical or cognitive impairment. Multiple correlation analyses are on going and corrections for depression, fatigue and sleepiness scales will be performed as to assess the exact role of dGM in affecting patients with MS when transient factors such as impairment due to mood changes, fatigue and tiredness are taken into account.

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