A VOXEL-BASED ASSESSMENT OF CERVICAL CORD DAMAGE IN MS PATIENTS

Paola Valsasina[1], Maria A. Rocca[2], Dusan Damjanovic[2], Sarlota Mesaros[3], Mark A. Horsfield[4], Tatjana Stosic-Opincal[5], Jelena Drulovic[3], Giancarlo Comi[6], and Massimo Filippi[1]
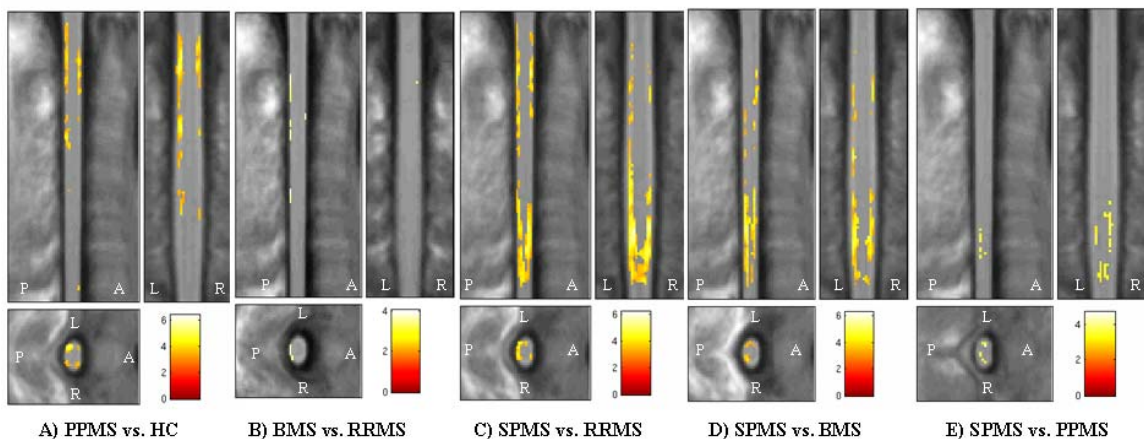
[1]Neuroimaging Research Unit, Institute of Experimental Neurology, San Raffaele Scientific Institute and Vita-Salute San Raffaele University, Milan, Italy, Italy, [2]Neuroimaging Research Unit, Institute of Experimental Neurology, San Raffaele Scientific Institute and Vita-Salute San Raffaele University, Milan, Italy, [3]Clinic of Neurology, Faculty of Medicine, University of Belgrade, Belgrade, Yugoslavia, [4]Medical Physics Group, Department of Cardiovascular Sciences, University of Leicester, Leicester, United Kingdom, [5]Clinic of Radiology, Faculty of Medicine, University of Belgrade, Belgrade, Yugoslavia, [6]Department of Neurology, San Raffaele Scientific Institute and Vita-Salute San Raffaele University, Milan, Italy, Italy

Introduction. Cervical cord atrophy in patients with multiple sclerosis (MS) has been correlated with clinical disability [1], especially in the progressive forms of the disease.

Objective. Aim of this study was to apply a voxel-based method to assess the regional distribution of cord atrophy and cervical cord lesions of MS patients with different clinical phenotypes.
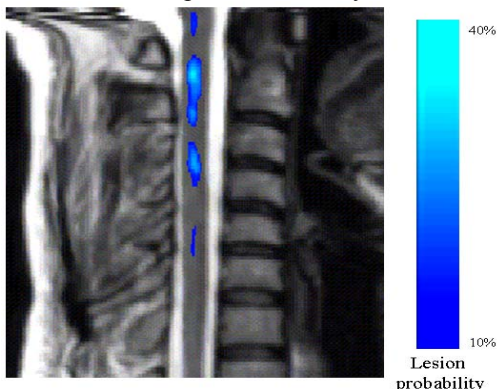
Methods. Brain axial dual echo (DE) scans, cervical cord sagittal 3D T1-weighted and sagittal DE scans were acquired from 31 healthy controls (HC) and 89 MS patients (16 clinically isolated syndrome [CIS], 17 relapsing remitting [RR] MS, 19 benign MS [BMS], 18 primary progressive MS [PPMS] and 19 secondary progressive [SPMS]). Brain T2 lesion volume (T2LV) was assessed on DE scans. Cervical cord lesions were marked on DE sagittal images, and corresponding lesion masks were created. 3D-T1 cervical cord images were analyzed by using a semi-automatic active surface (AS) method [2], which was able to rapidly segment the cord surface from C1 to C7 and create output images reformatted in planes perpendicularly to the estimated cord centre line. Unfolded cervical cord images were co-registered into a common standard space, and smoothed cord binary masks, produced using the cord outlines estimated by the AS approach, were used as input images for spatial statistics. Normalized cervical cord lesion masks were produced from the sagittal DE cord scans, by applying the AS method and the same procedure described above. The mean cord lesion probability map for MS patients was produced by averaging cord masks from each patient.Between-group comparisons of regional cervical cord atrophy and correlations with clinical and structural MRI variables were assessed with SPM8.

Results. Compared to HC, CIS patients showed no cord atrophy, while PPMS had a diffuse cord atrophy. Several clusters of cord atrophy were found in BMS *vs.* RRMS, SPMS *vs.* RRMS, BMS and PPMS patients. Atrophy mainly involved the posterior and lateral cord segments at different levels (Figure 1).

A) PPMS vs. HC   B) BMS vs. RRMS   C) SPMS vs. RRMS   D) SPMS vs. BMS   E) SPMS vs. PPMS

Figure 1 legend. *Between-group comparisons of regional cervical cord atrophy: A)PPMS vs. HC B)BMS vs. RRMS C)SPMS vs. RRMS D) SPMS vs. BMS E) SPMS vs. PPMS.*

Fifty-five of 89 (62%) MS patients had cervical cord T2-visible lesions. The median number of cord lesions was 2 (range= 1-9 lesions). The mean cord lesions probability map is shown in Figure 2. Lesions occurred more frequently in the posterior than in the anterior cord portion, and they were more frequently localized between C1 and C4 cervical cord segments.

Figure 2 legend. *Mean probability map of cervical cord T2-visible lesions in our MS patients cohort.*

In PPMS, regional cord atrophy was correlated ($p < 0.001$) with disability (r values ranging from -0.76 to -0.86) and brain T2LV (r values ranging from -0.78 to -0.90), while in the remaining MS phenotypes, taken separately, no correlations were found.

Conclusions. Voxel-based assessment of cervical cord atrophy and lesions allows a precise localization of regional cord tissue damage and may contribute to a better characterization of the clinical heterogeneity of MS patients.

References. [1] Rocca MA et al., Neurology 2011;76:2096-2102. [2] Horsfield MA et al., Neuroimage 2010;50:446-455.