Diffusion tensor imaging changes in the spinal cord of amyotrophic lateral sclerosis patients

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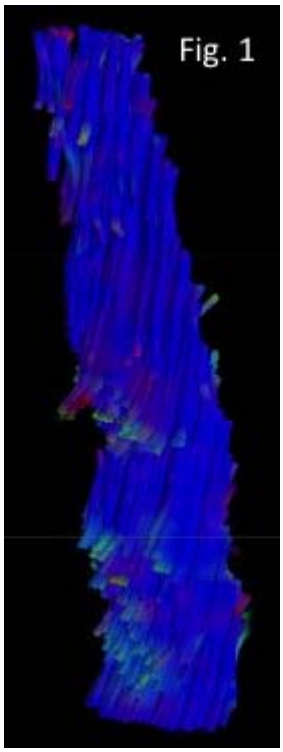

Introduction: Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disorder, characterized by the progressive injury and cell death of lower motorneurons (LMN) in the spinal cord and brain stem and of upper motorneurons (UMN) in the motor and premotor cortex. Patients experience progressive weakening of the muscles with accompanying wasting and brisk reflexes, thereby losing control of voluntary movement. The etiology of ALS remains poorly understood. In 10% of cases, it is a familial mostly autosomal dominant disorder, while in the remaining 90% ("sporadic ALS") the primary pathogenic process remains unknown.
Diffusion tensor imaging (DTI) has been extensively used to evaluate white matter (WM) breakdown in the brain of ALS patients. Since diffusion tensor imaging (DTI) provides quantitative measures of WM integrity, it is a very sensitive technique to investigate microstructural WM properties. Diffusion differences with healthy control subjects were found in the cortico-spinal tracts and in the frontal lobe of ALS patients. In this study, we evaluated the fractional anisotropy (FA) of the spinal cord in patients with ALS.

Methods: We examined 28 ALS patients (14 male, 14 female), of which 21 had laboratory supported definite ALS and 7 had laboratory supported probable ALS as defined by the El Escorial criteria (Brooks et al., 2000). The mean age of these patients was 58.9 +/- 11.8 years, ranging from 35 to 78 years and the mean time from symptom onset to the time of scanning was 14.6 +/- 8.2 months, ranging from 4 to 34 months. The mean score on the revised ALS functional rating scale was 39.7 +/- 6.3, ranging from 17 to 48. A more extensive description of the patient characteristics has been published elsewhere. Patients were included in the study if there was no history of other neurological and/or vascular diseases. Patients with evidence of dementia of whatever type or of behavioural or cognitive changes were excluded. Twenty-six healthy age- and sex-matched controls (11 male, 15 female) were concurrently examined. Their mean age was 53.7 +/- 11.8 years, ranging from 35 to 77 years, and were included if there was no history of any other neurological and/or vascular disease.
Diffusion tensor tractography was used to delineate the spinal cord tracts in all ALS patients and control subjects (see Fig. 1) [2-3]. An FA threshold of 0.2 was thereby used to obtain the tracts. Subsequently, FA values were derived from the fiber tracts and subdivided based on the cervical level, from C1 to C6. A t-test was used to evaluate the statistical differences of the derived FA values between control subjects and ALS patients in these different segments of the spinal cord.

Results: In Fig. 2, boxplots of the FA values are shown along the different spinal segments. The boxplots of the control subjects and the ALS patients are visualized in green and red, respectively. In addition, the p-values of the t-test are shown, comparing the FA values of control subjects and ALS patients in each of the spinal segments. Note that the FA was significantly different between both groups in C3-C5. The global p-value, comparing the FA values of the whole spinal cord between the subjects groups was 0.03.

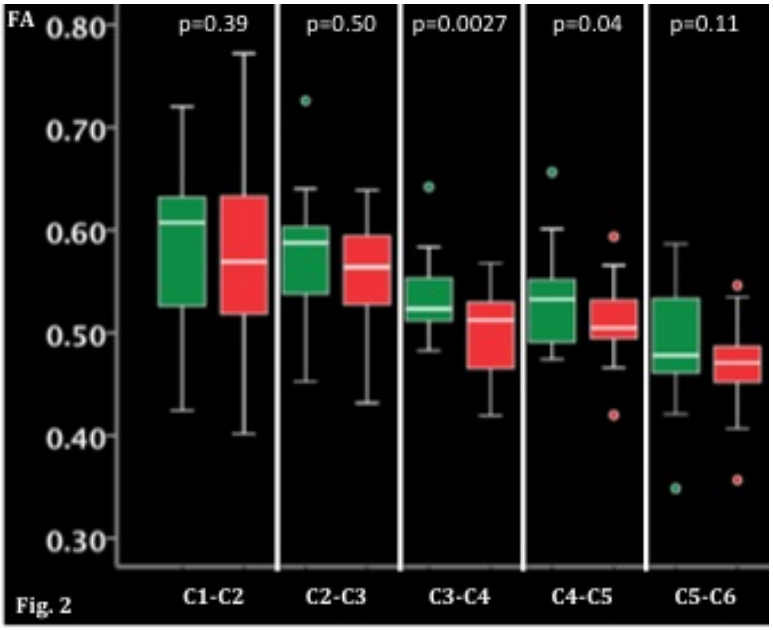

Fig. 2

Discussion: Our results suggest that the WM microstructure is altered in the spinal cord of ALS subjects compared to healthy controls. Especially in segments C3-C5, significant differences in FA values were observed. Significant correlations of FA values and disease duration were only found in C1-C2 (p-value of 0.04, results not shown) and of FA with the ALSFRS score in C1-C3 (p-value of 0.04, results not shown).

References : [1] Sage et al., 2009 (NeuroImage); [2] Van Hecke et al., 2008 (JMRI); [3] Van Hecke et al., 2010 (JMRI)