Cerebellar and frontal lobe involvement in ALS as determined by MR DTI

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Introduction

Our objective is to determine the extent of brain regions affected by ALS using MR DTI. ALS is a disease that affects mainly motor neurons. Various MR imaging methods were used in the past to visualize the disease involvement in motor cortex and corticospinal tract [1-3]. Studies that use PET [4] and volumetric analysis [5] have suggested that other regions of brain, particularly in frontal lobe, might be affected in ALS in addition to corticospinal tract.

Methods

16 ALS patients and 12 age-matched controls were studied using a clinical 1.5 T MR scanner and quadrature head coil. A single-shot EPI diffusion tensor sequence was used to collect images from 30 slices covering the entire brain. The slice thickness was 5 mm; FOV 22 cm; imaging matrix 128x128. Diffusion-weighted images from 26 gradient directions, as well as 6 images without diffusion weighting were acquired. Maximum b-value per gradient axis was 820 s/mm^2. Using all the images, the components of the diffusion tensor for every pixel [6] were determined. Maps of average diffusion constant (D_{av}) and diffusion anisotropy (FA) were then calculated. Using SPM2 (Statistical Parametric Mapping package, ref 7), The D_{av} and FA images from each subject were warped to fit an image template. Using voxel-wise one-tailed t-test, the regions that are either increased in D_{av} or decreased in FA in patients in comparison to controls were then computed. These regions were overlaid onto either axial D_{av} or FA maps, T_2 images or surface rendered 3D white matter volume.

Results

Our methods successfully visualized disease affected brain regions in motor cortex and pyramidal tracts in ALS patients (Fig. 1&2). In addition, we were able to show statistically significant ($p<0.001$) diffusion abnormalities extending throughout the frontal lobe regions that are involved by the disease process in the group of patients we studied. The white matter in cerebellum were also affected by ALS. To the best of our knowledge, this is the first time that widespread ALS involvement in frontal lobe and cerebellum can be visualized using MR DTI imaging.

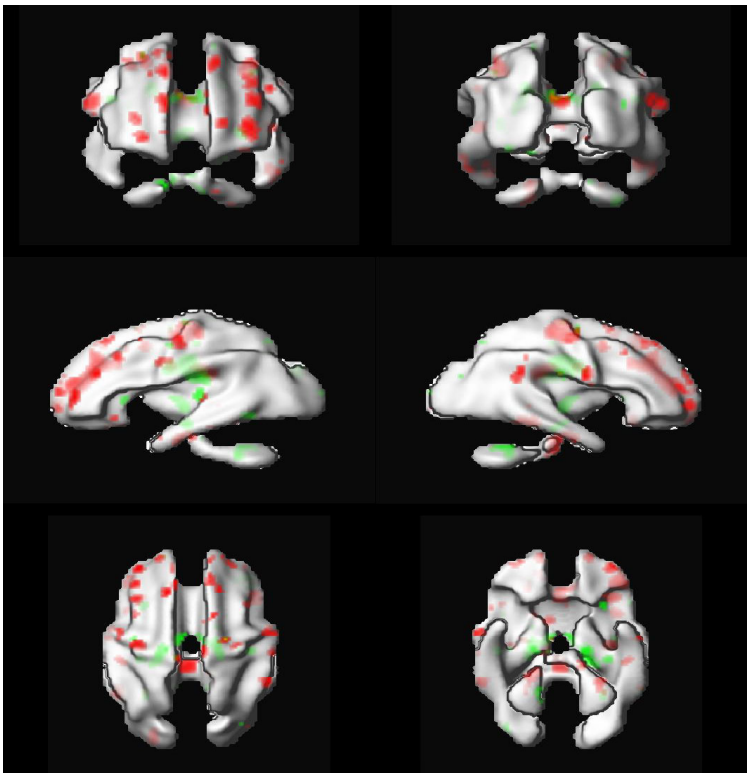

Fig 1. Regions in ALS patients with increased D_{av} (red), and decreased FA (green) are overlaid on 3D rendered white matter. Widespread frontal regions with increased D_{av} and cerebellar regions with decreased FA are clearly visible.

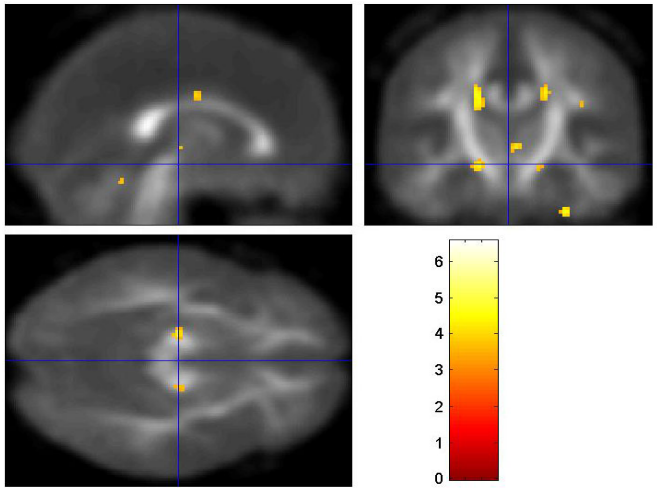

Fig 2. Disease involved regions in ALS patients with decreased FA (yellow) are overlaid on 3 orthogonal slices showing diffusion anisotropy. Corticospinal tract involvement is clearly visible.

Discussion

MR DTI visualized extensive areas in frontal lobe and in cerebellum that are involved in ALS in addition to motor cortex and corticospinal tracts. This study added to the increasing evidence that ALS is a disease that affects regions other than the corticospinal tract.

This study is supported in part by grants from National Institute of Neurological Disorders and Stroke (R01-NS41672), MDA Wings Over Wall Street, and ALSA.

References

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