

Diffusion Tensor Imaging in Differentiation of PLS Patients and Healthy Controls

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Introduction Primary lateral Sclerosis (PLS) is a rare neurologic disease characterized by progressive weakness in voluntary muscles. PLS is associated with upper motor neuron and corticospinal tract (CST) degeneration. Early diagnosis of PLS is difficult because its symptoms are similar to several other neurologic diseases, and the subtle changes caused by these diseases are not readily detected on anatomical MRI. Quantitative diffusion tensor imaging (DTI) could provide a useful evaluation of white matter changes associated with motor neuron degeneration and hence help to establish the diagnosis of PLS. In this study, fractional anisotropy (FA) and apparent diffusion coefficient (ADC) within the posterior limb of the internal capsule (PLIC) and the centrum semiovale (CSO) are compared between normal controls and PLS patients.

Methods Eight patients with PLS (mean age 60.5±10) and 7 age matched healthy controls (mean age 55.6±5.3) were studied using a 3T SIEMENS Trio system. An EPI sequence was used to obtain 2 partially overlapping sets of 20 axial DT images with b-values 1000 s/mm² in 12 directions, and FOV 224 mm, matrix 128 x 128, TR 3200 ms, TE 91 ms, slice thickness 3.5 mm, bandwidth 1300 Hz / pixel, 10 averages. DT images were registered to the b = 0, T2 weighted images with affine transformation in SPM2. After registration, FA and ADC maps were generated with the DTI Task Card (NMR Center, Massachusetts General Hospital, MA, USA). Mean values of FA and ADC with its standard deviation (SD) were compared in the same region of the PLIC and CSO based on anatomical knowledge and tractography respectively.

Table 1: FA and ADC (mean ± SD) at PLIC

	FA at PLIC	FA at PLIC along CST	ADC at PLIC (10 ⁻³ mm ² /s)	ADC at PLIC along CST (10 ⁻³ mm ² /s)
HC	0.65±0.02	0.54±0.04	0.71±0.01	0.72±0.02
PLS	0.62±0.05	0.53±0.03	0.74±0.04	0.75±0.06
P value	0.074	0.159	0.045	0.101

Table 2: FA and ADC (mean ± SD) at CSO

	FA at CSO along CST	ADC at CSO along CST (10 ⁻³ mm ² /s)
HC	0.42±0.05	0.71±0.03
PLS	0.38±0.04	0.79±0.10
P value	0.087	0.038

Results Using ROI-based analysis (36 voxels were picked), the FA at the level of PLIC was reduced in PLS (p = 0.074), while the ADC was significantly increased (p = 0.045). Using tractography, in the region of PLIC along the CST, the FA and ADC were not different between PLS patients and normal controls (p = 0.159 and p = 0.101). Again, using tractography, in the region of CSO along the CST, the FA was reduced in PLS (p = 0.087), and ADC was significantly increased (p = 0.038). It is difficult to pick up a ROI in CSO from anatomical knowledge since the CST is indistinguishable in that region; accordingly the ROI based analysis wasn't included.

Conclusions From these results, we find ADC is a more sensitive quantity to differentiate PLS patients and healthy controls in this study. Adding tractography to refine the ROI may introduce more numerical error, thus it appears less sensitive than direct ROI-based analysis. However, it is necessary to rely on tractography to select specific white matter tracts for analysis. Finally, these findings in FA and ADC are consistent with reports of neuronal degeneration in PLS patients.

References

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