Changes in Normal-Appearing Cervical Spinal Cord in Multiple Sclerosis Measured by Diffusion Tensor Imaging

S. Hesseltine[1], M. Law[1], M. Rad[1], Y. Ge[1], G. Johnson[1], R. Grossman[1]
[1]Radiology, NYU Medical Center, New York, NY, United States

INTRODUCTION: Primary demyelination continues to pose a diagnostic challenge in clinical practice; findings on conventional MR imaging can sometimes be nonspecific. Diffusion tensor imaging (DTI) and fiber tractography have been shown to provide physiologic information regarding cerebral white matter disorganization, which precedes abnormalities seen on conventional imaging [1]. Changes in DTI metrics have been demonstrated within focal spinal cord multiple sclerosis lesions [2]. The purpose of this study is to compare diffusion tensor metrics spatially within both the grey matter and white matter tracts of the cervical spinal cord in normal volunteers and in patients with multiple sclerosis, in regions of the cord that appear normal on conventional MR.

MATERIALS AND METHODS: DTI of the upper cervical spine was performed in 13 patients with relapsing-remitting multiple sclerosis and 9 healthy volunteers, using a pulsed gradient, double spin echo, echo planar imaging (2000/74; 128x128 matrix; 140x140 mm FOV; 10 contiguous 4 mm slices; b= 1000 s/mm^2) at 1.5T. At the C2-3 level, fractional anisotropy (FA) and mean diffusivity (MD) were calculated within regions of interest at the anterior, lateral, and posterior regions of the spinal cord, with separate bilateral regions of interest at each of these positions.

Fractional Anisotropy

	Anterior		Lateral		Posterior	
	Left	Right	Left	Right	Left	Right
Cases (*n = 13*)	0.52 ± 0.11	0.52 ± 0.13	0.45 ± 0.07	0.45 ± 0.07	0.54 ± 0.09	0.52 ± 0.11
Controls (*n = 9*)	0.49 ± 0.10	0.49 ± 0.10	0.59 ± 0.11	0.62 ± 0.09	0.63 ± 0.05	0.64 ± 0.06
P-values	0.42	0.54	**0.007**	**< 0.001**	**0.01**	**0.004**

Mean Diffusivity (x10^{-3} mm^{-2}s^{-1})

	Anterior		Lateral		Posterior	
	Left	Right	Left	Right	Left	Right
Cases	0.91 ± 0.25	0.99 ± 0.36	0.92 ± 0.24	0.92 ± 0.29	0.90 ± 0.33	0.94 ± 0.33
Controls	0.82 ± 0.15	0.86 ± 0.17	0.89 ± 0.13	0.92 ± 0.18	0.86 ± 0.18	0.84 ± 0.21
P-values	0.27	0.3	0.74	0.99	0.74	0.37

Table 1: DTI metrics at the C2-C3 spinal level in patients with multiple sclerosis and normal volunteers.

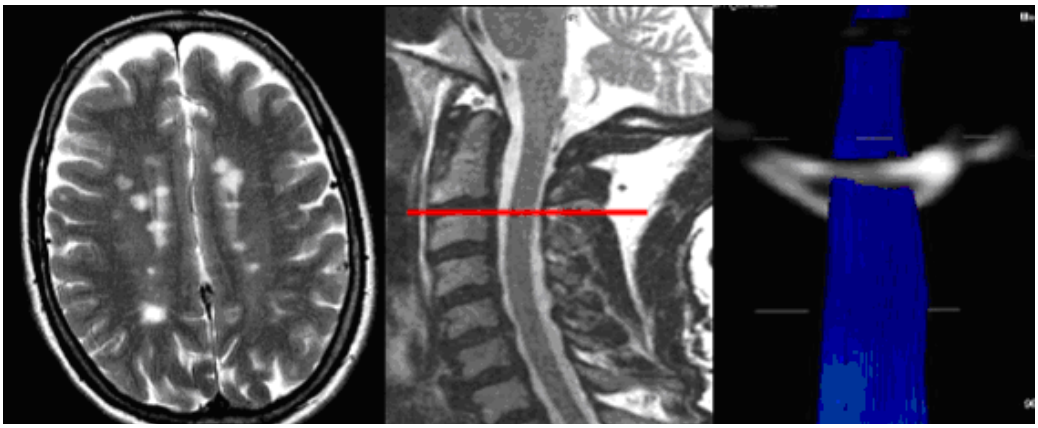

Figure 1 Left—Axial T2-weighted MR image of patient with relapsing-remitting multiple sclerosis. Center—Sagittal image demonstrates absence of cervical spinal cord signal abnormality. Right—Axial b=0 diffusion-weighted image at the C2-C3 level (red line, center image) with superimposed three-dimensional diffusion fiber tractography.

RESULTS: The average age of the multiple sclerosis patients was 43.0 ± 7.0 years (average ± standard deviation) vs. 34.3 ± 14.5 years in the control group (p = 0.13). Significantly decreased fractional anisotropy was present in the multiple sclerosis patients at the lateral and posterior regions of the spinal cord (see Table 1), with no significant difference detected at the anterior regions of interest. Although there was no significant difference in mean diffusivity between multiple sclerosis patients and controls, there was a trend towards slightly increased mean diffusivity in the diseased patients.

CONCLUSION: The study demonstrates a significantly decreased fractional anisotropy in the lateral and posterior tracts in the cervical spinal cord of multiple sclerosis patients, in the absence of spinal cord signal abnormality at conventional MR examination. These findings may be clinically more sensitive than conventional MR in differentiating primary from secondary causes of demyelination.

REFERENCES:

1. Sundgren PC et al. Neuroradiology 2004; 46:339-350.
2. Clark CT et al. Magn Reson Med 2000; 43:133-138.