Diffusion Tensor Imaging Metrics Correlate with Quantitative Tests of Physical Function in Cervical Spondylotic Myelopathy

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Introduction

- Diffusion tensor imaging is a MRI technique that shows promise as a biomarker for disease severity and progression among patients with cervical spondylotic myelopathy (CSM).
- Prior work has shown correlations between DTI metrics and the modified Japanese Orthopaedic Association score (mJOA).
- However, the relationship between DTI and quantitative tests of physical function in CSM has yet to be studied.
- We hypothesized that DTI metrics would correlate with the 10-meter walk test, grip strength, and the 9 -hole peg test.

Methods

We prospectively enrolled patients with CSM who were scheduled for elective surgery. We excluded patients who could not tolerate a MRI scan and patients with prior cervical spine surgery, a non-degenerative diagnosis or neuromuscular condition such as multiple sclerosis or rheumatoid arthritis. We obtained pre-surgical DTI images, the mJOA score, and the 10-meter walk test (average time of 3 trials); grip strength (average strength of 3 trials); and the 9-hole peg test (average time of 2 trials per dominant/nondominant hand).

Methods (continued)

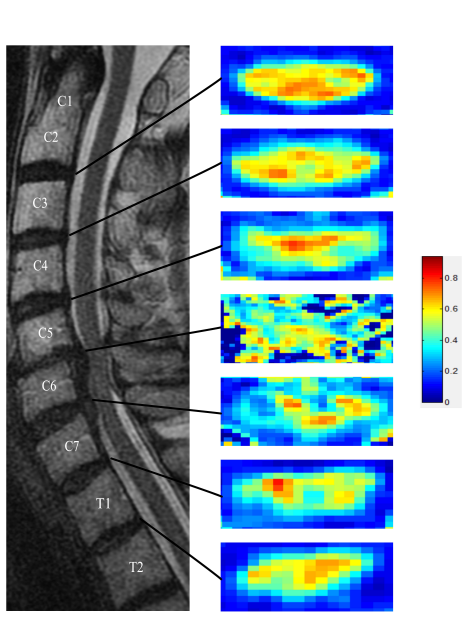
Subjects were imaged using a CTL spine coil in a 1.5T MR scanner. Diffusion-weighted images were obtained with a TR/TE= 5000/98.2, FOV= 19 cm2, number of excitations= 2 and matrix size of 128 x 128. Image acquisition was acquired in 15 diffusion encoding directions, using axial image slices 3 mm x 3 mm with 3 mm gap between slices, and collected with a b = 600 s/mm2 and a single T2-weighted (b=0 s/mm2) image. Fourier transform-based affine registration of the diffusion-weighted images to the T2-weighted images was used to correct for geometric distortions. Images and the eigenvalues of the tensor for each voxel identified were processed using the Analysis of Functional NeuroImages processing suite. Regions of interest: axial FA maps at the level of maximum compression were selected for analysis. Regions of interest were drawn manually to include the whole cord, excluding at least 2 voxels at the edge of the cord, thereby minimizing the risk of partial volume effects due to CSF.

A stipend was provided to CSM subjects for completion of the DTI scans, mJOA survey, and tests of physical function. We used Spearman's rho to test the association between DTI metrics and the quantitative tests of physical function. Significance was set at $p<0.05$.

Results

- 18 subjects were enrolled and had DTI imaging, mJOA, the 10-meter walk test, and grip strength test. Of these, 7 also had the 9-hole peg test.
- The mean mJOA score was 13.1 (SD 1.8). The mJOA was not significantly correlated with our quantitative motor tests.

Figure 1: DTI Cervical Spine in CSM Subject



Axial DTI map of CSM subject

Results (continued)

- DTI fractional anisotropy showed a trend towards correlating with mJOA (0.46, p=0.06); 10m-walk test (-0.42, p=0.09); and grip strength (0.47, p=0.05).
- DTI mean diffusivity significantly correlated with grip strength (-0.59, p=0.01); 9-hole peg test dominant and nondominant hand (0.96, p<0.01 and 0.93, p<0.01, respectively).

Conclusions

- In this pilot study, we found significant correlations between DTI mean diffusivity and upper extremity motor function, and a trend towards significant correlations between DTI fractional anisotropy and 10-meter walk test and grip strength.
- DTI metrics may be a biomarker for motor impairment in CSM and should be further studied in a larger number of subjects.

Learning Objectives

1. DTI is a promising biomarker for disease severity and physical function in CSM.
2. DTI may provide a noninvasive method to quantitatively measure dysfunction in CSM over time.

References: available from first author