Do Patients with Cervical Spondylotic Myelopathy Have Neural Degeneration Rostral to the Level of Compression? A Diffusion Tensor Imaging Study

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Introduction

- Conventional MRI rarely shows intramedullary changes rostral to the worst level of cord deformity.
- However, prior post mortem studies have shown neural degeneration rostral to the level of spinal cord deformity in cervical spondylotic myelopathy (CSM).(1)
- Diffusion tensor imaging (DTI), which measures water molecule diffusion in tissues, is sensitive to microstructural tissue architecture, and has the potential to better elucidate structural changes in the spinal cord.
- **Purpose**: to use diffusion tensor imaging to determine if patients with CSM had abnormalities in the spinal cord at and rostral to the worst level of cord deformity compared to normal controls.

Methods

- Prospective cohort study: 18 CSM patients (11 women, 7 men) and 13 neurologically intact controls were prospectively enrolled and underwent DTI of the cervical spinal cord.
- 1.5 T MR scanner: single-shot, echo planar pulse sequence with a twice-refocused spin-echo diffusion preparation. Axial diffusion-weighted images (3mm thick with 0.5 mm gap between slices) were acquired along 15 distinct directions at a b-value of 600 s/mm2 using a TR/TE of 5000/98.2 ms, matrix size of 128 x 128, and FOV of 19 cm2.
- Regions of interest were drawn on axial sections of the cervical cord. We measured DTI indices at the level of maximum cord deformity and at C2-3 in CSM patients and compared these to controls using the Mann Whitney U test.
- IRB approved; informed consent obtained.

Abbreviations

FA- fractional anisotropy, MD- mean diffusivity, lADC- longitudinal apparent diffusion co-efficient, tADC- transverse apparent diffusion co-efficient.

Results

- The majority of CSM patients had cord deformity at C5-6 (50%) or C4-5 (28%). At C2-3, no cord deformity or T2 abnormalities were noted.
- C2-3: CSM patients had significantly lower FA compared to controls. lADC was significantly lower in CSM patients compared to controls.
- Level of maximum deformity: CSM patients had significantly lower FA compared to controls. However, the lADC, while lower among CSM patients compared to controls, did not reach statistical significance.

DTI metrics: CSM patients vs normal controls

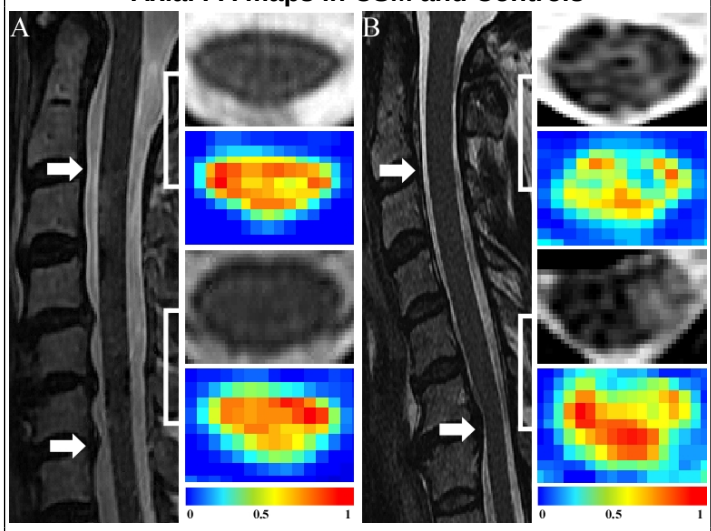
	Patients (n=18)	Controls (n=13)	P value
C2-3 level			
FA	0.57 (0.08)	0.64 (0.08)	0.04
MD*	0.85 (0.1)	0.90 (0.1)	NS
lADC*	1.47 (0.2)	1.71 (0.1)	0.004
tADC*	0.55 (0.1)	0.50 (0.1)	NS
*Level of maximum compression^*			
FA	0.53 (0.06)	0.56 (0.07)	0.02
MD*	0.95 (0.2)	0.97 (0.1)	NS
lADC*	1.47 (0.5)	1.73 (0.1)	0.13
tADC*	0.65 (0.2)	0.65 (0.1)	NS

Median (IQR); DTI metrics, C4-C7 in controls vs CSM at the level of maximum cord deformity (compression);*(x10-3 mm2 s-1)

Discussion

- DTI shows changes in the spinal cord among CSM patients, both at the level of maximum cord deformity and rostral to this level, unlike conventional MRI imaging.
- These DTI changes suggest ascending neural degeneration in CSM that corroborates both post-mortem studies (1) and recent studies using anisotropy contrast images.(2)
- Future work will evaluate the association between these DTI metrics and clinical outcome.

Axial FA maps in CSM and Controls



A. T2W MR image (left) of the cervical spine in a 62-year old control. Axial T2W images and FA maps (right) at C2-3 and C6-7 show intact cord structure. B. T2W sagittal MR (left) in a 59-year old with CSM and cord deformity at C6-7. Axial T2W images and FA maps (right) at the C2-3 level and C6-7 level show altered cord structure and areas of low anisotropy within the cord.

Conclusions

- In CSM, DTI shows abnormal findings ***at C2-3 and the level of maximum cord deformity*** compared to normals.
- These rostral DTI changes may reflect *ascending neural degeneration* from the level of compression, not detected using conventional MRI.

References

(1) Ono K et al. Spine. 1977;2(2):109; (2) Urakawa T et al. JNS Spine 2011;15(6):648-653.

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