

Diffusion tensor imaging of human cervical spinal cords in cervical myelopathy

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INTRODUCTION Magnetic Resonance Diffusion Tensor Imaging (DTI) is a promising technique to detect early changes of structures within the highly oriented tissues, such as brain, cervical spinal cord, and optic nerves using the anisotropicity of the microscopic water diffusion [1, 2]. Feasibility of DTI for clinical applications such as cervical spinal injury is ongoing studies. In our study, we quantified DTI parameters of in-vivo human cervical spinal cord of 14 healthy normal controls and 8 patients with spinal cord myelopathy (SCM) using 2D single-shot diffusion weighted EPI (2D ss-DWEPI) with the Interleaved Multiple Inner Volume (IMIV) imaging technique [1].

METHODS The MRI experiments were performed using a 3T whole-body MRI system (Trio, Siemens Medical Solutions, Erlangen, Germany) with Avanto gradients (45 mT/m strength and 150 T/m/s slew rate). To demonstrate in vivo DTI with the IMIV method, MRI experiments were performed on the midbrain and spinal cord of volunteers with 12 diffusion directions, using an twelve-channel receive-only head coil and spine coil with anterior neck coil assembly (USA Instruments, Aurora, OH) and a special purpose-built 8 channel spinal cord coil. The procedure was approved by the Institutional Review Board, and the volunteer gave informed consent. The imaging parameters of a 2D ss-DWEPI with the IMIV method were: TR 4000 ms, TE 65 ms, imaging matrix 160x40, in-plane resolution 1.5x1.5 mm² with 1.5 mm thickness, b of 500 s/mm², echo-train length (ETL) 41, 10 interleaved slices and receive bandwidth 1078 Hz/pixel. Imaging time for 2D ss-DWEPI was 7 minutes. T2 weighted images using 2D Turbo Spin Echo (TSE) were obtained to verify the location of the cervical spinal cord.

RESULTS AND DISCUSSIONS High resolution DTI data of cervical spinal cord (CSC) for control and myelopathy volunteers were obtained. The data were processed to extract the DTI parametric maps, i.e., the Fractional anisotropy (FA) and the RGB color fiber maps, as shown in Fig. 1. The color “blue” in the RGB map indicates the direction of principal water diffusion in the head-foot direction. Color degradation for the myelopathy patient indicates a degeneration of spinal cord corresponding to T2 weighted images. Average DTI parameters (FA and directional diffusivities) were calculated at the regions of interests (ROIs). The directional diffusivities of normals and 4 patients are presented in Fig. 2. Significant deviation of diffusivities was observed in myelopathy patients in comparison to normal volunteers, which correlates to clinical symptoms (Patient 1,2,: severe walking difficulty and numbness / Patient 3: severe walking difficulty, numbness and a central spinal cord injury / Patient 4: occasional walking problems and numbness in hands)

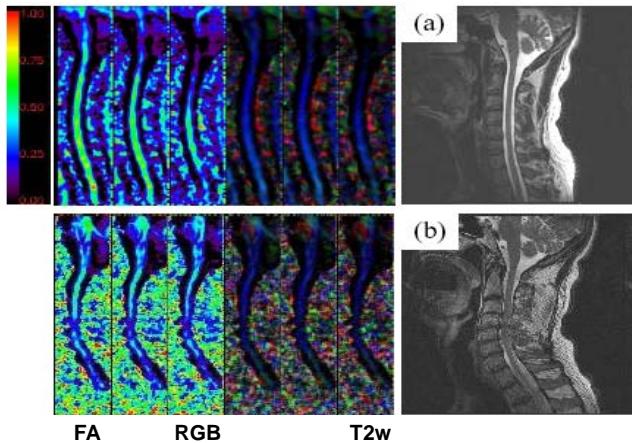


Fig. 1. FA, RGB color maps and T2w of (a) normal controls (age: 34 (std: 7), 8 males and 6 females vs. (b) 4 cervical myelopathy patients (age: 59.5 (42-73))

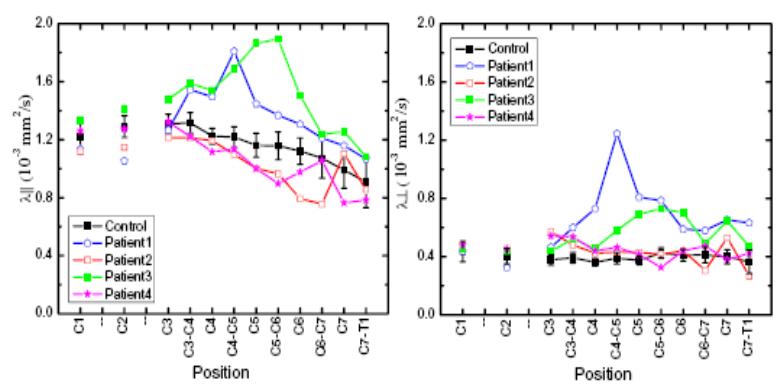


Fig. 2. DTI parameters: (left) longitudinal and (right) transversal diffusivities of CSC of normal and cervical myelopathy volunteers.

CONCLUSIONS In this report, we present the DTI results for in vivo cervical spinal cord using 2D ss-DWEPI with the IMIV method. Our study provides quantitative information on the diffusivities of CSC for normal volunteers and shows a deviation of diffusivities for cervical myelopathy patients from controlled values due to damages of cervical spinal cord. Therefore, DTI is a potentially useful modality for identifying cervical spinal cord injury.

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