Diffusion Tensor Imaging of the Human Cervical Spinal Cord at 1.5 and 3.0T

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Introduction: Despite the promising results in the cerebral white matter[1], the application of the diffusion tensor imaging (DTI) technique to the spinal cord is still hampered by a limited signal-to-noise ratio and spatial resolution, as well as by the pulsating motion of the spinal cord[2-3]. Moreover, high field MRI poses additional challenges due to increased magnetic field inhomogeneities and image blurring[4].

Purpose: The aim of the study was to test the feasibility of highly resolved DTI of the human cervical spinal cord at 3.0T. DTI parametrical maps and signal-to-noise ratios (SNR) were compared to results recorded at 1.5T.

Material and Methods: Eight healthy volunteers and one patient participated in the study. A transverse oriented single-shot cardiac triggered echo planar imaging sequence with double spin-echo diffusion preparation was applied for highly resolved (0.9 mm^2 in-plane resolution) DTI of the spinal cord. Signal yield, fractional anisotropy (FA), and mean diffusivity (MD) were compared for 1.5T and 3.0T. Clinical applicability of the protocol was tested in one patient with diagnosed amyotrophic lateral sclerosis (ALS) at 3.0T.

Results and Discussions: A mean increase of the SNR of 95.7±4.9% was found at 3.0 Tesla compared to 1.5 Tesla. Improved quality of the DTI parametrical maps was observed at higher field strength (Fig. 1). Comparable FA and MD (in units of 10^{-3} mm^2/s) values were computed in the dorsal white matter at both field strengths (1.5T: FA=0.748±0.082, MD=0.84±0.12, 3.0T: FA=0.740±0.043, MD=0.93±0.14). At the site of the diseased corticospinal tract, decreased FA (0.399±0.028) and increased MD (1.398±0.052) were found in the ALS patient (Fig. 1). The applied protocol avoided image artifacts due to the shortening of the T_2^* and the increase of the field inhomogeneities even at higher field strength. Three Tesla provided increased image quality in DTI of the spinal cord compared to 1.5 T. The proposed DTI protocol seems adequate for the assessment of spinal cord diseases.

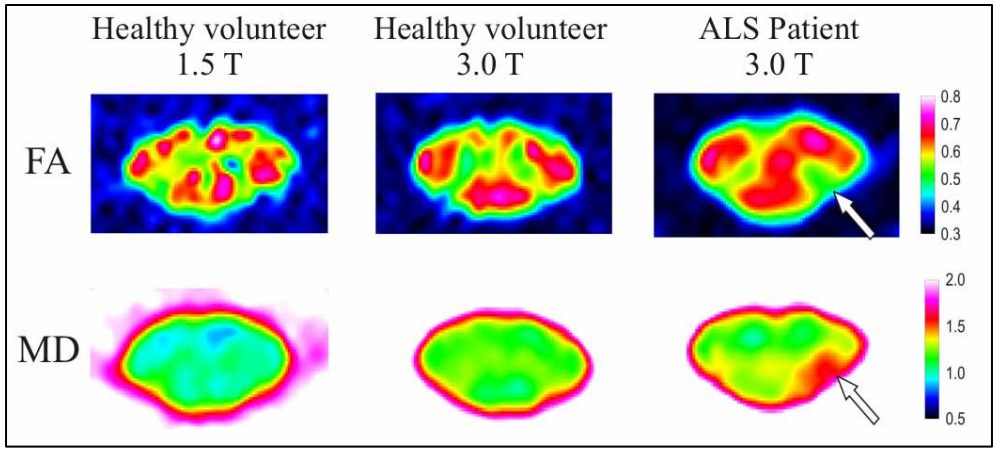

Fig. 1 The magnified fractional anisotropy and mean diffusivity maps computed for one representative healthy volunteer at 1.5T and 3.0T, and for the ALS patient at 3.0T are displayed. Improved quality can be observed in the parametrical maps reconstructed for the healthy volunteer at higher field strength. A decrease of the FA of 46.0±3.8% and an increase of the MD of 50.3±5.6% were found in the area of the diseased cortical-spinal tract in the patient (white arrows).

Reference: [1]Le Bihan D. et al., JMRI 2001; 13: 534-546. [2]Bammer R. et al., Top Magn Reson Imaging 2003; 14: 461-476. [3]Clark C. et al., NMR Biomed 2002; 15:578-586. [4]Schick F., Eur Radiol 2005; 15:946-959.