Diffusion tensor imaging of subjects with Cervical Spondlytic Myelopathy: use of the eigenvalues as indicators of spinal stenosis

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Introduction

Diffusion tensor imaging (DTI) is an attractive technique in the investigation of white matter (WM) diseases and disorders because of its ability to depict fiber tracts. Recent progress has been made towards detection of WM damage due to spinal cord stenosis in patients diagnosed with Cervical Spondylotic Myelopathy (CSM) using the apparent diffusion coefficient (ADC) and fractional anisotropy (FA)[1,2], however, DTI also offers information about the individual tensor components that may be more sensitive to WM damage. In this work the results of a study investigating CSM subjects using DTI are presented. We analyzed the FA as well as the parallel (LP) and radial (LR) eigenvalues of the diffusion tensor in stenotic and normal appearing regions of the cord.

Methods

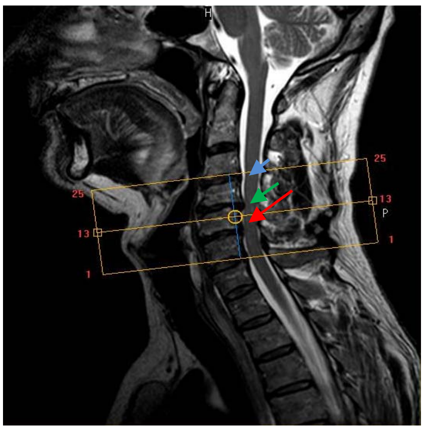
Subject information: 12 subjects diagnosed clinically with CSM (mean age 59, range (51-75)) were scanned.

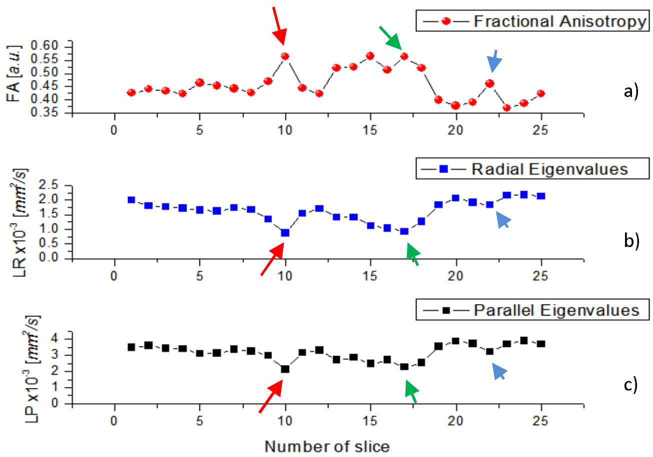
MR Experiments: Diffusion-weighted images volumes were acquired using spin-echo echo-planar imaging (TE/TR = 66/5455, BW = 1871.2 Hz/vx) with 6 isotropically distributed orientations for the diffusion-sensitizing gradients at a b-value of 600s.mm^2 and one b=0 image, the DTI sequence was gated to the peripheral pulse, with a delay time of 400ms to acquire data during the quiescent phase of cord motion.

Data Analysis: FSL and home-made Matlab software were used for DTI analysis and region of interest (ROI) selection, around the spine. All diffusion metrics were computed pixel by pixel in the ROI, from which the mean values for FA, LP and LR were determined for each slice. Segmentation of the spine was carried out by thresholding in the non diffusion weighted (b=0) signal. FA, LP and LR were plotted as a function of slice number for each subject.

Results

Figure 1 shows an example of the volume for which the diffusion data was collected and Figure 2 shows the corresponding plots of FA, LP and LR along the spinal cord, with arrows highlighting regions of stenosis. Overall, graphs demonstrated that the diffusion tensor eigenvalues were approximately constant along the spine, but with variations in regions with stenosis. Surprisingly, the FA was generally higher in the stenotic regions; however, LP and LR were generally reduced in regions of stenosis.





[Figure 1: Sagittal image from CSM subject showing the location of the DTI volume. Figure 2: a) Example of stenotic regions as indicated by arrows, b), c), and d) Plots of FA, LR and LP, respectively, along the spinal cord for subject shown in Figure 1.

Discussion

Recent studies have shown that different analysis software for fiber reconstruction can lead to different results depending on the reconstruction algorithm used and the threshold value chosen for the FA[3]. This phenomenon occurs mainly in the region of crossing fibers or in areas of high disturbance of the linearity of the fibers, while in the healthy spinal cord, the vast majority of fibers are collinear with the direction of the cord itself. The reduction of the radial eignevalues in regions of stenosis is surprising; since tissue damage in other nervous system tissue usually results in increased LP[4]. Presumably this reduction observed in CSM is a consequence of lateral pressure on the cord. This study shows how a known structural change alters the FA and individual eigenvalues in spinal cord; it should provide new insight into cord damage in cervical spondlytic myelopathy.

References

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