DTI Study of Patients with Cervical Spondylotic Myelopathy

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Introduction

Diffusion weighted imaging (DWI) and diffusion tensor imaging (DTI) is used routinely to evaluate neurological disorders. However, it has a limited role in the spinal cord due to technical difficulties. Cervical spondylosis is a common degenerative condition of the spine, found frequently in patients after the age of 65. The most serious complication is myelopathy due to cord compression by bulging or herniated disks and osseous spurs, leading to degeneration in the spinal cord tissues [1]. MRI with T_2 weighting has low sensitivity in detecting cervical spondylosis. Recently, interleaved diffusion weighted EPI sequence and DTI in sagittal plane was used successfully to detect this pathology [2]. In this study we applied single-shot EPI – DTI sequence in axial plane [3] to determine apparent diffusion tensor (ADT) to investigate patients with spondylotic myelopathy.

Materials and Methods

The study was conducted on a group of 15 patients (age 40 to 74, average 63) with cervical spondylosis on different severity levels. Imaging was performed on a GE SIGNA LX Echo-Plus at Helimed in Katowice, using a single shot EPI-DTI sequence [3]. All patients gave their informed consent and the investigation was performed within the guidance of our institutional Human Investigations Committee. All patients underwent full routine MRI scan of the CSC before DTI scans. DTI was performed by applying the diffusion gradients in 6 standard directions. A finger pulse trigger with minimal delay gated all DTI scans. Saturation bands were put in three directions to reduce aliasing artifacts. Diffusion weighted images were acquired with a 64x64 matrix, FOV = 9 cm, slice thickness = 7 mm, slice separation = 2 mm, number of slices 8, TR = 2 RR, NEX = 8, gradient factor b of 300, 450, 600 s/mm^2. Full DTI scan for 3 b-values took around 8 min. Data were analyzed off-line using an IDL based software developed in-house. Values of main diffusivities as well as anisotropy indices: Fractional Anisotropy FA and Relative Anisotropy RA, were calculated for different ROI's in the white matter (WM) and gray matter (GM). Reference values of FA and RA, used for comparison, were determined for a group of 20 healthy volunteers [3].

Results

DW images were recorded in axial plane for diffusion gradient in all directions making possible determination of ADT maps. On most T_2 weighted FSE images regions of higher intensity are not present. However, axial DW images show changes in diffusion values in slices corresponding to narrowing of the spinal canal. Fig. 1 presents sagittal T_2 weighted FSE image of a 41 years old patient with symptoms of cervical spondylotic myelopathy. There are no sign of increased signal intensity on T_2 weighted image. However, maps of Fractional Anisotropy FA for slices at C4/C5, C5 and C5/C6 levels, shown in Fig. 1 right, indicate changes in diffusion in the Ventral Funiculus in the WM. Fig. 2 shows Relative Anisotropy RA averaged over group of healthy volunteers (RA-V) and for a patient (FV-P) for the cervical spinal cord from C2/C3 to C6 levels. Note the increase in RA values at C4/C5 and C5/C6 levels corresponding to locations where spinal cord is compressed by bulging disks, as seen in Fig.1. For all patients ADT values in the region of spinal canal narrowing are higher than in the reference group of healthy volunteers. FA and RA values determined for selected ROI's in the WM and GM are also different, when compared to reference values.

Conclusion

We have demonstrated the feasibility of EPI-DTI in the axial plane in detection of cervical spinal cord myelopathy.

Acknowledgments.

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References

1/. Larocca H. Cervical spondylotic myelopathy: natural history. Spine 1988; 13:854–855. 2/. Demir A, et al., Diffusion-weighted MR Imaging with Apparent Diffusion Coefficient and Apparent Diffusion Tensor Maps in Cervical Spondylotic Myelopathy. Radiology 2003**;** 229: 37–43. 3/. Jasinski A., et al., Echo-Planar Diffusion Tensor Imaging of the Normal and Pathological Human Cervical Spinal Cord. Proc. 11 ISMRM 2003; 2462.

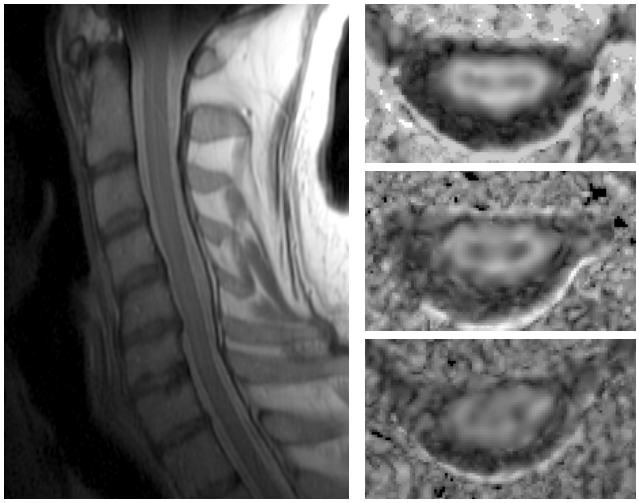

Fig1. FSE T_2 weighted image (left) of a patient with cervical spondylosis at levels C4/C5 and C5/C6. Set of axial FA (right) images at locations C4/C5, C5 and C5/C6

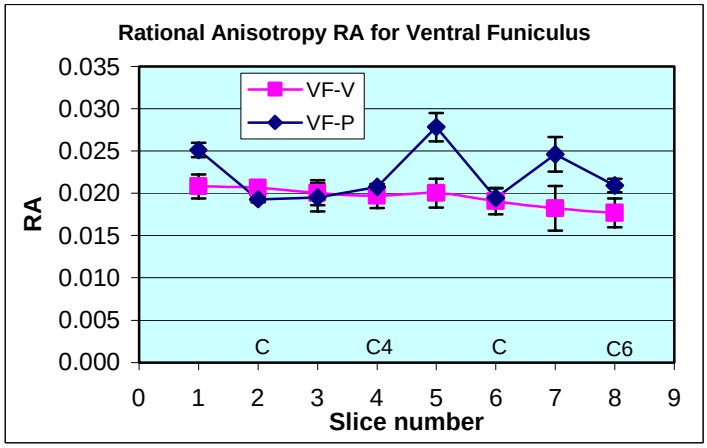

Fig. 2. Relative Anisotropy levels for Ventral Funiculus for a patient shown in Fig1 (VF-P blue) and reference values (VF-V red) Note the increase of anisotropy at the bulging disks sites.