Tractography of the Human Cervical Spine Nerve Roots

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Introduction

High field MR imaging of the human spine has recently resulted in the ability to perform complex structural imaging of neural tissues. As for the cerebral white matter, diffusion MRI and tractography algorithms enable the visualization of axonal pathways in the spinal cord. This follows, in part, from improvements in imaging sequences and post-processing techniques. We present one of the first depictions of clear fiber tractography of the human cervical spine nerve roots.

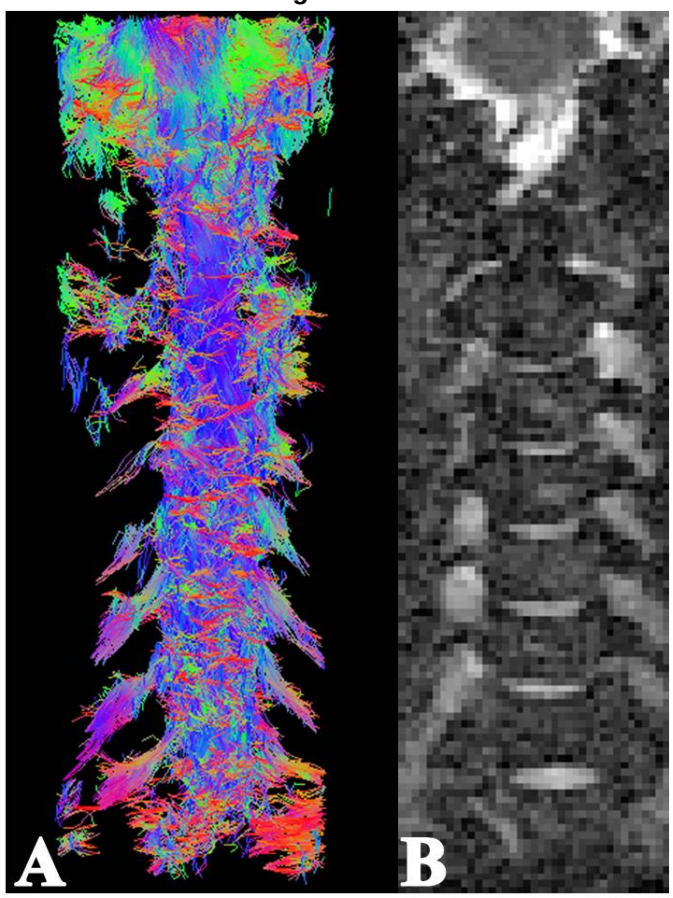
Methods

A healthy subject, without any clinical evidence of cervical spondylosis, negative history for neck disease, and without history of neck surgery/radiation/trauma of any kind, was scanned at 3T. We used an inner volume imaging (IVI) diffusion sequence with 64 diffusion gradient directions, 5 b0 images and a b-value of 1000 s/mm2. Diffusion tensors, fractional anisotropy (FA) and apparent diffusion coefficient (ADC) maps were calculated and deterministic tractography was performed using TrackVis.

Results

At the C2-C7 levels, we were able to visualize fiber tracts with tractography. In Fig. 1 (left), spinal nerve roots are clearly visible at multiple levels. The color code represents the direction of the tracts: red for left-right, green for anterior-posterior, and blue for inferior -superior. The corresponding ADC map is presented in Fig. 1.

Figure 1



Diffusion Tensor tractography (left) and ADC map (right) of the spinal cord and nerve roots.

Conclusions

To our knowledge, this is the first clear MRI depiction, using diffusion MRI tractography, at the nerve root level in the human cervical spine. This preliminary work will lead to quantitative analysis of nerve root function. In multi-level cervical radiculopathy, such objective data will greatly aid in determining the most symptomatic nerve roots.

Learning Objectives

1. High field MRI provides superior signal-to-noise ratio, which is key in performing diffusion imaging of the human spinal cord and its nerve roots.
2. Tractography is possible in the human cervical spine at the nerve root level.
3. Further work is being conducted to improved data quality to provide more clinically relevant diffusion values.

References

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