Investigation of the Internal Structures of the Brainstem and Cerebellum in Post-Mortem Brains with Surgical Fiber Dissection and Diffusion Tensor MRI

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Introduction

The poor understanding of the complex structures of the brainstem is a contributing factor in the high levels of morbidity in neurosurgical procedures. These structures have not yet been visualized with high resolution MRI and microsurgical dissection (1,2). This ongoing study is a comprehensive microsurgical anatomic dissection combined with high resolution MRI that together can reveal the complex intrinsic architecture of the brain stem.

Experimental

High magnetic field MR microscopy was performed using a 17.6 T (750 MHz) wide bore MRI scanner (Bruker Bio-spin) in the AMRIS facility at UF. We attempted to correlate the micro-anatomic dissection with the high resolution MR images to demonstrate the complex structures of the brainstem in more detail than found in the literature. The MR sequences used included conventional T1, T2, and diffusion weighted imaging to delineate the brainstem structures with endogenous tissue contrast. In addition, we performed fiber tractography using 21 directional diffusion tensor imaging (DTI) scans with 100 μm isotropic resolution for correlative analysis with the fiber dissection technique. The 3D DTI using 21 directions was reconstructed using the High Angular Resolution Diffusion Imaging (HARDI) tractography technique (3). Total scan time was ~72 hours per sample.

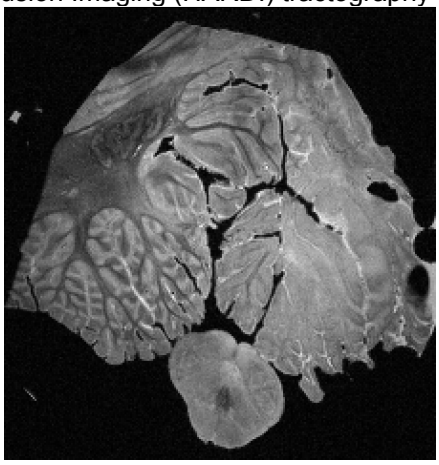

Figure 1. High resolution image of the cerebellum at 11 Tesla

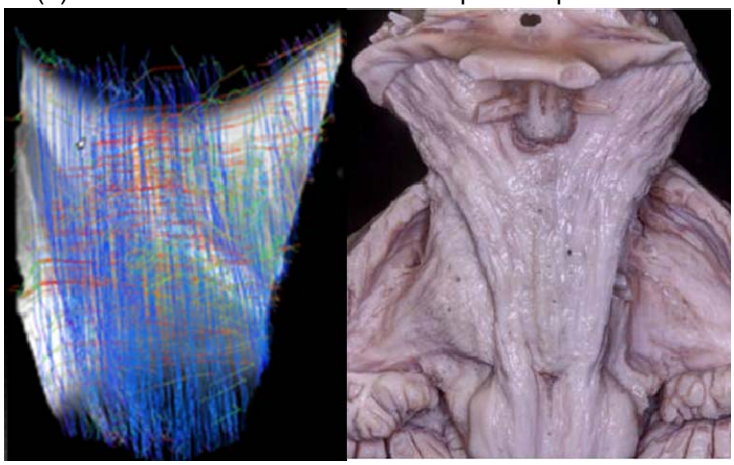

Figure 2. Left: Diffusion tractography imaging with 17.6 Tesla MRI of the pons. Right: Microanatomical fiber pathways of the pons obtained by the fiber dissection technique.

Figure 1 shows an example MRI of the cerebellum showing the exquisite detail that can be obtained at high field strength. Figure 2 shows an example surgical dissection of the pons of the brain stem along with a fiber tract map. The single slice of the MRI shows fibers running primarily along the tissue (top to bottom, represented by the blue tracts) as expected. We are now working to correlate the fiber tract maps directly with the microanatomical dissection.

Conclusions

These data demonstrate the feasibility of obtaining high resolution HARDI maps of the brain stem. Studies are continuing to provide direct correlation with anatomy, and to examine several normal samples. These data will then be used to generate an atlas that can be used as a reference for data sets obtained on abnormal tissue samples. We anticipate that the anatomical descriptions of these structures will be useful in decreasing the rates of surgical morbidity in clinic applications.

Acknowledgements:

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[2] Warwick R, Williams PL: Gray's Anatomy. Philadelphia, W.B. Saunders Co., ed 36, 1973.
[3] Ozarslan E,et al. Med Image Comput Comput Assist Interv. 2005;8(Pt 1):156-63.