MR MICROSCOPY OF BRAIN TISSUE USING A 200 MICRON DIAMETER SURFACE COIL

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Introduction

MRI has seen tremendous growth in its ability to resolve microstructural details of tissue. While single-cell imaging research has been conducted on excised cells from marine organisms as a means of overcoming resolution limitations, such studies are unable to accurately replicate in vivo tissue architecture. Likewise, all studies examining in vivo preparations of mammalian cells require the addition of exogenous agents such as supraparamagnetic iron oxide as a means of overcoming contrast and resolution limitations, and detect the presence of single cells rather than provide information on cell shape and internal composition. In this study, we demonstrate the ability to routinely resolve discreet microstructures in excised slices of the rat striatum using new surface microcoils developed by Bruker Instruments.

Experimental

Rat striatum was excised in 500μm thick slices and immersion fixed in a 4% formaldehyde solution made in phosphate-buffered saline (PBS) for no less than 24h. Following fixation, samples were washed in PBS overnight as a means of removing formaldehyde prior to our imaging experiments. Washed tissue was placed inside the sample well of a 200μm diameter micro surface coil (Bruker, Z76412) and MR data were acquired using a 600 MHz, 51mm vertical-bore spectrometer (Oxford Instruments) interfaced to a Bruker console. Three dimensional gradient-echo images were acquired at 4.7μm isotropic resolution [TE=10ms, TR=150ms, matrix=1283, 0.6mm FOV, acquisition time=22h]. Following imaging, samples (n=6) were snap-frozen in cryosectioning medium (Richard-Allan, 6502), sliced in 25μm increments, and affixed to poly-L-coated microscope slides. After allowing tissue slices to adhere overnight, slides were Nissl stained (0.5% cresyl violet, 0.3% acetic acid) in order to visualize the location of cell bodies contained within each slice.

Results and Discussion

Figure 1 shows a representative image taken by the 200 μm microcoil in the striatum. The non-contiguous nature of these structures allowed us to rule out vasculature as a potential histological correlate to the microstructures. Figure 2A is a representative image (4.7 μm isotropic, TE=10ms, TR=150ms) exhibiting a large volume of the microstructures. Accompanying is a Nissl-stained cryosection (25μm) which allows for visualization of both descending white-matter tracts and cell soma in rat striatal tissue.

Conclusions

The data demonstrate our ability to produce, to our knowledge, the highest resolution MR images of neural tissue known to date. When comparing the histology and MR images, it is tempting to conclude that the dark spots on the MRI are cell bodies; however, this has yet to be confirmed. The studies demonstrate the utility of these new microcoils for MR studies and are being presented at the ISMRM (1).

References.


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