Structural Contrast in *Ex Vivo* Mouse Neuroanatomy as a Function of Magnetic Field

J.A. Muniz (FSU, Chemical & Biomedical Engineering/NHMFL); I.S. Masad (FSU, Chemical & Biomedical Engineering/NHMFL); P.K. Thanos (Brookhaven National Laboratory, Department of Medicine); S.C. Grant (FSU, Chemical & Biomedical Engineering/NHMFL)

Introduction

Magnetic Resonance Microscopy (MRM) is used to define parameters that optimize regional contrast of neuroanatomical structures as a function of magnetic field strength. These optimizations are performed to delineate and measure structures that maybe be altered in genetic models of Attention Deficit Hyperactivity Disorder (ADHD). Characterized by inattention, hyperactivity and impulsivity, ADHD often continues into adulthood and affects 3-5% of all children [1].

Experimental

Ex vivo mouse heads were analyzed at 11.75-T (20-mm birdcage coil) and 21.1-T (18-mm birdcage coil) using a three-dimensional gradient-recalled echo (GRE) sequence with an isotropic resolution of 50 µm. The 11.75-T system is located at the FAMU-FSU College of Engineering and the 21.1-T ultra-widebore system is located at the National High Magnetic Field Laboratory. The mouse models used are genetic models that evaluate specific neurotransmitter receptors (AKO models) and are compared to wild-type (WT) controls. To evaluate contrast mechanisms in these fixed samples, images were acquired using multiple *T1* weightings, over a range of *TRs* (40-500 ms), and *T2**weightings, over a range of *TEs* (4.5-16.5 ms). Contrast-to noise ratios (*CNR*s) and signal-to-noise ratios (*SNR*s) were calculated for various segmented regions. Also, apparent *T1* and *T2** values were calculated to distinguish between tissue types.

Results and Discussion

Analysis indicates an increase in *SNR* in AKO models compared to WT and is more apparent at 11.75 T, which is possibly indicative of increased free water in the AKO brain. Looking at differences in relative contrast at 21.1 T, *T2**-weighted data shows an increase in relative contrast with increasing *TE*. *T1*-weighted data shows the relative contrast to be more consistent across the range of repetition times. This trend is also evident at 11.75 T, but to a lesser extent. Relaxation parameter quantification indicates that at 11.75 T, there is increased *T1* in the AKO models compared to WT controls. At 21.1 T, relaxation differences apparently remain unaffected. This reduction of relative *T1* differences between structures with increasing field strength has been suggested by *in vivo* studies of humans and rodents at much lower fields [2].

Conclusions

Differences in *T2**- and *T1*- weighted data indicate that contrast mechanisms are highly dependent on *T2**, especially at the higher field strength. Coronal images (Fig. 1) show enhanced contrast at 21.1 T, particularly in the hippocampus (see arrows). These coronal images of the hippocampus underscore some of the difficulty (but also the benefit) associated with comparing segmentation results between field strengths. *T1* differences may be attributed to morphological changes in the neuroanatomy of the ADHD brain that permit increased free water in structures. Furthermore, morphometric analysis is being carried out via manual segmentation (Amira, TGS, Inc) of the aforementioned ROIs in order to identify changes due to ADHD and correlate the changes with measured relaxation data. Preliminary results are shown in Fig. 2.

Acknowledgements and References

Funding provided by FSU Bess Ward Honors Thesis Award, FSU COE, NHMFL, NIAAA & U.S. Dept. of Energy. [1] Strock, M. NIMH, www.nimh.nih.gov/publicat/adhd.cfm (2007). [2] Rooney, W. D., *et al*. *Magn. Reson. Med.*, *57*(2), 308-318 (2007).

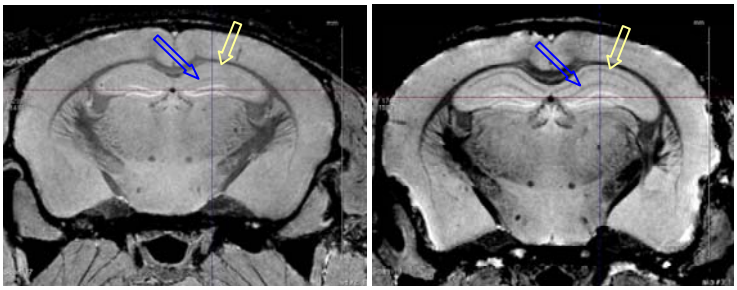

***Figure 1*:** Coronal 3D GREs of WT at 11.75 T (left) and AKO at 21.1 T (right).

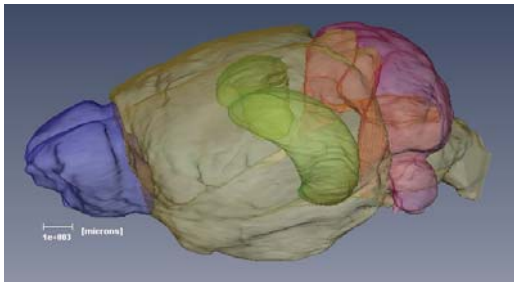

Figure 2: 3D rendering of neuro-anatomical segmentation.