Multiexponential T2 Analysis of Rat Brain and Spinal Cord

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INTRODUCTION: The focus of many multiexponential T2 studies of nerve tissue has been the use of the short T2 component as a surrogate marker of myelin content. It has been suggested that the fractional contribution from the long T2 component may provide useful information in pathologies like multiple sclerosis and phenylketonuria [1]. It is therefore important to understand regional variation in these components and to establish the characteristics of the T2 distribution of normal CNS tissue. We analyzed *in vivo* multiecho spin echo data from the 4 regions in the CNS: corpus callosum, cerebral cortex, cervical dorsal funiculus, and spinal cord grey matter in 5 healthy rats.

METHODS: Single slice multiecho spin echo (SE) images (TR/TE=1500/3 ms, inter-echo spacing = 3ms, 128 echoes, NA=4, FOV = 3x3 cm, matrix=128x128, slice=1 mm) were acquired on a 9.4T Bruker Avance system. Axial slices were positioned separately in the brain and in the lower cervical region of the spinal cord. Regions of interest (ROI) were drawn in the corpus callosum, cortical grey matter, dorsal funiculus, and spinal cord grey matter to select signals for T2 analysis Signal intensity decay curves were fit with a regularized NNLS algorithm [2]. The T2 distributions were separated into 3 regions: myelin water fraction (MWF) 5-25ms, intra/extracellular water fraction (IEWF) 25-100ms, and long T2 fraction 100-768ms. Geometric mean T2 (gmT2) and the peak areas were determined for each region. Two-factor analysis of variance with SNK post-hoc tests was used to compare brain and spinal cord grey and white matter results, with $p<0.05$ considered significant. Additionally, voxel-based maps were calculated for the fractional area and geometric mean T2 of each component [2].

RESULTS: Figure 1 summarizes the results for the myelin water and the intra/extracellular water fractions. The long T2 water component was detected in the corpus callosum of 3 rats and in the spinal cord grey matter and dorsal funiculus in 2 rats. The long T2 water component was absent in all cortical grey matter regions. No significant differences in either the long component fraction or gmT2 were detected, which may be due to the limited sample size. Figure 2 shows examples of the IEW gmT2 maps and demonstrates regional differences in these maps. A significant interaction between brain vs spinal cord and white vs grey matter was found ($p<0.001$). The IEW T2 of brain white matter is shorter than brain grey matter, while in the IEW T2 of spinal cord white matter is longer than in grey matter.

DISCUSSION: In addition to differences in myelin water fraction between grey matter and white matter, we found significant differences in MW fraction and gmT2 between brain and spinal cord areas. The *in vivo* values reported herein for spinal cord grey and white matter are similar to those reported by [3]. Regional variations in myelin water within the human brain have been reported previously [4, 5], however, we also found variations in the IE water component, particularly in the spinal cord. These results suggest that careful selection of regions is needed for making comparisons between healthy and disease conditions.

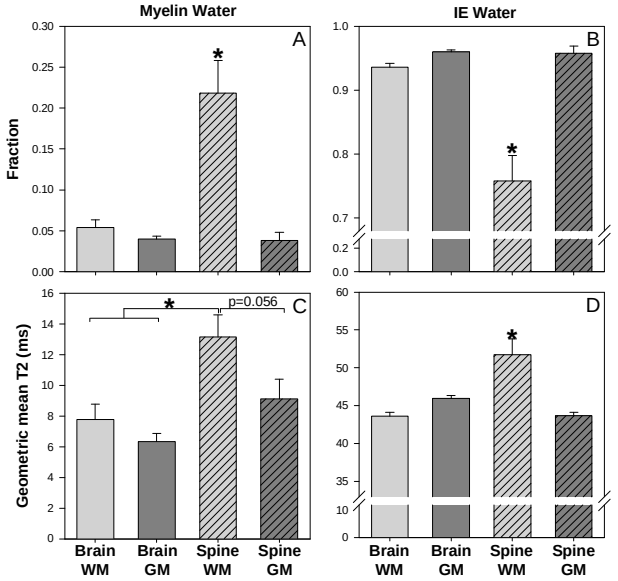

Figure 1. Geometric mean T2 and fractional area of each the myelin water (5-25ms) and intra/extracellular water (25-100ms) components. Significant differences ($p<0.05$) are indicated with asterisks. Spinal cord dorsal white matter is significantly different from corpus callosum white matter for MWF and IEW gmT2 and fraction. Grey matter in the brain and spinal cord were similar.

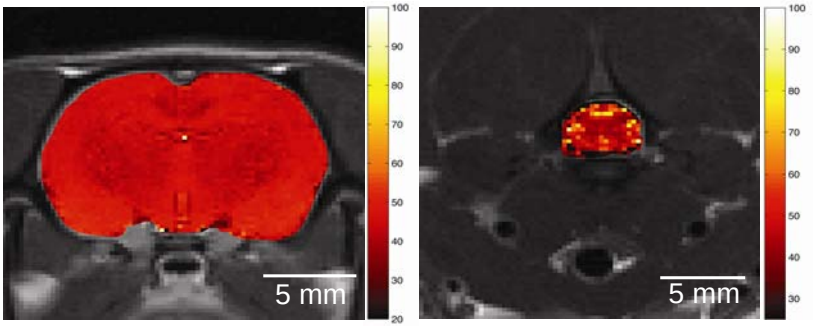

Figure 2. Spin echo images of the rat brain and cervical spinal cord with intra/extracellular geometric mean T2 maps overlays. In the corpus callosum, the IE T2 is lower than in cortex grey matter. However, in the spinal cord, white matter IE T2 is longer than in grey matter.

REFERENCES:

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