Changes of MRSI and DTI Findings Following Traumatic Brain Injury

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INTRODUCTION:

Our previous studies have demonstrated that whole-brain proton MRSI provides a sensitive method for detection of metabolic alterations following even mild closed head injury, and that these changes correlate with cognitive impact as measured by neuropsychological testing [1]. These studies, as well as measurements of axonal integrity using diffusion tensor imaging (DTI) support the hypothesis that diffuse tissue injury occurs that is not manifested in structural alterations visible by structural neuroimaging methods. While our previous study demonstrated that widespread and diffuse metabolic dysfunction occurs in the period of a few weeks following a mild closed head injury, little is known of the temporal evolution of these imaging measures.

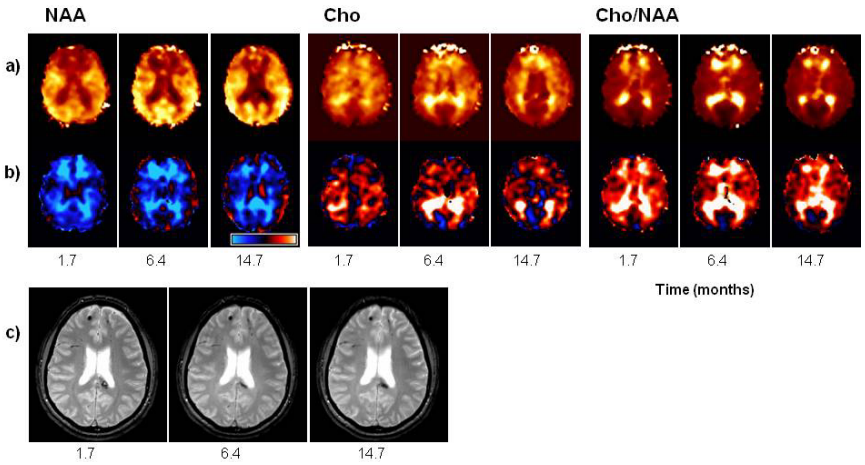
METHODS:

MRI and MRSI data was obtained from 4 subjects admitted to the trauma center with mild TBI, GCS score between 13 and 15, within a few weeks after injury and then again at approximately 6 months after injury. One subject participated in an additional study at 14 months after injury. Comparative data from control subjects was obtained from an existing database [2]. Structural MRI, DTI, and 1H MRSI data was obtained at 3 T. The MRSI data was obtained using a volumetric EPSI with TE=70 ms, data collection from the whole cerebrum, and reconstruction of images for N-Acetylaspartate (NAA), Creatine, and Choline (Cho) using the MIDAS package [3]. Processing included calculation of voxel tissue content, signal intensity normalization, and spatial registration and normalization.

Changes of tissue metabolites were evaluated by visual observation of metabolite images and by generating z-score maps that highlight significant alterations relative to control values. To evaluate the changes of diffuse metabolic alterations the average values of each metabolite, and metabolite ratios, was obtained for grey- and white-matter regions within each atlas-defined brain lobe, and results compared for the repeated measurements. Additional measurements obtained FA and ADC values from the DTI, and metabolite values from selected brain regions.

RESULTS AND CONCLUSIONS:

The Figure shows metabolite images (top row) at three time points for a 22 year old subject admitted with GCS 13 (classified as mild injury) following a motor vehicle accident. The z-score maps (2nd row) show significantly decreased values in light blue and increased values in red-white. This result shows: a) widespread metabolic alterations at all time points; b) continued deviation of metabolite concentrations between the initial and second measurement; and c) different spatial distributions and evolution for NAA and Cho. The structural MRIs (bottom row) indicate small hemorrhagic lesions in frontal lobe and corpus callosum that did not change over all studies. Results for subjects with less-severe injury classification show greater recovery to normal values at the 6-month time point.



The region-localized measurements showed a trend to reduced FA values at 6 months, but increasing at the 14-month study for the subject corresponding to the data shown in the figure.

This study indicates that volumetric MRSI provides an effective method for monitoring changes of brain tissue metabolites during the recovery period following traumatic brain injury. These methods could therefore be of value for monitoring treatment and rehabilitation protocols.

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