3D MRSI of Traumatic Brain Injury Patients at 3T

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Introduction

Traumatic brain injuries are suffered by approximately 1.4 million Americans each year, leading to 50,000 deaths, 235,000 hospitalizations, and over $60 billion dollars of medical costs and lost productivity according to a CDC report [1]. Conventional MR imaging does not accurately predict outcome in TBI, and proton MR spectroscopy has shown promise as a potential biomarker for injury severity and long-term neurocognitive and functional outcome. In this study, we utilized 3D MRSI at 3T with wide anatomic coverage to assess TBI, including serial examinations during the first year after mild TBI.

Methods

Five patients with moderate to severe TBI (Glasgow Coma Scale < 13), 28 patients with mild TBI (GCS 13-15), 6 leg injury control subjects, and 9 healthy volunteers were scanned on a GE 3T EXCITE scanner (Waukesha, WI, USA) equipped with an 8 channel receive coil. Control subjects and volunteers were matched to the TBI patients by age and gender. All TBI patients had witnessed loss of consciousness and post-traumatic amnesia. Moderate-severe TBI patients were scanned more than 1 month after injury (1month to 19 months). 20 Mild TBI patients were scanned serially within 2 weeks of injury, and at 1 month and 1 year after injury; 8 patients had initial scans but did not return for serial studies. The protocol included T2 FLAIR, T2* MPGR, and 3D T1 SPGR. The 3D MRSI was acquired using PRESS with TE/TR 144ms/1.1s, 12x12x8 matrix, 1cc resolution with reduced k-space sampling for a total scanning time of 9.5 minutes. Four slices were acquired with bottom slice at the level of the basal ganglia. Spectra were processed and analyzed using methods previously published [2]. NAA/Cho ratios from the patients groups across all MRSI voxels were statistically analyzed in comparison with control subjects using the t-test. Longitudinal scans of the mild TBI patients were analyzed using linear mixed effects model fit by maximum likelihood for repeated measures.

Results

The leg injury control group and healthy volunteer group showed no statistically significant difference and were combined in comparisons with the TBI patient groups. NAA/Cho ratios were 1.55±0.14, 1.87±0.41, and 1.94±0.51, respectively, for moderate-severe TBI, mild TBI (within 2 weeks of injury), and control subjects. Moderate-severe TBI patients demonstrated significant differences of NAA/Cho versus mild TBI patients and control subjects with $P<<0.01$. Mild TBI patients showed a trend of decreased NAA/Cho versus the control group at all three time points of within 2 weeks, 1 month, and 1 year; however, this did not reach statistical significance ($P=0.17$). For mild TBI serial study, NAA/Cho ratios were 1.90±0.36 (2 weeks), 1.89±0.37 (1 month), 1.86±0.38 (1 year). Examined longitudinally, NAA/Cho ratio did not show any significance when initial scans were compared to 1 month ($P=0.95$) and 1 year ($P=0.48$), and 1 month to 1 year ($P=0.53$). Also, the overall trend over the entire 1-year period did not reach statistical significance ($P=0.14$).

Discussion

To our knowledge, this is the first high-field (>1.5T) MRSI study of TBI, as well as the first longitudinal MRSI study of mild TBI. These results confirm previous reports of decreased NAA/Cho ratio, specifically a decrease in NAA following TBI [3-5]. In the mild TBI group, the decrease of NAA/Cho did not reach statistical significance due to wide variability between subjects. Future work will correlate this variability to neurocognitive and functional outcome measures to validate MRSI as a biomarker for mild TBI.

References

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