

# Decreased Basal Ganglia Neuronal Metabolism and Perfusion of Patients With Chronic Symptoms Following a Mild Traumatic Brain Injury.

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**Introduction:** Approximately 80% of traumatic brain injuries (TBI) are classified as mild, as defined by loss of consciousness less than 30 minutes, post-traumatic amnesia of less than 2 hours, and a Glasgow Coma Scale (GSC) score of 13-15<sup>(1)</sup>. Neurocognitive deficits are estimated to occur in 50-80% of mild TBI (mTBI) patients and may persist for several years<sup>(2)</sup>. Although many patients have normal conventional MR and CT imaging, studies using MR spectroscopy in the mTBI population have reported decreased N-acetylaspartate (NAA) in the acute and sub-acute time periods after injury<sup>(3,4)</sup>. In addition, assessments of cerebral perfusion using nuclear medicine, CT and MRI techniques have shown reduced cerebral perfusion after mild TBI<sup>(5-7)</sup>. To our knowledge, there have been no studies which measured cerebral metabolism and perfusion in the same population. The current study was designed to determine the relation between regional cerebral metabolite and perfusion changes in patients with chronic post-traumatic headache and neurocognitive deficits following mTBI.

**Methods:** Nineteen mTBI subjects (24.4 ± 14.3 yrs) and 21 normal control subjects (28.6 ± 16.1 yrs) were studied after obtaining appropriate consent. mTBI subjects had MRI (T2, T1, FLAIR, SWI, DSC-PWI) and 3D MRSI (PRESS TR/TE = 1700/144 ms) imaging 1 – 24 months post-injury using a Siemens Tim Trio 3T scanner. LCmodel was used to obtain semi-quantitative metabolite ratios for NAA/Cr, NAA/Cho and Cho/Cr. The ratios for each voxel were compared to control values to determine if the ratios were outside 2 standard deviations of normal for age. Voxels were grouped into bilateral frontal gray (FG) and white (FW) matter, parieto-occipital gray (POG) and white (POW) matter, and temporal gray (TG) and white (TW) matter, corpus callosum (CC), basal ganglia (BG) and thalami (TH) regions. Source DSC-PWI data was processed to create relative cerebral blood flow (rCBF), cerebral blood volume (rCBV) and mean transit time (rMTT) maps (Syngo MWWP, Siemens). Regional perfusion values were obtained in similar regions using region of interest analysis. Group differences in perfusion values were measured using the Mann-Whitney test. Correlation coefficients were obtained using Spearman's  $\rho$  analysis. All statistical analyses were performed using SPSS for Windows (Version 19, Chicago, IL) with differences considered significant at  $p = 0.05$ .

**Results:** In all mTBI subjects the structural (T1, T2, FLAIR, SWI) imaging studies were reported as normal. mTBI subjects showed a varying percentage of voxels with ratios that were 2 standard deviations below control values (Figure 1 shows NAA/Cr), however, regional mean ratios were not significantly different from controls. All regions showed a reduction in rCBF, compared to controls, which reached significance only in the right basal ganglia and thalamus ( $p = 0.035$  and  $p = 0.015$ , respectively) and left thalamus ( $p = 0.05$ ) of mTBI subjects (Figure 2). The percentage of voxels in the basal ganglia with reduced NAA/Cr correlated to the decrease in rCBF (right  $r = -.644$ ,  $p = 0.004$ ; left  $r = -.516$ ,  $p = 0.034$ ) and prolonged rMTT (right  $r = .531$ ,  $p = 0.028$ ; left  $r = .499$ ,  $p = 0.041$ ) measured in the basal ganglia. The duration of time between injury and MRI/MRS did not correlate to any perfusion parameter.

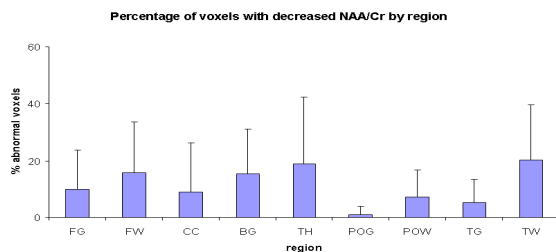


Fig. 1: Percentage of voxels with NAA/Cr that was 2 standard deviations below normal compared to age-matched controls in each region sampled.

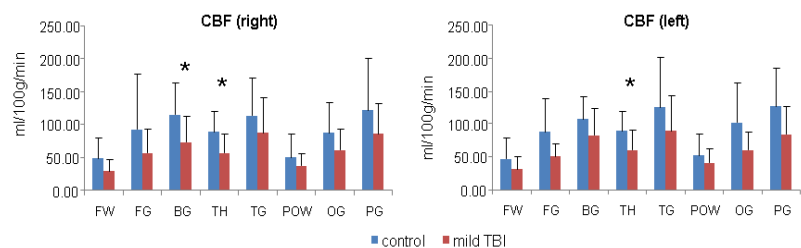


Fig. 2: The mean relative cerebral blood flow (rCBF) of mTBI subjects compared to age-matched controls in each region sampled. In mTBI subjects the rCBF was reduced, compared to controls. \* =  $p < 0.05$  vs. control.

**Discussion:** Our results, in a group of mild TBI patients with persistent symptoms demonstrate that neuronal loss or dysfunction as determined by MRS were present in multiple brain regions long after injury. These individuals also showed reduced rCBF and prolonged rMTT that correlated with the percentage of abnormal voxels in the basal ganglia, suggesting decreased neuronal activity or a reduction in neuronal volume in the basal ganglia. The use of data from different imaging methods may allow better ways to categorize regional injury severity that may more accurately correlate with specific neurological and neuropsychological impairments.

## References:

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