Using 3T Magnetic Resonance Spectroscopy to Assess the Long Term Effects of Mild Traumatic Brain Injury

L. M. Harris[1], P. Dean[1], and A. Sterr[1]
[1]Psychology, University of Surrey, Guildford, Surrey, United Kingdom

INTRODUCTION

Mild traumatic brain injury (mTBI) is defined as acute brain injury resulting from mechanical energy to the head from external forces (Holm, Cassidy et al. 2005). mTBI typically induces symptoms such as headaches, poor concentration and depressed mood; collectively these are referred to as Post Concussion Syndrome (PCS). PCS is generally perceived as a transient syndrome. But in some individuals PCS becomes a permanent condition (Sterr et al 2007). With the present study we aim to investigate the long-term consequence of mTBI in more detail. We hypothesised that chronic symptoms of mTBI may be associated with minute structural brain damage which would be reflected in altered metabolite profiles. Chronic PCS has further been associated with a deficit in working memory. Magnetic Resonance Spectroscopy (MRS) was therefore performed in the dorsolateral prefrontal cortex (DLPFC).

METHOD

Single voxel 1H-MRS was performed on a group of 19 participants, of these 13 had suffered an mTBI and 6 were healthy controls. Within the mTBI group, 7 showed symptoms of PCS (mTBI+PCS; diagnosed using DSM-IV criteria) and 6 did not (mTBI-PCS). MRS was performed at 3 Tesla, using a PRESS sequence at short echo time (TE = 30ms; TR = 1500ms). Voxels were all cubic with a 1.5cm side; these were all placed on the right DLPFC. This region of interest was selected due to it's high activation in the n-back task (Owen, McMillan et al. 2005) (figure 1). The MRS raw data was processed using TARQUIN (Reynolds, Wilson et al. 2006), to obtain a fitted spectrum and a list of metabolite concentrations, relative to water.

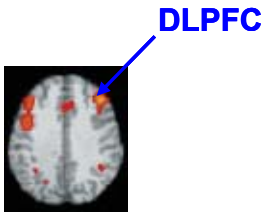

Figure 1: Dorsolateral Pre-frontal Cortex

PCS was assessed through the Rivermead Post-Concussion Symptoms Questionnaire (RPQ). Working memory ability was determined through the n-back task. PCS sum scores and 3-back error-rate were used to assess the association of metabolite profiles with symptom severity (RPQ) and cognitive ability (nback).

Two tailed t-tests were performed for group comparisons; correlations were assessed through spearman coefficients.

RESULTS

Of the 20 MRS investigations, all were of good quality and used in analysis. Average values for metabolite concentrations are plotted in figure 2. Lactate is lowest in the control group (1.05±0.14), higher in the mTBI-PCS group (1.27±0.32) and highest in the mTBI+PCS group (1.49±0.25). Lipids and Macromolecules at 0.9ppm (LMM09) concentrations are elevated in mTBI-PCS (3.65±0.30) and mTBI+PCS (3.66±0.19) groups compared with controls (3.37±0.18). In addition creatine was higher in the control group (6.31±0.20) when compared with mTBI-PCS (5.89±0.32) and mTBI+PCS (5.90±0.18). These changes showed a statistical trend (P<0.10).

RPQ showed a strong negative correlation with 3-back task performance (P=0.02). RPQ further correlated positively with lactate concentration (P=0.03), and showed a positive trend (P=0.08) for high LMM09.

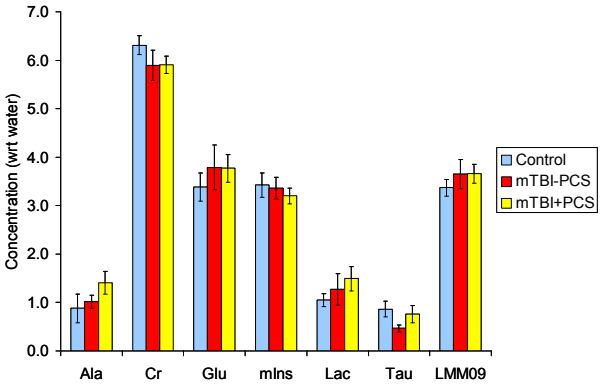

Figure 2: Metabolite concentrations across groups

DISCUSSION

The present study explores the link between brain metabolites, PCS symptoms and cognitive ability in participants who have experienced an mTBI. Lactate has been previously been shown to be elevated in acute mTBI (Son, Park et al. 2000), however, 2 month post-incidence lactate levels had returned to normal. The present study suggests that PCS symptoms as well as metabolite abnormalities may persist. More specifically the data provides initial evidence for a link between the elevation of lactate and with severity of long-term PCS following mTBI.