Using 3T Magnetic Resonance Spectroscopy to Assess The Long Term Effects of Mild Traumatic Brain Injury
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BACKGROUND
Mild traumatic brain injury (mTBI) can result in impairments in cognitive functioning, headaches, fatigue, and mood disorders. These symptoms, amongst others, are collectively referred to as post-concussion syndrome (PCS). The Rivermead Post-concussion symptoms Questionnaire (RPQ) can be used to ascertain the level of symptoms and aid PCS diagnosis. However, both mTBI and PCS are difficult and controversial diagnoses; replicable biological correlates have not been found. Previous studies [1,2,3] have shown the ability of MRS to assess metabolic differences in mTBI indicative of damage. This study focuses on mTBI at least one year post injury, splitting the mTBI group by PCS diagnosis to look at the effect of PCS on metabolite concentrations, in addition to mTBI alone.

METHODS
Participants
• 9 mTBI with PCS (mTBI+PCS; Age: 27.9±3.6, RPQ: 24.9±2.0)
• 10 mTBI without PCS (mTBI-PCS; Age: 28.9±2.6, RPQ: 9.6±2.3)
• 10 Control without PCS (Control; Age: 21.8±1.3, RPQ: 4.3±0.9)

Cognitive Tasks
Working Memory (n-Back: 0, 1, 2, 3-Back) and information processing speed (PVSAT [paced visual serial attention task]: 1, 1.5, 2, 2.5 second) tasks were performed in the same session as MRS to assess cognitive ability.

MRS protocol and analysis
Short-echo-time, single voxel MRS was performed at 3T (PRESS; TE=30ms; TR=1500ms). The voxel was placed over the dorsolateral prefrontal cortex (DLPFC), an area highly active during working memory tasks. Raw data was processed by TARQUIN (http://tarquin.sourceforge.net) and metabolite concentrations generated. All spectra were assessed visually to ensure good quality and lack of artefacts. Metabolite concentrations for the three groups were compared using two-tailed t-tests and an ANOVA and correlations were assessed.

RESULTS
Group Differences
• Creatine (Cr) is significantly higher ($P<0.05$) in controls (6.3±0.4) compared with mTBI-PCS (6.0±0.6) and mTBI+PCS (5.8±0.6).
• There is a non-significant elevation in LMM 0.9ppm and lactate (Lac).

Correlations with cognitive performance
• PVSAT: In the most difficult condition (1s), a positive correlation (Pearson) was seen between percentage correct and Cr ($P<0.04$). A positive trend with tNAA and a negative trend with LMM 1.3ppm were also observed.  
• N-Back: In the most difficult condition (3-Back) reaction time was negatively correlated (Pearson) with LMM 1.3ppm ($P<0.05$).  
• Trends were seen between RPQ and increases in both lactate and LMM 0.9ppm.

DISCUSSION
Overall, lower concentration of Cr and higher LMM is associated with a lower cognitive performance. Cr has long been considered a marker of healthy brain and an elevated level of LMM could be linked with necrosis. The only group difference observed was in Cr. Together, these findings are suggestive of small scale neuronal damage in chronic mTBI. In addition to these, variation was seen in both NAA and Lac. NAA is the highest peak in a spectrum of healthy brain, its concentration decreases here with poor cognitive ability. Lac has been shown to be elevated in acute brain injury [4], and shows a positive trend with RPQ. This study has shown long term alterations in metabolite concentrations in mTBI, in addition to alterations with PCS (as indexed by cognitive performance) within this group. We aim to expand the study with more participants and strengthen these findings.

REFERENCES