Preliminary findings: an MRI study tracking post-concussion brain recovery

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Introduction

Routine clinical magnetic resonance imaging (MRI) scans fail to detect concussion related brain injuries and symptom self-reporting remains highly variable and subjective [1,2]. However, advanced MRI analyses (functional MRI (fMRI) and diffusion tensor imaging (DTI)) can detect subtle damage [3]. The objective of this project is to track recovery post-concussion using our personalized MRI methodology in comparison to post-concussion symptoms. We expected that quantitative brain abnormalities would align with symptoms over the course of recovery.

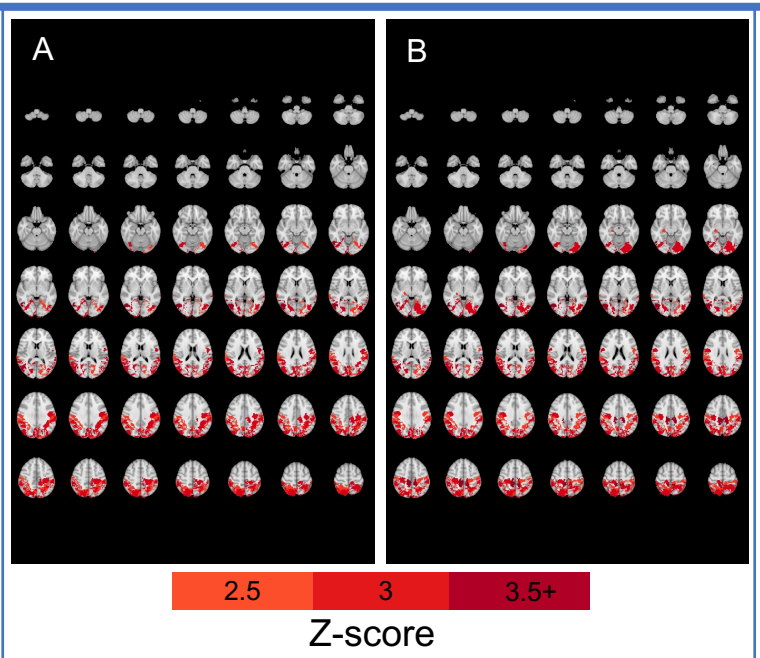

Figure 1. The visualization of the abnormal gray matter brain regions for participant one (A) acutely (9 abnormal ROIs) and (B) after 3-months (10 abnormal ROIs).

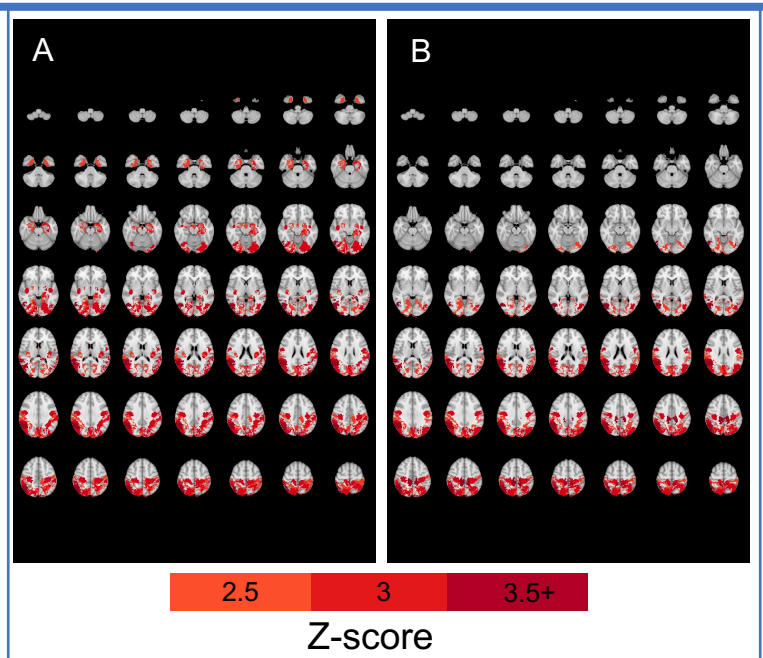

Figure 2. The visualization of the abnormal gray matter brain regions for participant two (A) acutely (20 abnormal ROIs) and (B) after 3-months (9 abnormal ROIs).

Results

One participant had an acute PCSS score of 17 and 9 abnormal GM ROIs, while after 3-months had a PCSS of 6 but still 10 abnormal GM ROIs plus one abnormal WM ROI (**Figure 1**). The other participant had an acute PCSS of 7 with 20 GM abnormalities and two WM abnormalities, and at 3-months had a PCSS of 1 but 9 GM abnormalities (**Figure 2**).

Conclusions

Preliminary results reported that symptoms overestimated brain recovery as brain abnormalities remained present after 3-months. Further investigation is required in more participants to more accurately characterize gray and white matter tissue recovery post-concussion.

Methods

Two acutely concussed (<2 weeks post-injury) adults (male, aged 26.5±0.7) have been recruited (Full study n=50). Participants completed the PCSS and an MRI session (T1, resting state fMRI, and DTI) acutely and 3-months post-concussion. The MRI data was analyzed using TBIFinder Inc software to measure rsfMRI temporal complexity (Hurst exponent=***H***) across 29 gray matter (GM) regions-of-interest (ROIs) and DTI fractional anisotropy (FA) was calculated for 18 white matter (WM) ROIs. These calculations were also made on 162 age/sex-matched healthy controls to establish a healthy baseline. A personalized ROI-based Z-score analysis (i.e., comparing one patient to many healthy controls) was implemented. Participant ROI Z-scores ≤-2.5 were considered abnormal and were compared to the categories of post-concussion symptoms (**Table 1**).

Table 1. A summary of the Post-Concussion Symptom Scale (PCSS) scores and abnormal brain regions-of-interest (ROIs) for the initial two study participants. Abbreviations: FA: fractional anisotropy, ***H***: Hurst exponent, ROI: region-of-interest.

	Participant 1: acute	Participant 1: 3-months	Participant 2: acute	Participant 2: 3-months
PCSS score	Somatic = 1 Cognitive = 12 Emotional = 2 Sleep = 2 Total = 17	Somatic = 2 Cognitive = 2 Emotional = 2 Sleep = 0 Total = 6	Somatic = 0 Cognitive = 2 Emotional = 0 Sleep = 5 Total = 7	Somatic = 0 Cognitive = 0 Emotional = 0 Sleep = 1 Total = 1
MRI abnormalities	FA = 0 of 18 ROIs ***H*** = 9 of 29 ROIs	FA = 1 of 18 ROIs ***H*** = 10 of 29 ROIs	FA = 2 of 18 ROIs ***H*** = 20 of 29 ROIs	FA = 0 of 18 ROIs ***H*** = 9 of 29 ROIs

References

[1] Chamard E, Lichtenstein JD. Brain Injury. 2018; 32(7): 816-831. **[2]** Rose SC, et al. Brain Injury. 2017;31(2):260–6. **[3]** Churchill NW, et al. Front Neurology. 2017;8.

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