Connectivity between specific ICA-derived functional networks is associated with symptom severity in mTBI
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Background: Mild traumatic brain injury (mTBI) is a sub-type of traumatic brain injury when loss of consciousness and disorientation is shorter than 30 minutes. Though brain imaging with MR and CT often appear normal, the patient may sustain long-term cognitive difficulties such as headache, blurry vision, memory problems, attention deficits, mood swings and frustration. In this study, we want to find functional connectivity biomarkers that are associated with mTBI symptoms with the eventual goal of these biomarkers contributing to predicting mTBI patient’s outcome and recovery.

Methods: After obtaining informed consent, rs-fMRI was recorded from 78 patients at four time points (3 days, 7 days, 3 weeks and 3 months) after mTBI and 26 healthy controls (2 sessions, 1 week apart). Using GE MR750 3T MRI scanner, multi-band (acceleration factor 3) 2D-EPI, TR/TE = 900/30 ms was acquired for 6 minutes (395 volumes), with 1.875 mm² in-plane resolution and 3 mm slice thickness to cover the whole brain. T1-weighted scan was acquired at each time point. All participants filled a neuropsychological self-assessment questionnaire that was used to calculate symptom severity scores (SSS). rs-fMRI data were motion corrected, rigid registered to T1-weighted image, non-rigid registered to MNI atlas and spatial smoothed using Gaussian filter (FWHM 4mm) using custom built software. Group Independent component analysis by temporal concatenation was performed to derive 30 components using custom built software. Neuro-physiologically relevant components were manually selected using spatial spread and frequency distribution of the component time courses. Between Network Connectivity (BNC) was computed using Pearson correlation between the network time courses. Association of the strength of BNC between pairs of networks and the SSS was computed and tested for statistical significance. FDR was used to control multiple comparison confounds.

Results: 21 neuro-physiologically relevant components were observed out of the 30 ICA components. The connectivity between each pair of nodes’ association to the SSS was found to be significant for the following pairs of networks.

1. Primary visual network to Supplementary motor area network
2. Higher order visual network to Ventral visual stream
3. Right executive control network to Ventral visual stream

The above associations were all negative, i.e. as the SSS increased, the connectivity between the above pairs decreased. No other associations between scores and BNC were significant.

Conclusions: Among between network connectivities, the visual networks appear to be consistently associated with symptom severity. Decreased connectivity between higher order visual networks and motor planning or executive control in high symptom patients may point to a disruption in the processing of visual input in TBI. These results suggest that connectivity between the visual networks and others are significantly impacted in mTBI and may be biomarker candidates for mTBI.