Negative Shift: A Novel EEG Biomarker for Mild Traumatic Brain Injury (mTBI)

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Introduction: Currently, the tools used to diagnose concussion, prognosticate symptom resolution and determine return to play in athletes who experienced mild traumatic brain injury (mTBI) are subjective, inaccessible, or not validated. Electroencephalography (EEG) has been encouraged as a prognostic tool because of its objectivity, however, no sensitive and specific application of EEG has been determined. Negative shift is a novel EEG characteristic that occurs in the delta wave at ~200-400 milliseconds after frequent stimulus of an auditory oddball task. The current prospective study aimed to investigate changes in negative shift after mTBI exposure in athletes aged 14-22.

Hypothesis: mTBI patients will have a significantly different change in negative shift amplitude from first EEG (pre-mTBI) to second EEG (post-mTBI) compared to change between first and second EEG in healthy controls.

Methods: EEG activity was recorded during the auditory oddball task on 109 healthy controls (ages 14-22) and prospectively on 35 participants who went on to sustain mTBI (ages 14-22). EEG data were processed and negative shift amplitude was determined using an algorithm known as *Spatio-Temporal Parcellation* (STEP), which analyzes EEG and how it changes over space and time after stimulus.

Results: During the first EEG recording of both experimental groups (concussed and healthy controls, ages 14-22), a significant negative deflection in the frontal-central regions was observed at ~200-400 milliseconds following the frequent stimulus. While the average negative amplitude decreased in the healthy control group's second EEG recording, it remained steady in the concussed group's second (post-mTBI) EEG recording, most prominently in the 14-17 age group. Pre- to post-mTBI change in amplitude was correlated with the time interval between recording days.

Conclusion: The results of this current prospective study indicates that negative shift changes are associated with mTBI exposure for adolescent athletes. This association shows that changes in frontal lobe electrophysiology occurs after mTBI exposure and that further exploration of negative shift and frontal lobe delta waves after mTBI may be useful in determining mTBI diagnostic/prognostic tools and post-mTBI pathogenesis.

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