Elevated and Slowed EEG Oscillations in Patients with Post-Concussive Syndrome and Chronic Pain Following a Motor Vehicle Collision

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Abstract

(1) Background: Mild traumatic brain injury produces significant changes in neurotransmission including brain oscillations. We investigated potential quantitative electroencephalography biomarkers in 57 patients with post-concussive syndrome and chronic pain following motor vehicle collision, and 54 healthy nearly age- and sex-matched controls. (2) Methods: Electroencephalography processing was completed in MATLAB, statistical modeling in SPSS, and machine learning modeling in Rapid Miner. Group differences were calculated using current-source density estimation, yielding whole-brain topographical distributions of absolute power, relative power and phase-locking functional connectivity. Groups were compared using independent sample Mann-Whitney U tests. Effect sizes and Pearson correlations were also computed. Machine learning analysis leveraged a post hoc supervised learning support vector non-probabilistic binary linear kernel classification to generate predictive models from the derived EEG signatures. (3) Results: Patients displayed significantly elevated and slowed power compared to controls: delta ($p = 0.000000$, $r = 0.6$) and theta power ($p < 0.0001$, $r = 0.4$), and relative delta power ($p < 0.00001$) and decreased relative alpha power ($p < 0.001$). Absolute delta and theta power together yielded the strongest machine learning classification accuracy (87.6%). Changes in absolute power were moderately correlated with duration and persistence of symptoms in the slow wave frequency spectrum (<15 Hz). (4) Conclusions: Distributed increases in slow wave oscillatory power are concurrent with post-concussive syndrome and chronic pain.