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NEWS

Slowing of Aperiodic Neurophysiological Activity in Concussed Adolescent Football Players

PURPOSE

American tackle football is associated with high concussion rates, leading to neurophysiological disturbances and debilitating symptoms. Previous investigations of concussion using magnetoencephalography (MEG) have largely ignored aperiodic (i.e., arrhythmic) neurophysiological activity. We examined whether concussion during a season of high school football is related to changes in aperiodic activity, as well as whether any such changes are associated with clinical outcomes and co-localize with regions dense in specific neurotransmitter systems.

METHODS AND MATERIALS

Pre- and post-season resting state MEG data were collected from 91 high school football players, of whom 10 were diagnosed with concussion. Data were source-imaged, frequency-transformed, and parameterized using specparam. Linear mixed models were used to examine effects of concussion on pre-to-post-season changes in neurophysiological activity. Co-localization of the resulting beta-weight maps with 19 neuromaps atlases was conducted using autocorrelation-preserving null permutations. Scores on the Post-Concussive Symptom Inventory were correlated with pre-to-post-season physical, cognitive and behavioral symptoms to determine clinical relevance.

RESULTS

Concussion was associated with increased aperiodic exponents in superior-frontal cortices, and this aperiodic slowing mediated concussion effects on delta and gamma power. Aperiodic slowing was also associated with higher post-concussion symptoms across participants. The concussion-aperiodic relationship was strongest in brain regions with high normative densities of cholinergic and noradrenergic neurotransmitter systems.

CONCLUSIONS

We find that concussion is associated with increased aperiodic exponents in superior-frontal cortices, potentially accounting for concussion-related delta increases and gamma decreases in similar regions, and the strength of this slowing effect is associated with higher symptom report. Neurochemical contextualization suggests possible involvement of noradrenergic and cholinergic systems implicated in the neuropathophysiology of concussion, suggesting targets for future pharmacotherapeutic studies.

CLINICAL RELEVANCE/APPLICATIONS

Greater concussion-related aperiodic neurophysiological slowing may be associated with increased symptoms, potentially supporting its use as a clinical marker.