

2023-02-17

Abstract for Student Research Day 2023 and Brain and Behavioral Health Day 2023

Repeated concussions and spreading depolarizations are associated with acute behavioral deficits

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It is estimated that more than 42 million individuals have a concussion or mild traumatic brain injury every year. These injuries are accompanied by acute symptoms including disorientation, impaired motor coordination, and altered mental state. These symptoms are attributed to neurological impairment caused by disruptions in ion gradients and neurotransmitters. Recently, spreading depolarizations (SDs) have been shown to occur in concussion model injuries. SDs are massive waves of chemical and electrical changes that spread slowly in a unique way through grey matter of the brain. Our previous work found that an SD is sufficient to produce the acute symptoms of a concussion in a preclinical model. In those studies, SDs were initiated from a concussion model, and compared to those initiated without mechanical force: chemically with a KCl injection, and optogenetically with light stimulation on a transgenic mouse. The SDs with and without mechanical pressure onto the head resulted in the same acute behavioral symptoms in an open field arena and on a series of neurological severity score tasks (Wald- $\chi^2=11.751$, $p=0.003$). Our current research is investigating repeated concussions, comparing no injury, a single injury, and two injuries at different time intervals. To investigate the neuroimmune response following repeated impacts, we are analyzing astrocyte and microglia activation in the brain, in addition to acute behavioral symptoms in open field and on the neurological severity score tasks. These data show an increase in behavioral deficits and an increase in mitochondria activation after repeated concussive injuries. Future studies will add repeated SDs initiated with optogenetic stimulation to compare to the SDs induced with concussion models.

Non-expert summary:

Concussions are considered mild traumatic brain injuries, but can have severe symptoms, especially if there are multiple injuries. Our work is investigating behavioral symptoms and markers of injury in the brain after no injury, a single injury, and two injuries at different time intervals. This work can help us identify when and how an individual becomes fully recovered from a concussion, so we can prevent repeated injuries.