Impairments in Cerebral Autoregulation is Associated with Postural Control in Sports Related Concussion

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ABSTRACT

Global and regional deficits in cerebral blood flow are reported with concussions, a major public health concern, with approximately 3.8 million incidences occurring annually in the United States alone. Recent studies have identified an increased risk of musculoskeletal injuries in athletes upon return-to-play. Complexity index is a sensitive marker of postural control, with low complexity index indicating a poor physiological adaptation to stress. **PURPOSE**: Twofold; 1. Examine complexity index and dynamic cerebral autoregulation (dCA) at rest and during physical stress (rhythmic squatting) in collegiate athletes following a concussion in comparison to non-injured controls. 2. Examine the association between complexity index and dCA. **METHODS**: Athletes (20±1 years) with sports-related concussions were tested on days 3 (N=33), 21 (N=29), and 90 (N=21) following the injury. Controls (N=27) were assessed at one time-point. Continuous mean arterial pressure (MAP) (finger photoplethysmography) and middle cerebral artery blood flow velocity (MCAV) (2 MHz transcranial Doppler ultrasonography) were obtained at rest for 6 minutes and during physical stress (squatting at 0.1Hz frequency) for 5 minutes. Transfer function analysis of beat-to-beat MAP and MCAV oscillations in the low frequency (LF, 0.07-0.20 Hz) range was utilized to assess dCA. Effective dCA dampens the fluctuations in MCAV in response to MAP oscillations, resulting in a low LF gain. Multiscale entropy analysis was used to determine complexity index from the center of pressure data obtained during quiet standing with eyes closed on a force platform. Two-sample Mann Whitney U test was used to compare data between control and concussed athletes at the three time points. Spearman correlation was used to examine the association between the variables. **RESULTS**: LF gain at rest was higher on day-3 (1.27±0.4U; p=0.007), and day-21 (1.27±0.5U; p=0.03) compared to the controls (1.03±0.2U). Similar findings were observed in LF gain with physical stress (day-3 p= 0.003; day-21 p=0.001). Postural complexity index was lower on day-3 (4.3±1.3U; p=0.004) and day-21 (4.5±1.1U; p=0.02) compared to the controls (5.4±1.4U). Moreover, a negative association was observed between complexity index and LF gain at rest (β= -0.66, p= 0.04) and during squatting (β= -1.53, p= 0.02). **CONCLUSION**: The findings confirm impairments in cerebral autoregulation and postural control during the acute and subacute recovery phases following a concussion despite symptom resolution. In addition, poor functional outcome, such as postural control, may be associated with alterations in cerebral blood flow regulation in this population. Tracking cerebral autoregulation during recovery phase may help in preventing musculoskeletal injuries in athletes after return-to-play following a concussion.