

Cardiac Vagal Tone Impairment is Associated with Reduced Cerebral Blood Flow in Collegiate Athletes Following Concussion

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ABSTRACT

Reduced cerebral blood flow (CBF) is linked to functional disturbances following concussion. Since cardiac vagal tone (an index of cardiac health) is associated with disturbances in the autonomic nervous system, deficits in CBF are likely associated with cardiac vagal tone impairment post-concussion. **PURPOSE:** The current study examined cardiac vagal tone and CBF on days 3, 21 and 90 following concussion in comparison to non-injured control athletes. The association between these two variables was also evaluated. **METHODS:** Concussed male and female collegiate athletes were evaluated day-3 (N=29), day-21 (N=25) and day-90 (N=17) post concussion and matched controls were enrolled (N=29). A 3-lead electrocardiogram was used to assess cardiac vagal tone in the high frequency domain (HF; 0.15-0.4 Hz). Beat-to-beat mean arterial pressure (MAP) was obtained via finger photoplethysmography and transcranial Doppler ultrasonography (TCD) was used to assess middle cerebral blood flow velocity (MCAV). To measure vascular tone, cerebrovascular conductance index (CVCi) was estimated by dividing MCAV with MAP. Symptom severity and cognition were assessed using the Sports Concussion Assessment Tool-3rd Edition (SCAT-3) and executive function was assessed with the Trails test A & B. **RESULTS:** On day-3, concussed athletes had lower cognition (SAC 28±1vs.26±2,P=0.0005; Trails B 48±8vs.58±15sec,P=0.006) and HF power (52±12vs.36±14,P=0.006) compared to controls. On days 21 and 90, values were comparable to the controls. However, concussed participants were also categorized based on day-3 MCAV (divided at the median), into low and high MCAV groups. On day-3, the group with lower MCAV exhibited lower HF power (29±13vs.42±11,P=0.006) and lower CVCi (0.60±0.13vs.0.88±0.13,P<0.0001) compared to the high MCAV group. On day-21, this low MCAV group (based on the day-3 data groupings) continued to display lower HF power (37±18vs.53±18,P<0.04) and lower CVCi (0.71±0.17vs.0.88±0.14,P<0.03) when compared to the high MCAV group. Additionally, the low MCAV group displayed poorer cognition (Trails A 21±5vs.16±3s P=0.03; Trails B 52±9vs.39±7s P=0.002; Adjusted Trails B 31±10vs.23±6s P=0.03; SAC 26±2vs.28±2,P=0.04) on day 21 compared to the high MCAV group. **CONCLUSION:** Cardiac vagal tone was impaired 3 days following concussion compared to controls. Lower CBF was also associated with higher cerebrovascular tone. Additionally, lower CBF was linked to blunted cardiac vagal tone and functional outcome on day-21. On day-90, CBF recovered with normalization of functional outcome. Future studies with large sample are recommended to validate these findings.