Cerebrovascular Alterations in Collegiate Football Athletes Following Repetitive Subconcussive Impacts

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Background

- Subconcussive impacts (SCIs) are direct or indirect hits to the head that do not result in acute neurological symptoms[1]
- The effects of repeated SCIs on cerebrovascular health remain unclear
- Two measures of cerebrovascular health include:
  - **Cerebral blood flow (CBF):** The rate of blood delivery to brain tissue, essential for metabolic support[2]
  - **Cerebrovascular reactivity (CVR):** The ability of cerebral vessels to respond to changes in metabolic demand, reflecting vascular reserve[3]
- Football players are at particular risk, with studies suggesting a single athlete can receive a thousand SCIs in one season
- Therefore, the present study aimed to determine whether exposure to repetitive SCIs across a competitive football season leads to changes in CBF and CVR

Hypothesis

After exposure to repetitive SCIs, football athletes will have decreased CBF and increased CVR compared to both their own baseline time point and to baseball controls.

Methods

- **Participants:** 24 male collegiate football athletes (21 ± 1 years) and 17 male collegiate baseball athletes (20 ± 1 years) as a control cohort
- **Timeline:** Football athletes were scanned at PRE-season, post-training camp (PTC), and POST-season. Baseball athletes were scanned at PRE-season and POST-season
- **MRI Acquisition:** All scans were performed on a 3T Siemens Prisma. The protocol included a T1-weighted MP-RAGE, Arterial Spin Labeling (ASL) for CBF, and a six-minute BOLD sequence with a controlled CO2 challenge using the RespirAct gas control system (Thornhill Medical, Toronto, Canada)
- **CBF:** ASL data was processed following the Human Connectome pipeline[4] to obtain CBF perfusion maps
- **CVR:** BOLD data was preprocessed using FSL,[5] and the seeVR toolbox[6] was used to calculate CVR
- **Standardization & Analysis:** MRI images were standardized to MNI152, with analysis performed in grey matter regions. Paired and unpaired t-tests were performed using FSL's randomise tool with 10,000 permutations and threshold-free cluster enhancement

Results

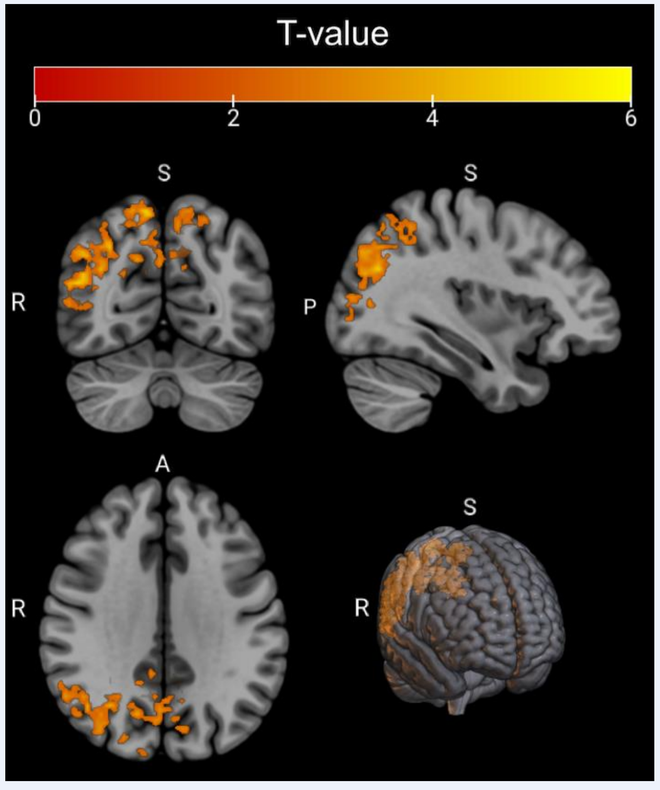

Figure 1. POST-season CBF decreases relative to PTC in 24 football athletes (paired t-test; $p < 0.05$, FWE corrected). Significant decreases in CBF were observed across temporal, parietal, and occipital cortices. Images are in MNI space (2 mm).

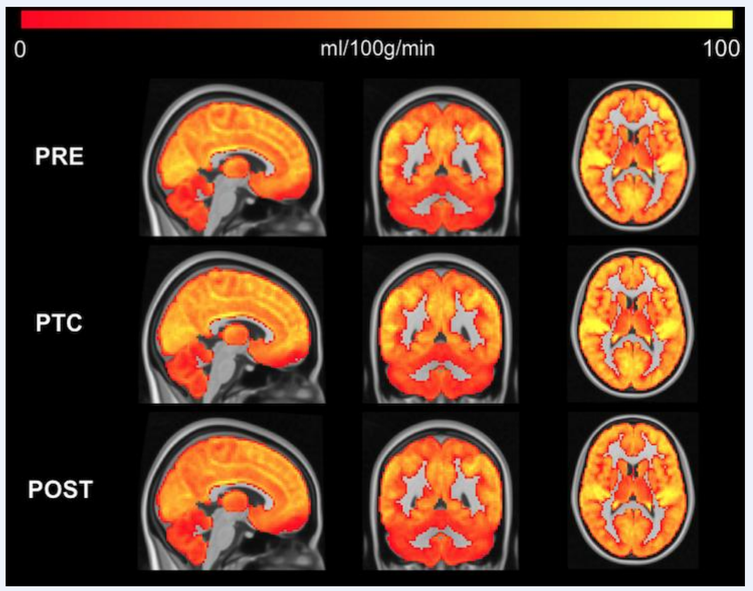

Figure 2. Average PRE, PTC, and POST CBF expressed in ml/100g/min (n = 24). Images are in MNI space (2 mm).

Discussion

- Our findings reveal significant regional CBF decreases between the PTC and POST-season time points
- Our results suggest that subclinical cerebrovascular alterations may occur from repetitive head impacts in the absence of a diagnosed concussion
- Future research may highlight the potential of CBF as an early biomarker of repetitive head impacts
- Alterations in CBF may precede the emergence of neurocognitive symptoms later in life
- Future studies should investigate the long-term consequences of this physiological alteration and implement player safety protocols designed to reduce the prevalence of SCIs

References

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