Introduction

- Every year, ~1,000,000 athletes in the US play American football competition at the high school level. Despite wearing helmets, their heads remain vulnerable to subconcussive impacts, which may lead to concussions.
- Previous concussion(s) may impair athletes’ cognition, but the neurobiological basis remains unclear.
- Magnetic resonance diffusion-weighted imaging (DWI) can quantitatively assess brain water diffusion and white matter (WM) microstructure (e.g., myelination).
- We investigated the WM microstructure and cognitive performances of local adolescent male football athletes (FB) and non-contact sports athletes (CON), with or without history of concussion (HOC+ & HOC-) over one competition season. We hypothesized:

  Compared to HOC- athletes, HOC+ athletes demonstrated greater WM microstructural deficits and cognitive impairments.

Methods

- Participants: Table 1:
  - 23 FB compl. 3 MRI sessions; 1 scan approx. 1 mo. before contact practice, 2 scans in the 1st and 2nd 6-wk periods of the season.
  - 15 CON compl. 2 MRI sessions bwt. ~5-18 wks.
  - Immediate Post-concussion Assessment and Cognitive Test (ImPACT) was assessed in each session.
  - Diffusion-weighted images were acquired by a 3T GE Signa HDx scanner, using a spin-echo echo-planar imaging sequence.
  - Data were processed using FSL:
    - Fractional anisotropy (FA) and mean diffusivity (MD) were estimated for each individual.
    - Mean FA and MD skeletons were created from tract-based spatial statistics.
  - Data analyses:
    - One-way analysis of variance with age as covariate was performed in both FB and CON to study the effects of concussion history on DWI measures.
    - Spearman’s correlation was used to explore associations between ImPACT scores & DWI measures.
    - All statistics were corrected for false discovery rate for multiple comparisons.

Table 1: Demographics and ImPACT scores [mean ± SD]

<table>
<thead>
<tr>
<th># of participants</th>
<th>FB</th>
<th>CON</th>
</tr>
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<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Female</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Age</td>
<td>16.3 ± 0.9</td>
<td>16.9 ± 1.0</td>
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<tr>
<td>Years of high school experience</td>
<td>2.0 ± 0.9</td>
<td>2.2 ± 0.8</td>
</tr>
<tr>
<td>Verbal memory composite</td>
<td>89 ± 10.3</td>
<td>89 ± 8.4</td>
</tr>
<tr>
<td>Visual memory composite</td>
<td>78.2 ± 11.1</td>
<td>82.8 ± 11.8</td>
</tr>
<tr>
<td>Visual motor speed composite</td>
<td>43.2 ± 5.3</td>
<td>45.7 ± 4.8</td>
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<tr>
<td>Reaction time composite</td>
<td>0.5 ± 0.1</td>
<td>0.5 ± 0.1</td>
</tr>
<tr>
<td>Impulse control composite</td>
<td>9.9 ± 6.5</td>
<td>7.1 ± 3.6</td>
</tr>
<tr>
<td>Total symptom score</td>
<td>1.9 ± 3.0</td>
<td>5.3 ± 9.4</td>
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</tbody>
</table>

Results

- HOC+ athletes demonstrated various regional WM microstructural abnormalities vs. HOC- athletes:
  - For FB (Fig. 2A), sig. higher MD in right fornix/stria terminalis (0.98 ± 0.03 × 10⁻³ vs. 0.96 ± 0.03 × 10⁻³, p = 0.004, Fig. 1 top left); sig. lower FA in the right posterior thalamic radiation (0.63 ± 0.03 vs. 0.65 ± 0.03, p = 0.019, Fig. 1 top right).
  - For CON (Fig. 2B), sig. higher MD in the right superior frontal-occipital fasciculus (0.73 ± 0.01 × 10⁻³ vs. 0.71 ± 0.02 × 10⁻³, p = 0.012, Fig. 1 bottom left) and the left anterior limb of internal capsule (0.87 ± 0.02 × 10⁻³ vs. 0.84 ± 0.02 × 10⁻³, p < 0.001, Fig. 1 bottom right).

- In FB, 8 HOC+ exhibited faster visual motor speed ass. with higher FA in the right posterior thalamic radiation (Fig. 3).

Conclusions

- Our study showed an effect of concussion history on regional WM microstructure within thalamocortical tracts in FB and projection fibres in CON.
- The regions found in FB and CON vary, likely due to differences in systematic (FB) and accidental (CON) nature of collision exposure in these sports.
- Altered WM microstructure correlated with several cognitive measures, suggesting HOC+ athletes may experience greater cognitive impairments with repeated collision exposure events.

REFERENCES:

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