Quantifying Head Impact Exposure in Collegiate 15s Rugby and Relationship to Clinical Measures

Lauren A. Duma[1], Dr. Nicole E.-P. Stark[2], Dr. Steve Rowson[3]

[1]School of Neuroscience, Virginia Tech, United States, laurenduma@vt.edu

[2]Department of Biomedical Engineering, Virginia Tech, United States, nestark@vt.edu

[3]Department of Biomedical Engineering, Virginia Tech, United States, srowson@vt.edu

Introduction:

Concussions are a common sports-related injury, and repetitive concussions have been linked to long-term neurodegenerative processes. Previously, studies have observed changes in symptom reporting and the Pupillary Light Reflex (PLR) after concussion. However, less is known about the cumulative effects of subconcussions: head impacts that do not result in a concussion diagnosis but induce mild concussion-like symptoms.

Objective:

The objective of this study was to quantify head impact exposure across a season of collegiate 15s rugby and to relate impact exposure to changes in symptom reporting and PLR metrics.

Methodology:

Twenty-one male collegiate rugby players were observed during seven 15s rugby games across a semester. Players wore instrumented mouthguards (Prevent Biometrics) during each game. Head impacts above 8 g and 400 rad/s^2 were included in the analysis and impacts 20 g or higher were video verified. Before and after each game, players completed a Graded Symptom Checklist (GSC) and PLR measurement. The total number of reported symptoms and the Symptom Severity Score (SSS), the sum of all symptom ratings, were calculated for each GSC. PLR measurements were taken with a PLR-4000 pupillometer (NeurOptics) on both eyes, then averaged. For each player, the change in SSS, number of symptoms, and PLR metrics were calculated by subtracting baseline measurements from post-game measurements.

Results:

A total of 1332 head impacts were recorded over the season. Peak linear acceleration averaged 15.6 g (SD = 9.2, Max = 105), peak rotational acceleration averaged 1138 rad/s^2 (SD = 872, Max = 14921), and peak rotational velocity averaged 10.5 rad/s (SD = 5.6, Max = 40). Across players, there was a wide range in head impact exposure. The average number of head impacts per game per player ranged from 0.1 to 22.4, with a mean of 10.2 (SD = 7.1).

The average change in SSS across the season was 3.7 (SD = 7.9), and 14% of player matches resulted in SSS changes $\geq$ 10. One player was diagnosed with a concussion, and his change in SSS was the highest recorded over the season (change in SSS = 47). There was no correlation between the number of head impacts per game and change in SSS, number of symptoms, or any PLR metric (SSS: $r^2 = 0.05$, $p = 0.02$; Number of symptoms: $r^2 = 0.09$, $p < 0.01$; Average constriction velocity: $r^2 = 0.01$, $p = 0.22$; Average dilation velocity: $r^2 = 0.02$, $p = 0.13$) (Figure 1).

Conclusions:

Head impact exposure varied between rugby players, with many players sustaining several subconcussive head impacts per game. Players often reported concussion-like symptoms in the absence of a diagnosed concussion. However, changes in symptom reporting were not correlated to the number of head impacts per game. In contrast to previous studies of concussed athletes, the head impacts observed in this study were likely not severe enough to result in changes in the PLR.

Figure 1: Correlation between head impacts per game and change in Symptom Severity Score (SSS), number of symptoms, average constriction velocity, and average dilation velocity after each game compared to baseline.