Analysis of Head Acceleration Events in Elite Rugby League Players Using an Instrumented Mouthguard and Video Analysis Approach

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I. INTRODUCTION

Chronic traumatic encephalopathy (CTE) is a form of neurodegeneration that has been diagnosed in former players of numerous contact sports [1-2], including rugby league [3]. Within the neuropathology of CTE, it has been suggested that there may be a greater significance attached to prolonged exposure to repetitive head impacts, rather than the number of concussive events, in developing the condition [4]. There is a growing concern that the incidence of CTE may be greater than current numbers in the literature suggest [1], and this has led to a shift in focus amongst researchers and head injury prevention experts towards the effect of prolonged accumulation of subconcussive impacts on brain injury [5]. There is a growing body of research attempting to quantify head impact exposure across various sports using instrumented mouthguards [6-9]. To date, however, there are no published data for subconcussive loading within elite rugby league players. In this study, we equipped players from a professional rugby league team with instrumented mouthguards to measure head kinematics from in-game impacts and incorporated qualitative video analysis. This study design will quantify the impact kinematics experienced by rugby league players and allow us to identify high-risk impact scenarios.

II. METHODS

A total of nine players were recruited from a Super League team for a combined total of three matches to date. Each player was fitted with a Prevent Biometric mouthguard, which recorded linear and angular time histories from impacts sustained within regular matches. In-house algorithms transformed linear acceleration and velocity time-traces to the head centre of gravity (CG). Any impacts exceeding a peak value of 8 g or 800 rad.s^2 were included within the study so as to include any impacts above those induced by running [10]. Broadcast quality time-stamped video footage was available for each match. False positive analysis was conducted using video-verification as well as infrared proximity and light sensor values, and false positives were removed from the study. Each mouthguard-triggered impact was timestamped and synchronised to video footage with a 40 ms resolution. Qualitative video analysis included labelling impacts as either a Tackle Contact, Post-Tackle Contact, Ground Impact, Wrestle Impact or Other (Table I). For each impact, the player with the mouthguard was labelled as either the ball-carrier (BC) or the tackler. Further analysis was carried out using a framework adapted from the Rugby Union Video Analysis Consensus Group [11], including tackle type, tackle sequence, speed, anticipation, tackle outcome, initial contact.

TABLE I
IMPACT EVENTS AND THEIR DEFINITIONS

Impact Event	Definition
Tackle Impact	Any impact resulting from the initial contact between a BC and tackler whilst the BC has not been grounded.
Post-Tackle Contact	Any contact between the BC and tackler that occurs after the initial impact between the two players has been made whilst the BC has not been grounded.
Ground Impact	Any impact that is transmitted as a result of players hitting the ground.
Wrestle Impact	Any impact that occurs whilst players are on the ground after the BC has been grounded.
Other	Any tackles that do not fit within the aforementioned events, e.g. celebrations, off-the-ball contact.

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III. INITIAL FINDINGS

In total, 358 impacts over the threshold were recorded across three matches. Similar peak angular accelerations can be observed between impact events (Fig. 1). Direct head impacts appear to have a greater peak linear acceleration than inertial head loading cases in both ball-carriers and tacklers during the tackle (Fig. 2).

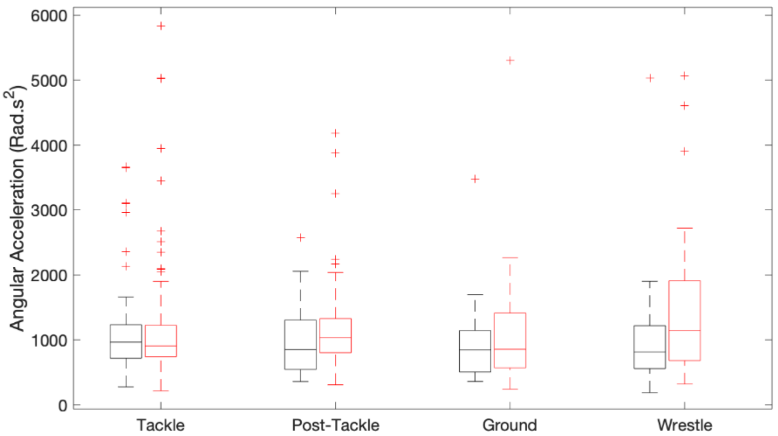

Fig. 1. Median peak angular acceleration values based on impact event type. Black plots show ball-carrier impacts (tackle n=49, post-tackle n=27, ground n=18, wrestle n=23) and red plots show tackler impacts (tackle n=93, post-tackle n=59, ground n=45, wrestle n=24). Red crosses show outliers.

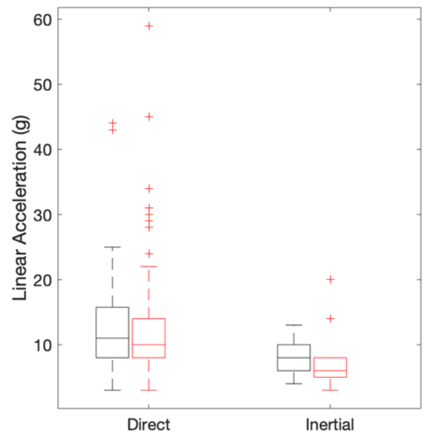

Fig. 2. Median peak linear acceleration values of tackle impacts based on impact type. Black plots show ball-carrier impacts (direct n=35, inertial n=15) and red plots show tackler impacts (direct n=79, inertial n=14). Red crosses show outliers.

IV. DISCUSSION

Early results seem to suggest that inertial loading may result in lower kinematics than direct head impact cases in tackle events. However, given that over a quarter of tackle impacts were inertial, they still represent a substantial portion of subconcussive loading experienced by elite rugby league players. Furthermore, with 60% of impacts being sustained by players outside of the initial tackle contact, this highlights the importance of monitoring head impacts that occur after the initial tackle contact has been made. These findings demonstrate the ability a combined biomechanical and qualitative approach has to guide our understanding of the loading patterns sustained within a sport. A validation study is currently underway and more impact data are being recorded, which will allow for more reliable and in-depth analysis to be carried out in the future.

V. REFERENCES

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