

Reconstruction of Real-life Concussive Head Impacts in Rugby and Australian Rules Football with Madymo

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ABSTRACT

Numerical simulations of previously analysed videos of Australian Rules Football and Rugby concussive head impacts were performed in order to assess the dynamics associated with this specific injury.

A set of a hundred videos of concussive impacts was recorded and analysed previously, including anthropometric data, medical assessment of the injury and estimation of player's kinematics. From this set, 27 videos were selected, according to accuracy of available boundary conditions and feasibility of a reliable simulation. Madymo Human facet models were positioned to reproduce the initial relative position of each player, and scaled to the available anthropometric data. Simulations of the impacts were then performed, where the initial velocities of each body segment and the stiffness of each joint were tuned to obtain a satisfactory match between the simulated kinematic behaviour of the bodies and the real event on video.

Results consist of the dynamics of the head (linear and angular accelerations, impulse, impact energy, as well as the Head Injury Criterion). Mean values for concussion reached 360 for the HIC, 103 g's for the head's CoG linear acceleration, and 8000 rad/s² for its angular acceleration. These values were coherent with similar studies, and also showed significantly higher levels for grade3 compared to grade1 concussions for all parameters, except for angular rotations.

This simulation protocol, being based on the reconstruction of real-life concussive impacts, should allow a better assessment of tolerance levels for Mild Traumatic Brain Injuries and help us in the improvement of protective devices.

Keywords

Head, Injury, Concussion, Rugby, Football, Numerical modeling.