Measuring Head Movements During Free-Living Daily Life

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Background and aim: Head movements are crucial for daily functioning, reflecting various aspects of neurological health including mobility, vestibular function, and oculomotor control. Laboratory-based studies have shown that head movements can be impaired in people with mTBI, with slower and smaller head turns after injury. However, traditional clinic and lab-based assessments may not reflect head-movements in real-world settings, highlighting the need for more ecologically valid measurement approaches. The aim of this study was to explore differences in head turn frequency and kinematics between individuals with persisting symptoms after mTBI and healthy controls (HC) during free-living daily life.

Methods: Ten participants with persisting symptoms after mTBI (6F, mean (SD) = 29 (6.9); symptom score (SD) = 28.5 (17.9)) and 21 HC participants (14F, mean (SD) = 30.1 (7.6) years) provided informed written consent for this IRB-approved study. Participants wore three inertial measurement units (IMUs) on their head, neck, and lumbar regions continuously for seven days. The IMUs (Axivity Ax6) sampled acceleration and angular velocity data at 100 Hz. Head turns were identified as events where the peak yaw angular rate of the head IMU exceeded 15°/s. Kinematic measures included head turn amplitude (integrated angular rate over each turn), speed (maximum angular rate per turn), and frequency (the quantity of head turns performed). Generalized linear models were used to compare groups, accounting for the effects of age, sex, and the age*group interaction.

Results: On average, individuals with mTBI demonstrated similar head turn amplitudes (mTBI mean (SD): 58.5° (1.58°); HC mean (SD): 63.5° (9.63°)) and head turn speeds (mTBI mean (SD): 99.6°/s (10.3°/s); HC mean (SD): 104.8°/s (9.12°/s)) compared to HCs. However, young individuals with mTBI (< 30 years old) exhibited slower median head turn speeds than similarly aged controls, as indicated by an age*group interaction (β=0.969, p = 0.011). No significant differences were observed in median head turn amplitudes between individuals with mTBI and HC (β=0.032, p=0.77), but individuals with mTBI performed fewer head turns, with a significant concussion status by age*group interaction (β=150.78, p=0.007).

Conclusions: Head movements captured during daily living may reveal differences between mTBI and similarly aged controls. While head turn amplitudes and speeds were similar overall, younger individuals with mTBI showed lower head turn speeds, suggesting subtle motor impairments. These findings demonstrate the feasibility of continuously tracking head movement patterns in real-world environments and encourage larger studies to confirm their potential for understanding neurological function and monitoring post-mTBI recovery.