DUAL-TASK GAIT BALANCE CONTROL ASSESSMENT WITH AN INERTIAL MEASUREMENT UNIT FOLLOWING CONCUSSION

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INTRODUCTION
Despite increased awareness about the detrimental effects of concussion, injury management is currently one of the most difficult and controversial issues in clinical sports medicine (1). As balance impairments following concussion have been widely documented (2), balance control testing has been identified as a crucial component to the overall clinical management plan (3). However, many of the most sensitive measurements require expensive laboratory equipment, while many clinical assessments lack necessary objectivity and sensitivity for evaluating effects from a concussion (2).

Previous research has indicated that concussion may induce dual-task gait balance control impairments for up to two months post-injury (4). However, such deficit detection was identified using a motion analysis system. Thus, the purpose of this study was to evaluate gait balance control under dual-task conditions following concussion using a single inertial measurement unit.

METHODS
Subjects who were diagnosed with a concussion were identified and reported to the laboratory within 72 hours of injury and returned one week, two weeks, one month, and two months post-injury. Control subjects were initially assessed and then tested according to the same timeline.

Subjects walked over ground while simultaneously completing a cognitive task. Acceleration data from an IMU (Inertial Measurement Unit; APDM Inc. Opal, Portland, OR) were obtained at a sampling rate of 128 Hz while subjects completed the dual-task protocol. The IMU was placed at L5 with an elastic belt (5) and peak accelerations in frontal (Fig. 1A) and sagittal planes of motion were identified.

Retro-reflective markers were also placed on bony landmarks and whole body movement was recorded using a ten camera motion analysis system (Motion Analysis Corp., Santa Rosa, CA) at a sampling rate of 60 Hz. Peak linear center-of-mass (COM) anterior and medial-lateral (Fig. 1B) velocities were identified during the gait cycle. The mean of 4 walking trials was computed for each dependent variable (frontal plane peak acceleration and velocity, sagittal plane peak acceleration and velocity) at each time point. Two-way mixed effects ANOVAs were used to determine the effects of group and time, and the interactions between independent variables.

RESULTS AND DISCUSSION
Ten subjects with concussion (mean age 19 ± 5 years) and 7 healthy control subjects (mean age 20 ± 5 years) completed the study protocol. Concussion subjects demonstrated significantly less mean frontal plane peak acceleration than the control group across the two months of testing (main effect of group: p = .019; Fig. 2A). Concussion subjects also walked with significantly less mean sagittal plane peak acceleration than the control group at the 72 hour, one week, and one month time points (time*group interaction, p = .026; Fig 2B).

Figure 2: Results (mean ± SE) for concussion and control groups for (A) frontal and (B) sagittal plane peak acceleration.

The results suggest that peak frontal plane acceleration may be reduced following concussion, potentially leading to increased COM medial-lateral velocity, which has been previously documented to affect adolescents with concussion for a time period of up to two months post-injury (4,6). Decreased peak forward acceleration was detected up to one month post-injury and may represent an effort to reduce forward body momentum in order to accommodate divided attention (4).

The study results indicate that a dual-task IMU assessment may be able to detect balance control difficulties following concussion. Further investigations are warranted as this tool may provide an additional way for health care professionals to objectively and sensitively track recovery from concussion.

REFERENCES