INTRODUCTION

Impaired postural control is a cardinal symptom of a concussion. Functional reserves and resource reallocation have been suggested to be compensatory mechanisms utilized by post-concussion individuals to successfully accomplish simple balance and posture tasks.[1] In moderate to severe traumatic brain injury, movement variability has been identified as an effective assessment tool which taxes the available neurological resources.[2] Gait initiation, literally the act of beginning to walk, has successfully identified impairments in postural control in a wide range of patient populations. Therefore, the purpose of this study was to evaluate variability during gait initiation in individuals who have suffered a sports-related concussion.

METHODS

The 17 participants (Female: 10, Age: 18.9 ± 0.9 years old, HT: 1.74 ± 0.10m, WT: 77.1 ± 14.4kg, MTBI history: 0.88 ± 1.17, 52.1%) were all NCAA Division I student-athletes. All participants underwent Gait Initiation (GI) assessment on two separate occasions: 1) during a baseline screening at the individuals’ pre-participation physical examination (PRE), 2) within 24 hours of suffering a concussion (DAY 1). All participants completed 5 trials of self-selected pace cued GI on both testing days. Participants began each trial with one foot each on adjacent forceplates, initiated movement in response to a verbal cue, and proceeded down a 7m walkway with the initial step on a subsequent separate forceplate. (Figure 1)

Figure 1. Lab Set-up. Participants begin the trials standing on forceplate 1 & 2 and walked from left to right with their initial step onto forceplate 3 or 4.

The kinetic data were sampled at 1,000 Hz from the 4 forceplates (AMTI, Watertown, MA, USA). The dependent variables quantified were both the mean and variability of the the center of pressure (COP) displacement during the anticipatory postural adjustment (APA) phases of GI in the posterior and lateral direction as well as the resulting initial step length and velocity which were calculated from kinetic data. Variability was calculated as the Coefficient of Variation (CV=SD/Mean * 100%). The dependent variables were compared between the two testing sessions with a paired samples t-test (alpha = .05) and Cohen’s D effect sizes were calculated.

Figure 2. Exemplar COP excursion during GI.
RESULTS AND DISCUSSION

The participants’ concussions in this study were graded retrospectively based on the Cantu revised evidence based guidelines and the majority (75%) were classified as grade II (symptoms lasting longer than 24 hours but less than 7 days). [3] The post-injury loss of consciousness rate was 11.8% and the post-traumatic amnesia rate was 41.2%.

There were between session differences in the APA COP displacement in both the posterior (t=8.43, P<0.001; \( d=2.14 \)) and lateral (t=3.89, P=0.001; \( d=0.96 \)) directions. There was also a significant difference between test sessions for initial step length (t=2.28, P=0.0411, \( d=0.57 \)), but no differences in step velocity (t=1.96, P=0.067).

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>Day 1</th>
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<tbody>
<tr>
<td>S1 A/P*</td>
<td>6.1 ± 1.6cm</td>
<td>2.6 ± 0.9cm</td>
</tr>
<tr>
<td>S1 M/L*</td>
<td>6.3 ± 2.1cm</td>
<td>4.1 ± 1.6cm</td>
</tr>
<tr>
<td>Step Length*</td>
<td>0.65 ± 0.11m</td>
<td>0.59 ± 0.07m</td>
</tr>
<tr>
<td>Step Velocity</td>
<td>0.64 ± 0.17m/s</td>
<td>0.58 ± 0.11m/s</td>
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Table 1. Means and Standard Deviations. * indicates significant difference between sessions.

There were between session differences in the variability of the APA COP displacement in both the posterior (t=5.133, P<0.001, \( d=1.47 \)) and lateral (t=3.125, P=0.007, \( d=1.05 \)) directions. There were no differences between sessions for initial step length (t=0.077, P=0.94) or step velocity (t=0.89, P=0.38) variability.

Increased gait variability is frequently associated with instability in the postural control systems. [4] These instabilities are frequently associated with impaired central nervous system communication with the peripheral skeletal muscular system. Further, reduced attentional capacities have been associated with increased gait variability. In the post-concussion testing session, the individuals, had significant increases in COP displacement variability, during the APA phase, with large effect sizes evident between testing sessions (Cohen’s D >0.8).

The results of this study suggest that GI performance is impaired following a sports related concussion. Specifically, post-concussion individuals demonstrated reduced APA’s and initial step length as well as increased variability in the COP displacements during the APA phase of GI.

REFERENCES


ACKNOWLEDGEMENTS

Supported by: NINDS 1R15NS070744-01A and Georgia Southern University Faculty Development Committee.