INTRODUCTION

Much of the current concussion literature has focused on neuropsychological testing. While the use of this type of evaluation has recently been advocated as the “cornerstone” of proper concussion management (Guskiewicz et al., 2004) it does not assess all domains that may be impacted by brain injury. One such domain that has not frequently been investigated is post-concussion recovery of dynamic motor function. Parker and colleagues (in press) introduced a method of assessing concussion and recovery that focused on gait as a dynamic functional motor task during conditions of divided and undivided attention. It was found that gait stability, marked by increased sway and sway velocity of the whole body center of mass (COM), decreased when concussed subjects were asked to walk while simultaneously performing a secondary cognitive task compared to walking without mental distraction. A recent study has further suggested that participation in contact sports may produce cognitive impairments without diagnosed concussion (Killiam et al., 2005). Therefore, the purpose of this study was to investigate the extent to which athletes differ from non-athletes in the maintenance of gait stability following concussion.

METHODS

Fifty-six college-aged men and women served as subjects for this study. The subjects were categorized into four groups according to athlete and concussion status. The concussed groups consisted of NCAA Division 1 or University Club Sports athletes (CONC-A; n=14) and non-athletes who engaged in no regular sports activities (CONC-NA; n=14). The uninjured control groups consisted of NCAA Division 1 or University Club Sports athletes (NORM-A; n=14) and non-athletes who engaged in no regular sports activities (NORM-NA; n=14). The control subjects were matched to concussed subjects by gender, age, height, weight, and physical activity. All CONC subjects were tested within 48 hours of injury and again at 5, 14, and 28 days post-injury. The NORM participants were tested at the same time intervals.

The gait protocol was the same for each testing day and consisted of level walking with no obstructions and was performed under two conditions: 1) with undivided attention (single-task) and 2) while simultaneously completing simple mental tasks (dual-task). In order to assess gait variables a set of 31 reflective markers were placed on bony landmarks. An eight-camera motion analysis system (Motion Analysis Corporation, Santa Rosa, CA) was used to capture and reconstruct the 3-dimensional trajectory of the surface markers and compute the COM.

Variables were examined in one gait cycle including the medial-lateral COM displacement (MLdisp) and average gait velocity (GV). Repeated measures (4 x 2 x 4) mixed design analyses of variance (ANOVAs) were performed to determine whether differences ($p < 0.05$) existed.
between groups and within task and day. An analysis of co-variance was used to identify any effects of between-group GV differences on the COM displacement in the frontal plane.

RESULTS AND DISCUSSION

The gait velocity of athlete groups was significantly slower than non-athlete groups in both task conditions for all testing days. During the single-task, the concussed and normal athletes walked significantly slower than the concussed (p = 0.032; p = 0.002) and normal non-athletes (p = 0.003; p = 0.000). With the addition of the dual-task, the GV was slower for both athlete groups when compared to the normal non-athletes (p = 0.002; p = 0.001).

![Figure 1](image)

**Figure 1**: Group means and standard errors for medial-lateral displacement in single- and dual-task conditions averaged across testing days. **= Significantly less than CONC-A and NORM-A; ‡ = Significantly less than CONC-A.

For MLdisp the dual-task produced significantly greater sway than the single-task for all groups (p = 0.002). Specifically, during the single-task the concussed and non-concussed athletes had significantly greater sway than the concussed (p = 0.000; p = 0.000) and normal non-athletes (p = 0.004; p = 0.006). For the dual-task condition, the CONC-A group demonstrated significantly more sway than either non-athlete group (CONC-NA, p = 0.002; NORM-NA, p = 0.001) while the NORM-A subjects showed greater sway than those in the CONC-NA group (p = 0.001; Figure 1). Furthermore, the analysis of co-variance showed no significant effect of gait velocity on the medial-lateral COM displacement (p = 0.178).

The athletes whether concussed or not, displayed greater sway excursion than the non-athletes. In contrast, the athletes walked slower than the non-athletes. These differences were pronounced during the dual-task compared to the single-task condition and were evident from 2 to 28 days.

SUMMARY/CONCLUSIONS

The current results suggest that individuals with concussion may maintain their balance through reduced sagittal plane movement in an effort to control for increased coronal plane sway.

REFERENCES


Parker T.M., Osternig L.R., van Donkelaar P. et al. *MSSE (in press).*

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