IDENTIFYING DYNAMIC INSTABILITY DURING OBSTRUCTED GAIT FOLLOWING TRAUMATIC BRAIN INJURY

Li-Shan Chou 1, Ann E. Walker 2, Kenton R. Kaufman 2, Robert H. Brey 3 and Jeffery R. Basford 4

1 Department of Exercise and Movement Science, University of Oregon, Eugene, OR
2 Department of Orthopedic Surgery, 3 Department of Otorhinolaryngology and 4 Department of Physical Medicine and Rehabilitation
Mayo Foundation, Rochester, MN
E-mail: chou@oregon.uoregon.edu

INTRODUCTION
Sensation of imbalance has been troublesome for as many as 30% of patients following a traumatic brain injury (TBI) despite an often unremarkable neurological and physical exam (Alves et al., 1986; Cicerone and Kalmar, 1995). Given that additional injuries may occur due to consequences of unsteadiness or imbalance during locomotion, it is important to reveal the influence of TBI on an individual’s ability of balance control during balance-challenged activities, such as walking and stepping over obstacles. This information may enhance the development of TBI rehabilitation and education programs and lead to increased safety and faster integration into the community. Therefore, the purpose of this study was to develop a quantitative measurement system to identify dynamic instability during gait of individuals with TBI.

METHODS
Ten subjects (6 men and 4 women, ranging in age from 19 to 62 years, and at least 3 months post injury) with documented TBI and complaints of “imbalance” or “unsteadiness” while walking and ten age, gender, and stature-matched healthy individuals were recruited for this study. Subjects were instructed to walk along a 10m walkway at a comfortable self-selected speed while barefoot. Whole body kinematic data were collected from each subject using a six-camera ExpertVision™ system during unobstructed level walking and when stepping over an obstacle of height corresponding to 2.5%, 5%, 10%, or 15% of the subject’s height. The order of obstacle height was randomly selected. A 13-link biomechanical model of the body was used to compute the kinematics of the whole body’s COM (Chou et al., 2001). A two-way ANOVA with repeated measures of obstacle height was used to test for group differences and obstacle height effect on the temporal-distance parameters, range of motion of the COM and its peak velocities in three orthogonal directions during the crossing stride.

RESULTS AND DISCUSSION
Post-TBI subjects adopted a gait pattern with a significantly slower walking speed (p=0.02) and shorter stride length (p=0.018) than controls during all obstacle conditions. The walking speed was found to decrease linearly (p<0.001) as obstacle height increased. Significantly smaller/slower COM movement in the A-P direction (p≤0.012) was also observed in post-TBI subjects than controls. The A-P COM range of motion and peak forward velocity decreased linearly (p<0.001) as obstacle height increased.

Although neither significant group nor obstacle height effects were detected for the step width, significantly greater/faster COM movement in the M-L direction (p≤0.007) was found in post-TBI subjects than controls during all obstacle conditions (Figure). The M-L COM range of motion and peak velocity were also found to increase linearly (p<0.001) with obstacle height.

Stepping over a higher obstacle was found to impose a greater perturbation on the M-L COM motion in the TBI subjects than normal individuals. Also, magnitudes of the M-L COM excursion and peak velocity of the TBI subjects are similar to those reported for the balance-impaired elderly adults (Hahn et al., 2001), which indicate poor balance control in the frontal plane. Our data also imply that the feasible range of COM movement during which balance can be successfully maintained in the sagittal plane has been reduced in the TBI subjects relative to their controls.

SUMMARY
Examining the COM motion provides an objective measurement to better document complaints of instability not observable on clinical examination for individuals who suffered a TBI. Subjects with a TBI may be under a greater risk of sideways instability/falling during obstacle crossing.

REFERENCES

ACKNOWLEDGEMENTS
This study was supported by the Mayo Foundation.