EFFECT OF PERTURBATION DIRECTION ON THE THRESHOLD OF BALANCE RECOVERY PRELIMINARY RESULTS

Alessandro Telonio, Marc-André Cyr, Kodjo E Moglo and Cécile Smeesters
Research Center on Aging, Sherbrooke Geriatric University Institute, Sherbrooke, QC, Canada
Department of Mechanical Engineering, Université de Sherbrooke, Sherbrooke, QC, Canada
email: Cecile.Smeesters@USherbrooke.ca web: www.cdrv.ca

INTRODUCTION

It is only recently that studies have focused on postural perturbations at the threshold of balance recovery, i.e., postural perturbations large enough that balance recovery is not always possible and a fall can occur. The knowledge at the threshold of balance recovery is thus very limited. In particular, the effect of perturbation direction on the threshold of balance recovery has not been quantified, despite evidence of its importance during small and medium postural perturbations [e.g.: 1-2]. Moreover, understanding the effect of perturbation direction is particularly important given that case controlled studies have shown that sideways falls, compared to other fall directions, increases hip fracture risk [e.g.: 3-5]. Therefore, the purpose of this study is to quantify the effect of perturbation direction on the threshold of balance recovery.

METHODS

Balance recovery following sudden release from an initial lean was performed by six healthy younger adults, three males and three females (23.3 ± 2.3 yrs, 1.74 ± 0.07 m, 67.1 ± 11.5 kg). The maximum lean angle that these younger adults could be released from and still recover balance using a single step was determined for i) forward, ii) dominant side, iii) non-dominant side and iv) backward leans. The lean angle was sequentially increased until the subjects failed twice at a given angle and the lean directions were randomly ordered. Lean angles, reaction times, step times, step lengths and step velocities were measured using force platforms (AMTI, Newton, MA) and an Optotrak motion measurement system (NDI, Waterloo, ON). One-way analyses of variance with repeated measures were used to determine the effect of the lean direction.

RESULTS AND DISCUSSION

Since there were no significant differences between dominant and non dominant side results, non dominant side results were not considered in the analyses of variance. The lean direction significantly affected the maximum lean angles that younger adults could be released from and still recover balance using a single step (Figure 1 and Table 1). Moreover, at the maximum lean angles, the lean direction significantly affected reaction times, step times, step lengths and maximum step velocities (Table 1). Specifically, forward results were different from dominant side and backward results ($p < 0.034$) but dominant side and backward results were not different ($p > 0.452$). On the other hand, at the maximum lean angles, the lean direction did not significantly affect mean step velocity (Table 1).

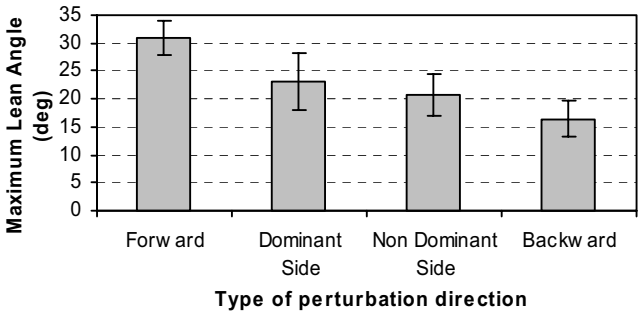

Figure 1: Effect of the lean direction on the maximum lean angle that younger adults could be released from and still recover balance ($p = 0.018$).

CONCLUSIONS

Preliminary results have shown that the perturbation direction significantly affects the postural disturbance younger adults could sustain. It is thus conceivable that different mechanisms could be responsible for balance recovery in different directions. Further experiments are needed to confirm these preliminary results in a larger sample of younger adults and, more importantly, in a sample of older adults.

REFERENCES

1. Hsiao ET and Robinovitch SN. *J Gerontol* **56**(1), M42-47, 2001.
2. Maki BE, et al. *J Biomech* **29**(3), 343-353, 1996.
3. Greenspan SL, et al. *Am J Med* **104**(6), 539-545, 1998.
4. Hayes WC, et al. *Calcif Tissue Int* **52**(3), 192-198, 1993.
5. Nevitt MC and Cummings SR. *J Am Geriatr Soc* **41**(11), 1226-1234, 1993.

ACKNOWLEDGEMENTS

We gratefully acknowledge the assistance of Jean-Sébastien Gosselin, Vincent Deschamps-Sonsino and Mathieu Hamel along with the support of the Junior I Research Fellow Grants 6391 and 5393 from the Fonds de la Recherche en Santé du Québec for Cécile Smeesters.

Table 1: Effect of the perturbation direction on the threshold of balance recovery.

Lean direction	Forward	Dominant Side	Non Dominant Side	Backward	p
Maximum Lean Angle (deg)	30.9 ± 3.1	23.1 ± 5.2	20.8 ± 3.8	16.4 ± 3.1	0.018
Reaction Time (ms)	153 ± 13	215 ± 21	203 ± 13	206 ± 31	0.030
Step Time (ms)	238 ± 7	184 ± 22	167 ± 13	193 ± 28	0.020
Step Length (m)	1.032 ± 0.082	0.694 ± 0.075	0.634 ± 0.090	0.724 ± 0.047	0.018
Maximum Step Velocity (m/s)	6.282 ± 0.559	4.589 ± 0.439	4.558 ± 0.576	4.782 ± 0.332	0.017
Mean Step Velocity (m/s)	4.327 ± 0.334	3.796 ± 0.474	3.806 ± 0.527	3.807 ± 0.656	0.122