CORRELATION BETWEEN POSTURAL SWAY DURING QUIET STANDING AND BALANCE RECOVERY AFTER SMALL PERTURBATIONS

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INTRODUCTION

Previous studies have found minimal correlation between postural steadiness during quiet standing and recovery of balance from a perturbation (Owings, Pavol et al. 2000; Mackey and Robinovitch 2005). These results may reflect differences in the governing postural control mechanisms involved in these two tasks. These studies, however, used relatively large perturbations that significantly challenged the postural control system in order to maintain balance. Investigating small perturbation in this regard may provide insight as to how the postural control system adapts to different tasks and difficult levels.

The goal of the current study was to determine correlations between commonly used postural sway measures during quiet standing and measures of recovery from a small postural perturbation. We hypothesized that stronger correlations would exist with small perturbations as opposed to large perturbations used in previous studies (Mackey and Robinovitch 2005). We also hypothesized that there will be a difference in these correlations between young and older adults, which may indicate differences in the flexibility of the postural control system to adapt to different tasks.

METHODS

Thirty subjects including 16 young (19.4 ± 1.4 years) and 14 older (62.2 ± 5.1 years) participated in the study. Each age group was comprised equally of males and females. Two tasks were performed by each subject: quiet standing and perturbation trials. For all tasks, subjects stood on two force platforms with one foot on each platform. Force platform data were sampled at 1000 Hz (Bertec Corporation, Columbus, OH) and center of pressure was calculated.

During quiet standing trials, subjects were instructed to stand as still as possible with their feet together, eyes closed, and hands at their sides for 60 seconds. Subjects performed three trials.

During perturbation trials, subjects were instructed to stand with their eyes closed and hands behind their back. A ballistic pendulum was used to apply an anteriorly-directed impulse of 6.5 N-s just inferior to the scapula. This perturbation was small enough that a step was not required to maintain balance. Subjects performed six trials.

Six quiet standing and six perturbation variables were calculated from center of pressure data. The quiet standing variables consisted of 50% power frequency (MFreqQS), maximum distance (MaxDQS), mean distance (MeanQS), mean velocity (MeanVelQS), maximum velocity (MaxVelQS) and estimated time to support boundary (TTBQS). The perturbation variables consisted of maximum distance (MaxDP), time to maximum displacement

(TTM), maximum velocity (MaxVelP), time to maximum velocity (TTMVelP), estimated time to the support boundary (TTBP), and time to return to within 20% of the relative displacement (Ret20P).

The coefficient of determination (r^2) was found from correlations between all quiet standing variables and all perturbation variables. A Wilcoxon Rank-Sum test was used to analyze differences in r^2 values between age groups.

RESULTS AND DISCUSSION

Statistically significant correlations were found between some quiet standing and perturbation variables (Table 1). These moderate correlations suggest that the postural control system may employ some of the same control mechanisms in response to a small perturbation as during quiet standing.

Quiet Standing	**Perturbation**	**Age Group**	**r^2**
TTB	TTMVel	Young	0.53
MaxVel	TTMVel	Young	0.52
MeanVel	TTB	Old	0.44
MeanVel	TTMVel	Young	0.42
MaxVel	TTB	Old	0.41
MaxVel	MaxD	Old	0.39
MeanVel	MaxD	Old	0.34

Table 1. Statistically significant quiet standing and perturbation coefficients of determination.

There was no difference in r^2 values between quiet standing and perturbation variables across age groups ($p=0.175$).
A qualitative comparison between the r^2 values of the present study and those presented by Mackey et al. (2005) showed that measures from small perturbations tended to have higher correlations with quiet standing than measures from large perturbations. This may indicate more similar postural control mechanisms between quiet standing and small perturbations compared to large perturbations.

A p-value of 0.175 between age groups suggests no age-related difference in the adaptability of the postural control system between quiet standing and the perturbations used here.

SUMMARY/CONCLUSIONS

Moderate correlations were found between quiet standing and perturbation variables. These results suggest that the governing strategies of the postural control system for maintaining balance and recovering balance do share some similarities. Future studies should investigate a range of perturbation magnitudes to more clearly understand how the postural control system adapts from quiet standing to perturbations.

REFERENCES

Mackey, D. C. and S. N. Robinovitch (2005). *Clin Biomech* 20(8): 776-83.
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