POSTURAL STEADINESS DURING QUIET STANCE DOES NOT ASSOCIATE WITH ABILITY TO RECOVER BALANCE IN OLDER WOMEN

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INTRODUCTION
Falls cause substantial death and morbidity in the elderly. Risk for falls associates with a wide variety of neuromuscular, behavioural, and environmental variables, but it depends ultimately on an individual’s ability to maintain and recover balance. It is unclear whether, among elderly individuals, these two domains of postural stability are governed by similar neuromuscular variables. This is an important issue for the design of clinical balance assessment tools and exercise-based fall prevention programs. To improve our understanding of this relationship, we examined whether steadiness during quiet stance associated with ability to recover balance using a feet-in-place strategy, and whether these two measures of postural stability associated with similar neuromuscular variables.

METHODS
We conducted experiments with 24 community-dwelling elderly women (mean age = 78 ± 7(SD) yrs). All subjects reported at least one fall in the 18 months prior to testing and were free of substantial orthopaedic or neurological impairment. All subjects provided written informed consent.

In balance recovery trials, we used a tether and chest harness to position the subject in an inclined standing position (Figure 1A), and measured the maximum release angle \( \theta_{\text{max}} \) where she could recover balance by contracting her ankle muscles after the tether was suddenly released. We also measured three neuromuscular variables during the recovery response: reaction time \( \Delta t \), rate of ankle torque generation \( C \), and peak ankle torque \( T_{\text{max}} \) (Figure 1B).

In balance maintenance trials, we instructed the subject to stand still for 15 seconds with her feet on the rigid ground (R) or on foam (F), with her eyes open (EO) or closed (EC). We calculated 4 measures of postural sway of the centre of pressure (COP) of the feet in the anterior-posterior (AP), medial-lateral (ML), and resultant directions. These were range of sway (RANGE), root mean square distance of sway (RMS), mean velocity of sway (MVEL), and mean frequency of sway (MFREQ) (Prieto et al., 1996).

In all trials, we used a force plate (Bertec) to measure (at 540 Hz in balance maintenance trials, and 960 Hz in balance recovery trials) the position of the COP between the feet and the ground, and a seven-camera motion measurement system (Qualisys) to measure...
(at 60 Hz) the position of 16 skin surface markers (Figure 1A).

RESULTS AND DISCUSSION

We found no significant correlations between $\theta_{\text{max}}$ and any of the postural sway variables for the EOR, ECR, and EOF conditions of balance maintenance. For the ECF condition, MVEL-ML was the only sway variable that was significantly correlated with $\theta_{\text{max}}$ ($r = 0.487$, $p = 0.029$).

$\theta_{\text{max}}$ was associated with peak ankle torque and reaction time (Table 1). In contrast, postural sway variables were not associated strongly or consistently with the neuromuscular variables across different conditions of quiet stance.

Our results show that among healthy elderly, who nevertheless had a history of falls, steadiness during quiet stance and ability to recover balance are not well correlated, and furthermore, not associated with similar neuromuscular variables. This suggests that deficits (or exercise-based enhancements) in one measure are not predictive of performance in the other.

The one significant correlation between $\theta_{\text{max}}$ and MVEL-ML during the ECF condition indicates that ability to rapidly generate corrective postural actions under conditions of sensory deprivation is associated with improved ability to recover balance following a perturbation. This may relate to the higher sway and elicitation of balance recovery responses in the challenging ECF condition.

While previous studies have shown that postural sway during quiet stance is a significant predictor of fall risk, the association is moderate at best (Lord et al., 1994). It is likely that ability to recover balance may provide additional information about fall risk.

SUMMARY

We found that, among elderly women, ability to maintain and recover balance were not highly associated. Therefore, clinical balance assessments and fall prevention programs should target both components of postural stability.

REFERENCES


ACKNOWLEDGEMENTS

Operating grants from CIHR, NIH, & CDC. DCM had NSERC & MSFHR fellowships. SNR had a CIHR New Investigator Award & a MSFHR Scholar Award.

Table 1: Correlations between postural sway, balance recovery, and neuromuscular variables.

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<th>MFREQ</th>
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* $p<0.05$, ** $p<0.01$