POSTURAL STIFFNESS MODEL AND FUTURE FALLS IN OLDER ADULTS: THE MOBILIZE BOSTON STUDY

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INTRODUCTION

Cognitive distractions that divert attentional resources seem to impair postural control, and thus may increase fall risk. Standing posture is hypothesized to be controlled mainly through maintaining postural stiffness [1]. During dual task, the lack of attentional resources may lead to the inability to maintain adequate muscle tone and thus enough stiffness to maintain upright standing, leading to falls. We tested whether these postural stiffness model parameters predict the prospective risk of falls in a representative sample of community-dwelling older adults.

METHODS

The MOBILIZE Boston Study is a prospective study examining risk factors for falls, including pain, cerebral hypoperfusion, and foot disorders in the older population [2]. The study includes a representative population sample of 765 elderly volunteers age 70 or above from the Boston area. Center of pressure (COP) and falls data with ≥6 months of falls follow-up data were available in 640 participants, who were 77.9±5.3 years old, with height of 1.63±0.10 m and weight of 73.9±15.5 kg. 65% were female.

Subjects stood barefoot with eyes open on a force platform (Kistler 9286AA). The COP data were sampled at 240 Hz in anteroposterior (AP) and mediolateral (ML) directions. Subjects performed two sets of five quiet standing trials, 30 seconds each. One set included a serial subtractions task.

Postural stiffness was calculated as previously described [1], where the postural system is modeled as an inverted pendulum with stiffness and damping. Movement of center of mass (COM) was estimated. Fourier transform of the difference between COP and COM was fit to a damped oscillator model to determine K_e (stiffness) and B (damping). V_o, the velocity of the inverted pendulum at vertical, was also calculated. K_e, B, and V_o values were determined for each trial using MATLAB 7.4, and then scaled to body size [3] and log-transformed.

Falls were reported using a monthly mail-in postcard calendar from each participant, after the COP measurement, with mean follow-up of 17 months (range 6-32 months). The association between K_e, B, and V_o values with prospective rate of falls were determined using a negative binomial regression [4] with and without including other covariates associated with falls using SAS 9.1. They include age, sex, race, education, daily alcohol use, gait speed, executive function, depression, disability, peripheral neuropathy, Berg balance scale, urinary incontinence, and history of falls.

RESULTS AND DISCUSSION

Postural damping during dual task, not stiffness, was the strongest predictor of falls (Table 1). With each unit increase of damping, future rate of falls was reduced to 64% (AP) and 61% (ML), even after accounting for other predictors of falls (Table 1). Thus postural damping seems to be a novel independent predictor of falls. Postural damping may be indicative of passive mechanical properties and feedback systems that prevent falls. Further study of the effect of dual task on postural damping, and their role in fall risk is warranted.

REFERENCES

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Table 1: Incidence rate ratio (IRR) of prospective fall rates using negative binomial regression

				bivariate				multivariate adjusted			
			mean±SD[1]	IRR[2]	95% CI[4]		p-value	IRR	95% CI		p-value
Quiet Stance	ML	K_e	-0.68±0.43	0.82	0.63	1.07	0.14	-	-	-	-
		V_o	0.59±0.39	**1.34**[3]	1.03	1.76	**0.03**	1.35	1.02	1.78	0.04
		B	-1.15±0.27	0.75	0.50	1.13	0.17	-	-	-	-
Dual Task	AP	K_e	-0.51±0.47	0.92	0.73	1.17	0.52	-	-	-	-
		V_o	1.14±0.32	1.24	0.90	1.71	0.20	-	-	-	-
		B	-0.77±0.32	**0.64**	0.45	0.90	**0.01**	0.60	0.43	0.84	0.002
	ML	K_e	-0.83±0.45	0.90	0.70	1.17	0.44	-	-	-	-
		V_o	0.61±0.39	1.32	1.00	1.73	0.05	-	-	-	-
		B	-1.06±0.31	**0.61**	0.43	0.87	**0.006**	0.69	0.49	0.96	0.03

[1]Scaled, log-transformed values. [2]Incidence rate ratio (IRR): increase in fall risk associated with a unit increase in the predictor variable. [3]IRR=1.34 would mean a 34% increase in fall rate for each unit increase in V_o. [4] 95% CI = 95% confidence interval of the IRR. If the CI includes 1 (i.e., null), the predictor is not significantly associated with fall risk. Model parameters from AP direction during quiet stance were not associated with fall risk, and thus are not shown.