POSTURAL SWAY ON A SLIDING PLATFORM: ASSESSING SPATIAL AND TEMPORAL STABILITY

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INTRODUCTION

If a fall is regarded as a situation in which a person fails to recovery the body center of mass from the edge of the base of support, balance assessment is required to measure the excursion distances of the center of pressure (COP) as well as reaction time [1]. A quick response is preferable to achieve efficient recovery from stability limits. In order to assess spatial and temporal stability [2], we designed a sliding platform anchored at one end of a sliding rail. The platform helps the subject to transfer his or her weight from heel to toe or from toe to heel when performing voluntary anterior-posterior (AP) sway of the COP on the platform. The aim of the present study was to describe the various characteristics of AP sway among young, and elderly subjects, as well as in subjects with Parkinson's Disease (PD).

METHODS

Our subjects consisted of 37 healthy university students (17 female and 20 male; age range = 18-27 years, mean = 20.1 ± 2.3 years), 29 healthy elderly subjects (13 female and 16 male; age range = 65-89 years, mean = 69.9 ± 4.7 years), and 7 subjects with PD (4 female and 3 male; age range = 55-72 years; mean = 63.7 ± 6.6 years). PD subjects were recruited from Kitasato University East Hospital and elderly subjects were recruited from the local community.

Wearing a safety harness, subjects performed voluntary cyclic AP sway standing on the sliding platform or a fixed platform, each of which contained three load cells to measure vertical ground force. Data were recorded at 100 Hz and the associated COP was then computed. An auditory metronome guided subjects to sway the COP at 0.5 Hz. Once the subject swayed rhythmically, force data were recorded for 10 seconds. Time series were analyzed for each trial corresponding to COP sway (Fig. 1). COP amplitude was calculated using the distances between the peaks and the valleys, and duration was defined as the times between the peaks. The calculated values were averaged across three trials per subject.

RESULTS AND DISCUSSION

The mean duration achieved by elderly and PD subjects was found to be longer than that of young subjects under both fixed and sliding conditions (Fig. 1, Table 1). Most young subjects were able to pace their AP sway with the auditory cue, while elderly and PD subjects did not maintain the pace. The ranges of duration on the sliding platform were 1.8 to 3.0 sec for the young, 1.0 to 6.4 sec for the elderly, and 1.8 to 6.1 sec for PD subjects. Both elderly and young subjects showed shorter duration under sliding conditions than under fixed conditions ($p < 0.001$ and $p < 0.05$, respectively), and the mean amplitude of elderly and PD subjects was significantly smaller than that of the young under both conditions ($p < 0.01$). Sliding conditions produced smaller amplitude than fixed in the young and the elderly ($p < 0.01$). The sliding mechanism was found to be an effective method of testing the speed of sway, especially in elderly subjects, however, this method was less effective in the case of PD subjects.The duration of voluntary AP sway was found to decrease with decreasing amplitude.

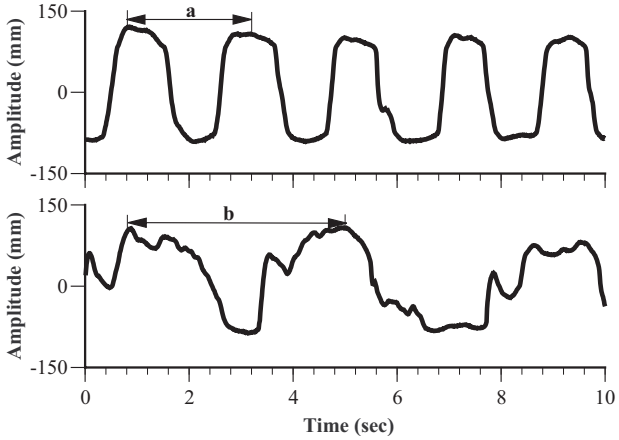

Figure 1: Representative AP displacements of the COP on the sliding platform in a young subject (top) and an elderly subject (bottom). The intervals designated by "a" and "b" indicate duration.

CONCLUSIONS

The sliding platform was found to help subjects perform fast AP sway provided that they were able to easily move their body weight. In subjects with a balance problem, fast AP sway is more difficult to achieve.

REFERENCES

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Table 1: Amplitude and duration of COP time series under fixed and sliding conditions for young, elderly, and PD subjects.

	Young		Elderly		PD	
	Fixed	Sliding	Fixed	Sliding	Fixed	Sliding
Amplitude (%FL)	82.2 ± 4.8	78.1 ± 4.6	74.5 ± 7.3	70.9 ± 9.6	68.4 ± 4.9	63.9 ± 8.5
Duration (sec)	2.2 ± 0.4	2.0 ± 0.2	4.2 ± 2.5	2.6 ± 1.4	3.1 ± 1.2	3.8 ± 2.1

FL denotes foot length.