EFFECTS ON POSTURAL CONTROL DURING QUIET STANDING UNDER RESTING AND FATIGUED CONDITIONS

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BACKGROUND

The study of Center of Pressure (COP) measures during quiet standing have often been used to help us increase our understanding of the control of balance. While there has been convincing evidence that postural control strategies are distinct for both anterior-posterior (A-P) and medial-lateral (M-L) planes, the time-dependent characteristics of the separate control strategies have not been explored. Data analyses suggest that these time-dependent differences may provide further insight to help us understand the body's systematic approach to postural control.

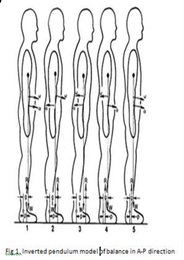

Fig 1. Inverted pendulum model of balance in A-P direction

PURPOSE

Center of Pressure (COP) data were analyzed to: 1) describe the time-dependent normalizing strategies the body adopts during quiet standing and after physical fatigue; 2) determine the order of these time-dependent effects; and, 3) generate further hypotheses regarding the clinical implications of the preferred control system.

METHODS

- COP excursion range (Fig. 2) and, the root mean squared (RMS) variability about the mean center of pressure (COP) were calculated in 1 s intervals for 60 s of quiet standing.
- 60 subjects stood quietly with feet together side-by-side or hip width apart (stance randomly assigned), while staring at a fixed picture located 3 m anterior to the force plate.
- COP measures were collected prior to the fatigued condition and after performing 20 burpees (a combination of push-ups and vertical jumps).
- COP measurements were taken within 5 seconds of subject getting onto the force plate, or 10 seconds after the last burpee.

Equipment

- Force records were measured (Kistler Instruments Corp, Amherst, NY) at 50 Hz for 60 seconds, with A-P and M-L COP position data calculated for each sample

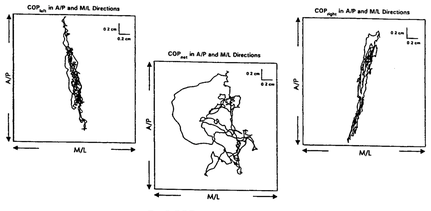

Fig 2 COP excursions measured on force plate.

METHODS - continued

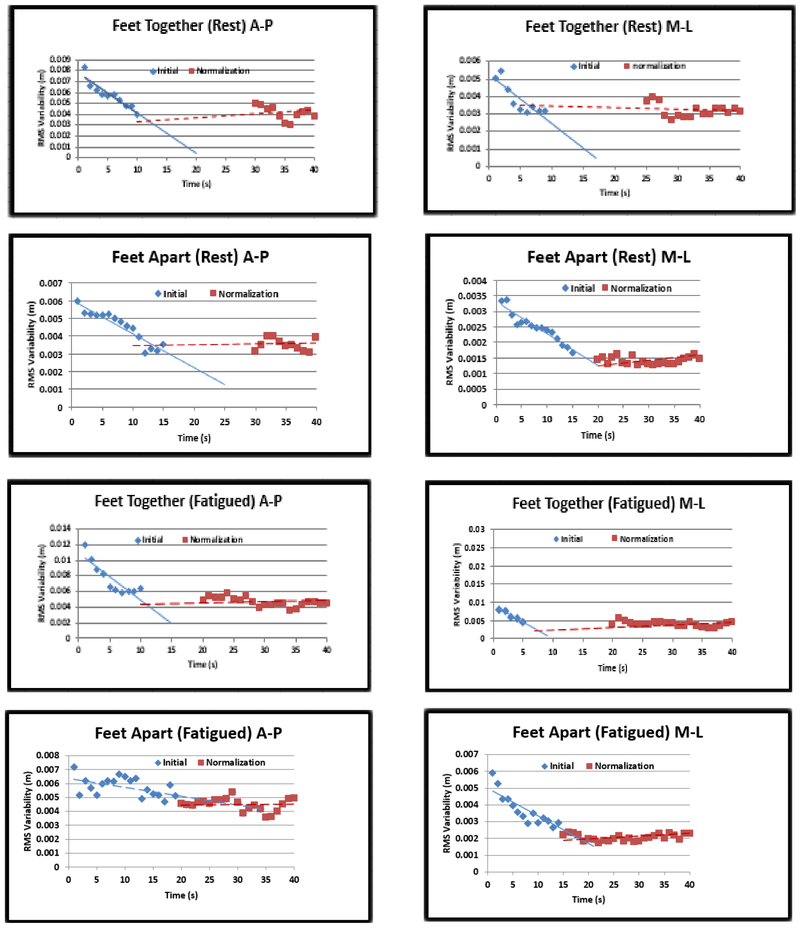

Fig 3. COP variability as a function of time. Intercept represents a linear interpolation of a postural equilibrium time point.

Retrospective Data analysis

- Data analyses involved a mathematical modeling procedure that used variability measures and linear regression to determine postural equilibrium time points (Fig. 3).
- The time intercepts were calculated from the equations defining each of the two linear lines (Fig. 3).
- Paired t-test were used to determine significant differences ($p \leq .05$) in COP excursion over the 60 s time for each condition (Table 1).

RESULTS

Table 1: COP excursion (cm) averaged across subjects

	Rested		Fatigued	
Direction	Feet together	Feet Apart	Feet Together	Feet Apart
A-P	2.9	2.3	3.7	3.0
M-L	2.2	1.2	3.3	1.8
Significant ($p \leq 0.05$)	* A-P>M-L	* A-P>M-L	No	* A-P>M-L

- There were significant differences between the anterior-posterior (A-P) and the medial-lateral (M-L) center of pressure (COP) excursion for each of the standing conditions analyzed in feet apart, and the rest condition in feet together side-by-side (Table 1).
- There was no significant difference between A-P and M-L COP excursion in the fatigued condition for feet together side-by-side (Table 1).
- During narrow stance and under fatigued conditions in feet apart, time to a more stable position in M-L precedes A-P (Fig 3).
- Time to a more stable position in M-L did not precede A-P in feet hip width apart when rested (Fig 3).

SUMMARY AND CONCLUSION

- The time-dependent normalization effect of M-L suggests further insights to the application of our postural control system during perturbed conditions.
- The understanding of this time-dependent normalization effect could reflect the importance of hip abductors/adductors and the critical role they have in postural control and balance when physically fatigued.
- Time-dependent normalization effects should be considered when interpreting the magnitude of COP excursion measures in postural control

LIMITATIONS

- The analysis were generated on existing data, which prevented further manipulation of design parameters. Further studies should be explored in varying perturbed conditions and across different populations.

Reference

Winter, D. A., Patla, A. E., Prince, F., Ishac, M., & Gielo-Perczak, K. (1998). Stiffness control of balance in quiet standing. Journal of neurophysiology, 80(3), 1211-1221.

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