ISB 2013 BRAZIL
XXIV CONGRESS OF THE INTERNATIONAL SOCIETY OF BIOMECHANICS
XV BRAZILIAN CONGRESS OF BIOMECHANICS

ANALYSIS OF THE BEHAVIOR OF THE CENTER OF PRESSURE IN STANDING POSITION USING PRINCIPAL COMPONENT ANALYSIS

[1] Pedro Paulo Deprá, [2] Felipe Arruda Moura
[1]State University of Maringá, Biomechanics and Motor Control Laboratory, Brazil; e-mail: ppdepra@uem.br
[2]State University of Londrina, Laboratory of Applied Biomechanics, Brazil.

SUMMARY
The aim of this research was to study the dynamic behavior of the center of pressure coordinates by the angle of the first principal component with a vector parallel to the mediolateral axis. Two healthy individuals were select to stay 120 seconds on a force platform in quiet standing position. A principal component analysis was accomplished and the angle of the first principal component was calculated cumulatively. The results revealed a dynamic behavior of the angle of the first principal component and time required for stabilization.

INTRODUCTION
The 2D position of the center of pressure (CP) on floor has been used to study human quasi-static balance [1]. By the principal components of the CP coordinates distribution it is possible to define an ellipse to demonstrate the maximum variability of the data, its area and anteroposterior e mediolateral displacements [2].

The literature shows diverse protocols related to the period of permanence on the force platform (EMGSystem). As example, the standing period was used at 30 s [3] and 31 min [4]. The time at least 60 s is recommended to be used to optimize the stability and reliability of RMS signals of CP during quiet stance [5].

The aim of this research was to study the dynamic behavior of the center of pressure by the angle of the first principal component.

METHODS
Two healthy individuals were select to the experiment, Ind1 (24 Years; 92 Kg;1,80m) and Ind2 (24 Years;114 Kg;1,73m). The experiment consisted in stay during 120 seconds on a force platform in quiet standing position. The force platform registered the CP 2D coordinates at a sample range of 100 Hz. The data were filtered by a 2 order lowpass digital Butterworth filter with 9 Hz of cutoff frequency.

From the first second, a principal component analysis was accomplished and the eigenvectors were calculated. The angle of the first eigenvector with a parallel vector to the mediolateral axis was then calculated cumulatively in each 1/100 seconds, considering the past values of CP.

In order to evaluate the differences of the COP behavior in different periods of the test, the data were selected in six intervals, equally spaced: 1 to 20 s.; 20.01 to 40 s.; 40.01 to 60 s; 60.01-80 s.; 80.01-100 s.; 100.01-120 sec.

The reshaped data were analyzed statistically. Since the Shapiro-Wilk Test revealed a non-normal distribution, the Friedman and Wilcoxon tests were applied ($p<0.05$).

RESULTS AND DISCUSSION
The figure 1 shows the dynamic behavior of the angle of the first principal component for Ind1 and Ind2.

Region of great variability is highlighted at the beginning of the time series in contrast to the relative stability region between 90 and 120 seconds for both individuals.

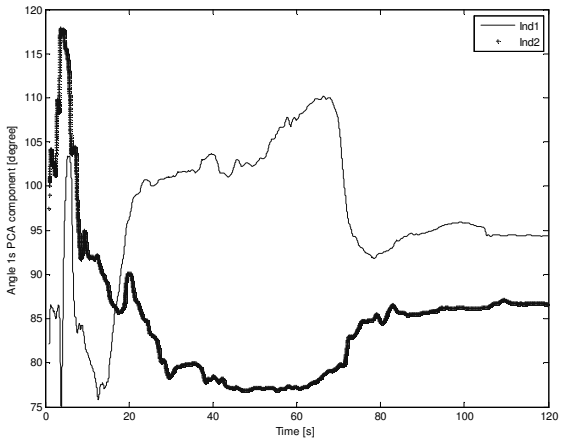

Figure 1- Angle of the fisrt principal component

It can be seen that the bigger variability in both individuals happens between the periods: 1 - 20 s. and 60.01 - 80 s (Table 1). On the other hand, median similar angles were observed for both individuals at the last two intervals (Table 1 – intervals 5 and 6).

Therefore, a 30 second test, as reported in previous study [3] may represent an analysis of a COP behavior with great variability.

The statistical analyses showed differences between the intervals for both individuals. Table 1 shows the median angle of the first component as function of the time range.

Face to these results, it is understood that it is necessary to evaluate these behaviors in other subjects. However, it seems there is clear evidence to suggest that the time spent on the force platform must be taken into consideration depending on the proposed search.

CONCLUSIONS

The behavior of CP is dynamic and reveled time required for stabilization. This behavior suggests that the exposure time can be related to different objectives of evaluation.

REFERENCES

1. Freitas, SMSF; Duarte M., *Gait&Posture*. **35**(1):83-7,2012.
2. Winter DA, et al., *J Neurophysiol.* **75**(6):2334-43, 1996.
3. Harris GF, et al., *IEEE Eng. Med. Biol.* **11**(4):57-58,1992.
4. Vieira TMM; Oliveira LF, *Rev Bras Med Esporte* **12**(3), 2006.
5. Carpenter MG, et al., *Gait and Posture*.**13**:35 – 40,2001.

Table 1: Results of the angle of the first principal component with a parallel vector to the mediolateral axis, applied in center of pressure coordinates during a standing test of 120 s (median ± interquartile range).

Interval	Time Range (s)	**Angle (deg)**	
		Individual 1	**Individual 2**
1	1 to 20 s	84.32±8.82	92.04±14.49
2	20.01 to 40	101.01±1.37	79.89±4.20
3	40.01 to 60	102.92±6.79	77.13±0.15
4	60.01-80	107.69±15.35	79.31±5.51
5	80.01-100	94.63±1.46	85.74±0.68
6	100.01-120	94.45±0.89	86.69±0.46