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Sway ratio – a new measure for quantifying postural stability

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In the search of a reliable postural stability index, two sway time series: the center-of-mass (COM) and the center-of-foot pressure (COP) were recorded simultaneously in elderly subjects standing quiet with eyes open and with eyes closed. From a battery of commonly use sway measures, only the anteroposterior COM and the COP path lengths proved their high sensitivity and discriminative power to the imposed vision conditions. Based upon these indices, a new measure – sway ratio (SR) – was computed, as the COP-to-COM path length ratio. The measure can easily distinguish vision vs. no vision in the elderly. The SR can be successfully accessed base upon the COP signal only. In contrast to traditional sway indices, the SR as a relative measure is insensitive to the length of sampled record and to the signal sampling frequency. Its magnitude can be interpreted as an average amount of balance controlling motor activity that coincides with a unit COM displacement. The SR is recommended as a reliable measure that allows for assessment of postural stability.

Key words: sway ratio, posture, postural stability, balance, elderly

INTRODUCTION

Force plate posturography, an easy and safe method that is commonly used in contemporary laboratories, can furnish insights into the physiological correlates of postural stability. The problem, however, of identifying postural instability in the elderly and in patients with neurodegenerative disease using force-plate posturography, is still unsolved. The results of this method simply show a scale of the problem we found in the laboratory assessment of postural stability. For instance, an increased postural sway during quiet stance is not usually conclusive evidence for postural instability. Other proof, related to the dynamics of postural control, such as a decline in postural stability borders are usually needed (Błaszczyk et al. 1994, 2007). Moreover, most of the commonly exploited sway indices are neither sensitive enough nor do they exhibit specific effects, for a given postural dysfunction. It is usually a very sophisticated task to find in the center of foot pressure (COP) characteristics, those changes specific for instability. This is especially true for those with potential physiological meanings. Many parameters that are derived from the COP time series seem to provide very similar information and due to the specificity of experimental techniques used in different laboratories, it is almost impossible to compare posturographic results (Raymakers et al. 2005).

Discussion on the nature of postural sway has taken place recently in the literature (Bottaro et al. 2005, Raymakers et al. 2005). The question of why people sway and what is the physiological outcome of that movement is crucial for this discussion. The control of human upright posture stability is commonly viewed as a continuous process of the stabilization of a multilink inverted pendulum (for review see Maurer and Peterka 2005). In this model, the main controlled parameter is the center of mass (COM) position within limits of the base of support. Postural stability control involves the generation of appropriate stabilizing responses. This is done either by triggering and scaling preprogrammed reactions or by continuous updating the COM position in a feedback mode. During quiet stance stabilizing torques generated at different levels of the body's

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