RELEVANCE OF FREQUENCY-BASED POSTURAL STABILITY BIOMARKERS IN GYMNASTICS SPORTS

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The most commonly used measure of postural sway is the center of pressure (COP), reflecting the displacements of the point location of the vertical ground reaction force vector. However, this approach has often been criticized because of non-stationarities in recorded signals and its very limited application to the assessment of postural stability. In fact, only recently has a stability criterion been proposed which is based not on external characteristics of body sway, but on the second order autoregressive model which links the performance of stace with the operation of the neuro-muscular system (NMS). The excursions of the COP are dependent on the superposition of the torque caused by the center of gravity position and another torque resulting from the activity of feet accomplishing the ankle strategy by changing plantaflexor and/or invertor activity. The latter activity represents the neural control of the ankle muscles and may be effectively extracted from COP data by means of exponential smoothing technique, as a feet-related displacement (FRD) of the original COP. The application of the autoregressive model to the FRD allows us to compute two parameters which serve for the calculation of stability biomarkers: stability margin and peak frequency. These markers reflect the rate of FRD corrective movements and, to a certain extent, the level of internal preparation of subjects performing more or less challenging postural tasks, thus giving some insight into the operation of the NMS. Consequently, one can hypothesize that a comparison of scores based on these markers for different athletes, in particular in balance exercises, may be a measure permitting one to assess the amount of effort made by an individual at a certain stage of training. An experiment was performed using a group of female rhythmic gymnasts performing four balance exercises. Athletes who had achieved better records in their careers exhibited distinct differences in scores computed for all exercises, the biomarkers increasing with the growing challenge of subsequent tasks, while the remaining ones differentiated poorly between the three more difficult exercises. This result leads to the conclusion that subjects who are proficient and/or talented in a given element of gymnastics apply just the appropriate effort to their performance. Less skilled athletes overestimate the difficulty and are too involved, handicapping the final effect. Frequency-based stability biomarkers can be used to assess individual abilities in equilibrium exercises or evaluate progress in training.