29 - ANALYSIS OF POSTURAL STABILITY OF YOUNG ADULTS IN THE PRESENCE AND MOMENTARY ABSENCE OF VISION

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INTRODUCTION

Humans utilize all sensorial information from sensory organs in order to maintain equilibrium, and the absence of any sensory data can alter equilibrium control (TEIXEIRA et al., 2007, p. 637). It is well known that vision is one of these sources and is of fundamental importance for control of the postural system given that it supplies environmental information, direction, and velocity of body movements in relationship to its own environment (CASTRO et al., 2009, p. 180). Although equilibrium is a natural activity, attention should be given to any possible disequilibrium that may compromise execution of daily activities.

In an erect semi-static posture the human body demonstrates small oscillatory movements. The force of gravity challenges the human body to maintain stability of the center of gravity (CG) over a small area limited by the feet, called the base of support. The body is considered in stable equilibrium when the vertical line of center of gravity (CG) falls within the base of support (FREITAS, 2003, p. 17).

The most common method for studying postural control is by observing corporal oscillation. (DUARTE, 2000, p. 12). In this system there are two parameters to be considered, one involves postural orientation, or the maintenance of the position of body segments in relationship to themselves and their environment, and the other involves postural equilibrium, represented by the relationship between forces that act on the body in search of equilibrium during motor actions (FREITAS; DUARTE, 2006, p. 1).

The evaluation of equilibrium and postural instability can be performed by means of a force platform that consists of a board with sensors arranged to measure three components of force, Fx, Fy and Fz, and the three components of moment of force, Mx, My and Mz (DUARTE, 2000, p. 41). The center of pressure (CP) is the point of application of the vertical force acting on the support surface, the measure of displacement dependent of the body CG. While CG oscillation represents a body movement, the oscillation of the CP indicates a neuromuscular response to the variation of CG (FREITAS; DUARTE, 2006, p. 1).

Accordingly, the objective of this study was to analyze the influence of momentary deprivation of vision on the postural orthostatic equilibrium of young healthy individuals, based on oscillation from the center of pressure.

MATERIALS AND METHODS

Four young healthy individuals, 1 male and 3 females with mean age of 24 ± 3.4, body weight of 666.97 ± 104.18 N and height of 1.68 ± 0.07m participated in this study. Participants presented no history of musculoskeletal or vestibular (dizziness, labyrinthitis, vertigo) problems. Subjects were all registered in the Masters program of Pontifical Catholic University of Parana (PUCPR).

The instrument utilized for data collection was the Biomechanics Platform AMTI (Advanced Mechanical Technologies, Inc.), model OR6-7. Shown on figure 1 is the force platform with its respective axes of measurement. This instrument allows for the acquisition of stabilographic data in an erect static or dynamic position. In the present study the platform was utilized for static analysis, assembled according to the manual of technical regulations and positioned in the center of the room at the Rehabilitation Engineering Laboratory (LER) of PUCPR on a plane, adequately leveled surface.

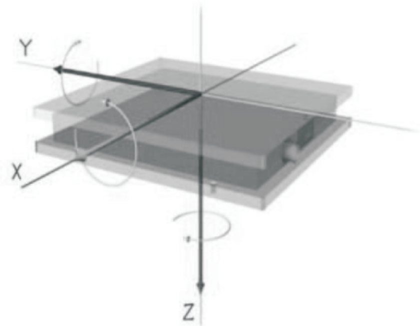

Figure 1 – Representation of the force platform and axes (FREITAS; DUARTE, 2006).

Prior to data collection the size and body weight was recorded for all subjects. At the moment of data collection, the subjects were dressed appropriately for the climate, without shoes, however, all wore socks and one wore eyeglasses.

The data was collected in two conditions: 1) eyes open and 2) eyes closed. In the first condition, subjects were oriented to keep their eyes fixed on a specific point marked at a distance of one meter from the field of vision at eye level and measured for each subject according to recommendations [6]. For the second condition subjects remained on the platform with eyes closed. Three repetitions were executed for each condition for a total of 6 times for each subject. The time for each collection was 60 seconds.

All subjects received instructions to maintain an erect posture as stable as possible, keeping, for all analyzed conditions, a two feet stance on the platform with feet in a comfortable position, however, respecting the limit of hip width, and arms along side the body.

Signals from the platform were captured and pre-processed by NetForce – AMTI software (Version 2.2.1), in which reaction forces were obtained from the base by three force components (Fx, Fy and Fz) and the three components of the moment of force (Mx, My and Mz) across the X, Y and Z axes in the antero-posterior direction (a-p) medio-lateral (m-l), and vertical, respectively. The frequency of acquisition of the kinetic data for the platform was 100 Hz.

Data were processed by a program developed in a Matlab environment in which the following variables were calculated as proposed by Freitas and Duarte (2006, p. 6): CP coordinates in the direction a-p (equation 1) and m-l (Equation 2); the CP trajectory expressed as the length of the trajectory of CP over the base of support (Equation 3); the magnitude of displacement of CP that represents the maximum and minimum of CP direction, or CPa-p (Equation 4) and CPm-l (Equation 5) Mean velocity (VM) of CPa-p (Equation 6) and CPm-l (Equation 7); and, the mean total velocity calculated by the trajectory of displacement of both directions divided by the total time of experiment (Equation 8).

$$CP_{a-p} = \frac{-h \cdot F_y - M_x}{F_z} \quad (1)$$

$$CP_{m-l} = \frac{-h \cdot F_y - M_x}{F_z} \quad (2)$$

$$Trajetória_{CP} = \sum \sqrt{{CP_{a-p}}^2 + {CP_{m-l}}^2} \quad (3)$$

$$ACP_{a-p} = \max(CP_{a-p}) - \min(CP_{a-p}) \quad (4)$$

$$ACP_{m-l} = \max(CP_{m-l}) - \min(CP_{m-l}) \quad (5)$$

$$VM_{CP_{a-p}} = \sum |CP_{a-p}| \cdot \frac{Frequência}{nº\ de\ amostras} \quad (6)$$

$$VM_{CP_{m-l}} = \sum |CP_{m-l}| \cdot \frac{Frequência}{nº\ de\ amostras} \quad (7)$$

$$VM_{total} = \sum \sqrt{{CP_{a-p}}^2 + {CP_{m-l}}^2} \cdot \frac{Frequência}{nº\ de\ amostras} \quad (8)$$

Excel software was subsequently utilized for statistical analysis and plotting of the results.

RESULTS

Figure 2 shows the results of the CP trajectory with the respective standard deviations as well as the means obtained for the 4 subjects in both conditions of eyes open and eyes closed.

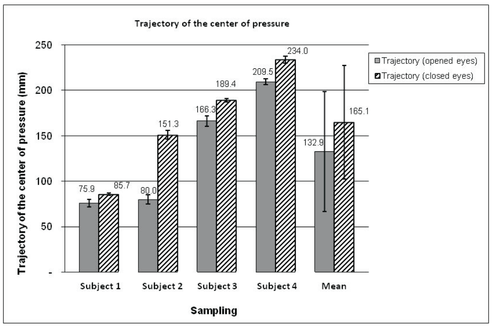

Figure 2 – Trajectory of the Centers of Pressure with respective standard deviations

Figure 3 presents the results of magnitude of displacement of CPm-l and the respective standard deviations for the 4 subjects with eyes open and closed as well as the mean values for both conditions. Figure 4 presents the magnitude of displacement of CPa-p.

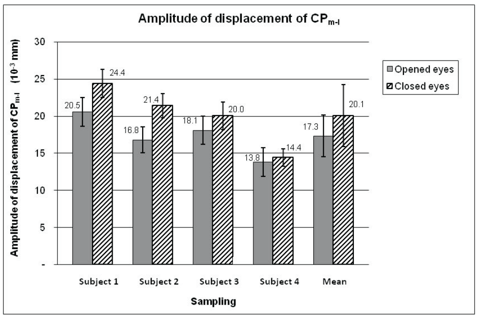

Figure 3 - Amplitude of displacement of CPm-l with respective standard deviations

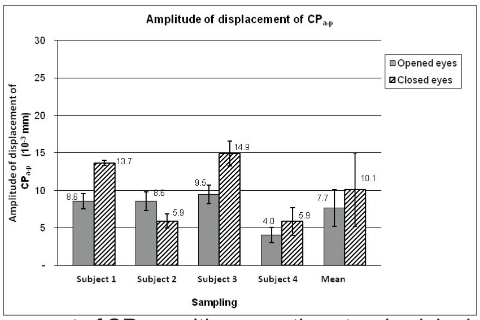

Figure 4 – Amplitude of displacement of CPa-p with respective standard deviation

Figure 5 presents the results for mean velocity of displacement of CPm-l with the respective standard deviations obtained for the 4 subjects as well as the mean values for both conditions. Figure 6 shows that mean velocity of displacement of CPa-p.

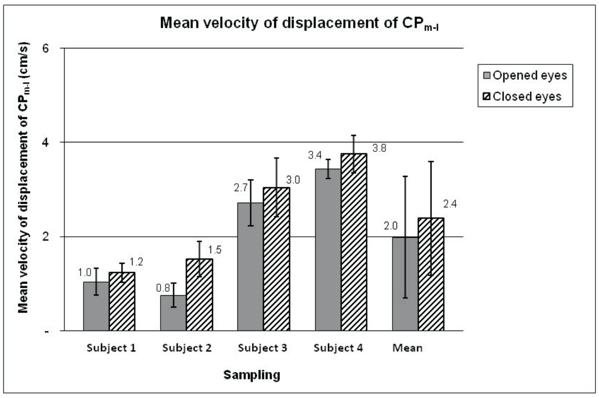

Figure 5 – Mean velocity of displacement of CPm-l with respective standard deviations

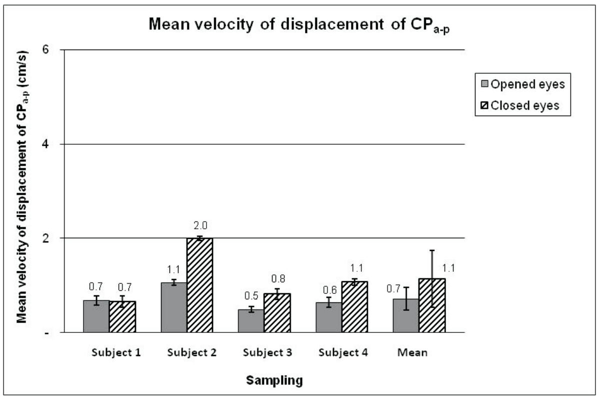

Figure 6 – Mean Velocity of displacement of CPa-p with respective standard deviations

In Figure 7 we present the total mean velocity displacement of CP obtained for each subject, in the condition o eyes open and eyes closed, with respective standard deviations and mean values for both tested conditions.

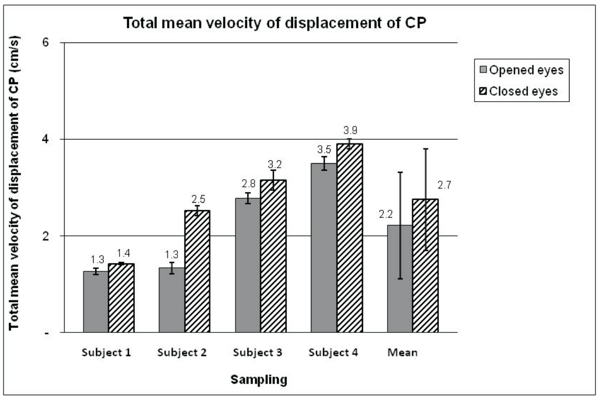

Figure 7 – Total mean velocity of displacement of CP with standard deviation

DISCUSSION

In the second condition in which the subjects were tested with closed eyes, can be observed that the mean values obtained for all analyzed variables (CP trajectory, displacement a-p and m-l, mean velocity a-p and m-l, and total mean velocity) were greater, when compared to condition 1, in which the subjects' eyes were open. In general, we can confirm that under condition 2 (eyes closed) oscillation values of measured variables are greater, which demonstrates lower stability than under condition 1 (eyes open).

These results cited above can be explained by the tendency of the force of interaction between visual information and postural oscillation and the influence of the continuous alterations of visual information in postural oscillations (FREITAS, 2003, p. 17).

Subject 4 presented the greatest trajectory of CP, with the least magnitude of displacement a-p and m-l, however, the greatest total mean velocity when compared to other subjects. Subject 1 presented the smallest trajectory of CP, with the largest magnitude of displacement m-1 and the second greatest displacement of a-p, but with the lowest total mean velocity when compared to the other subjects. Was observed the correlation that the greater the total mean velocity, the lower the magnitude of displacement and vice versa. If the trajectory of CP were greater the subject could have achieved a greater magnitude of displacement with a lower velocity, or a lesser magnitude of displacement with a greater displacement velocity, the latter being that chosen by the referred subject.

Subject 2 obtained the greatest differences between the two conditions, when compared to the other subjects, observed by the following variables: CP trajectory, magnitude of displacement m-l, mean velocity of displacement a-p and m-l, and total mean velocity. We believe this to be a result of the subjects' frequent habit of dancing. In the studies of Perrin et al. (2002,

p. 188) the results showed that classic ballet dancers depend more on the visual entry for posture regulation.

Subject 2 was the only individual that showed a greater displacement a-p with eyes open, contrary to the others that presented greater displacement with eyes closed. This may have occurred given that with eyes closed the subject maintained a more rigid stance, which would also explain the fact that subject 1 was the only individual to have the same measure of mean velocity a-p for both conditions, eyes open and closed.

Studies demonstrate that posture maintenance is in constant adaptation and that postural orientation is associated with stability between the individual and his external environment, continuously utilizing sensory information and motor action by the postural control system (BARELA, 2000, p. 1; CAMPELO et al., 2000, p. 2). Accordingly, the alterations of the variables analyzed in the present study demonstrate the existing relationship between vision deprivation and postural control for the evaluated individuals.

CONCLUSION

The visual system presents an important contribution to postural control, since the deprivation of vision caused immediate alterations in trajectory, displacement and velocity of displacement of the center of pressure, which allows us to conclude that vision plays an active role in fine-tuning of equilibrium stability.

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ANALYSIS OF POSTURAL STABILITY OF YOUNG ADULTS IN THE PRESENCE AND MOMENTARY ABSENCE OF VISION

ABSTRACT:

The aim of this study was to analyze the influence of momentary deprivation of vision on the postural orthostatic balance of healthy young individuals, based on the oscillation of the center of pressure. Four subjects, one male and three females, mean age 24 ± 3.4 years, body weight 666.97 ± 104.18 N, and height 1.68 ± 0.07 meters participated in this study. Data was collected on a force platform under two conditions; eyes open and eyes closed. The test was repeated three times, 60 seconds for each condition. Variables included force and moment of force, axes X, Y, Z. Deprivation of vision caused changes in trajectory, velocity, and displacement of the center of pressure, causing higher center of gravity oscillation.

KEY WORDS: Momentary absence of vision, Postural control, Posturography.

ANALYSE DE LA STABILITÉ POSTURAL D'ADULTES JEUNES EN PRÉSENCE ET ABSENCE MOMENTANÉE DE LA VISION.

RÉSUMÉ:

L'objectif de cette étude était d'analyser l'influence de l'absence momentanée de la vision de l'équilibre orthostatique posturale de jeunes adultes en santé, basée sur l'oscillation du centre de pression. L'étude comprenait quatre personnes, dont un homme et trois femmes, âge moyen de 24 ± 3,4 ans, poids moyen de 666,97 ± 104,18 N et de hauteur moyenne de 1,68 ± 0,07 m. Pour réaliser la collecte des données, on a adopté une plateforme de force sous deux conditions : les personnes débout en alternance aux yeux ouverts et aux yeux fermés, en trois répétitions de 60 secondes pour chaque condition. Les forces de réaction du sol et des moments de force dans les axes X, Y, Z ont été les variables étudiées. Et puis, la privation momentanée de vision a provoqué des changements dans la trajectoire, la vitesse et le déplacement du centre de pression, ce qui a causé de la fluctuation davantage dans le centre de gravité.

MOTS-CLÉS: L'absence momentanée de la vision, L'contrôle postural, La posturographie.

ANÁLISIS DE LA ESTABILIDAD POSTURAL ADULTOS JÓVENES EN LA PRESENCIA Y AUSENCIA DE VISIÓN MOMENTÁNEA.

RESUMEN:

El objetivo de este estudio fue analizar la influencia de la ausencia momentánea de la visión en el equilibrio postural ortostático de adultos jóvenes sanos, sobre la base de la oscilación del centro de presión. El estudio incluyó a cuatro personas, un varón y tres mujeres, edad media 24 ± 3,4 años, peso corporal medio de 666,97 ± 104,18 N y la altura promedio de 1.68 ± 0.07 m. La recolección de datos se realizó mediante una plataforma de fuerza bajo dos condiciones, con los ojos abiertos y los ojos cerrados. Hubo tres repeticiones de 60 segundos para cada condición. Las variables estudiadas fueron las fuerzas y momentos de la fuerza en los ejes X, Y, Z. La privación de la visión momentánea provocado cambios en la trayectoria, velocidad y desplazamiento del centro de presión, causando más de fluctuación en el centro de gravedad.

PALABRAS CLAVES: La ausencia momentánea de la visión, Control de la postura, Posturografía.

ANÁLISE DA ESTABILIDADE POSTURAL DE ADULTOS JOVENS NA PRESENÇA E AUSÊNCIA MOMENTÂNEA DA VISÃO.

RESUMO:

O objetivo deste estudo foi analisar a influência da privação momentânea da visão no equilíbrio postural ortostático de jovens saudáveis, com base na oscilação do centro de pressão. Participaram do estudo quatro indivíduos, um do sexo masculino e três do sexo feminino, com idade média de 24 ± 3,4 anos, peso corporal médio de 666,97 ± 104,18 N e estatura média de 1,68 ± 0,07 m. A coleta de dados foi realizada utilizando-se uma plataforma de força sob duas condições, com os olhos abertos e com olhos fechados. Foram feitas três repetições de 60 segundos para cada condição. As variáveis estudadas foram: as forças e os momentos de força nos eixos X, Y, Z. A privação momentanea da visão causou mudanças na trajetória, na velocidade e no deslocamento do centro de pressão, causando maior oscilação do centro de gravidade.

PALAVRAS-CHAVE: Ausência momentânea da visão, Controle postural, Posturografia.