36 - ANALYSIS OF POSTURAL CONTROL OF YOUNG WOMEN DURING EXPOSURE TO SENSORY PERTURBATIONS

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INTRODUCTION

The maintenance of body balance during upright posture is critical to the performance on daily basis activities. This maintenance is thanks to postural control system, consisting of the nervous, sensory and motor system, which performs the function of keeping the body in balance (FREITAS, DUARTE, 2006).

Thus, the sensory information allows the postural control system to obtain an estimate of body orientation in space, and the muscle activity enables the forces acting on the body to be balanced (BARELA, 2000).

Another important aspect regarding balance is that the upright posture is still unstable due to external and internal disturbances, which causes small oscillations of the body, almost imperceptible to the naked eye. If the postural control system is not able to nullify the effect of these disturbances, a fall may occur (FREITAS; DUARTE, 2006).

The postural control system receives sensory stimuli, visual, vestibular and somatosensory. These stimuli converge onto the central nervous system, where they are integrated in order to provide an appropriate muscle response (KOOJI et al., 1999).This interaction between sensory information and motor action is essential to the maintenance of balance (BARELA, 2000).

A way to evaluate how the postural control system uses sensory information is to manipulate the stimuli coming from these means and check the motor responses resulting from this manipulation. And depending on the environment where a certain task is performed, the postural control system can assign greater or lesser importance to a kind of sensory information, hence the importance given to each sensory system depend on its usefulness to the postural control system in each time (BONFIM; POLASTRI; BARELA, 2006).

To test the hypothesis that the sensory disturbances influence the postural control, this study aims to analyze the posturographic responses to sensory disorders in young women in four different conditions.

Materials and Methods

The study was conducted in collaboration with the Rehabilitation Engineering Laboratory at the Catholic University of Parana (LER-PUCPR).

For the data collection were applied: a force platform (AMTI, OR6-7-1000), a foam support (10 cm in height, density 33) coated on the size of the platform (Figure 1), and a screen, in which a visual target was set.

Figure 1 – Foam on the force platform

The sample consisted of four young women, with an average age of 27.4 ± 5.4 years, body mass 598.7±146.7N, and height of 1.7±0.13m, with no history of vestibular problems or significant skeletal muscles.

Each volunteer performed four different experimental conditions in a still-upright posture in the following order: 1 - eyes open without the foam support, 2 - eyes closed without the foam support, 3 – eyes open with the foam support, and 4 - eyes closed with the foam support. Three repetitions were performed for each condition, with a compiled time of 60 seconds in each position, resulting in twelve repetitions for each volunteer. Between each collection, the examinees took a two-minute break, sitting on a chair next to the platform. The acquisition frequency was 100 Hz.

We measured the height and weight of each volunteer before the data collection inception. With reference to the condition with the foam support, the platform was reset, so that their weight does not tamper the result. During data collection, the examinees were barefooted, and two volunteers remained with prescription glasses, and a volunteer using contact lenses of regular use. They were all instructed to maintain the upright posture, remaining on bipedal support on the platform, with their feet in a comfortable position during the different conditions. These parameters follow recommendations (FREITAS, DUARTE, 2006).

The data were processed, analyzed and plotted in Excel software, where the following variables were calculated: the RMS value of CP displacement of a-p and m-l, which represents the length of the trajectory of CP on the support base, and the RMS value of the average velocity (AV) of CP displacement of a-p and m-l, which is calculated by the CP dislocation travel in both directions, divided by the total time of collection. The general formula to calculate the RMS value is below, where the value of x is replaced by the value of the CP displacement or the value of the CP average velocity. And the value of N represents the total number of points acquired, in this case, 6000 points.

$$RMS_{\square} = \sqrt{\frac{{x_1}^2 + {x_2}^2 + \cdots + {x_N}^2}{N}}$$

These variables were chosen by their reliability and validity in clinical quantification of postural control (NIAM et al., 1999).

Results

As a result, we present the figures with the RMS values of the CP displacements, on the a-p and m-l directions, and the figures with the RMS values of the average velocity of dislocations in directions a-p and m-l for the five volunteers in the four conditions, as well as the average of the individuals on the left side of each figure.

Figure 2 presents the RMS value of CP displacement towards a-p, in the conditions of eyes open and eyes closed without the foam support. It is shown in figure 3 the RMS value of CP displacement towards m-l under the same conditions.

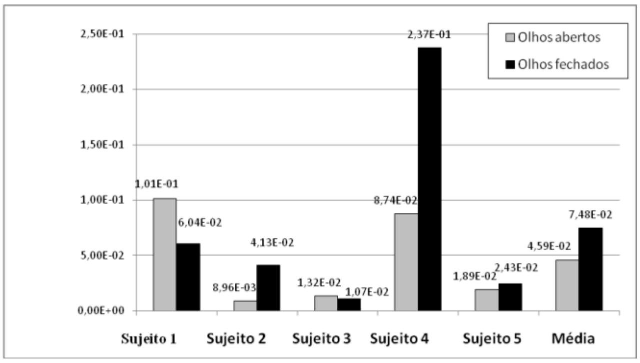

Figure 2 - RMS displacement of the CPa-p. Subjects without foam.

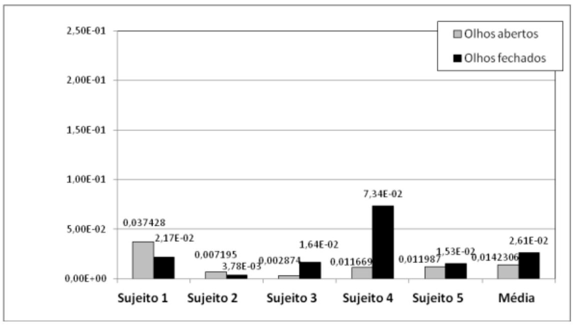

Figure 3 - RMS displacement of the CPm-l. Subjects with foam.

Figure 4 shows the RMS value of CP displacement towards a-p on the condition of eyes open and eyes closed with the foam support. And on figure 5 the RMS value of CP displacement towards m-l under the same conditions.

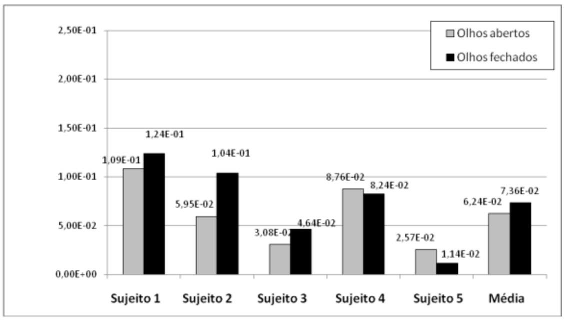

Figure 4 – RMS displacement of the CPa-p. Subjects with foam.

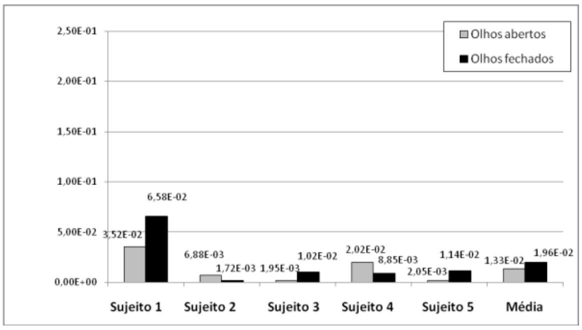

Figure 5 - RMS displacement of the CPm-l. Subjects with foam.

Figure 6 shows the RMS value of the average velocity of CP displacement towards a-p on the condition of eyes open and closed without the foam support.

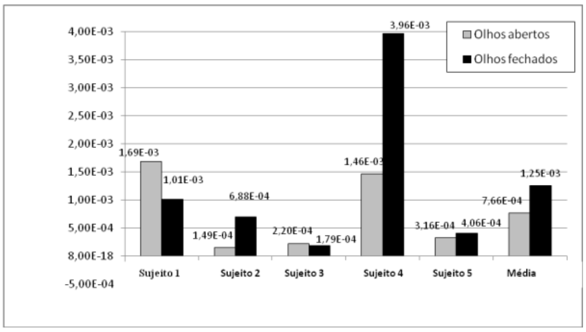

Figure 6 - RMS velocity average displacement of the CPa-p. Subjects without foam.

Figure 7 shows the value of the average velocity in the direction of displacement m-l under the same conditions.

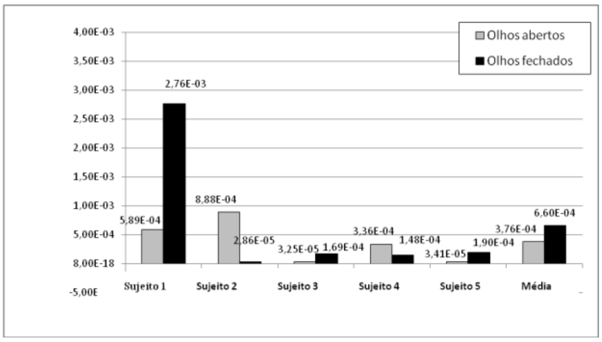

Figure 7 - RMS velocity average displacement of the CPm-l. Subjects without foam.

Figure 7 shows the RMS value of the average velocity of CP displacement towards a-p on the condition of eyes open and closed with the foam support. It is shown in figure 9 the value of the average velocity in the direction of displacement m-l under the same conditions.

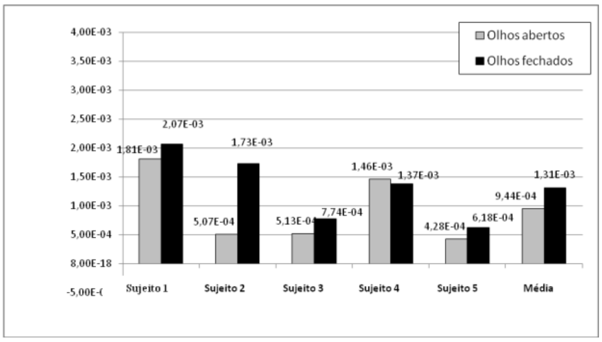

Figure 8 - RMS velocity average displacement of the CPa-p. Subjects with foam.

Discussion

The information integration from the sensory systems is regulated to adapt to the changes that occur in the environment and the sensory information available in each moment (PETERKA, 2002).

In other words, when one is standing on the foam support, the somatosensory information is disrupted and the individual begins to rely more on other information such as the vestibular and visual. In addition to that, the examinee is deprived of visual information, the reference information may become vestibular information.

To assess the individual's ability to use available sensory information, and withhold that inaccurate sensory information, some studies have manipulated the sensory systems of visual, vestibular and somatosensory systems [2, 5, 9].

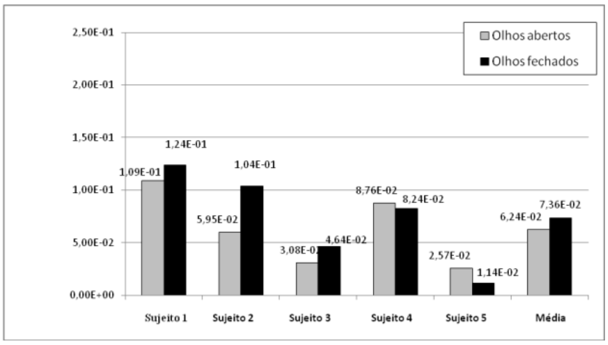

Figure 9 - RMS velocity average displacement of the CPm-l. Subjects with foam.

The current study aimed to investigate the acute effects of sensory disturbance on postural control of young women, in different conditions and visual support.

When examinees were deprived of vision, without the foam support, the RMS value of CP displacement was higher in a-p than in m-l (figures 2 and 3).

Now with the foam support, we see that individuals have a tendency to make a greater CP displacement in both directions (figures 4 and 5).Then again, the disturbance of somatosensory information has led to an increase in CP displacement in both directions.

Researchers Wang and Lin (WANG; LIN, 2008) placed some experiments leading to different stages of somatosensory loss in healthy volunteers and assessed their effects on postural control, concluding that the higher the somatosensory loss, the greater the oscillation amplitude of the pressure center of the individual, that is, the higher your body oscillates.

In figures 6 and 7 we see that the RMS values of medium speed, a-p and m-l, were higher when examinees were deprived of sight, but were not higher when compared to the different support bases, that is, individuals did not have RMS speed value greater when they were on the foam support. This may be due to non-normal distribution of data, since there are individuals pulling this average to values that do not represent very well the group.

The first examinee had the highest RMS value of m-l velocity with eyes closed, without the foam support. Examinee 4 also had the highest RMS value of m-l velocity with eyes closed, without the foam support. This shows that the examinees rely more on visual information to maintain postural control.

The examinees had the highest RMS values of average speed on a-p and m-l directions when they were on the foam support (figures 8 and 9), than when they were not on the foam support. And this RMS value of average velocity increased in all conditions and also when examinees were deprived of vision.

A difference can be noticed between the conditions performed with and without the foam support, some people are far from the group average, in the conditions without foam support. This can be explained by the occurrence of accommodation, since the first six attempts had no foam support, and the last six had the foam support, this standard sequence was used on the collection and may have tampered the results.

From the obtained results, it was found that the foam support increased body oscillation in all visual conditions, and that, further deprivation of vision also increased body oscillation in different situations of support.

But despite the results, it is not possible to guarantee the predominance of one sensory information over the other, because it occurs predominantly in different ways depending on particular circumstances.

For instance, in the condition of this study, visual information overlaid somatosensory information, which was disturbed by a foam support, so that visual information has become vital for the postural control system.

Despite a limited number of volunteers, which can be increased in the future, the analysis can use more variables and assessing different forms of sensory disorders.

Conclusions

In this study, despite the obtained results, it was not possible to confirm that a sensory system was more prevalent than others.

Therefore, the use of sensory information by the postural control system will depend on the condition of the task to be performed, and the relevance of the information available at this time.

Acknowledgements

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References

BARELA, José A. Control strategies in complex movements: perception-action cycle in postural control. **Paulista Journal of Physical Education,** São Paulo, supl. 3, p. 79-88, 2000.

BONFIM, T. A.; POLASTRI, P. F.; BARELA, J. A. Effect of light touch and visual information in the control of standing adult. **Journal of Physical Education and Sport.** São Paulo, v.20, n.1, p.15-25, 2006.

FREITAS, S. M. S. F.; DUARTE, M. Methods of analysis of postural control. **Laboratory of Biophysics.** School of Physical Education and Sport, University of Sao Paulo, 2006.

KOOIJ, H. V. D.; JACOBS, R; KOOPMAN, B.; GROOTENBOER, H. A multisensory integration model of human stance control. **Biological Cybernetics.** v.80, p. 299-308, 1999.

NIAM, S.; CHEUNG, W.; SULLIVAN, P.E.; KENT, S.; GU, X. Balance and physical impairments after stroke. **Archives of Physical Medicine Rehabilitation.** v. 80, n. 10, p. 1227-33. 1999

PETERKA, R. J. Sensorimotor integration in human postural control. **Journal of Neurophysiology.** Bethesda. v. 88, n. 3, p. 1097-1118, 2002.

WANG, T.; LIN, S. Sensitivity of plantar cutaneous sensation and postural Stability. **Clinical Biomechanics.** v. 23, p. 493–499, 2008.

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ANALYSIS OF POSTURAL CONTROL OF YOUNG WOMEN DURING EXPOSURE TO SENSORY PERTURBATIONS

ABSTRACT

The aim of this study was to analyze the influence of sensory disturbance on postural orthostatic balance of young women, based on the oscillation of the pressure center. Participated in this study five women, with mean age 27,4 ± 5,4 years, body weight 598.7 ± 146.7 N, and height 1.7 ± 0,13 m. Data collection was performed on a force platform under four conditions, with eyes open and eyes closed, with and without the foam backer. Three repetitions of 60 seconds for each condition. The variables analyzed were: RMS velocity average, and RMS displacement of the center of pressure. The results obtained showed that the foam support with increased body sway in both situations visuals, and yet, deprivation of vision also increased body sway in different situations of support.

KEY WORDS: postural control, sensory disturbances, posturography.

ANALYSE DU CONTRÔLE POSTURAL DE FEMMES JEUNES PENDANT L'EXPOSITION DES PERTURBATIONS SENSORIELLES.

RÉSUMÉ

L'objectif de cette étude était d'analyser l'influence de la perturbation sensorielle dans le contrôle posturale orthostatique dans femmes jeunes, basée sur l'oscillation du centre de pression. L'étude comprenait cinq femmes, âge moyen de 27.4 ± 5.4 ans, poids moyen de 598.7 ± 146,7 N, et de hauteur moyenne de1.70 ± 0.13 m. Pour réaliser la collecte des données, on a adopté une plateforme de force sous quatre conditions: les personnes débout en alternance aux yeux ouverts et aux yeux fermés, avec et sans l'aide sur la mousse en trois répétitions de 60 secondes pour chaque condition. Les valeur RMS de la vitesse moyenne, valeur RMS du disloquement du centre de pression, ont été les variables étudiées. Et puis, les résultats obtenus ont montré que le support de mousse a augmenté l'oscillation corporelle dans les deux conditions visuelles, et encore, la privation de la vision a aussi augmenté l'oscillation corporelle dans les différentes situations de support.

MOTS-CLÉS: contrôle posturale, perturbations sensorielles, posturografie.

ANÁLISIS DEL CONTROL POSTURAL DE LA MUJER JOVEN DURANTE LA EXPOSICIÓN A ALTERACIONES SENSORIALES

RESUMEN

El objetivo de este estudio fue analizar la influencia de los trastornos sensitivos en el control postural ortostática en mujeres jóvenes, sobre la base de la oscilación del centro de presión. El estudio incluyó a cinco mujeres, edad media de 27,4 ± 5,4 años, peso corporal medio de 598,7 ± 146,7 N, y la altura media de 1,70 ± 0,13 m. Para recopilar los datos se utilizó una plataforma de fuerza bajo cuatro condiciones, con los ojos abiertos y los ojos cerrados, con y sin el apoyo de la espuma. Hubo tres repeticiones de 60 segundos para cada condición. Las variables estudiadas fueron: valor RMS de la velocidad media, el valor RMS de desplazamiento del centro de presión. Los resultados mostraron que el respaldo de espuma mayor balanceo del cuerpo, tanto en condiciones visuales, y la privación adicional de la visión también aumentó balanceo del cuerpo en diferentes situaciones de apoyo.

PALABRAS CLAVE: control postural, trastornos sensoriales, posturografía.

ANÁLISE DO CONTROLE POSTURAL DE MULHERES JOVENS DURANTE A EXPOSIÇÃO Á PERTURBAÇÕES SENSORIAIS

RESUMO

O objetivo deste estudo foi analisar a influência da perturbação sensorial no controle postural ortostático em mulheres jovens, com base na oscilação do centro de pressão. Participaram do estudo cinco mulheres, com idade média de 27,4 ± 5,4 anos, peso corporal médio de 598.7 ± 146.7 N, e estatura média de 1,70 ± 0,13 m. Para a coleta de dados foi utilizada uma plataforma de força sob quatro condições, com os olhos abertos e olhos fechados, com e sem o apoio sobre a espuma. Foram feitas três repetições de 60 segundos para cada condição. As variáveis estudadas foram: valor RMS da velocidade média, valor RMS do deslocamento do centro de pressão. Os resultados obtidos mostraram que o suporte de espuma aumentou a oscilação corporal nas duas condições visuais, e ainda, a privação da visão também aumentou a oscilação corporal nas diferentes situações de suporte.

PALAVRAS-CHAVE: controle postural, perturbações sensoriais, posturografia.