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Postural changes associated with ageing on the sensory organization test and the limits of stability in healthy subjects

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ABSTRACT

Objective: Acknowledgement of the age effects on postural control and balance is essential to differentiate between physiological changes and actual pathological alterations of the elderly. The aim of this study is to establish the age-related postural changes recorded by the Computerized Dynamic Posturography.

Material and methods: 70 healthy individuals (35 males and 35 females) with an average age of 44.9 years, evenly distributed in seven age groups. We carried out a *Sensory Organization Test* and *Limits of Stability* with the Neurocom Smart Balance Master® posturography platform. Statistical analysis was undertaken using ANOVA ($p < 0.05$).

Results: Increased age-related balance percentage for Condition 4 ($p = 0.022$), reduced usage rate of ankle-strategy for Conditions 3 ($p = 0.027$) and 4 ($p = 0.05$) for the higher age groups were reported. Regarding limits of stability, the following were the results: age-related differences at an early stage, reaction time from 40 to 49 years, velocity of movement, excursion and directional control from 50 to 59 years.

Conclusions: Age only affects the balance rate under more complex sensory conditions. For healthy people, ankle strategy is more frequently used than hip strategy; however, the use of hip strategy increases under more difficult sensory conditions. Limits of stability get worse with age, namely after the age of 40–50 years.

1. Introduction

Balance is a reflex activity through which humans are able to maintain their body posture against gravity and natural inertia without falling. To maintain balance, it is necessary, first, to obtain a stable field of view, coordinating eye and head movements (vestibulo-ocular system), and second, to maintain muscle tone coordinating the movements of the skeletal muscles (vestibular-spinal system) so that the centre of gravity lies within the support base. In addition, temporal orientation is needed [1]. As a result of individual learning processes, balance control varies widely among healthy people [2].

Vertigo, dizziness and balance disorders in general, are some of the most frequent reasons to meet a general doctor or a otorhinolaryngologist. Balance disorders are a serious problem affecting socially, economically and personally [3,4]. They can cause significant impacts on the quality of life of affected persons, usually leading to a sedentary lifestyle, largely reducing the ability of the persons to undertake common activities such as work and leisure and leading to higher levels of morbidity due to the increased risk of falls and subsequent fractures, especially in elderly patients. Such disorders may also lead to life-threatening situations, for example, for operatives working at heights, e.g. aerial installers, scaffolders, etc. [5].

Recent years have shown a progressive increase in life expectancy, which means that general practitioners and specialists increasingly need to face a more elderly population in their daily appointments. In order to adequately evaluate the presented conditions of these ageing patients, a good knowledge of the effects of age on postural control and balance is key, as only this will allow the ability to distinguish between age-related physiological changes and actual pathological changes [3–6].

Therefore, the aim of this study is to establish the age-related postural changes recorded by the Computerized Dynamic Posturography (CDP).

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2. Material and methods

2.1. Subjects

As part of a wider postural study of healthy subjects, a group of 70 healthy individuals with no history of balance pathologies (35 men and 35 women) with an average age of 44.9 years (range 16–81 years) were selected. They were homogeneously distributed into seven age groups (10 subjects per group, 5 women and 5 men), children under 20 years, between 20 and 29, 30 and 39, 40 and 49, 50 and 59, 60 and 69 and equal to or greater than 70 years.

This study has been approved by the Comité Ético de Investigación Clínica de Galicia (CEIC) and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki (as revised in Tokyo 2004). All persons gave their informed consent prior to their inclusion in the study.

Inclusion criteria of subjects in the study were as follows: absence of pathologies affecting balance; no use of medication affecting the central nervous system, balance or coordination; no clinical imbalance; absence of clinical disease suggestive of vestibular or neurological disorders; absence of psychological disorders (including depression); no records of unexplained falls in the previous 6 months, and normal vision with glasses or contact lenses compensated.

A detailed medical history was obtained for each patient, including demographic and clinical data. Demographic data recorded comprised: name, age, sex and profession. Clinical data recorded comprised: personal history and current treatments. On physical examination records of height and weight were collected and a basic otoneurological scan was performed. The scan included otoscopy, evaluation of the strength, sensation, cranial nerves, Bárány pointing test, cerebellar testing, verification of absence of spontaneous or induced nystagmus test cephalic agitation, absence of saccades by Halmagy test, Romberg test and test of Unterberger.

2.2. Postural study

In order to develop the study the Neurocom Smart Balance Master® posturography platform was used (Fig. 1).

For the postural study a *Sensory Organization Test* (SOT) was carried out, which recorded the movements of the centre of pressure with the patient standing in 6 conditions: Condition 1: eyes open, fixed visual environment and fixed platform. Condition 2: eyes closed and fixed platform. Condition 3: eyes open, moving visual environment and fixed platform. Condition 4: eyes open, fixed visual environment and mobile platform. Condition 5: eyes closed and mobile platform. Condition 6: eyes open, moving visual environment and mobile platform. The patient was placed on the platform in the Romberg position, barefoot, with a safety harness. The time running each condition was 20 s.

To study the *Limits of Stability (LOS)*, the patient was asked to move their centre of pressure (represented by a pictogram on a screen in front of him) along the path of a moving circle through eight different points in the space, always passing through the central starting position.

2.3. Statistical study

The variables analysed in the *Sensory Organization Test* were the percentage of balance and strategy analysis. For the *Limits of Stability*, the reaction time, velocity of movement, excursion and directional control were analysed.

The collected data was recorded in the Microsoft Excel Microsoft Office 2000 package. The data was subsequently imported into SPSS 16.0 for Windows for the inference statistical analysis. Normality of the variables was tested using the Kolmogorov–Smirnov test. Finally, in order to establish the possible existence of significant differences between different age groups, the ANOVA test was used with a significance level of 5% (p-value less than 0.05).

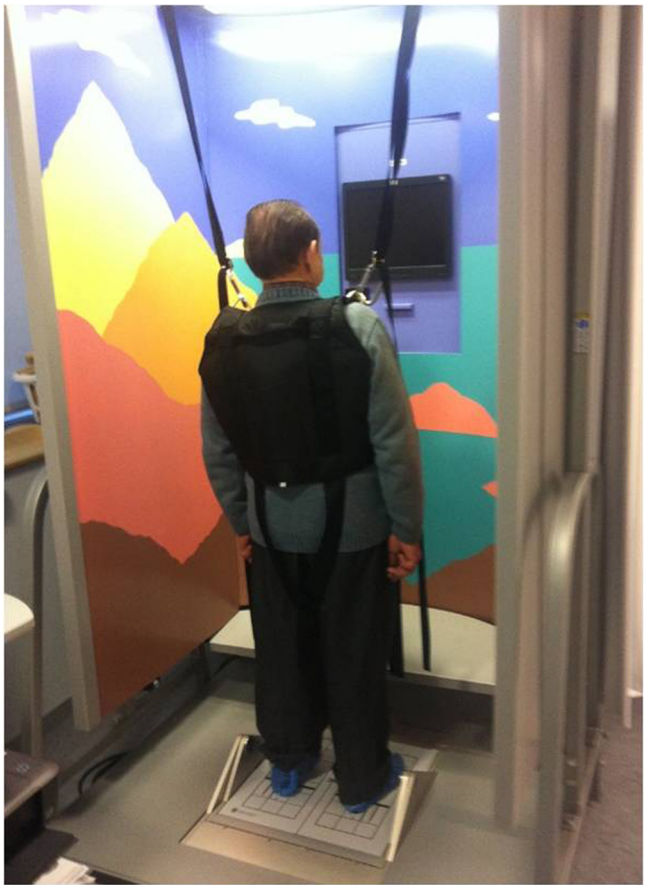

Fig. 1. Computerized dynamic posturography: Neurocom Smart Balance Master® posturography platform.

3. Results

3.1. Sensory organization test

3.1.1. Percentage of stability

Table 1 shows the results of the percentage of stability for each one of the six conditions and the composite of the *SOT* for each of the different age groups. Applying ANOVA establishes the existence of statistically significant differences of the average balance percentage between the different age groups for Condition 4 ($p = 0.022$) (Fig. 2).

In Condition 5 we see that the percentage of balance tends to decrease with age, but this decrease is not statistically significant ($p = 0.05$).

3.1.2. Strategy analysis

The strategy analysis, using percentages of stability, provides us information regarding the relative amount of movement of the ankles or hips that the patient uses to maintain balance in the sensory conditions tested. Table 2 summarizes the strategies used under the conditions of the SOT for the different age groups. It can be seen that the percentage decreases over the years, which means that with increased age the hip strategy is used more frequently, but these differences are statistically significant only for the ankle

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