

COMPUTERIZED POSTUROGRAPHY IN THE DIAGNOSIS AND TREATMENT OF THE INSTABILITY OF THE ELDERLY

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ABSTRACT

Aging of the world's population is a fact that accounts for the emphasized interest for the pathology of the elderly. The objective of this paper is the evaluation of the utility of computerized posturography in the diagnosis and treatment of the instability in the elderly. The syndrome of instability of the elderly, also called presbyastasis is a pathology that requires increased attention because of the traumatic risks involved, due to the falls. Presbyastasis is difficult to diagnose because there are no functional alterations perceivable at the vestibular examination (no spontaneous nystagmus, no rotatory and caloric tests modifications). Computerized posturography may be used to diagnose the instability syndrome appeared in the elderly. There are modifications at the sensory organization test (SOT) that can be revealed in computerized posturography. The risk of falls can be assessed using special tests. The therapy of the instability syndrome of the elderly is mainly based on vestibular rehabilitation therapy that can be performed using the posturography platform.

In conclusion computerized dynamic posturography is a diagnostic as well as a therapeutic tool that can be used for the diagnostic and treatment of age related balance disorders.

Key words: computerized posturography, elderly, presbyastasis, vestibular rehabilitation

INTRODUCTION AND BACKGROUND

Presbyastasis is defined as the syndrome of instability in the elderly. Presbyastasis is a term used to designate the impairment of the capability of maintaining balance, appeared in old ages. This term was used for the first time by Belal and Glorig in 1986 in a study on 740 elderly patients with vestibular dysfunction (1). Aging of the world's population is a well known fact. That is the reason why the pathology of the old age is a major interest for the medical community. It is considered that thirty percent of the people over 65 years of age experience some form of dizziness (2-4).

Presbyastasis appears as a result of the degeneration of all the structures involved in equilibrium. The labyrinth, the visual system, the vestibular nerve, the central nervous system, the propriocep-

tors, the muscular system are affected by age related degeneration (2,5). We prefer the use of the term of presbyastasis instead of other terms encountered in the literature such as presbyvertigo or presbyataxia. We don't consider the usage of the term "presbyvertigo" very accurate because there seldom can be found a true vertigo (defined as a false rotation sensation), as a result of age degeneration. Vertigo is usually the result of an acute unilateral lesion of the vestibular system mainly a lesion of the peripheral component. On the other hand, aging is a process that involves the entire organism, not only the labyrinth. We also consider improper the use of the term "presbyataxia". The definition of ataxia is a lack of coordination of the muscular movement but the instability exhibited by the elderly with equilibrium disorders is the result of the lack of muscular movement coordination and also

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the result of the degeneration of other structures involved in maintaining the equilibrium: the vestibular system, the visual system, the proprioceptive system. Therefore “presbyataxia” doesn’t describe all the alterations related to the instability in the elderly.

At old age, all the labyrinth structures degenerate. The otoliths undergo a process of demineralization, fragmentation that generates otolitic disorders (2,5,6). This accounts for the increased incidence of benign paroxysmal positional vertigo in old ages (7).

The number of ciliate cells diminish with age. It is considered that at 65 years there is a 40% decrement in the number of receptor cells in the ampular crests and a 20% decrement in the number of receptor cells in the otolitic organs (7,8).

Type I cells are the most affected.

The number of nerve fibers in the vestibular nerve and the the number of neurons in the Scarpa ganglia diminishes. The cerebellum degenerates with age in such a manner that at 60 years there is a decrement with 25% in the number of Purkinje cells (8).

Visual aging induces characteristic changes. Cataract, glaucoma, age related macular degeneration may occur. The motility of the eyebulbs decreases with the decrement of the type II muscular fibres – rapid fibres. As a result the quality of the visual information is impaired and the visual input is affected.

Proprioceptive aging leads to the malfunction of the mechanisms of postural adaptation. The muscular mass diminishes. The articulations and the ligaments are affected by arthrosic processes, fibrosis, demineralization (9).

The fact that in the great majority of cases there are no functional alterations is an important characteristic for presbyastasis. There is no nystagmus, the caloric and rotatory tests are negative. (9,10)

The posturographic measurements may highlight changes. The computerized posturography is able to asses the instability and may measure modifications occurred in the equilibrium system as a result of aging.

COMPUTERIZED POSTUROGRAPHY

Posturography is used to asses the stability of the body, it is an instrument able to quantify the equilibrium function. It may also reveal a visual dependency or a vestibular omission that may characterize old age equilibrium (11).

Posturography is a method of measuring the proportion in which different inputs participate at maintaining the equilibrium: the visual input, the vestibular input and the proprioceptive input (12). Posturography consists in a sensory organization test SOT and a dynamic computerized posturography test.



FIGURE 1. Posturography platform

SOT (sensory organization test)

The classic SOT is a test that consists in 6 different conditions used to maximize or minimise the input from somatosensory, visual and vestibular systems. The postural sway is assessed using force-plate technology. The first three conditions use a firm plate with the eyes opened, closed or with a swaying visual surround. The next three conditions use a mobile, unstable plate. In this condition the tests are repeated with eyes opened, closed and swaying surround. Normal subjects control their gravity center keeping it inside the base of support, preventing falls. (13)

The results of the posturographic assessment are compared to age matched norms.

Posturography demonstrates which sensory systems are used to maintain balance, assessing the functional use of the vestibular system to achieve postural control. The result is represented with his-

tograms. For an easier interpretation the normal results are coloured in green and the pathologic ones are coloured in red. (14) We are currently using a Sinapsys posturographic system. The results of a SOT performed by this system are represented in the figure (see figure2).

There are several possibilities:

- A normal result: all the columns are green
- The equilibrium is globally affected but all the systems involved function normally: only the global evaluation is red, the other columns are green
- Abnormal visual input: the visual column and the global column are red
- Abnormal vestibular input: the vestibular column and the global are red
- Multisensorial impairment: any combination. Usually this means that the lesion is situated at a central level (15)

The swaying and the postural instability in the elderly is best assessed and analyzed quantitatively by using the posturography. The distance of sway increases with advanced age. The total area covered by the centre of gravity has a tendency of decreasing with age, showing a negative correlation with age. Computerized posturography seems to be a useful investigating tool in assessing the age related balance disorders (16).

Faller assessment

Motor dynamic posturography shows a great capacity of detecting the subject tendency to fall. Identifying the “fallers” has an important role in avoiding traumatic pathology (17).

The computerized dynamic posturography includes also tests involving displacements of the platform eliciting balance maintaining reflexes. In

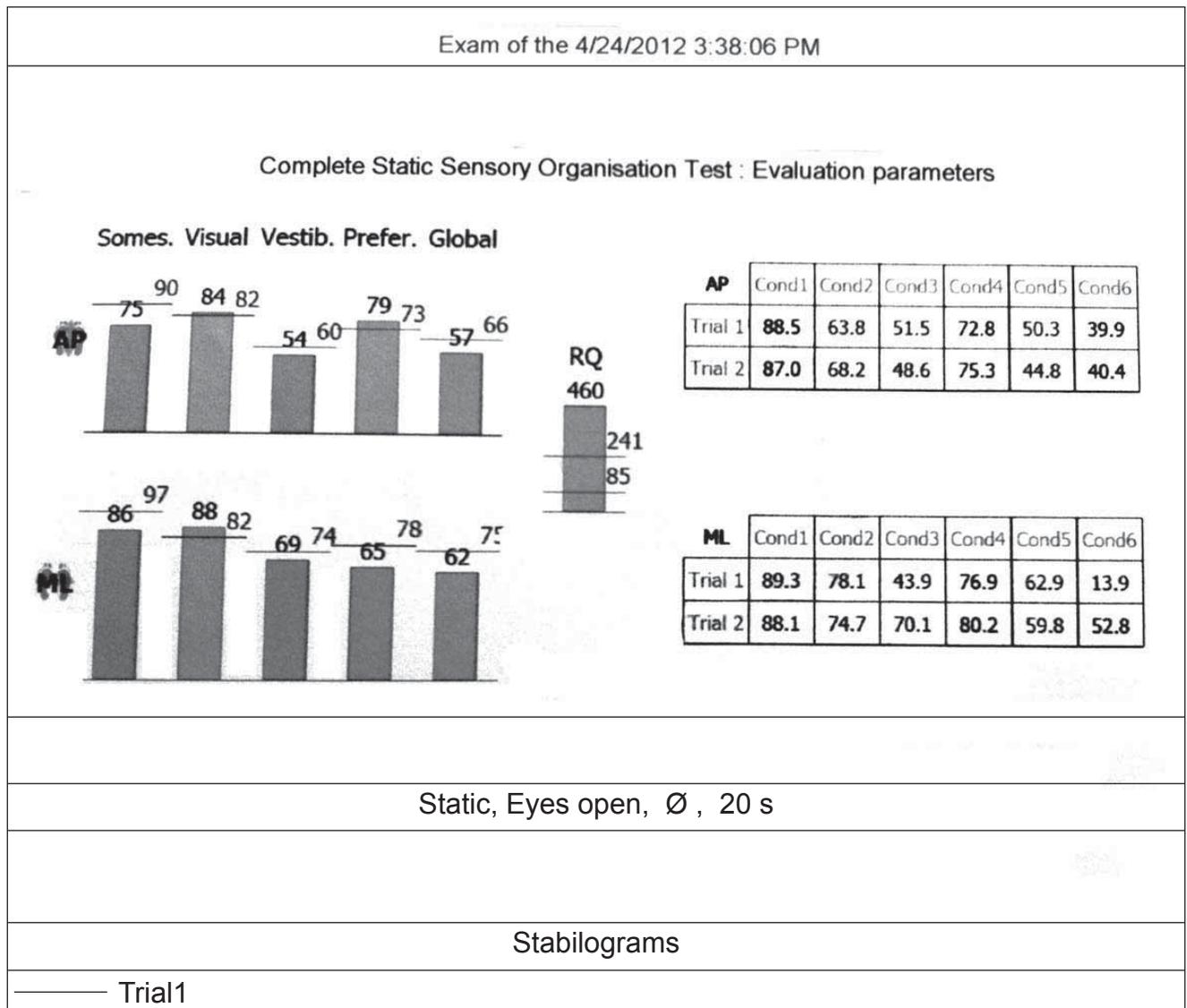


FIGURE 2. SOT results. Notice the proprioceptive, visual, vestibular, preferential and global scores and the normal histograms coloured in green and the pathologic histograms coloured in red.

this manner it is assessed the subject's capability to avoid falling (18).

Faller assessment is an indicator on the risk of falls for the elderly. The tests of the assessment provide four evaluation criteria for the risk of fall (19). The following table indicates the different parameters examined as well as the alternating conditions of the criteria.

TABLE 1. Criteria used for assessing the risk of falling

Criteria	Tests	Parameters	Alternating conditions of the criteria
1	Translation eyes open	Energy in X Energy in Y Recovery time in X	2 or 3 supratreshold parameters = positive criteria
2	Translation eyes closed	Energy in X Energy in Y Recovery time in X	2 or 3 supratreshold parameters = positive criteria
3	Sinusoidal movement	Gain in Y Eyes closed Gain in X Eyes closed Gain in Y Open eyes	2 or 3 supratreshold parameters = positive criteria
4	Limits of stability	Surface	< 20000 mm ² = positive criteria

The simultaneous alternating of the last three of the four criteria is a very relevant index, making it possible to identify the fallers with a responsiveness of 97% and to recognize the non fallers with a specificity of 77% (20,21,22).

Vestibular rehabilitation using the posturography platform

Another application of the computerized posturography is the possibility of using the platform for vestibular rehabilitation (23). Vestibular rehabilitation is a treatment modality used to increase static and dynamic postural control and minimize the risk of falling. (24)

Medication has low impact on the vestibular impairment of older individual. There are studies that show a correlation between the number of medications and the postural performances (25,26). A vestibular rehabilitation program permits the adjustment of the relationship between visual, proprioceptive and vestibular information (27,28,29). Vestibular rehabilitation is exploiting the mechanisms of neuroplasticity specific to the central nervous system. Neuroplasticity represents the physiological base of vestibular compensation (29,30, 31).

There are four types of rehabilitation games available on the Posturography System:

- Stabilisation, these are the games whose instruction to the patient is to stay as stable as possible
- Weight shift: the patient is instructed to reach a target by performing a weight shifting then come back to its initial position
- Weight bearing: the patient must perform weight shifting then stay in this instable position.
- Postural control: the patient must maintain his balance. These games combine the stabilisation, the weight shift and the weight bearing.

Patient's evolution during the rehabilitation therapy is assessed by the "limits of stability" tests carried out in each session (32).

When used alone, vestibular rehabilitation is efficient in approximately 54% of the patients (33).

DISCUSSIONS AND CONCLUSIONS

Aging of the world's population is a well known fact. Medicine is facing new problems concerning old age health related issues. Balance in the elderly is one of these problems, because of the risks related to falls. Traumatic pathology frequently occur in old patients with balance disorders. On the other hand, the quality of life of the elderly is impaired by the chronic instability. Psychological changes such as depression, anxiety, loneliness may also occur.

The term of presbyastasis is a term that appeared in order to designate all the changes that are related to the old age instability. Presbyastasis is an exclusion diagnosis. Measuring the balance deficit linked to this sort of pathology is not easy taking into account the fact that the clinical tests performed can be normal. Usually there are no clinically detectable deficits. Even technical investigations such as electronystagmography or videonystagmography with rotatory and caloric tests, may not reveal typical modifications.

Computerized dynamic posturography is an useful tool that assesses the balance disorders in old age. It quantifies the deficits and the proportion, the weight, each balance input has in the process of maintaining the equilibrium. Another important aspect regarding the clinical use of posturography is the detection of the "fallers" through special tests involve motor control.

Computerized dynamic posturography is also useful in the therapy of age related balance disorders. Vestibular rehabilitation exercises are available for this platform. The evolution of the patient's

performances through the sessions can be measured offering support for the therapy.

In conclusion computerized dynamic posturography is a diagnostic as well as a therapeutic tool

that can be used for the diagnostic and treatment of age related balance disorders.

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