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The influence of age on a postural balance

Ewelina Pankanin

Scientific Circle at Department of Hygiene, Epidemiology and Ergonomics. Division of Ergonomics and Exercise Physiology, Nicolaus Copernicus University in Toruń, Collegium Medicum in Bydgoszcz, Poland

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Abstract

The physiological and correct posture of a human body is a vertical attitude. A small support surface and relatively high body height cause a small but continuous balance. Maintaining a stable posture requires efficient operation of the balance system. However, with age, the involutionary changes taking place in the body impair its functioning.

Balance

The typical human straight posture is characterized by vertical positioning of the body axis in relation to a small support plane. Such a body orientation in the gravitational field and a multi-segment structure, as well as a small support surface and considerable body height cause that in static conditions the standing posture of the person is unstable. However, the constant, active posture regulation exercised by the balance control system can ensure body stability. Balance

control relies on static and dynamic balancing the destabilizing forces of gravity and inertia (and their moments) by stimulating appropriate muscle groups.

The balance control system includes many structures of the central nervous system. It can be assumed that the control system has three inputs on the base, which determine the spatial position of the body's centre of gravity. Under physiological conditions, information arrives from the vestibular system, the organ of vision and deep sensory receptors (found in the muscles, joints and skin), it allows the correct orientation of the body in space and maintaining balance. Compatibility and multiplicity of information reaching the central nervous system through individual sensory inputs cause that impairments of the function of one of them are quickly and effectively compensated. The controlled parameter is the spatial position of the body's central centre of gravity (COG). Both COG positions relative to the support surface and physiological stability limits are controlled. The theoretical limit of stability of the human posture is the surface passing through the centre of gravity, whose shifts can cause a fall. Under normal conditions, the balance control system provides a certain margin of stability, i.e. the optimal position of the centre of gravity of the body relative to the limit of stability [1].

Senility, aging - definition and division

Old age and aging are concepts that have not yet been clearly defined. Old age is treated as a phenomenon, the life phase, while aging is a process. Old age is a stage, a state in human life and is static, aging, on the contrary, it is a developmental process and a dynamic phenomenon. Aging can be defined as a gradual decrease in the functional reserve of organs, which reduce the possibility of maintaining the systemic balance. It is a continuous and irreversible process, proceeding in stages [2].

Aging is similarly described by Kijak RJ. and Szarota Z., according to them, it is a multilayered and multidimensional process, depending on many co-existing factors, internal and external (genotype and phenotype, i.e. environmental impact). It is also a natural developmental phase in the life cycle. In the biological aspect, it consists in decreasing the ability to regenerate the system, decrease the ability of self-renewal of cells and tissues, and finally - weaken the adaptive capacity of the body. The involutionary processes dominate the evolutionary ones. This process is not the same for everyone: there are significant individual differences in the aging rate, including all internal organs that may age ("consume") at a different pace under the influence of lifestyle and external factors. The different pace of aging is influenced by genetic factors, as well as the conditions of existence of the individual and preferred lifestyle and habits.

Although we know what the aging process is, so far the causes of this process have not been known [3]. A few hundred hypotheses have been formulated, but none of them has gained unambiguous recognition.

Bromley D. divides the biological theories of aging into two groups:

- stochastic theories - assume that aging is a derivative of random factors, the effect of cumulative damage and injuries, occurring in the earlier stages of life, as a result of which harmful substances are accumulated in the body, being a derivative of metabolism and cell distribution
- demonstrative determinants - they assume that life expectancy, the rate of the aging process and its quality are regulated by genetic predispositions [4].

Aging is a purposeful process, programmed by nature: it depends on the biological clock, it is regulated by genes. During life, there are numerous damages to the genetic material (chromosomes). Cellular theories of aging assume that the number of cell division is strictly defined. The cause of aging and, as a consequence, cell death is the loss of the ability to further divide, caused by shortening the ends of chromosomes called telomeres [3].

There are many divisions of old age in literature.

WHO recognizes 60 years of age as the beginning of old age. It distinguishes three basic stages:

- from 60 - 75 years of age - early old age;
- from 75 - 90 years old - late old age;
- 90 years and above - longevity [3].

Simone de Beauvoir, on the other hand, believes that old age is not a uniform period and has distinguished two stages of the last phase of life, taking as one of the criteria the functional age, i.e. psychophysical abilities of an elderly person:

- in the first phase, the elderly are functionally independent,
- in the second phase older people are dependent [5].

Stuart Hamilton I. identified four age groups:

- "young old" (60-69 years old),
-old middle-aged (70-79 years old),
- "old old" (80-89 years),
-defective old-after the age of 90 [6].

The aging process can also be divided. The first type is healthy aging (the least common), in the course of which there are no disease processes. Another, that is, ordinary aging, consisting of minor disease states. These diseases are chronic and do not significantly affect the deterioration of the quality of life of older people. The least favourable type listed in this division is pathological aging [7].

The influence of age on the balance

Posture and its stability change with individual development - from childhood to old age. The posture control is continuously adjusted to changing environmental conditions. Permanent modifications of posture control are observed as a result of developmental and pathological changes taking place in the body. In the period to 7.-8. year of life, the posture gradually stabilizes. During the body's puberty, the posture of the body flares under the influence of neurohormonal changes, followed by the adoption of a correct, stable figure. This posture is characterized by proper muscle tone and the education of physiological curvatures of the spine. This condition lasts only until the age of 30, after which a gradual degradation of the balance system function occurs. As a result, with age, a gradual impairment of the motor and postural system functions is observed, since the performance of which determines the stability of posture. For a long period of life, central compensatory mechanisms effectively counteract the effects of loss of postural stability, however, in the late old age failure of these mechanisms causes a sharp decline and breakdown in posture stability [1]. In addition, the balance among older people is often influenced by the drugs used, for example, psychotropic, antidiabetic or hypotensive, which may cause dizziness and be a reason for imbalance. Also often preferred, passive lifestyle conducted by elderly people favours postural disorder. In addition, a worse balance results also from psychic aspects, i.e. fear of falling [8]. The main symptom of postural instability is imbalance, which results in falls - often with tragic consequences [1].

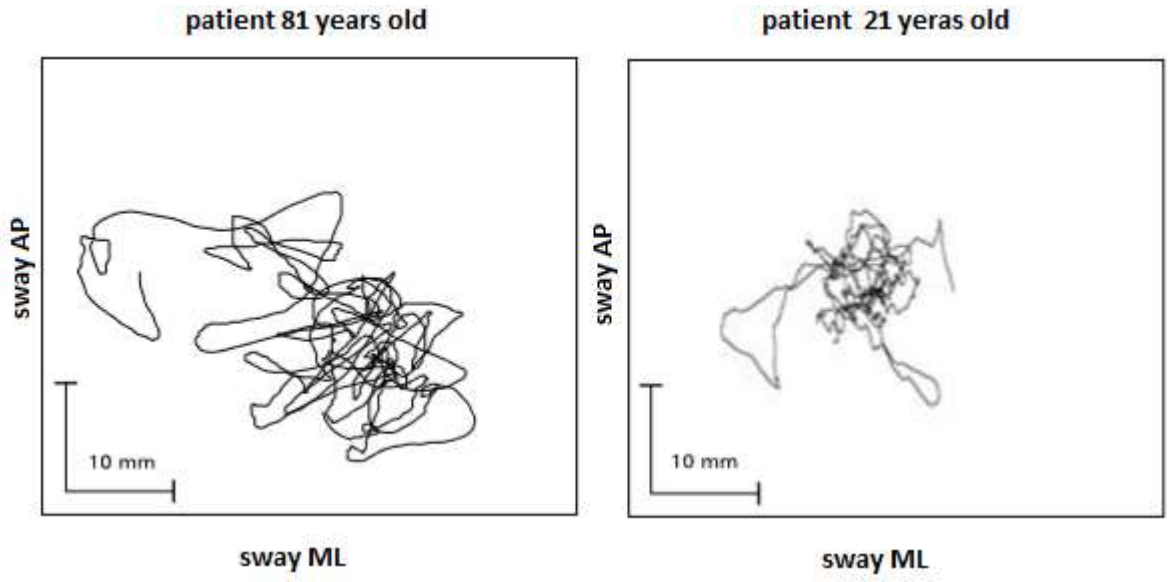

Figure 1. Comparison of elderly (aged 81) and young adults spontaneous postural sway measurements during quiet standing [1].

Protasowa, Bondarewskij, Levando distinguish three involutional phases of balance. The first in the age of 26-45 years, ie the phase of compensation without noticeable statistical differences, the second phase falls on 46-55 years with a tendency to deteriorate the balance function and the third phase from 56 years, when statistically significant changes in the sense of balance are observed [9].

Research

Studies by many authors have shown that the regression of the body balance function increases with age.

1. Patricia A. Hageman et al. they compared the balance of 24 people qualified to the appropriate age group. The first group consisted of people aged 20-35, while the second group was composed of people aged 60-75. Both men and women were in both groups. Outcome measures included five force platform measures and functional reach (cm). The force platform measures, obtained using the Balance Master system, included movement time and path length to targets, and sway area under conditions of eyes open, eyes closed, and with visual feedback.

Results

Results showed that age was significant in all six outcome measures. Older adults demonstrated larger areas of sway regardless of condition (eyes open, eyes closed or with visual feedback).

Older adults had longer movement times, longer path lengths, and shorter distances of functional reach when compared with younger adults [10].

2. Robert W. Baloh and others compared the balance of a group of young people (18-39 years) with a group of older people (> 75 years of age).

Results

Studies have shown that mean sway velocity and the ratio of high to low frequency sway velocity were significantly increased in older subjects compared with younger subjects for static and dynamic tests with eyes open and with eyes closed. Measures of anterior-posterior sway velocity during angular tilt of the platform with eyes closed best distinguished young from older subjects (almost three-fourths of older subjects had values greater than 2 standard deviations from the young normal mean). On average, velocity of sway is higher in older subjects compared with younger subjects, and the difference between young and old is greater with dynamic posturography than with static posturography [11].

3. Takuo Fujita and others they were interested in the dependence of the balance on age. This study was conducted on 144 subjects (51 men and 93 women) between 22 and 88 years of age, without specific diseases of the nervous, vestibular, or muscular systems, or disorders of the endocrine system or mineral metabolism. Informed consent was obtained from each participant, in response to a detailed explanation of the safety and significance of the test. Computerized posturographic measurements were carried out by using a Gravicorder (Anima) to analyse the tract of the centre of gravity when subjects were standing erect with their eyes open or closed.

Results

LNG and LNGT, parameters of track length; and REC, ENV, and RMS, parameters of track area, showed highly significant positive correlations with age, both with subjects' eyes open and with their eyes closed, with correlation coefficients slightly higher in the former, indicating an age-associated increase in swaying [12].

4. D. Abrahamova and F. Hlavacka examined healthy subjects between 28-82 years of age during quiet stance with eyes open and closed. Body sway was evaluated from centre of foot pressure (CoP) positions during a 50 sec interval. The 7 CoP parameters were evaluated to assess quiet stance and were analyzed in three aged group: juniors, middle-aged and seniors.

Results

The regression analysis showed evident increase of body sway over 60 years of age. Scientists found that CoP parameters were significantly different when comparing juniors and seniors in all static conditions. The most sensitive view on postural steadiness during quiet was provided by CoP amplitude and velocity in AP direction and root mean square (RMS) of statokinesigram. New physiological ranges of RMS parameter in each condition for each age group of healthy subjects were determined. Their results showed that Cop data from force platform in quiet stance may indicate small balance impairment due to age [13].

Summary

The above review of the literature confirms the assumption that with the age the functioning of the balance system worsens, resulting in a worse balance. However, it should be remembered that old age is divided into many periods and in each of them postural control may be at a different level. In addition, the individual rate of aging and its type are of great importance in the impact of age on the balance.

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