

The impact of hearing disorders on the body balance

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Keywords: postural balance, hearing disorders, deafness

Abstract

Body balance is one of the basic human motor skills. The efficient functioning of the balance system depends on the proper functioning of the balance organ, the deep sense and vision organ. Any dysfunctions in operation, any of the above systems interfere with the balance system. Hearing pathologies seem to be closely related to the maintenance of balance, due to the integrity in the construction of the organ of balance and the organ of hearing and the huge role that hearing plays in the orientation in space.

Balance

The balance of posture can be defined as the body's ability to recover a designated position in space after the stimulus of destabilizing. Assuming that the body is a geometrical object, it can be concluded that the vertical posture is stable as long as the projection of the centre of gravity of the body is inside the base box. It follows that the stability of the posture depends primarily

on the physical characteristics of the individual, i.e. on its weight, height and on the size of the base area determined by the size and spacing of the feet. In addition, the stability of the posture is influenced by the active role of the nervous system. Balance also depends on the speed with which the nervous system can detect and then correct the disturbance of stability by introducing an appropriate movement program that counteracts the loss of balance. These features depend primarily on the speed of information processing in the nervous system and the efficiency of the motor apparatus. All kinds of pathological or functional changes, e.g. deafness, impair the operation of the steering or executive system, are reflected in changes in posture stability [1].

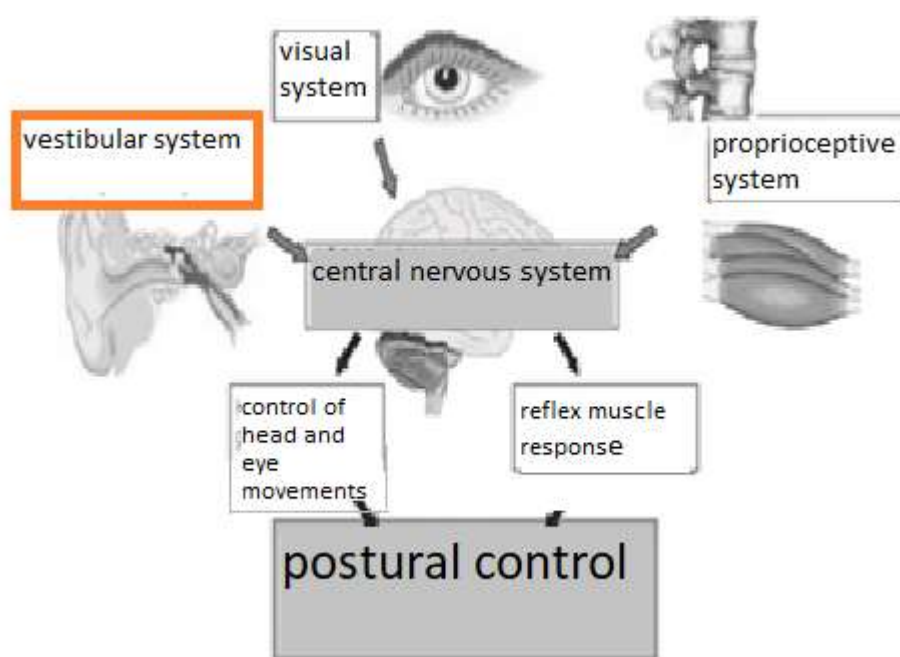


Figure 1 Postural control (źródło: Kuczyński M., Podbielska M. L. I in., Podstawy oceny równowagi ciała: czyli co, w jaki sposób i dlaczego powinniśmy mierzyć?, Acta Bio- Optica et Informatica Medica. Inżynieria Biomedyczna 2012; 18(1); 243-249)

Definition of deafness

Deaf people are not able to receive sound signals coming from the environment, and they have interference in the integrity of the central nervous system and semi-circular canals. Probably the dysfunction of hearing caused by damage to the vestibular system results in impaired balance control. Functions of the labyrinth and semicircular canals are taken over by the organ of sight and proprioceptors. In people without hearing, the correct compensation is based on the other senses, in particular sight, touch, taste, smell, feeling of vibration and the ability to orientate in space. The level of development of compensatory functions determines the motor

capacities, however, even the highest level of compensation cannot completely replace lost senses [2].

There are many definitions of deafness in the literature. Sękowska specifies that a deaf person is a person whose loss or significant impairment of the analyzer prevents the understanding of human speech by the ear and for which in the work and any tasks of life hearing is not practical [3]. UNESCO, on the other hand, describes that deaf people are those in whom the spontaneous development of speech and language remains very delayed or has been completely inhibited due to significant hearing loss, lack of pedagogical interactions, and failure to use a prosthesis [4].

Division of deafness

There are many divisions of deafness due to the use of various criteria.

The functional classification seems to be simple and transparent. It distinguishes people:

1. deaf - with hearing loss to the extent that it is impossible to receive speech naturally by means of hearing; a characteristic feature is the inability to control oral speech by natural means,
2. hard of hearing (hearing impaired) - with hearing loss to a degree that limits the reception of speech by auditory means; a hearing impaired person can master speech in a natural way through hearing [3].

International Bureau for Audiophonologie (BIAP) also applied the division due to the depth of dysfunction:

1. Lightweight hearing loss (20 to 40 dB) - these people use hearing aids. People with this degree of damage are called slightly hearing-impaired. In principle, they do not differ from hearing people. A slight hearing loss, up to 40 dB, makes it difficult to hear a whisper and silent speech. However, in a noisy environment, a common conversation can be incomprehensible.
2. Damage to moderate hearing (from 40 dB to 70 dB) - people with this hearing hear and understand speech tones only in favorable acoustic conditions, often using hearing aids and other technical aids to eliminate the effects of this disability. They use speech as the basic means of communication, but they speak with articulation defects. They are also called hearing-impaired. These people have difficulty in receiving colloquial speech. Statements are inaudible from a further distance. Without the hearing aids speech is

incomprehensible from a distance greater than 1 meter. It is difficult to keep up with the long conversation, no voice intonation.

3. Hearing damage to a significant degree (from 70 to 90 dB) - hearing and understanding speech without the use of hearing aids is impossible (the level of loud speech, heard from a distance of 2 meters, is approx. 60 dB). Even with the use of hearing aids, auditory identification of all speech sounds is not possible, hence eye and lip reading plays an important role in the reception of speech.
4. Hearing damage in a deep degree (over 90 dB) - prevents speech understanding even with hearing aids. If people with this hearing impairment opt for the use of hearing aids, they can only receive strong sounds and noises from the environment. Sometimes it is also possible to hear some of the speech sounds thanks to the deaf aids, but without identifying them. It does not allow to understand speech, but it significantly facilitates reading from the mouth, which becomes the dominant method of receiving speech by visual means [5].

On the other hand, U. Eckert has divided people with hearing impairments due to the location of:

1. Conductive hearing losses - damage to the part of the hearing organ that leads the sound, i.e. the external auditory canal, the middle ear and part of the inner ear with the inner ear fluid, is damaged. As a result, the hearing of low frequencies deteriorates, so the person cannot hear the low-pitched sounds. The speech of these people is silent, because they receive weak sounds heard by bone conductivity. People with this type of damage have a reduced sensitivity to the intensity of sounds.
2. Receiving losses - damage refers to an organ that conducts sound vibrations to nerve impulses. People with this type of deafness are characterized by inferior hearing of high frequency oscillations, worse voices are heard having high formants.
3. Mixed cavities - complex conductive - receiving [6].

Impact of hearing impairment on body balance - a review of the literature

There is scientific research on the impact of hearing loss on the balance, but their results are not the same. Wieczorek M. and Zajac M. conducted a study aimed at recognizing and comparing the level of coordinating capacity of girls and boys deaf and hearing. The research covered 120 students in the 11-13 age group, including 30 boys and 30 deaf girls, 30 boys and 30 hearing girls. The research method used in the work was a set of motor tests described by Raczek,

including the ability to maintain dynamic and static balance - "Flamingo test" - keeping balance in the flamingo position. Analysis of the results showed that in terms of equilibrium, there are no statistically significant differences between hearing and deaf people [7].

Bolach E. et al. they examined the comprehensive physical fitness of children at a younger school age with significant bilateral hearing loss. Their research also concerned, among other things, the balance they assessed using the "flamingo" test - standing for 1 minute on a narrow slat in a flamingo stance. The study was attended by 60 students: 15 girls and 15 boys with hearing impairment, and 15 girls and 15 hearing boys. The results showed that hearing children more often performed this test flawlessly. The difference between hearing and hearing children with a sense of balance was greater in girls. The majority of hearing girls, i.e. 87%, made the attempt without falling, 60% among hearing-impaired girls. In boys: 67% hearing and 53% hearing impaired. However, the predominance of the sense of balance of children hearing over the hearing impaired did not prove statistically significant [8].

Rutkowska I. et al. in their study they compared the level of boys' motor coordination abilities with sensory dysfunctions (including the deaf) and non-disabled ones. 14 blind boys, 18 deaf people and 15 non-disabled boys participated in the study. Dynamic equilibrium was assessed on the basis of a test based on rotation on the gym bench. Based on the analysis of the results, no differences were found between deaf and non-disabled persons [2].

Gayle G. W. and Pohlman R. L. compared the static, dynamic and rotational equilibrium of hearing and deaf children. 20 deaf and 20 non-disabled children participated in the study. A series of Wilcoxon signed-ranks tests and a Kendall *Tau* were applied to assess whether balance was affected in sensorineural deafness. Significant differences between groups were recorded in the dynamic and rotational balance tests. Although not significant, there was a difference of 57.8% in number of trials for successful completion of static balance in favor of the hearing children. In the present study, over-all balance in deaf children was significantly inferior to the balance in hearing children [9].

Summary

The above analysis of the literature shows different results obtained by the researchers, these results are not the same and even contradictory. This does not allow to draw conclusions, however, it should be emphasized that the results of most studies do not show any significant differences in maintaining the balance between deaf and hearing people.

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