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THE INFLUENCE OF THE VISUAL ANALYZER ON POSTURE AND BALANCE – REVIEW TYPE STUDY

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ABSTRACT. Introduction: The posture of the body in space is influenced by information from outside and inside the human body. The eye has a dual role being both an exteroceptor and an enteroceptor. Exteroception is achieved through peripheral vision and proprioception is related to the activity of the extrinsic muscles of the eyes and the oculo-cephalo-gyrus pathways. Therefore, the visual analyzer can influence the posture through refractive disorders (myopia, hypermetropia or astigmatism) or blindness, but also through convergence disorders and heterophoria. **Purpose:** The present study was carried out with the aim of analyzing the influence of the visual analyzer in maintaining the correct posture of the body **Material and method:** Search engines Google Scholar as well as Frontiers, BioMed and ScienceDirect databases were searched using keywords on the desired topic and 53 articles were found. After inclusion criteria were applied (studies from the last 15 years, full articles, studies using cohorts of subjects or case studies), 20 articles were chosen for analysis. **Results:** In the 20 articles chosen for the study, blind participants were discussed, healthy subjects whose response to different visual stimuli was analyzed or subjects with different visual impairments who were investigated to maintain balance and correct body posture in different conditions. **Conclusions:** After analyzing the 20 articles, we came to the conclusion that the visual analyzer influences balance and can produce changes in body posture in space. Improving the function of the visual analyzer can be achieved through specific exercises, various surgical interventions or balancing performed by specialists such as aophthalmologist doctor, physiotherapist or posturologist.

Keywords: *visual impairment, posture, balance, visual analyzer*

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Introduction

Posturology is the medical science that deals with the global assessment of the body's position in relation to the vertical. The postural system performs many functions in an attempt to keep the body in balance both statically and dynamically. For a normal operation, the postural system depends on the information received from exteroceptors and interoceptors (Bachigeanu, 2018). According to Bricot (2010), in the postural system, the eye has a double role, being exteroceptor and interoceptor. Exteroception is achieved through peripheral vision and proprioception refers to the activity of extrinsic muscles and the oculo-cephalo-gyrus pathways, thus resulting in the subordination of the neck muscles to the eyes (Bricot, 2010). The visual analyzer provides information about the position of the body in space, the color, shape and size of objects as well as the relationships that exist between them. The visual function provides a percentage of 88-92% of the information gathered from the environment and this is an essential function for interacting with the environment, in this way being assimilated information to be processed by the visual analyzer thus determining a self-regulating dynamic process (Baritz, 2016).

The processes of sensation and perception are as complex as a whole that they can be very different from one person to another. The visual analyzer can unbalance the postural system through two specific pathologies: refractive and convergence disorders (Bricot, 2010). Refractive disorders involve exteroception, namely minor disorders such as myopia, astigmatism and hypermetropia, which can be corrected with glasses or contact lenses. Conversely, convergence disorders are less frequently diagnosed and are corrected through interventions performed by a posturologist and an orthoptist in collaboration with an ophthalmologist (Bricot, 2010).

Purpose

Since more and more people are diagnosed with postural deviations and many of them present some disorders of the visual analyzer, we wanted to carry out an analysis of the literature with the aim of observing what is the opinion of the specialists on the influence of the visual analyzer in maintaining the correct posture of the body and balance

Material and method

Searches were conducted on the Google Scholar search engines, as well as the databases of Frontiers, BioMed and ScienceDirect. The search strategy was initially based on the use of keywords: visual impairment, posture, balance,

visual receptor. Then helpful elements were added to narrow the search and find the necessary articles: postural stability in binocular viewing, postural stability in children with strabismus, balance in elderly with visual impairments, baropodometry analysis in visual disorder, blind individuals postural control.

The inclusion criteria were: articles from the last 15 years referring to the visual analyzer, being studies in which one or more subjects were evaluated, articles being able to be read in full text. 53 articles were found of which 7 were review articles and were excluded from the current study, 19 of them were not of interest because they did not meet all inclusion criteria, 7 were duplicates and were excluded and 20 of articles were selected to be studied. These were articles conducted on groups of patients from different geographical areas, with a variety of ages and conditions that influence posture or balance, but there are also a studies conducted on healthy subjects that demonstrates the influence of visual inputs on balance. The way to select the items is presented in Figure 1.

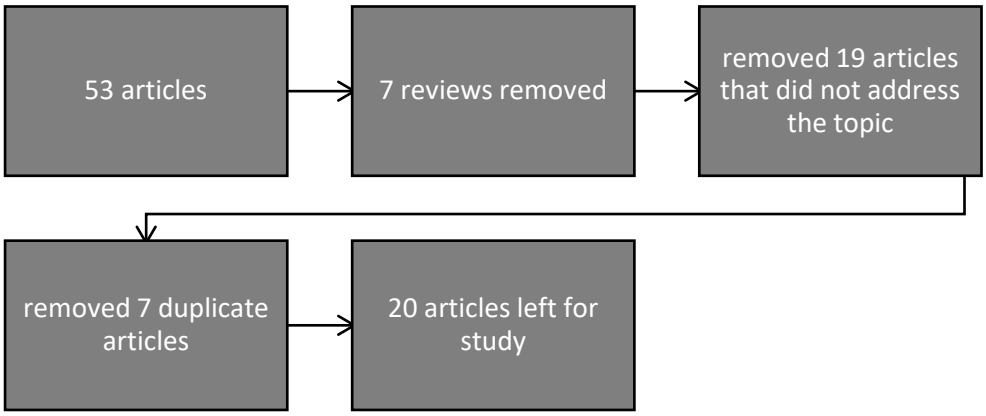

Figure 1. *The process of collecting the sources needed for the current study*

Discussions

Affecting the visual analyzer, as well as how it responds to stimuli, plays an extremely important role in maintaining posture and balance. Of the 20 articles included in this review, 3 of them studied patients with blindness and the influence of this disability in maintaining posture, 7 articles investigated the response of subjects with different impairments of the visual analyzer to stimuli or balance and posture testing, 3 presented studies on the elderly with various eye conditions, 7 articles observed the reaction of healthy subjects to different visual inputs or the reaction to the use of VR headsets.

The researchers made a comparison between congenital and acquired blindness. Castro K.J. et al. (2021), Schwesing R. et al. (2011), Soares A.V. et al. (2011) demonstrated that acquired blindness produces greater balance disturbances as well as higher plantar pressures compared to congenital blindness, which provides greater adaptability of compensatory mechanisms. The researchers highlighted that an important element in the case of people with blindness is also given by the duration of the acquired deficiency. Deficiencies newer than 2 years fail to compensate through other mechanisms, while those older than 10 years are much more adapted to the environment, almost like congenital ones.

Visual impairments developed by the elderly have been studied by Wiszomirska I. et al. (2015), Thomas, N. M et al. (2016), Haibach-Beach P. et al. (2020). They looked at the impact of exercise on improving gait, posture, and balance, and demonstrated that regular exercise can help the postural tonic system respond better to stimuli. Physical exercise increases stability and causes a decrease in the rate of injury in the elderly with various vision deficits. Also, Alex.A Black et al. (2008) and Caldani S. et al. (2019) discuss eye diseases such as glaucoma and Usher syndrome respectively, and their impact on posture. Their studies mainly focus on stability and reach similar conclusions after tests on stable and foam surfaces. Both studies state that a more severe damage to the visual analyzer unbalances the body more strongly, although in the case of Usher syndrome the damage to the vestibular system also intervenes, while in the case of glaucoma in the elderly a strictly ocular approach is needed to restore visual acuity and binocular vision, this causing an improvement in the fall percentage of affected people.

Subjects diagnosed with strabismus were studied by Bucci M.P. et al. (2016) and Legrand A. et. al. (2011). They examined differences in postural control before and after surgery, using tests on pressure platform, with eyes closed and eyes open, and the dominant and non-dominant eye open, respectively. It was found that visual acuity and foot pressure were improved with the eyes closed, but also with the non-dominant eye open, resulting the fact that post surgery the subjects developed better postural stability. Gaertner G. et al. (2013) approached the topic from a different perspective and wanted to observe the differences of the Romberg coefficient in children with divergent and convergent strabismus according to the viewing distance in two conditions, eyes closed and eyes open for binocular vision and monocular. After testing, it was found that the distance does not significantly influence the Romberg coefficient, but a medio-lateral pressure change was noticed for divergent strabismus and an antero-posterior swing in monocular vision with the dominant eye. The study demonstrated that binocular vision improves postural control regardless of

distance or type of strabismus. The same result was reached by Zipori A.B. et al., (2018) and Sánchez-González, M. C., et al. (2020) who investigated balance in subjects with strabismus, with and without amblyopia, but also in healthy subjects. Subjects' Bruininkis-Oseretsky test scores highlighted that there is a disturbance in maintaining balance in subjects with strabismus and those with amblyopia compared to the control group, and these differences are observed even in subjects with mild binocular dysfunction (intermittent strabismus and good stereopsis).

In healthy people, research shows that balance and posture change when the visual analyzer is disabled or disturbed. It seems that the rest of the systems are not able to compensate for the deficit, the period being too short for the adaptation of the other systems (Rodrigues et all, 2015). Hans-Georg Palm et al. (2009), Mohapantara S., et al. (2011) demonstrated that healthy subjects have impaired balance and anticipation if the eyes are closed. Visual stimuli are much more important in maintaining balance than auditory stimuli. Park D.J., (2016) demonstrated that balance training can be achieved by the action of bidirectional peripheral visual stimuli.

As video games using VR headsets are increasingly present in our homes in recent years, Luo H., et al. (2018) and Tychsen L. & Foeller P. (2019) used virtual reality to establish the relationship between eye stimuli and postural changes. These tests showed conflicting results but under different test conditions. It seems that optical stimulation through virtual reality that only requires eye movements to follow the target significantly destabilizes the posture. But if the target is tracked through head and eye movements, then the postural destabilization appears to be extremely small. In the study by Tychsen L. & Foeller P. (2019) conducted on 6-year-old children who participated in 2 sessions of a flight game in which a 3D VR headset was used and head movement was required to control the craft, for 30 minutes, postural destabilization was affected by only 9%. Children manage to adapt more easily to the visual stimuli specific to video games that use VR headsets, in their case maintaining postural stability and adapting the vestibulo-ocular reflex.

There is also a reverse approach. Postural deficits in the frontal plane, namely idiopathic scoliosis, were studied in an attempt to correlate them with eye problems. Scoliosis with a Cobb angle greater than 15 degrees was found to have lower latency characteristics in saccadic movements and decreased reaction speed. A larger Cobb angle means normal vestibular responses but altered oculomotor functions due to cerebellar dysfunction (Lion A., et all in 2013). Unfortunately, the study does not concretely show whether the appearance of eye defects is a factor in the appearance of scoliosis or vice-versa.

Conclusions

The visual analyzer remains one of the main factors influencing the postural tonic system. Any imbalance at this level can affect the musculature at the level of the neck that can change, in time, the musculature at the level of the whole body and can cause a postural instability that affects the balance.

There are many ways to alleviate eye problems: corrections with glasses and lenses, surgical interventions or even exercises that address the extraocular muscles or the muscles of the whole body for sighted or blind people, in order to improve balance and posture. Studies on healthy people demonstrate the importance of this analyzer, observing imbalances when it is non-functional, higher anterior-posterior pressures and differences in pressure between the limbs.

Deficiencies such as strabismus, amblyopia or glaucoma affect balance and body posture. Alignment of the visual axes after surgery provides improved postural stability, suggesting the major role of proper functioning of the visual analyzer for good postural control. Differences were observed related to congenital and acquired blindness and distance in years since vision loss. Congenital blind people manage to compensate and adapt better to the environment through the rest of the systems, while acquired blindness determines adaptation and adequate response to external stimuli only 8-10 years after the incident. The eye is an integral part of the tonic postural system, and its disturbances are reflected in human posture and balance.

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