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REHABILITATION MEASURES CAN RESTORE POSTURAL BALANCE IN OSTEOSARCOPENIA

N. I. Turchin

Odessa National Medical University, Ukraine

Abstract

Imbalance (or postural balance, postural instability), is one of the most common complaints of osteosarcopenia patients. **The aim of the work** is to evaluate the effectiveness and feasibility of using modern computerized HUBER systems with biological feedback function in the restoration of postural balance in osteosarcopenia. **Material and methods.** 40 osteosarcopenia women aged 56.7 ± 2.3 years have been examined. The methods used: X-ray absorptiometry (DEXA), HUBER platform; balancing platform hemisphere “OsportBosu” without biofeedback function; complex "Insight TM", Algometry; ROM, inclinometry; EMG; thermography; heart rate variability. **The results** of the treatment performed showed an increase in the parameters under study in all observation groups. **Conclusions.** Rehabilitation measures with the use of apparatus biofeedback treatment are a highly effective method in the medical maintenance and prevention of postural disorders in patients with osteosarcopenia and other disorders.

Key words: rehabilitation; postural balance; osteosarcopenia; HUBER system.

Imbalance, or postural balance (postural instability (PI)), is one of the most common complaints of osteosarcopenia patients. Currently, there is an increase in the number of patients with imbalance in peripheral nervous system diseases, the consequences of injuries and diseases of the musculoskeletal system, in particular after arthroplasty of large joints of the lower extremities [1, 2]. Imbalance is a short-term or constant inability to control the position of the body in space, manifested by an unstable gait, swaying, poor coordination, and unexpected falls. PI has a high social significance, since the majority of patients are people of working age and this maladaptive symptom significantly worsens the quality of their life and limits professional activity [3].

A complex statokinetic system is involved in the implementation of the balance function, including afferent (vestibular, visual, proprioceptive) and efferent links (neurovegetative, muscular). The receptors of the vestibular apparatus are activated first, the nerve impulses from which are transmitted along the descending vestibulospinal tracts to the muscles of the trunk and limbs, as well as along the vestibulocerebellar connections to the cerebellum. In the nuclei of basal ganglia and cerebellum, nerve impulses from proprioceptors pass along the ascending pathways, switching in the thalamus to the second neuron and projected into the parietal lobe of the brain, where the body scheme is formed. In the statokinetic system, all its components are equally important, it cannot be argued that any one the analyzer or physiological mechanism has an exceptional role. Currently, statokinetic stability is understood as the ability of a person to maintain a stable functional state, spatial orientation, balance function, professional performance due to the optimal regulation of all physiological functions under the influence of statokinetic stimuli that arise passively and actively in space. A similarly meaningful concept of "postural balance" is defined as the ability to maintain, control the general center of mass (GCM) of the body in order to prevent loss of balance in static and dynamic positions. Thus, the concept of a single statokinetic system of a person is a methodological basis for assessing the function of balance and coordination of movements. The statokinetic system provides equilibrium of the body in statics and dynamics by integrating three main functions: sensory, motor and trophic (energy support of movement). Essentially, organic or functional changes in the organs performing any of these functions will certainly lead to imbalances - clinically significant or subclinical (compensated). As the results of recent studies show, the leading mechanism of persistent compensation in such cases is the activation of cognitive motor control. An important provision in the concept of the statokinetic system should be considered the division of its reactions into physiological, pathophysiological and pathological [4-6]. In natural conditions, physiological reactions are manifested by the sensation of the position of the body and its purposeful movement in space [7].

An upright posture for a human is one of the physiological functions of the body. Many researchers have been studying the mechanisms of regulation of posture maintenance for 100 years [8-11]. The physiologist N. A. Bernshtein is the founder of the theoretical basis of modern posturology. He had clearly formulated the concept of feedback in physiology of movements and three main types of postural balance control mechanisms:

• reflexes - automatic responses of the nervous system to changing conditions;

• synergies - classes of movements with kinematic characteristics;

- strategies - complex movements performed unconsciously or consciously to obtain the desired result [7].

In the correction of musculoskeletal system developing changes and restoration of stato-kinetic functions, the "HUBER" system is used, since it has a great range of use and is directed to improve the balance and coordination of movements, and motility - for non-mobile patients. Through the influence to the muscular chains, the system obtains the possibility of step-by-step increase of load from the warm-up to the special muscle-strengthening exercises, for individuals who require an update of the physical form. The HUBER system proposes 4 ranges of physical exercises, with three levels of complexity each (initial, middle, advanced), from the initial to the professional level. The system users create their own physical exercises. The HUBER system effectively strengthens the deep muscles of the back, ensures coordinated strain on the legs, arms, buttocks, belly and back and influences on the whole human’s body. A feature of the HUBER system is a multisensory effect on proprioception, exteroception and the patient's sensory organs during isotonic-isometric effort in different variants of the motor task, which vary with the speed and amplitude of movement of the support platform. Particularly effective in enhancing the body's capabilities is a methodological technique aimed at providing additional information - biofeedback [13]. The feedback principle is the basic and universal principle for controlling various systems. It is a mechanism used in the body to maintain an optimal state of the internal environment (homeostasis) and carry out outward-directed actions. Biofeedback is a way to obtain additional information about the work of the body and its components, biological mechanism for controlling the quality of the achieved result. This is a complex of methods and technologies based on the principles of feedback and aimed at activating the internal reserves of the body, developing self-control and self-regulation of important physiological functions of the body [14].

Trainers with biofeedback function allow to inform a person about the state of his bodily functions with a minimum time delay, due to which there is a possibility of their conscious regulation. The main task of the biofeedback method is precisely the training of self-regulation, and the equipment used makes available to a person information that is not perceived by him in ordinary conditions [15].

Training on the HUBER apparatus with the use of feedback on the parameter "applied efforts" had the most pronounced effect on the indicators of the bioelectrical activity of the brain. [16].

The results of the study of the effectiveness of the HUBER system in clinical practice indicate a positive effect on locomotorium and neuroreceptor apparatus of patients, especially with severe disorders, changes in the stereotype of posture support and restoration of static and dynamic stereotypes that occur with promoted participation of autonomic nervous system. The cost of cardio-respiratory support of the performed work is minimal. HUBER technology has hypoalgesic, locomotor-correcting and defibrosing effect of mechanical therapy factors in patients with spinal diseases and injuries of muscles and large joints [17, 18].

At present, the features of postural disorders in patients with diseases and consequences of injuries of the musculoskeletal system remain poorly understood. Methods of diagnostics (stabilometry) and restoration of postural stability (stabilization) using a computer stabilizer with biological visual feedback to correct the center of foot pressure on the platform are promising areas of medical rehabilitation [12].

The aim of the work is to evaluate the effectiveness and feasibility of using modern computerized HUBER systems with biological feedback function in the restoration of postural balance in osteosarcopenia.

Material and methods. 40 women (mean age 56.7 ± 2.3 years) with osteosarcopenia were under examination. Bone mineral density was assessed using dual-energy X-ray absorptiometry (DEXA). Patients received standard osteotropic therapy (vitamin D metabolites and denosumab) and, according to rehabilitation methods, were randomized into two groups: 1 (n = 90), trained in a comprehensive program on the HUBER platform; 2 (n = 50), training according to the classical complex program on the balancing platform hemisphere “OsportBosu” without biofeedback function.

To assess the functional state of locomotor system a complex for registration and processing of biosignals in vertebrology "Insight TM" was used. Its components were determined: pain sensitivity (Algometry); spine flexibility (ROM, inclinometry); surface electromyography (EMG); spinal muscle thermography (Therma); heart rate variability (PWP). The parameters were assessed in accordance with the “InsightTM” point scale, where a value from 0 to 50 points was assessed as a very problematic functional state of the locomotor system, from 60 to 69 points - problematic, from 70 to 79 points - average, from 80 to 89 points - good, from 90 to 100 points - excellent. The assessment of coordination was carried out taking into account the time of maintaining balance on a movable opposing support platform of the Huber apparatus. The measurements were done in seconds (sec) from the moment the platform began to rotate until the first signs of uncoordinated movements appeared. The results were assessed at baseline and inr 6, 12 months of rehabilitation measures.

Results and discussion. All the patients (100%) complained of back pain, pain in the pelvic bones and lower extremities, weakness, increased fatigue and decreased ability to work

Work decrement was reported by 98 (81.6%) of the patients. An analysis of osteosarcopenia risk factors showed a history of low-energy fractures in 32.5% of patients. Of these, a history of one fracture was in (27.6%) individuals, and two or more fractures were in (15.8%) patients.

Patients in both groups were comparable in age and BMD values. The T-score in the both group patients was -3.52 ± 0.54 SD.

In 12 months BMD in patients of group I was according to T-test -2.51 SD, ($p < 0.05$); in the second group - (T-test -2.74 ± 0.07 SD), (p <0, 05), so it increased compared to the initial values ($p < 0.05$). This indicates a positive effect of osteotropic therapy on the state of BMD. However, a higher increase in BT was observed in the 1st group. It patients trained according to the complex program on the HUBER platform ($p < 0.05$). Algometry index before treatment did not differ significantly ($p > 0.05$) in the groups under study, the Algometry index in patients of group I was significantly higher ($p < 0.05$) than in group II in 6 and 12 months.

Before treatment, the ROM values were comparable in both groups. An increase in the inclinometry index was noted in all patients, however, a significant increase ($p < 0.05$) of the index was noted in group I, as compared to group II. In group I EMG indicators improved in 6 months treatment by 12%, ($p < 0.05$), in 12 months - by 20%, ($p < 0.05$), which was higher compared to 1 gr.

Thermal value in 12 months increased in both groups: in group I by 30.4%, in group II - 27.4% ($p > 0.05$) The PWP index before treatment in groups I and 11 was 82.3 ± 3.2 points, in 6 months it was 94.5 ± 1.92 points, and after 12 months - 99.4 ± 0.45 points.

Evaluation of coordination showed a significant ($p > 0.05$) increase in the time of maintaining balance in patients of group I in 6 and 12 months by 70% compared to those in group II. The results obtained indicate the effective influence of the multifunctional hardware complex on the improvement of coordination in persons with osteosarcopenia and postural disorders.

Thus, the results of the treatment performed showed an increase in the parameters under study in all observation groups ($p<0.05$). However, the best increase in BMD was noted in the group of patients where a multifunctional hardware complex was used to correct structural-and-functional changes of the locomotor system ($p<0.05$). Indicators of the functional state of the spine: NSF index, Algometry, ROM, EMG, Thermal, PWP monotonically increased in all study groups, but a significant increase in these parameters was in group I ($p<0.05$), which indicates a more effective improvement in biomechanical and neurological condition of the spine with the help of a set of exercises proposed on the apparatus "Huber". Also, there was a positive dynamics of the data on the time of maintaining balance in I group patients. The results of the time of maintaining balance indicate that the individual and dosed performance of complex coordination tasks on the “Huber” hardware complex helps to improve the patient's coordination abilities.

Conclusions. Rehabilitation measures with the use of apparatus biofeedback treatment are a highly effective method in the medical maintenance and prevention of postural disorders in patients with osteosarcopenia and other disorders.

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