



Biofeedback Technology for Degenerative-Dystrophic Diseases of the Spine

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Abstract: A study of the effectiveness of using a combination of therapeutic gymnastics and electromyographic training (EMG training) in osteochondrosis of the spine was conducted. In the course of the study, it was revealed that the course of physical therapy in combination with the course of EMG-biofeedback helps to reduce soreness, increases amplitude characteristics in the cervical spine and allows you to relax the muscles of the shoulder girdle arbitrarily.

Key words: physical rehabilitation, biofeedback technologies, EMG-biofeedback, osteochondrosis.

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Degeneration of the intervertebral disc (IVD) with its subsequent destruction and the formation of protrusion and herniation is considered the main and one of the most common causes of the development of chronic pain syndrome, which naturally entitles clinicians to use the term "discogenic pain" in the lumbar spine [1]. The formation of an IVD hernia of degenerative genesis with its prolapse towards the spinal canal causes the likelihood of developing compression radicular syndrome. Formed persistent pain syndrome in the lumbar spine it is the leading cause of long periods of disability and disability of patients, and therefore the solution of this problem is socially significant [1].

In 86% of cases of observations, pain syndrome in the lumbosacral spine is associated with a radicular conflict [2]. It should be noted that IVD degeneration leads to various pathological clinical conditions, including not only lumbalgia and lumboishalgia, but also disorders of biomechanics and the supporting function of the spine. In different periods of the development of IVD degeneration, spondylosis develops, spondyloarthrosis of arch-process joints, bone-cartilage nodes are formed, leading to the stenosing process of the spinal canal with the development of compression syndrome of vascular-neural structures [3].

Decompression laminectomy with its various modifications occupies a leading place in the surgical treatment of compression syndrome of vascular-neural structures on the lumbar spine [4]. According to the author, laminectomy is the "gold standard" surgical treatment of degenerative spinal canal stenosis at the lumbar level [5]. Decompressive laminectomy adheres to the basic rule: adequate decompression is better than its insufficiency, which is important for restoring the function of the compressed neurovascular structures of the spinal canal and regression of neurological deficit in the postoperative period [5]. One of the main complications in the postoperative period after laminectomy is the development of instability in the operated vertebral-motor segment, followed by the formation of spondylolisthesis and the progression of degenerative-dystrophic changes in this area [6, 7]. Another of the complications of laminectomy may be restenosis of the spinal canal with compression of vascular-neural structures by the emerging epidural fibrosis, which leads to the progression of pain syndrome and dysfunction of neural structures [8].

There is information in the literature on the obtained models of the formation of degenerative-dystrophic changes in the IVD in the experiment, which are based on mechanical damage to the fibrous ring of the intervertebral disc using needles of various diameters [9, 10]. There is no who in the described models - the possibility of obtaining primary and natural degenerative changes in the microstructures of the pulpous nucleus and the fibrous ring. The mechanical damage of the intervertebral disc itself is accompanied by the destruction of the fibrous ring, through the channel of which the migration of the pulp nucleus tissue is ensured. The pulp nucleus tissue is barrier-free and leads to the development of a systemic inflammatory response in the migration zone. The described models do not take into account the factor of instability of the vertebral-motor segment, one of the important mechanisms of development and progression of degenerative-but-dystrophic changes in the intervertebral disc.

Degenerative-dystrophic diseases of the spine, including osteochondrosis, are among the most common pathologies today. The analysis of modern literature has shown great interest in physical methods of treatment of this disease. For example, therapeutic gymnastics, depending on the period of the disease, helps to strengthen the muscular corset of the neck, the muscles of posture and the upper shoulder girdle, and also helps to relieve muscle tension [1, 2, 4, 5]. Traction of the spine allows to reduce compression of nerve roots, blood vessels, to expand the interarticular spaces between the vertebral bodies. When using physiotherapy, blood circulation and metabolic processes in the tissues improves, which helps to reduce swelling in them and relieve pain. Massage for osteochondrosis allows you to weaken or eliminate pain, relieve spasm of the back and neck muscles. But, despite

having the means of physical rehabilitation, the search for innovative effective means continues. One of the effective innovative technologies is a technique using biofeedback. This technology is based on self-regulation mechanisms and allows a person to learn using a visualized game to control the strength of tension and relaxation of muscles over which arbitrary control was lost during the disease [6].

Biofeedback (BFB)?

This is a special type of training that allows for arbitrary regulation of many physiological parameters - bioelectric fluctuations of the brain potential (electroencephalography or EEG), heart rate, skin temperature, degree of muscle tension, electrical resistance of the skin, respiratory characteristics, etc. Usually these physiological reactions are not realized, and therefore are not subject to our control. The essence of the BFB method is to "return" to the patient on the computer monitor screen or in audio form the current values of his physiological parameters determined by the clinical protocol. (Protocol - a set of conditions governing the conduct of the BFB procedure). In this sense, all BFB protocols are divided into two large groups - firstly, this is the direction designated in the English-language literature by the concept of "neurofeedback", within which modification of various parameters of the brain EEG (amplitude, power, coherence, etc.) is carried out. The main rhythms of the EEG are also designated by the term "neurotherapy"), and another direction, designated by the concept of "biofeedback", within which the indicators of autonomic (sympathetic-parasympathetic) activation (skin conductivity, cardiogram, heart rate, respiration, electromyography, temperature, photoplethysmogram, etc.) are changed. According to modern concepts, regulatory changes in the activity of the autonomic nervous system caused by severe and/or chronic stress are one of the most important factors in the occurrence of a large group of diseases, designated by such concepts as psychosomatic disorders, regulatory diseases, etc.

According to the definition of the American Association of Applied Psychophysiology and Biofeedback (AAPB), "BFB is a non-pharmacological method of treatment using special equipment for recording, amplifying and "returning" physiological information to the patient. The main objective of the method is to teach self-regulation, feedback facilitates the process of learning physiological control as well as the process of learning any art. The equipment makes available to the patient information that is not normally perceived by him".

Schematically, the BFB procedure consists in continuous monitoring of certain electrophysiological indicators and "reinforcement" with the help of multimedia, gaming and other techniques of a given range of values. In other words, the BFB interface is a kind of "physiological mirror" for a person, in which his internal processes are reflected. Thus, during the course of the BFB sessions, it is possible to strengthen or weaken this physiological indicator, which means that the level of tonic activation of the regulatory system whose activity this indicator reflects. For example, training with the help of the BFB method to arbitrarily raise the temperature of the fingertips leads to a decrease in sympathicotonia, which means a decrease in peripheral vascular spasm. A necessary component and condition for conducting a BFB training is motivation to achieve results, the ability to form which in the subject is an important element of the professionalism of the BFB therapist.

It was with the advent of the innovative method of EEG-BFB therapy that it became possible to noninvasively and purposefully influence the configuration of neuromarkers causally related to the brain mechanism of the occurrence of a particular mental disorder, bringing it to a normal state and thus eliminating the psychiatric symptoms that these neuromarkers indicate.

To date, the most reliable evidence has been obtained for the effectiveness of EEG-BFB therapy in the treatment of attention deficit hyperactivity disorder - ADHD - in children and adults, epilepsy and anxiety disorder - level 5 on the five-point scale of reliability assessment of data from the American

Psychological Association (APA). Most likely, BFB therapy is highly effective in the treatment of various types of addiction, post-traumatic stress disorder - PTSD, various pain syndromes, depressive disorder - score 4 on the APA scale. The effectiveness of BFB therapy in relation to many other mental disorders, syndromes and symptoms is under study.

BS therapy using neurointerfaces is one of the most promising areas in modern psychiatry.

One of the most promising and most "advanced" subspecies of EEG BFB therapy is the so-called Z-BFB therapy. Its essence lies in the fact that the "working" parameter of the BFB training is not the amplitude of any EEG rhythm or coherence or spectral power, but the magnitude of the statistical deviation from the corresponding indicator of the age norm, measured by the Z-coefficient. This approach allows not only to assess the presence of statistically significant deviations from the norm in the EEG of a particular patient, but also to direct EEG-BFB training to normalize these individual deviations within the boundaries of normative indicators. The most important condition for the emergence of such a method of BOS therapy was the creation of regulatory EEG databases for all ages (2 months - 90 years), obtained on large groups of carefully selected healthy subjects without experience of mental and neurological diseases. The use of such normative EEG databases in diagnostics and BFB therapy suggests the emergence of modern personalized neuropsychiatric care, based in its diagnostic and therapeutic part on accurate data on the work of the brain.

In addition, today BFB therapy is considered as one of the most promising methodologies in the arsenal of preventive medicine, the main purpose of which is to prevent the development of the disease. At the stage of pre-illness, the use of BFB methods is especially attractive, since it helps to stop or stabilize pathological development. In this regard, BOS therapy uses the same approaches and principles as cognitive therapy, which equips a person with a set of certain skills and allows them to deal with disorders such as depression, pathological anxiety, panic attacks, etc.

The purpose of the study: to study the effectiveness of the combined use of therapeutic gymnastics and EMG training in patients with osteochondrosis of the spine.

Materials and methods. The study was conducted on the basis of BUZ NGO "City Hospital No. 2". Two experimental groups of 15 women aged 45-55 with a diagnosis of osteochondrosis of the cervical spine were formed by random sampling. All patients were familiar with the methodology and pedagogical testing, had informed consent. During the experiment, drug therapy and physiotherapy were not carried out. In order to assess the effectiveness of the course of physical rehabilitation, a questionnaire was conducted ("Visual analog scale", E. S. Huskisson, 1974 and "Index of disability due to neck pain", H. Vernon, J. Mior, 1989); pedagogical testing to study the mobility of the cervical spine (assessment of flexion and extension in the sagittal plane, assessment of lateral mobility and assessment of rotation); registration of surface EMG recorded with musculus trapezius. EG1 patients underwent a course of therapeutic gymnastics according to the method of M. V. Devyatova [3] and sessions of EMG-biofeedback; EG2 patients underwent a course of therapeutic gymnastics with stretching elements. 15 physical therapy sessions and 10 sessions of EMG training were conducted with patients of each group. Statistical data processing was carried out using the Statistica-6 program, the reliability of the differences in paired samples was determined by the Wilcoxon T-criterion. The statistical significance of the differences was calculated by the Mann-Whitney U-test at a significance level of $p < 0.05$.

The results of the initial survey of all participants of the experiment on the "Visual analog scale" showed a value of 8.6 ± 1.3 points, which is characterized as "severe pain"; 33.1 ± 1.6 points in the questionnaire "Index of disability due to neck pain", which indicates a large restriction of mobility and is 63%, with a norm of 0-9%. The most frequent responses should be noted: "at the moment, the pain in the neck is very strong", "to serve myself, I need outside help every day", "I can only lift very light

objects", "I can't read as much as I want because of severe neck pain", "headaches are constant". A meaningful analysis of the results of pedagogical testing showed limited mobility in the cervical region in the sagittal and frontal planes. The results obtained are consistent with other authors indicating a reflex increase in the tone of the neck muscles due to a pain symptom.

The lesson of therapeutic physical culture was aimed at reducing pain in the cervical spine, improving trophic processes, strengthening the musculoskeletal system of the spine, relieving spastic tension of the neck muscles, as well as restoring the usual amplitude of movement. A variety of starting positions were used. To reduce compression and inflammation of the spinal roots, exercises were used to relax the muscles of the neck, shoulder girdle and upper extremities. In order to prevent vestibular disorders, exercises to increase vestibular stability, coordination of movements and dynamic exercises for the joints of the upper limb were used. Exercises to relax the muscles of the neck and upper extremities were performed from the initial positions lying on the back. Relaxation of the muscles of the upper extremities was achieved by shaking the wrist joints.

After practicing therapeutic gymnastics in EG1, sessions of EMG-biofeedback were conducted using the BOSLAB PROFESSIONAL + hardware and software complex. EMG sensors were superimposed on the upper bundles of the musculus trapezius (right and left sides). Integral EMG and skin peripheral temperature were recorded. The main purpose of the sessions is to reduce the integral amplitude of the electromyogram. For this purpose, the standard tabs "MIO relax" and "Jacobson" were selected. The hardware and software complex allows you to adjust the session time and set the value of the "threshold", the excess of which provides a feedback signal. The average duration of the session was 25-30 minutes, the form was a game. Stretching exercises for neck and trunk muscles in combination with relaxation exercises were performed with EG 2 patients after the therapeutic gymnastics lesson. Starting positions: standing, sitting, lying on your back. The time is 20-25 minutes.

After passing the course of physical rehabilitation, control testing of the examined women was carried out. The results of repeated questioning on the "Visual Analog Scale" showed a value of 4.3 ± 1.2 points in EG 1 and 3.9 ± 1.2 points in EG 2 (before the experiment 8.6 ± 1.3 points), which is characterized as "average pain"; 7.8 ± 1.5 points in EG 1 and 8.4 ± 2.9 points in EG 2, which it indicates a small restriction of mobility and is 13%, with a norm of 0-9% (the initial indicator is 33.1 ± 1.6 points in the questionnaire "Index of disability due to neck pain"). The most frequent responses have also changed: "at the moment, neck pain is moderate", "I can lift heavy objects with minor neck pain", "I have rare moderate headaches", "my sleep is slightly disturbed". Positive dynamics was noted in tests of cervical mobility. Measured indicators improved in both groups ($p \leq 0.05$). Intra-group differences were revealed in the indicator "rotation", in EG 2 it increased by more than 6 cm. There were positive changes in the relaxation of the musculus trapezius muscle in both groups, but the ability to arbitrarily reduce EMG and increase peripheral temperature was mastered by patients EG1.

Thus, the BOS methodology allows a person to modify his behavior with the help of a reverse physiological connection towards a greater degree of self-regulation and homeostaticity. Based on the fundamental principles of I.Pavlov's theory of conditioned reflexes and implicit learning, the BFB-learning procedure is also associated with special, "altered" states of consciousness, which have been little studied so far, but are directly related to creativity and creative abilities in a broad sense.

List of sources used:

1. Agasaryan, N. K. Comprehensive rehabilitation in osteochondrosis / N. K. Agasaryan // Russian Neurosurgical Journal. Professor A.L. Polenov. - 2021. - T. 13. - No. S1. - S. 63-64.
2. Grigoryan, T. A. Therapeutic physical culture in osteochondrosis / T. A. Grigoryan, V. E. Kulchitsky // Questions of Pedagogy. - 2021. - No. 2-1. - S. 30-34.

3. Devyatova M.V. Lumbar osteochondrosis: the role of exercise in the treatment of its initial manifestations. - // Adaptive physical culture. - 2000. - No. 3-4. - P.52-54;
4. Ivanov, V. A. Anatomico-neurological changes in osteochondrosis of the spine / V. A. Ivanov, V. V. Kharchenko // Integrative trends in medicine and education. - 2022. - T. 2. - S. 50-57.
5. Sedykh, N. V. Peculiarities of the influence of means of adaptive physical culture in the process of correction of cervicothoracic osteochondrosis in the elderly / N. V. Sedykh, E. I. Glazkova // Physical education and sports training. - 2022. - No. 2 (40). - S. 108-111.
6. Talamova I.G. Complex use of EGG biofeedback in the process of physical rehabilitation in osteochondrosis of the spine. - The book: Vita REHAB WEEK 19 "Modern technologies and equipment for medical rehabilitation, spa treatment and sports medicine", III-International Scientific and Practical Congress, 2019, P.58-59.

