

COMPLEX APPROACH TO PHYSICAL HABILITATION IN PARKINSON'S DISEASE

**S.I. Goncharova¹, N.A. Shnayder¹,
M.R. Saprionova¹, T.E. Popova²,
A.A. Tappakhov^{2,3}, T.Ya. Nikolaeva²,
L.T. Okoneshnikova³, E.E. Konnikova^{2,3},
A.Yu. Petrova³**

¹ *Krasnoyarsk State Medical University
named after N. F. Voyno-Yasenetsky,
Krasnoyarsk, Russia*

² *M.K. Ammosov North-Eastern Federal
University, Yakutsk, Russia*

³ *Republican Hospital 2 — The center
of emergency medical care, Yakutsk,
Russia*

Correspondence address:

*1, Partizan Zheleznyak str.,
Krasnoyarsk, 660022, Russia,
E-mail: nataliashnayder@gmail.com*



Svetlana I. Goncharova,
*MD, Cand Med Sci,
Neurologist, Physiotherapist*



Natalya A. Shnayder, MD,
*D Med Sci, Prof., Head of the
Neurological Center*



Margarita R. Saprionova,
*MD, Cand Med Sci, Ass. Prof.,
Neurologist*



Tatyana E. Popova, MD,
D Med Sci, Prof., Neurologist



Alexey A. Tappakhov, MD,
*Neurologist, Postgraduate
student*



Tatyana Ya. Nikolaeva, MD,
*D Med Sci, Prof., Head of the
Department*



Ludmila T. Okoneshnikova,
*MD, Head of the Neurological
Department*



Edilia E. Konnikova, MD,
Cand Med Sci, Assos. Prof.



Alena Yu. Petrova, MD,
Neurologist

ABSTRACT — Habilitation is an important part of a complex approach to treatment and rehabilitation of patients with severe movement disorders, including Parkinson's disease. Today, Parkinson's disease is one of the socially significant diseases in the World. The steady increase in the number of patients associated with the aging of the population and better diagnosis of primary disease. Unfortunately, treatment of Parkinson's disease in many cases includes only the pharmacological treatment. At the same time, a complex approach to the use of non-pharmacological methods of treatment and rehabilitation can improve the quality of patients' life. This article presents modern approaches physical habilitation in Parkinson's disease.

KEYWORDS — Parkinson's disease, habilitation, rehabilitation, treatment, exercise therapy, balneotherapy, peloid therapy, transcranial magnetic stimulation, transcranial electrical stimulation, diet therapy, massage, occupational therapy.

INTRODUCTION

Parkinson's disease (PD) is one of the most common neurodegenerative diseases of central nervous system [1]. The prevalence of parkinsonism in Russia reaches up to 186.5 per 100 000 population, 75% of them are cases of PD (prevalence PD — 139.9 per 100 000 population). It is expected that over the next twenty years the number of patients will double [2].

Motor symptoms include three core features: hypokinesia, rest tremor and postural instability. Usually, the disease is characterized by unilateral onset. During one or two years symptoms gradually affect other limb the same side. Furthermore, dyskinesia and wearing "off" occur in 37.7% and 73.6% of patients respectively in 15–20 years of the onset of disease and in 55.3% and 76.3% of patients in 21 years or more respectively [3].

The main method of treatment of PD currently remains pharmacotherapy. However, until now possible only symptomatic treatment of PD. Effective pathogenetic and etiological treatment has not been developed to date [4].

In addition to the medical treatment throughout the disease it is recommended comprehensive use of non-drug methods such as physical therapy, kinesiotherapy, massage, diet therapy, psychotherapeutic support, etc. [5].

Habilitation

(*abilitatio; habilis* — a comfortable, adaptive) is medical and/or social activities for people with disabilities aimed at their adaptation to the daily and professional life. Habilitation involves a comprehensive approach (behavioral, drug-free, and medical) to care for people with progressive hereditary diseases and congenital malformations [6]. The aim and tasks of habilitation in PD are the reducing disease progression; the improv-

ing cerebral metabolism; stimulation of endogenous dopamine synthesis; the decreasing pain sensitivity and activation of sensory balance; normalization of function of the neuromuscular system; normalization of mental and emotional state; the improving the self-service function; the increasing social activity [7].

Principles of physical habilitation in PD

Early initiation of habilitation measures to reduce or prevent a number of complications of early PD. Habilitation in PD must start and be carried out against the background of pharmacotherapy. With the gradual increase in the intensity of habilitation measures in some cases it is possible a gradual reduction in the dose of drugs. It is important systematic and duration, phasing and complexity of habilitation measures in PD using all available and appropriate habilitation activities. Multidisciplinary approach to the habilitation of patients with PD is to participate in the habilitation process of various specialists: neurologists, physiotherapists, kinesiologists, psychologists, speech therapists, social workers, neurosurgeons. It should be taken into account individualization habilitation program and its social orientation, participation in the process of habilitation of the patient, his relatives and friends, the use of methods of control of the adequacy and effectiveness of habilitation loads, as well as adjust the habilitation program in accordance with the course and stage of disease [8].

Russian scientists have proposed to divide patients with PD into 4 main groups: 1) patients with initial manifestations of the disease up to 50 years old; 2) patients with initial manifestations of the disease 50–70 years old; 3) patients with advanced stage of the disease with concomitant diseases; and 4) patients after surgical treatment [7]. This approach is important to consider when drawing up individual programs habilitation of patients with PD.

Physical therapy in PD

The aim of physical therapy — reduction the rigidity, hypokinesia, tremor, depression; the slowing of disease progression; the improving cerebral metabolism; increase physical activity of the patient with PD [9].

Balneotherapy

is recommended in the early stages of PD to reduce symptoms, improve overall body tone, and improve psycho-emotional status. Sodium chloride baths are recommended to reduce the rigidity and the presence of co morbidity among patients. Hydrogen sulfide baths are appointed in the presence in patients with cardiovascular disease. Radon baths are suitable in the

presence of concomitant diseases of the musculoskeletal system and the peripheral nervous system. Alpha radiation of radon stimulates cerebral metabolism, activates the production of biologically active substances, and improves the adaptive processes of the organism. For the purpose of relaxing and sedative effect can be used iodine-bromine baths. This leads to a positive impact on the psycho-emotional sphere of patients and reduces rigidity and tremor [7].

Peloid therapy

This method reduces the excitability of the spinal motor neurons, enhances the functional lability of neuro-motor apparatus, and activates the central nervous system [10]. Thermal mud treatment is assigned for reducing the severity of rigidity, hypokinesia, and tremor. It should be noted that the presence of benign oncological processes, even outside the overlay area of mud applications, is an absolute contraindication to peloid therapy.

Preformed physical factors

Electrophoresis was carried out various drugs for activate the cerebral circulation, improve trophic processes in the brain, providing a hypotensive action, and reduce the symptoms of PD. It uses nicotinic acid, ascorbic acid, potassium iodide or sodium iodide, drotaverinum, dibazolom, aminophylline by the neck and orbito-occipital technique. Electrophoresis of L-DOPA (appoint endonasal or fronto-occipital technique) is effective in patients with akinetic-rigid PD. Tremor, arterial hypertension and mental disorders are contraindications for this method [7].

Electrotherapeutic sleep therapy

largely reduces the severity of rigidity and rest tremor, lesser extent — hypokinesia. In addition, electric sleep reduces depression, anxiety and cognitive disorders. Electric sleep procedures conducted by the orbito-occipital technique. It is recommended in patients with akinetic-rigid, shaking-rigid PD.

The Institute of balneology, physiotherapy in Moscow were developed therapeutic complexes for patients with PD, which included decimeter waves therapy (DMW-therapy), sinusoidal modulated currents (SMC-therapy), hydrogen sulfide and radon baths.

The complex number 1 includes the consistent application of the therapy sinusoidal modulated currents, then hydrogen sulfide and radon baths. The method of electrical stimulation on the extensor muscle group with a threshold current intensity, causing painful cuts was proposed. This complex recommended for PD patients with hypokinesia and rigidity.

The complex number 2 includes DMW-therapy, hydrogen sulfide baths, therapeutic exercise. It improves the functioning of the sympathetic-adrenal system, vegetative functions, and stimulates the metabolism of the brain cells. DMW-therapy enhances cerebral blood circulation, activates the exchange of neurotransmitters. Elderly patients in the presence of cerebral arteriosclerosis DMW appointed on neck region. The impact of DMW on neck region has a reflex effect on the adrenergic structures of the brain and dopamine centers in the basal ganglia and segmental apparatus of the spinal cord (motor and intercalary neurons) which are responsible for the symptoms of Parkinson's disease. Then therapeutic exercise carried out for 30–40 minutes [7].

The complex number 3 includes hydrogen sulfide baths, inductothermy on neck region, exercise therapy, electrophoresis of drugs, and thalassotherapy. The course is 15-20 procedures every day or every other day.

Methods of physical habilitation after surgical treatment of PD

After the surgical treatment of PD used the same program, as well as in patients who do not need surgery. The complex number 1 including SMC-therapy, balneotherapy (hydrogen sulfide and radon baths), or the complex number 2 consisting of DMW-therapy, balneotherapy (hydrogen sulfide baths), physiotherapy is recommended. Psycho and reflexology, if necessary - social and labor rehabilitation are recommended for inclusion in the complex habilitation of patients with PD [7].

Transcranial magnetic stimulation (TMS)

The method is based on the impact of the pulse magnetic field for various brain structures and inducing therein electric current. Repetitive TMS of the prefrontal cortex causes increased release of dopamine in the caudate nucleus on the side of stimulation and stimulation in the posterior cranial fossa projection increases dopamine concentration in the blood and cerebrospinal fluid [11]. Other results of TMS are antidepressant and metabolic effects, activation of neuroplasticity, and normalization of cerebral blood flow [12]. TMS significantly reduces anxiety, depression and cognitive impairment. These effects are due to the pronounced influence of the magnetic field on the serotonergic and histaminergic systems, opiate receptor system, glial activation and strengthening of inhibitory processes in the brain [11].

Transcranial electrical stimulation (TES)

is based on the impact on the structure of the brain stem of small amplitude pulse currents (up to 3 mA)

with a rectangular asymmetric bipolar pulse shape. This effect in PD patients leads to the activation the brain alpha rhythms, normalization of other brain biorhythms, increasing the concentration of serotonin, acetylcholine, met-enkephalin and beta-endorphins. There is evidence on the positive effects of TES in the treatment of emotional and volitional disorders in PD, reducing depression and anxiety, and the normalization of nocturnal sleep [13].

Therapeutic exercise

As a result of clinical and experimental studies have provided evidence of the positive effects of exercise on the dopamine metabolism. Thus, the method of positron emission tomography revealed that brisk walking for an hour without specific therapy increases the release of dopamine from the nigrostriatal dopaminergic neuronal endings in patients with PD [14]. Furthermore, it is shown that moderate physical activity increases the absorption of levodopa in intestine, which contributes to a better efficacy. There was a significant increase in daily activity, improving walking (increase stride length, tempo), a decrease in postural instability, reducing the "pour" during walking [15]. In addition to improving motor function, the positive effect of physical activity appears to change the psychological state – increasing satisfaction with their health and quality of life [16].

The main tasks of exercise therapy in PD are the maintenance of general motor activity, increase muscle strength and flexibility, facilitating the initiation of movements, the improvement joint mobility, the maintenance correct posture, the improvement walking and maintaining balance, prevention of contractures and pain syndromes, prophylaxis of respiratory disorders, and injury prevention.

The basic principles of exercise therapy in PD: 1) regularity of employment (daily); 2) dosed physical activity; 3) rhythmic accompaniment sessions using external acoustic (account, music) or visual (light bulb flashing, markings on the floor) impulses; 4) exercise therapy for all muscle groups and joints (including mimic muscles); 5) inclusion exercises for coordination and elements of sports in the early and advanced stages of the disease; 6) the use of weights (dumbbells, expanders, weights) and gymnastic articles (balls, sticks, rope); 7) aerobic exercise since early stages of the disease ("Swedish walking", walking, training on a stationary bike, swimming); 8) conduct of exercise therapy in the later stages of the disease during the period of drug action ("on"-period) [14].

For example, fig. 1 and 2 show exercises for improving joint mobility. Fig. 3 demonstrates the training of fine motor skills of hands.

THE TACTICS OF MOTOR REHABILITATION IN VARIOUS STAGES OF PD (STAGES 1–4 BY HOEHN AND YAHR)

The main task of exercise therapy in the early stages of the disease (stages 1–2) is the maintenance or improvement of general motor activity, prevention the formation of secondary musculoskeletal disorders as a result of the major symptoms of the disease. For improve the general motor activity and its adaptation possibilities, exercises with the simultaneous implementation of several motor programs or tasks to maintain attention are recommended. For example, continued walking with long strides or exercise turns during a phone conversation, arithmetic account etc. Foot and turns tests in the different situations can be recommended: in the plain, at a slant, the open spaces and the passage of the bottlenecks, in the free areas or in the presence of people and others [5].

In the advanced stage of PD (stage 3) the need to maintain the correct posture and correction of altered posture, improvement of walking, maintain a balance and prevention of falls are added. Focus the attention of the patient on the main aspects of walking (step width and rhythm control) and turns (alignment of the body and leg movements) contributes to the improvement walking and postural control on the background of disturbed automatism. In contrast to the recommendations in the early stages, patients are recommended to avoid situations that require the simultaneous execution of multiple tasks, divert attention from the action performed [17].

The main task of exercise therapy in the advanced stages of the disease (stages 4–5) is patient education correct strategies for the movement as much as possible maintain a daily locomotor activity and functional independence; prevention of the formation of contractures and respiratory disorders. Active attention of patients to goal setting of the planned actions and thinking through the sequence of implementation of each component of its motion is required to replace the lost (to varying degrees) motor automatism [14].

ORGANIZATIONAL RULES OF EXERCISE IN PD

Conduct exercises better during the good health of the patient on the background an optimal effect of antiparkinsonian drugs. In some cases, exercise in the morning (before the first dose) contribute to improving the well-being and allow to take a dose of dopaminergic drugs later. Physical exercise should be increased gradually. Performing exercises with active movements begin with 2–3 repetitions and then increase repetitions multiplicity up to 5–10 times.

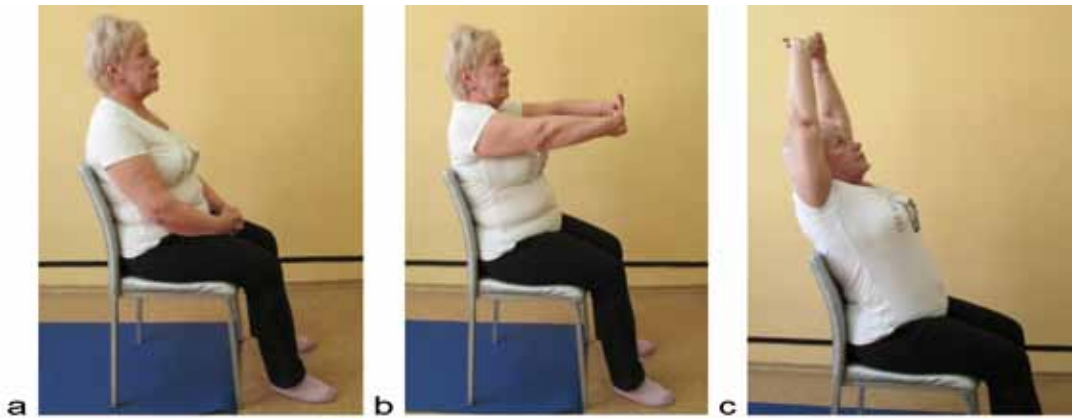


Fig. 1. Exercises for improving joint mobility (photo by authors)



Fig. 2. a – initial position; b, c – steps of exercise (photo by authors)

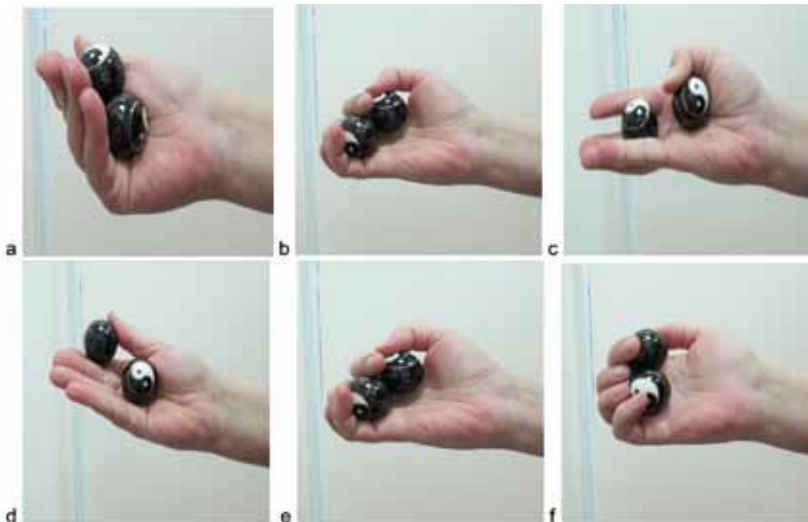


Fig. 3. a–e — sequence of fingers and hands motions during exercise (photo by authors)

Exercises to stretch the muscles begin since hold postures for 1–2 minutes, gradually increasing the duration up to 3–5 minutes. Exercises should bring a sense of pleasant fatigue. Do not exceed the loads until the feelings of exhaustion or pain in muscles and joints. If the patient has heart disease, he should discuss with

doctor the planned training program. When the unpleasant sensations in the head ("lightness" or "heaviness", darkening) during exercise, the patient should sit or lie down. Most likely, this condition is caused by reduction of blood pressure in the upright position of the body. It is necessary to measure blood pressure at

the time of "discomfort" and spend orthostatic test at rest.

Should be noted that number of patients at increased physical activity is characterized by faster "depletion" effect of a single dose of levodopa. In case of early reduction of drug action, the patient may take next dose drugs before the scheduled hour. Before starting the exercises should sure that patients understand the tasks of exercises and the sequence of its constituent parts. In severe PD the number of authors offers to reduce symptoms of disease such as hypokinesia, muscular rigidity, tremor, postural instability with a special cycle of exercises: 3 dynamic, 3 static exercises and exercises to improve mobility in the joints [18].

OTHER NON-PHARMACOLOGICAL METHODS OF HABILITATION IN PD

Diet therapy is an important part of the program habilitation PD patients. This is due to the following features: the presence of symptoms of damage to the autonomic nervous system, the impact of certain proteins on the bioavailability of levodopa, underweight, motor activity of the patient [19]. If the patient has daily fluctuations in motor function with on-off periods, a diet low in protein is recommended during the daytime and a diet high in protein — in the evening. At night should be limited fluid intake. Herbal teas (mint, lemon, chamomile and others.) are recommended instead of black tea and coffee. The consistency of the food must not impede swallowing (creams, mashed potatoes, peeled, chopped or grated vegetables and fruit) [17, 20].

Massage. The procedure should affect the neck region, back, paravertebral areas, and extremities. Duration of procedure is 10–20 minutes. The treatment course consists of 15–20 procedures that are performed daily or every other day in combination with one of the following methods — hydrogen sulfide baths, electrophoresis of drugs, inductothermy, physiotherapy, and sea bathing [21].

Ergotherapy (occupational therapy) enables patients to adapt to their disease, increase their independence, teaching specific skills self-service. Ergotherapy in PD includes main points: self-service, work and leisure [22].

Apitherapy. The mechanism of action is exogenous dopamine replacement therapy contained in bee venom stimulation biogenic amine system, the activation of the dopaminergic systems of the organism. Apitherapy also reduces the level of cholesterol, contributes to hypocoagulation and vasodilation. In addition, amino acids that are part of apitoxins provide the basis for synthesis of nerve fibers. The improve-

ment observed in all forms of Parkinson's disease in the form of reduced rigidity, tremor, improvement walking [23].

Correction movements using biofeedback therapy in PD is based on visual monitoring of posture using stabilometric systems [24]. In the early stages of the disease, and in patients with moderate postural disorders games with posture control using stabilometric platform used. In patients with severe PD uses only computer-stabilometric games, because in these patients the process of formation of skill arbitrary posture control is broken. The positive effect of biofeedback therapy on the severity of hypokinesia and postural instability was observed [24].

CONCLUSION

Thus, there is a wide range of non-drug treatments for Parkinson's disease. Appropriate combination of these methods with a specific drug significantly improves the quality of life of patients. Clinical experience shows, when the patient remains active and relatives are actively involved in the rehabilitation process, the disturbed functions recover faster and more fully.

REFERENCES

1. ALVES G. ET AL. Epidemiology of Parkinson's disease // *J. Neurol.* 2008. Vol. 255. P. 18–32.
2. LEVIN O.S., SHINDRYAEVA N.N., DOKLADINA L.V. Clinical epidemiology of Parkinson's disease // *Extrapyramidal disorders: yesterday, today, tomorrow.* M., 2013. P. 41–52.
3. MIZUNO Y., SHIMODA S., ORIGASA H. Long-term treatment of Parkinson's disease with levodopa and other adjunctive drugs. // *J. Neural Transm.* 2017.
4. FERREIRA J.J. ET AL. Summary of the recommendations of the EFNS/MDS-ES review on therapeutic management of Parkinson's disease // *Eur. J. Neurol.* 2013. Vol. 20. P. 5–15.
5. DEMAGD G., PHILIP A. Parkinson's Disease and Its Management: Part 3: Nondopaminergic and Nonpharmacological Treatment Options. // *P T.* 2015. Vol. 40, T. 10. P. 668–679.
6. SHNAYDER N.A., GONCHAROVA S.I. Physiotherapy in Charcot-Marie-Tooth // *Neuro-muscular diseases.* 2013. Vol. 4. P. 13-18
7. KORNYUKHINA E.YU. Medical rehabilitation of Parkinson's disease // *Medical rehabilitation / ed. by V.M. Bogolubov.* M.: Binom, 2010. P. 44–54.
8. NODEL M.R. Physical rehabilitation of patients with Parkinson's disease. Guidelines. M. Sandos, 2013. 23 p.
9. TOMLINSON C.L. ET AL. Physiotherapy intervention in Parkinson's disease : systematic review and meta-analysis // *BMJ.* 2012. Vol. 345, August. P. 1–14.
10. BEER A.-M., FETAJ S., LANGE U. Peloid therapy. An overview of the empirical status and evidence of

- mud therapy // *Z. Rheumatol.* 2013. Vol. 72, T. 6. P. 581–589.
11. LEFAUCHEUR J.-P. ET AL. Evidence-based guidelines on the therapeutic use of repetitive transcranial magnetic stimulation (rTMS). // *Clin. Neurophysiol.* 2014. P. 1–57.
 12. BENNINGER D.H. ET AL. Intermittent theta-burst transcranial magnetic stimulation for treatment of Parkinson disease // *Neurology.* 2011. Vol. 76. P. 601–609.
 13. KORNİYUKHINA E.YU. ET AL. The use of transcranial pulsed electrostimulation and an alternating electrostatic field in the treatment of the syndrome of "restless legs" in patients with Parkinson's disease // *Issues of balneology, physiotherapy and exercise therapy.* 2010. Vol. 2. P. 38–40.
 14. CAMAKINOVA A.B., GOLUBEV V.A. Kinesiotherapy – the base element of non-drug treatment of Parkinson's disease // *Journal of neurology and psychiatry.* 2013. Vol. 10. P. 69–73.
 15. YUNISHENKO N.A. Violations of walking and postural stability in Parkinson's disease: autoref. diss. ... cand. of medicine sciences. M, 2005. 26 p.
 16. UHRBRAND A. ET AL. Parkinson's disease and intensive exercise therapy--a systematic review and meta-analysis of randomized controlled trials. // *J. Neurol. Sci.* 2015. Vol. 353, T. 1–2. P. 9–19.
 17. TABA P. ET AL. Parkinson's disease. The book for patients and their family III. Estonia: EstiHaigekassa, 2007. 112 p.
 18. LEVIN O.S. Exercise therapy in Parkinson's disease. Guide for patients and their relatives. M.: MEDPress-inform, 2014. 83 p.
 19. BARICHELLA M., CEREDA E., PEZZOLI G. Major nutritional issues in the management of Parkinson's disease. // *Mov. Disord.* 2009. Vol. 24, T. 13. P. 1881–1892.
 20. PODOBEDOVA N.S. Smoothing of Parkinson's disease symptoms using the medication and nutrition. M.: Incombook, 2012. 400 p.
 21. GHAFFARI B.D., KLUGER B. Mechanisms for alternative treatments in Parkinson's disease: acupuncture, tai chi, and other treatments. // *Curr. Neurol. Neurosci. Rep.* 2014. Vol. 14, T. 6. P. 451.
 22. SAINT-HILAIRE M. Occupational therapy for Parkinson's disease: increasing awareness. // *Lancet Neurol.* Elsevier Ltd, 2014. Vol. 13, T. 6. P. 527–529.
 23. DOO K.-H. ET AL. A Prospective Open-Label Study of Combined Treatment for Idiopathic Parkinson's Disease Using Acupuncture and Bee Venom Acupuncture as an Adjunctive Treatment. // *J. Altern. Complement. Med.* 2015. Vol. 21, T. 10. P. 598–603.
 24. NANHOE-MAHABIER W. ET AL. The effects of vibrotactile biofeedback training on trunk sway in Parkinson's disease patients // *Park. Relat. Disord.* Elsevier Ltd, 2012. Vol. 18, T. 9. P. 1017–1021.