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Effectiveness of the application of resonant magnetoquantum therapy in complex restorative treatment of patients who have had ischemic stroke

I. P. Shmakova, V. V. Teschuk

Odessa National Medical University of the Ministry of Health of Ukraine

Abstract

The effectiveness of the application of RMQT in addition to drug therapy was studied in 98 patients who had had IS at the early stage of rehabilitation. Based on the performed clinical, neurofunctional, biochemical studies, life quality assessment, there were established the features of the action of RMQT at the stage of early rehabilitation on the pathological and sanogenetic mechanisms in the patients having had IS: improvement of the state of cerebral hemodynamics; brain electrogenesis; liquor dynamics; lipid metabolism, rheological properties of blood, which contributed to the regression of neurological symptoms, namely, an increase in the range of active motions and muscle strength, a reduction in the muscle tone, a decrease in the arterial pressure (AP), an improvement in cognitive, intellectual-mnestic functions.

It has been established that the patients having had IS were characterized by subjective and neurological manifestations of the disease, changes in the functional state of the nervous system (disturbance of cognitive and intellectual-mnemonic functions, brain electrogenesis, liquor dynamics) and cardiovascular system, cerebral circulation (hyperperfusion in all vascular basins, asymmetry of the blood circulation, increase in the peripheral vascular resistance), biochemical indices and quality of life.

It has been shown that the use of the RMQT complex by a multilevel method in addition to basic medical therapy of the patients who have had IS at the stage of early rehabilitation can reduce the subjective and neurological manifestations of the disease, improve cognitive and intellectual-mnemonic functions, improve intracardiac hemodynamics, cerebral circulation through the main head vessels and intracranial arteries, which characterized by an increase in the linear velocity of blood circulation, decreased hyperperfusion, peripheral vascular resistance and their asymmetry. It allows to improve significantly bioelectric activity of the brain, liquor dynamics, rheological-coagulation properties of blood and lipid metabolism. The effectiveness of RMQT was obtained in the patients with IS in 3 weeks and significantly increased after 3 months.

The effectiveness of the application of RMQT by a multilevel method facilitates the achievement of a fairly high quality of life of the patients who have had IS, followed by preservation of it for 3 and 6 months according to the indices of working capacity, general well-being, intellectual-mnemonic functions, and social activity.

Key words: ischemic stroke, early rehabilitation, resonance magnetoquantum therapy, efficacy.

**Ефективність застосування резонансної магнітоквантової терапії (РМКТ)
у комплексному відновлювальному лікуванні хворих, які перенесли ішемічний
інсульт (ІІ)**

І. П. Шмакова, В. В. Тещук

Резюме

В дослідженнях на 98 хворих, які перенесли ІІ, на етапі ранньої реабілітації вивчена ефективність застосування РМКТ додатково до медикаментозної терапії. На підставі проведених клінічних, нейрофункціональних, біохімічних досліджень, оцінки якості життя встановлено особливості дії РМКТ на етапі ранньої реабілітації на пато- та саногенетичні механізми у хворих, які перенесли ІІ: покращання стану церебральної гемодинаміки; електрогенезу головного мозку; ліквородинаміки; ліпідного обміну, реологічних властивостей крові, що сприяло, регресу неврологічної симптоматики, а саме – збільшенню обсягу активних рухів і м'язової сили, зменшенню м'язового тону, зниженню артеріального тиску (АТ), покращенню когнітивних, інтелектуально-мнестичних функцій.

Встановлено, що для хворих, які перенесли ІІ, в ранньому реабілітаційному періоді характерні суб'єктивні і неврологічні прояви захворювання, зміни функціонального стану нервової (порушення когнітивних і інтелектуально-мнестичних функцій, електрогенезу головного мозку, ліквародинаміки) і серцево-судинної систем, мозкового кровообігу (гіперперфузія у всіх судинних басейнах, асиметрії кровообігу, підвищення периферичного судинного опору), біохімічних показників та якості життя.

Показано, що використання комплексу РМКТ за багаторівневою методикою додатково до базової медикаментозної терапії хворих, які перенесли ІІ, на етапі ранньої реабілітації дозволяє зменшити суб'єктивні і неврологічні прояви захворювання, поліпшити когнітивні і інтелектуально-мнестичні функції, покращити внутрішньосерцеву гемодинаміку, мозковий кровообіг по магістральних судинах голови і інтракраніальних артеріях, що характеризується збільшенням лінійної швидкості кровообігу, зниженням гіперперфузії, периферичного судинного опору і їх асиметрій, дозволяє значно поліпшити біоелектричну активність головного мозку, ліквародинаміку, реологічно-коагуляційні властивості крові і ліпідний обмін. Ефективність застосування РМКТ отримана у хворих з ІІ через 3 тижні і значно збільшується через 3 місяці.

Ефективність застосування РМКТ за багаторівневою методикою сприяє досягненню відразу після лікування досить високого рівня якості життя хворих, які перенесли ІІ, з подальшим збереженням його протягом 3 і 6 місяців за параметрами працездатності, загального самопочуття, інтелектуально-мнестичних функцій, соціальної активності.

Ключові слова: ішемічний інсульт, рання реабілітація, резонансна магнітоквантова терапія, ефективність.

Relevance of the work. Cerebrovascular diseases are among the first in prevalence, mortality and disability in Ukraine and in the world, and therefore many physicians and scientists focus on this issue. According to WHO, from 100 to 300 strokes per 100 thousand of population are annually registered in the developed countries of the world [13, 15, 19].

The incidence of cerebral stroke in Ukraine is 280-290 cases per 100 thousand of population, while in Western Europe it makes 200 cases per 100 thousand of population [5, 6, 10].

In Ukraine, the level of disability in a year after a stroke rises from 76 to 85%, while in Western Europe it is 25-30%, which indicates an inadequate level of organization of the medical and rehabilitation process [24].

Most survivors of the stroke become disabled, 20-25% of them need extra care for the rest of their lives, and a significant part needs care of the relatives of working age, which determines the socioeconomic significance of this problem [4, 10, 14, 15].

In the structure of the cerebrovascular diseases, the leading place belongs to ischemic cerebrovascular accident. Recent decades have been marked by significant advances in the field of angio-neurology, in particular, in understanding the mechanisms of cerebral ischemia. The concept of "heterogeneity of ischemic stroke" has been formulated, and its main pathogenetic subtypes have been determined. The potential reversibility of cerebral ischemia has been proved; there have been specified consistent pathobiochemical and cellular-molecular mechanisms leading to ischemic damage of the cerebral tissue [4, 8, 12, 14, 20, 23, 24]. Based on these data, the limits of the "therapeutic window" have been determined, i.e. the period, during which intensive therapeutic measures are most effective. There has been proved the role of apoptosis - a special type of cell death in the formation of long-term consequences of cerebral ischemia. The results of these scientific studies determined the therapeutic strategy for ischemic diseases of the brain. In this aspect, the development of new effective methods of secondary neuroprotection, aimed at interrupting apoptosis and other consequences of ischemia, becomes especially important. Undoubtedly, in the acute stage of cerebral dyscirculation, methods of pharmacotherapy are of paramount importance, but at the stage of early rehabilitation the essential role is played by methods of physical therapy, which facilitate the incorporation of adaptation mechanisms, the development of collateral circulation, and the suppression of non-functional neurons in the zone around the ischemic focus. Numerous methods of physiotherapy and balneotherapy of the patients with cerebrovascular diseases have been developed, but the scientific substantiation and introduction of new methods of physical therapy of patients in this category does not lose its relevance [1, 2, 7, 11, 17, 21].

New technologies for the rehabilitation of the patients who have had IS, on the basis of applying medical therapy and physical factors, which are appointed by the multilevel methods at the stage of early rehabilitation, require further elaboration. RMQT deserves the greatest attention [3, 16, 22].

The aim of the work. To increase the effectiveness of early rehabilitation of the patients who have had IS by application of RMQT in the complex treatment taking into account the peculiarities of the disease course.

Materials and methods. The clinical-instrumental and laboratory examination of 98 patients aged 30 to 60 years old who had had IS, including 42 (66.1%) males and 56 (56.01%) women, was conducted for solving the tasks. It is important to emphasize that the working-age population (average age 52.05 ± 2.0 years) prevailed.

A clinical diagnosis was made according to the International Classification of Illnesses of X Review.

Clinical and neurological studies included analysis of complaints, data of neurological status (study of the motor, reflex, coordination and intellectual-mnemonic functions) as well as changes in AP and the severity of autonomic disorders.

In determining motor disorders the following was taken into account: the range of active motions, muscle strength, the state of the muscle tone. In order to quantify the various indices of elementary functions, a standardized scale by T. Demidenko was used [9].

The nature of the blood flow disorders was assessed using USDG [18].

To study the state of functional activity of the brain, a study of electrogenesis of the brain through electroencephalography (EEG) was conducted.

The following biochemical indices were determined: the level of total cholesterol (HF), triglycerides (TG), low density lipoprotein cholesterol (LDL cholesterol), high density lipoprotein cholesterol (HDL-HDL), the index of atherogenicity (IA), the prothrombin index (PI), plasma tolerance to heparin, fibrinogen, fibrinase activity, fibrinolytic activity, prolonged platelet aggregation with ATP.

Assessment of the immediate results was carried out according to the criteria of the effectiveness of rehabilitation of the patients who had had cerebral stroke in accordance with the recommended standards of treatment for various clinical and rehabilitation groups. Dynamics of restoration of the motor functions and household activity was determined by the Bartel scale.

The patients were represented by 2 groups:

The 1st group (38 persons) received standard medical treatment.

The 2nd group (60 persons) received RMQT on a multi-level basis in addition to standard medical treatment.

The method of RMQT is carried out as follows: **in IS in the basal area of the internal carotid artery**, RMQT is first used with magnetic field induction (MF) of 10-30

mTl, the laser radiation power (LR) in the red range was with the power of 5-30 mW, infrared - 5-40 mW with the amplitude modulation and additionally RMQT was carried out to the following specific areas: the area of the eye through the closed eyelid on the side of the ischemic cell with the induction of MP 10-30 mTl, LR of the red range 10-30 mW on the projection of C7-Th3 segments of the spinal cord with the induction of MP 10-30 mTl, the power of LR of the infra-red range was 10-40 mW, frequency - 8-10 Hz, for 10 minutes. **In IS in the vertebral-basilar basin (VBB)**, RMQT is initially administered with the induction of MF of up to 40 mTl and LR capacity in the infrared range of up to 50 mW, frequency modulation of up to 37-38 Hz, it is applied subcapsially on the projection of the vertebral arteries on both sides, exposure time is up to 10 min After that, RMQT with the induction of MF of up to 50 mT and LR in the red range with the power of up to 70 mW, frequency modulation of 0-11 Hz is applied on the projection of the brain stem (large ophthalmic area) and simultaneously MF with the induction of up to 50 mTl, LR with the power of up to 70 mW, frequency modulation of 0-11 Hz - to a specific area: the projection of C7-Th3 segments of the spinal cord (zone C7-D1 vertebrae), exposure time is up to 10 minutes. It is recommended that all the above-mentioned operations be carried out within the first 3-5 days. (Patents of Ukraine № 115807, № 116946).

Results and discussion. There were followed up 98 patients with IS developed against the background of cerebral atherosclerosis, hypertension and their combination. Most of the examined (68) had had a cerebrovascular disorder in the carotid system, while others (30) experienced VBB. The predominant number of patients was admitted to treatment in the early recovery period of the disease (up to 3 months from the onset of the disease). The clinical picture varied depending on the affected vascular basin and the location of the focus. In the carotid stroke there were found disorders of the cranial innervation, mainly central paresis of the facial and sublingual nerves, motor, speech and sensory disorders in the neurological status. In a stroke in VBB, dyscoordination syndrome was often observed in combination with the symptoms of affection of the separate cranial nerves and pyramidal insufficiency. Both in carotid and stroke in the VBB, motor disorders in the form of hemipareses of varying severity were the most permanent. Thus, before treatment of the patients with carotid stroke, the assessment of muscle strength was (2.2 ± 0.7), muscle tone - (2.43 ± 0.1), walking skills - ($3.14 \pm 0, 09$) and self-service - (3.9 ± 0.02) points.

Among the concomitant pathologies, cardiovascular diseases were prevalent: arterial hypertension - in 95 (96.9%), ischemic heart disease, myocardial dystrophy and heart rhythm disturbances - in 66 (67.3%) persons. Characteristically, most patients - 58 (59.2%) were

found to have post-stroke arthropathy. The presence of marked and stable arterial hypertension as well as post-stroke arthropathy significantly restricted the possibility of active motor rehabilitation and physiotherapy procedures.

Under the influence of RMQT the patients with IS had a decrease in the severity of cerebral and emotional-volitional disorders, parenthesis in the paretic limbs, pain of arthropathic genesis. Besides, there were positive changes in the motor sphere: an increase in the range of movements in the paretic limbs, a decrease in high muscle tone, improvement in walking and self-care skills. A quantitative analysis of the state of motor functions (according to the scale of T.D. Demidenko) revealed a significant decrease in the severity of the neurological motor deficiency in all studied indices. The dynamics of motor disorders and other focal neurological symptoms was more pronounced in complex use of RMQT by a multi-level method with drug therapy.

The data of USDG before the beginning of rehabilitation showed a significant decrease in the blood supply to the vascular basins of the brain, especially the carotid basin. Disorders of cerebral hemodynamics were of a generalized nature and were manifested not only on the side of the affection but also on the intact side. However, against the background of bilateral circulatory changes there were observed clear interlobar asymmetry (asymmetry factor - in the carotid basin ($65.6 \pm 2.8\%$), in VBB - ($54.7 \pm 3.9\%$), they were due to greater reductions in the pulse blood filling on the side of the focus.

Studies conducted in the dynamics have shown the beneficial effect of MRCT on cerebral hemodynamics. This was manifested by the improvement of the blood flow to the ischemic vascular basin, decreased tone of the cerebral arteries, and decreased interhemisphere asymmetry. The direction of hemodynamic changes, despite the reliable positive dynamics of the indices, did not reach the level of physiologically normal state. This indicated the development of compensatory and adaptive mechanisms in the post-stroke patients towards adaptation to a reduced level of functioning of various systems, including cerebral hemodynamics.

The analysis of the initial EEG revealed the presence of both diffuse and local changes in the patients with IS. Diffuse brain biopotential changes were observed in 88.1% of patients, they were characterized by amplitude relationship disturbances of basic EEG rhythms: lower representation of alpha rhythm, increased severity of beta rhythm, decreased responsiveness to functional load. The indicated changes were more pronounced in the affected brain of the cerebral hemisphere. Focal changes were detected in 80.0% of patients; they were expressed in the presence of pathological focus activity (teta- and delta waves), mostly in the central and

parietal leads, and interhemisphere asymmetry. The patients with IS were more likely to have pathological types of EEG-III (desynchronous) in 45.9% of patients, and V (disorganized) in 21.4% of patients. Spectral analysis data showed the predominance of the EEG wave structure of the slow range and the significant reduction of the alpha range power. This suggests that the preservation of the focus of the slow activity and lack of alpha activity in the affected hemisphere are an EEG-equivalent of a stable neurological impairment and have an adverse prognostic value.

The EEG studies conducted after a course of treatment with the use of RMQT established a certain improvement in bioelectric activity of the brain in all patients. The dynamics of diffuse changes was expressed by an increase in the total amplitude level of the brain biopotentials, especially in the affected hemisphere, by improving reactivity to functional load. The dynamics of focal changes was manifested by the narrowing of the focus of the slow activity, the decrease of interhemisphere asymmetry. It should be noted that under the influence of the methods studied essential regression was subjected to local changes in the affected hemisphere. So, after the course of RMQT by a multi-level method, 58.2% of patients had interhemisphere asymmetry decreased due to the increase in the amplitude of alpha waves in the affected hemisphere (from 18.6 ± 2.9 to 32.1 ± 3.2 mcV, $p < 0.01$).

The study of lipid metabolism rates in the vast majority of patients with IS found the phenomenon of hypercholesterolemia and hyperlipidemia when receiving rehabilitation.

The study of the state of the system of hemorrheology, which is one of the main mechanisms in the development of acute cerebrovascular disorder, has shown that deep disturbance remains in the postnatal patients, characterized by activation of the coagulation properties of the blood, inhibition of fibrinolysis, deterioration of the aggregation state of the blood. 62.2% of the subjects were found to have a hypercoagulation state, which was confirmed by the shortening of the time of general coagulation tests, the increase of the prothrombin index and the concentration of fibrinogen.

The application of complex treatment with the inclusion of RMQT by a multilevel method in the patients with IS contributed to a significant improvement in hemorrheological status. After the rehabilitation course, a significant reduction in HF, CHL-LDL and, at the same time, an increase in the level of HDL-HDL resulted in a decrease in IA in patients of the main group ($p < 0.05$). In the control group, changes in lipid metabolism were more related to the decrease in HF, with the level of lipoproteins and, accordingly, IA was not significantly changed. As a result of the course of rehabilitation involving RMQT, lipid metabolism

improvement was registered in 26.6% ($p < 0.05$), in the control group - in 10.5% of the patients ($p > 0.05$).

The analysis of coagulograms in the patients of the main group after treatment showed an increase in fibrinolytic activity of blood 1.5 times more than in the controls as well as statistically significant increase in kaolin time and decrease in fibrinogen. The duration of aggregation of platelets with ADP in the main group increased twice ($p < 0.05$), in the control – 1.3 times and was at the lower limit of normal.

The use of the RMQT complex by a multilevel method increases the effectiveness of early rehabilitation of the patients who have had IS, which is manifested by the significant growth of both immediate (86.7%) and remote (83.3%) outcomes that exceed the results of the independent use of drug therapy.

RMQT by the multi-level method facilitate the achievement of a sufficiently high quality of life of the patients who have had IS immediately after treatment, followed by preservation of it for 3 and 6 months according to the parameters of disability, general well-being, intellectual-mnestic functions, social activity.

Thus, the developed method of RMQT by a multi-level method has a clear pathogenetic orientation and affects the main links of the pathological vascular process. Its use in the patients who have had IS increases the compensatory capabilities of the vascular system of the brain, has a cerebroprotective effect, and affects the trigger mechanisms of long-term effects of ischemia. The main role in the implementation of therapeutic action is the elimination of the blood supply shortages in the vascular basins of the brain due to improved regulation of cerebral circulation, normalization of the tonus of arterial and venous vessels. Due to the improvement of the blood supply and reduction of hypoxia, bioelectric and functional activity of the cerebral cortex increases. RMQT has a corrective effect on the hemorrheology system, contributing to the reduction of hypercoagulation, activation of fibrinolysis, and improvement of microcirculation. Neurofunctional indices achieved improve the clinical condition, restore the motor functions and significantly improve the quality of life of patients.

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