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THE IMPACT OF MAGNETIC AND LASER THERAPY ON LIPID METABOLISM IN COMPLEX TREATMENT OF PATIENTS WITH ISCHEMIC STROKE IN ACUTE PERIOD

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Acute cerebrovascular disease is an urgent and the most socially important problem in modern neurology, medical science and public health in Ukraine. Disturbed lipid metabolism plays a key role in development of cerebral atherosclerosis and eventually cerebrovascular incidents. New pathogenesis-associated treatment approaches are being searched. This article summarizes the experience of magnetic and laser therapy of patients with ischemic stroke in acute periods, and the impact of treatment on host lipid metabolism parameters.

Key words: Acute cerebrovascular disease, ischemic stroke, magnetic and laser therapy, lipid metabolism.

Disturbed lipid metabolism is a pathogenic basis for the development of cerebral atherosclerosis [1].

The current views of disturbed lipid metabolism emphasize alterations in blood lipoproteins where changes in apolipoprotein composition, as well as excessive intake of exogenous lipids, are considered to play the key role [1]. Lipid ingestion by tissue begins from activation of lipoprotein lipase which cleaves major energy important lipids – triglycerides - into fatty acids and glycerol digested by tissues, the role of this lipid metabolism stage is being quite significant, if not fundamental [1].

The objective of our study was to develop magnetic and laser therapy (MLT) methods and to investigate its efficacy in complex treatment of patients with acute ischemic cerebrovascular stroke (AICVD), as well as its impact on lipid metabolism in general. 26 patients (19 males, 7 females) aged 45-70 years with acute ischemic cerebrovascular stroke hospitalized in Angioneurology Department of Neurosurgery and Neurology Clinic of Southern Regional Army Health Clinical Centre (Odessa) and General Intensive Care Unit of Kiev Regional Clinical Hospital (Kiev) were examined. We evaluated treatment of verified ischemic

stroke (n = 26) in the middle cerebral artery (MCA) circulation using magnetic and laser therapy (MLT) and traditional medications vs. medication-only therapy (n = 30).

Our MLT methods involved transcranial impact on ischemic focus, projection of carotid arterial bifurcation on the side of the focus, on eye bulb through closed eyelid on the side of the focus and on collar zone (C₈-Th₃ segment projection), as well as investigation of high density lipoproteins (HDL), low density lipoproteins (LDL), triglycerides, total cholesterol. Magnetic field (MF) induction reaches up to 30 mT, laser power (LP) - up to 50 mW, and frequency modulation – up to 10 and 37.5 Hz.

Based on the direct results, the treatment of 15 (57.69 %) patients in the study group, and 33.3 % of patients in the control group have finished treatment with minimal and mild neurological deficiency. In the follow-up the obtained results remained the same for one year when continuing rehabilitation activity.

We observed 26 patients with verified ischemic stroke (IS) in the middle cerebral artery (MCA) circulation (17 left, 9 right), average age was 55.3 ± 4.7 years. The group included: 19 (73.1 %) males and 7 (26.9 %) females. When hospitalized, patients, consid-

ered to have moderate state by clinical course using NIH SS Scale, Glasgow Coma Scale, modified Barthel index adapted for acute stroke trials, were selected for treatment. All patients were examined using the unified program of clinical, electrophysiological, Doppler ultrasonographic, neurovisual (brain computed tomography and brain magnetic resonance imaging) and laboratory biochemical studies.

The main reasons of IS were: atherosclerosis at 18 (69.23%) patients, atherosclerosis with arterial hypertension at 22 (84.61 %) patients. For 12 (46.15 %) patients the proximal cause of development of hemodynamic brain disturbances was extra-magistral cerebral stenosis and occlusion (stenosis more than 50% or significant deformation of vessels). Patients' IS developed with blood pressure (BP) changes, sudden rise or drop. For 6 (23.07 %) patients a stroke was preceded by transient cerebrovascular events. Using brain CT or MRI the focus of ischemic lesion has been verified at 26 (100.0 %) patients: 7 (26.92 %) patients had cortical or subcortical lesions; 5 (19.23 %) patients had hemispheric deep lesions, 14 (53.85 %) patients had cortical foci. We didn't include transient cerebrovascular events in our investigation. The focus was large (more than 40 mm in diameter) in 4 (15.38 %) patients, and medium (10–40 mm) in 12 (46.16 %) patients, very small (less than 10 mm in diameter) in 10 (38.46 %) patients. During neurological examination of IS patients, we have found the disordered motor function of all patients monitored: hemiplegia in 6 (23.08 %), severe hemiparesis in 11 (42.31 %) (reduced muscular power to 1-2 points), moderate hemiparesis in 4 (15.38 %) (reduced muscular power to 3 points), slight and mild hemiparesis in 5 (19.23 %) (reduced muscular power to 4 points). Disturbed or changed sensitivity has been observed at 24 (92.31 %) patients, speech disturbances (motor and/or sensory aphasia, disartria of different intensity) were registered at 23 (88.46 %) patients.

3 (11.54%) patients demonstrated extrapyramidal symptoms; 2 (7.69%)

patients demonstrated blurring. All IS patients ($n = 56$) examined were randomized into two groups: the first group (study group, $n = 26$ pts.) received magnetic and laser therapy (MLT) with basic medication treatment; the second group (control group, $n = 30$ pts.) underwent medication-only treatment. Basic therapy included standard dosages of current medications (ceraxon, actovegin, aspirin, sulphated magnesia, cerebrolysin, gliatilin; fraxiparin in individual patients etc.). Moreover, moderate hemodilution has been performed with blood rheology and Ht monitoring, and when intracranial hypertension symptoms occurred, furosemide (lasix) was added. Blood sugar level was also corrected. Our method of MLT was used for the first group patients. MLT was performed using serial unit "MIT-1-MLT" of domestic production by company "Medintech" SRI LLC. Patients underwent treatment immediately after IS verification (brain CT or MRI).

MLT procedures in the middle cerebral artery circulation at ischemia were as follows:

- transcranially at the projection of ischemic focus (MF up to 30 mT, LP up to 50 mW, $I = 0.78 \mu\text{m}$, frequency modulation 37.5 Hz). Exposure onto the focal region supposed regulation of physical and chemical processes penumbra, decrease in local edema and inflammatory events, stabilization of cell membranes.
- projection of carotid arterial bifurcation on the side of the focus (MF up to 30 mT, LP up to 40 mW, $I = 0.67 \mu\text{m}$, frequency modulation 37.5 Hz). Exposure to this zone provided magnetic and laser irradiation of blood, glomus caroticus and n. vagus. Stimulation of this important structures resulted in influencing blood rheology, BP and lipid metabolism, vegetative functions etc. Specified zones were stimulated simultaneously for 10 - 15 min, which corresponded to irradiation dose of 2–3 J/cm² per zone [2,3].

Subsequently two more zones were exposed:

- eye bulb through closed eyelid on the side of the focus (MF up to 30 mT, LP up to 40 mW, $l = 0.67 \text{ } \mu\text{m}$, frequency modulation 10 Hz). Magnetic and laser stimulation of this zone influenced vessels of the eye fundus (the middle cerebral artery circulation) and optic nerve leading to reduced angiospasm and functional reorganization of optic and epiphyseal system;
- projection on spinal cord at C_8 - Th_3 (MF up to 30 mT, LP up to 50 mW, $l = 0.78 \text{ } \mu\text{m}$, frequency modulation 10 Hz). Exposure to this zone (segmental vegetative centre promoting maintenance of all sympathetic brain structure) involved normalization of energetic and metabolic processes in the brain, vascular tone etc. [2, 3]. Stimulation of these zones was also concurrent.

Thus, one session included exposure to 4 zones using two frequency modulations 10 and 37.5 Hz, the total duration was up to 30 minutes. The treatment of 17 (65.39 %) patients started within 24 hours, 4 (15.38 %) patients - within 1-5 days, and 5 (19.23 %) patients - within more than 5 days from AICVD event.

The procedures were performed twice 24-hours on the first days. MLT procedures were performed each 24 hours after 5-7 days of stroke. The control group and the study group were identical in timing of treatment, clinical course and other symptoms ($p > 0,05$).

Therefore, inclusion of MLT into the complex treatment of AICVD patients improved the majority of hemodynamic parameters. The other important data in analysis of response to MLT included observations ($n = 5$) when exactly on day 2–3 a hypodense zone of medium ($n = 4$) or big size ($n = 1$) was registered, the brain matter density alterations not being detected on 20–25 day. These observations were not found in the control group.

Discussion of the results

Physical and chemical blood alterations play a major role in mechanisms of vascular

pathology development, and when severe disturbances, the vascular-thrombocytic factor is added to atherosclerosis. In vascular-thrombocytic mechanism realization, two main processes are involved: fibrinogenesis and fibrinolysis at the same time. Normally they are mutually balanced, the platelet adhesion increase in case of pathology and the thrombocytic agents can appear on the inner surface of cell wall, especially in the sites of its lipid infiltration. Further involvement of blood sedimentation different factors results in fibrin thrombus formation. As a result, the important objective of the modern clinical medicine is to search for medicinal products and methods which would extensively influence intravascular hemocirculation and would be safe for patients. One of these methods is a magnetic and laser therapy (MLT) which has favorable impact on hemostasis according to numerous studies issues: reduced aggregation of red blood cell and platelet, increased time of hemorrhage and coagulation, decreased content in fibrinogen, increase in fibrinolytic activity. MLT and medication treatment had more favorable impact on these parameters compared to medication-only therapy. After ten sessions of magnetic and laser therapy (MLT) we observed reduced levels of triglycerides from $2.18 \pm 0.054 \text{ mmol/L}$ to $1.89 \pm 0.129 \text{ mmol/L}$ and low density lipoproteins from $3.2 \pm 0.451 \text{ mmol/L}$ to $3.1 \pm 0.342 \text{ mmol/L}$ at our patients. Evidently MLT has peculiar heparin-like effect eventually due to the breach of heparin-sulphate links resulting in lipoprotein lipase (LPL) enzyme release into blood circulation. This enzyme provides exogenous fat intake by tissues [1]. LPL is localized onto vascular endothelium, to which it is "attached" with heparin-sulphate proteoglycan chains [1], breaking off after heparin administration. This enzyme can cleave triglycerides [4]. At the same time an increase in cholesterol level from $5.6 \pm 0.654 \text{ mmol/L}$ to $5.9 \pm 0.263 \text{ mmol/L}$, B-lipoproteins from $53 \pm 3.67 \text{ U}$ to $54 \pm 2.375 \text{ U}$, and high density lipoproteins from $1.4 \pm 0.153 \text{ mmol/L}$ to $1.6 \pm 0.146 \text{ mmol/L}$ was observed.

Thus, MLT inclusion into the complex treatment had a favorable impact on all key values of blood rheology and coagulation; essential is that those changes were reported relatively early on 7-10 day after IS. Subsequently, changes rate was not so fast but de facto continued for the whole acute period. Significant changes ($p < 0,05$) of several hemorheological values in the control group were recorded on 12–14 day only. Specifically, changes in hemorheology and coagulation blood parameters correlated with improved clinical manifestations. According to immediate results, 15 (57.69 %) patients in the study group, and 33.3 % of patients in control group underwent treatment with minimal and mild neurological deficiency. While analyzing the treatment outcomes in the study group in 6 months, the following data was obtained. The recovery processes continued within the whole group, and rehabilitation level of the patients increased significantly ($p < 0,05$) (the number of patients with severe and partial dependence reduced and the number of patients “completely independent” increased by 10 %). In the control group ($n = 30$): 1 patient had suffered the internal carotid artery operation and 1 patient died due to repeated AICVD, other patients kept de facto the same rehabilitation capacity with slight increase in positive gradation. In one year we could obtain data concerning health condition of 23 (88.46 %) study patients and 28 (93.33 %) control patients. It should be noted that the number of patients “completely independent” and “independent in everyday life” remained almost unchanged, and the number of patients with more severe condition decreased by 7.69 %. Patients’ social activity level in the control group did not significantly change compared to 6 months period, but it remained lower that in the study group. Therefore, our investigations show that the most significant recovery time for loss functions at patients with moderate AICVD was acute period of IS when patients reached by 21 day a certain social activity level. No wonder that the tendency for early rehabilitation at cerebrovascular accident patients is evidently observed in modern

angioneurology. These effects are observed when patients are transferred from intensive care unit to early rehabilitation unit under condition of the stable hemodynamics on 5-7 day of disease. Therefore, our clinical studies show that complex treatment of acute IS (optimal treatment beginning in the “therapeutic window” period) using conventional medication therapy, and MLT represents an effective method significantly better than medication-only therapy. However, medication therapy with MLT of approximately 30% patients in the very early period allows preventing development of ischemic focus and restricts its development (hypodense zone registration). Moreover, the early rehabilitation of AICVD patients is a necessary instrument to prevent development of muscular contractures, dystrophic changes in joints etc., eventually determining patient’s ability to work, self-maintenance, namely to social independence.

Thus, magnetic and laser therapy of patients with acute ischemic cerebrovascular stroke has a significant neuroprotective effect manifesting in positive dynamics of cognitive functions and whole brain symptoms. And the focal symptoms decreased faster with essential function recovery speed compared to the group of patients received medication-only therapy. Magnetic and laser therapy positively influenced the vegetative nervous system, enabled improvement in blood rheology, elimination of vasospasm, reduced cerebral edema (if present) and decreased the period of its existence evidently influencing the rate of thrombosed vessel recanalisation. Actually, the developed method of magnetic and laser therapy has no contraindications, however it is advisable to use it during acute period, optimally during “therapeutic window” period, namely, on the first 24 hours of a cerebrovascular accident. At the same time, the MLT method is still advisable in later periods (up to 12-15 days after stroke). Magnetic and laser therapy is convenient to apply for each patient without complications and it can be carried out at the specialized angioneurology units in combination with

standard medication therapy with significantly reduced pharmacological load. The mechanisms of lipid metabolism regulation in vascular cerebral accidents are still not completely studied. Verification of our hypothesis of MLT impact on lipid metabolism will enlarge our knowledge of cerebral atherosclerosis pathogenesis and consequently of acute ischemic cerebrovascular disease thus giving opportunity to prevent the vascular cerebral accident, and when incurred, to include MLT into pathogenetic therapy of acute ischemic cerebrovascular disease.

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Резюме

ВПЛИВ МАГНІТОЛАЗЕРОТЕРАПІЇ НА ЛІПІДНИЙ ОБМІН ПРИ КОМПЛЕКСНОМУ ЛІКУВАННІ ХВОРИХ В ГОСТРОМУ ПЕРІОДІ ІШЕМІЧНОГО ІНСУЛЬТУ

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Гострі порушення мозкового кровообігу представляють собою актуальну та найбільш соціально значиму проблему сучасної неврології, медичної науки та охорони здоров'я на Україні. Порушення

ліпідного обміну відіграють основну роль в розвитку церебрального атеросклерозу, а в послідовному інсульті. Проводиться пошук нових патогенетично обумовлених методів лікування. В статті представлений досвід застосування магнітолазеротерапії при лікуванні хворих в гострому періоді ішемічного інсульту, вплив лікування на показники ліпідного обміну в організмі пацієнтів.

Ключові слова : гостре порушення мозкового кровообігу, ішемічний інсульт, магнітолазерна терапія, ліпідний обмін.

Резюме

ВЛИЯНИЕ МАГНИТОЛАЗЕРОТЕРАПИИ НА ЛИПИДНЫЙ ОБМЕН ПРИ КОМПЛЕКСНОМ ЛЕЧЕНИИ БОЛЬНЫХ В ОСТРОМ ПЕРИОДЕ ИШЕМИЧЕСКОГО ИНСУЛЬТА

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Острые нарушения мозгового кровообращения представляют собой актуальную и наиболее социально значимую проблему современной неврологии, медицинской науки и здравоохранения на Украине. Нарушения липидного обмена играют основную роль в развитии церебрального атеросклероза, а в последствии инсультов. Проводится изыскание новых патогенетически обусловленных методов лечения. В статье обобщен опыт использования магнітолазеротерапии при лечении больных в остром периоде ишемического инсульта, влияние лечения на показатели липидного обмена в организме пациентов.

Ключевые слова: острое нарушение мозгового кровообращения, ишемический инсульт, магнітолазерная терапия, липидный обмен.

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