

The use of Intravenous Laser Blood Irradiation (ILBI) at 630-640 nm to prevent vascular diseases and to increase life expectancy

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Background and Aims: The mortality rate from vascular diseases is one of the highest. The use of Intravenous Laser Blood Irradiation (ILBI) within the last 30 years has demonstrated high efficacy in the treatment of vascular, cardiac and other systemic diseases.

Rationale: Laser energy at 630-640 nanometers is arguably the most effective for irradiation of blood and the vascular wall. Photons at this wavelength are absorbed by oxygen, improve micro-circulation, can change the viscosity of the blood and affect vascular endothelium.

Conclusions: In summary, more than 25 years of experience of using laser energy at 630-640 nm has shown that this waveband directly influences the parameters of all cells in the blood, blood plasma, the coagulation process and all the structural components of the vascular wall.

Additionally, ILBI directly or indirectly affects the cells of the immune system, hormones, and exchange processes in an organism, thereby not only improving the function of the vascular system, but also the other systems of an organism. It can finally lead to lower the incidence and number of vascular diseases, and indirectly to the reduction of the number of diseases in other organs and even systemically, thus helping to prolong the lifespan.

Key words: Intravenous Laser Blood Irradiation • coronary and heart disease • lifespan

Introduction

According to the World Health Organization, ^{1, 2)} hypertension is a high-risk condition that causes approximately 51% of deaths from stroke and coronary heart disease. It was considered directly responsible for 7.5 million deaths in 2004, about 12.8% of the total of global deaths. Every third adult in the world has hypertension, which is the reason why about 50% of all deaths are from a stroke or heart troubles. Furthermore, every tenth adult has diabetes.

I think that this percentage will increase even more if we take into account that irregularities of the microcirculation act as a stimulus for the development of diseases of the other organism systems (neurologic, pulmonary, oncological) and are responsible for delivery of immune system cells to the centers of the devel-

opment of pathological processes. Therefore the development and the deployment of any methods for the prevention and the treatment of vascular diseases represent the most important problem in modern medicine.

Without understanding the mechanism of the evolution of living systems and the general regularities of the development of an organism it is impossible to approach the solution of any tasks in the field of medicine and medical technologies. Therefore Gipertsikl's modern theory gains importance as the principle of the natural self-organization causing integration and coordinated evolution of the system of functionally connected self-replicated units. ³⁾ This theory allows us to understand and systematize the principles of the regulation of various functional systems of an organism and the development of various pathological processes.

The regulation and synchronization of the activity of all systems of an organism happen due to neural and humoral regulation. On the other hand, if the nervous system is autonomous and its regulating influence

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is carried out through a complex arrangement of neurons, humoral regulation is impossible without the existence of the organs synthesizing hormones, and the vascular system which then delivers these hormones and other biologically active agents to their targets in the organism.

The vascular system, besides its regulatory functions, carries out the function of transfer of oxygen to the tissues by means of erythrocytes and blood plasma, plus delivery of nutrients and drainage of fluids and toxins. It is clear that the activity of the immune system is impossible without the vascular system enabling delivery of the immunocompetent cells to the various organs.

The activity of the vascular system is carried out through the work of the heart and the blood vessels. From a long time previously, and even more so today, the main reason for vascular diseases has been seen in the development of cardiac pathologies. According to the WHO data from 2000 to 2011, mortalities from coronary heart disease had increased from 5.8 up to 7 million persons ^{1, 2)}.

However in my opinion the main reason for the development of coronary heart disease and other cardiac pathologies is the development of pathological processes in the walls of the blood vessels leading to a disturbance of their function. These changes subsequently lead to adverse changes in the coronary arteries and the myocardium.

For the first time this idea arose when different types of ILBI were first used. Continuous wave irradiation had no impact on the indicators of blood pressure in patients with a hypertensive illness. On the other hand, when we used frequency-modulated irradiation, a reliable decrease in blood pressure in this category of patients was revealed ⁴⁾. This result helped us to understand of the principles of biomechanics and to construct mathematical models for cardiac activity: the power of the heart at rest has been given as 3.3 W. With this comparatively low output power, the heart can pump the blood through the vascular system, the total length of which in humans approximates 100,000 km ⁵⁾. Even the pulling power of the thorax is not able to pull blood through such a length of the vascular network to the right atrial appendage.

In my opinion the heart as a vascular pump has the sole responsibility for the delivery of oxygen, blood cells and nutrients to tissues concomitantly with the removal of waste products and toxins. Synchronized contractions of vascular smooth muscles allow the regular movement of blood over such huge distances and then to deliver it back to the heart. Even absolutely minor local changes in a vessel causing dis-

ruption in the hemodynamics of the vessel can lead to the appearance of various diseases.

Any systemic disturbance of the activity of the heart as the central vascular pump leads to the increase of intravascular pressure and the emergence of hypertensive illness and coronary heart disease. Local disturbances can cause various diseases depending on the organ where they develop.

- Any disturbance in the nutrition of the pancreatic islets of Langerhans leads to a decrease in the production of insulin and the manifestation of diabetes.
- Malnutrition of hepatocytes leads to a disturbance of liver function.
- Disturbance of the delivery of the immune cells to their target tissues increases the probability of the development of carcinogenesis.
- Disturbance of waste products and toxin drainage from any organ causes intoxication and dysfunction of cells in the affected organ.

Therefore any action or intervention which can maintain the contractile function of vascular walls will help to prevent the emergence of many diseases and to increase life expectancy. This would be true no matter how it could be achieved - by the use of medicaments, physical approaches, chemical methods or exposure to laser energy at appropriate wavelengths. The main point is that the exposure should be systematic.

Intravenous Laser Blood Irradiation (ILBI) at 630-640 nm for the treatment of various diseases has been used since 1988. ⁶⁾ The accumulation of clinical and experimental data have allowed elucidation of the mechanism of action of this type of treatment, to define the indications and the contraindications for its use in clinical practice and to reveal that range of diseases for which this method of treatment can be the most effective.

For more than 25 years, the studies of my colleagues and I have showed that ILBI directly acts on the parameters of all the blood cells, on the state of the plasma, and on all the structural components of the vascular wall. In addition, by acting on immune system cells, hormones and exchange processes, ILBI can influence all the other systems of an organism. ⁴⁾

Research into the efficacy of ILBI with the red waveband

Influence on Blood Cells

Under the influence of ILBI there are favorable changes in peripheral blood: the red cell count increas-

es⁷⁾, reduction is seen in the erythrocyte sedimentation rate (ESR),⁸⁾ together with increased functions of lymphatic and macrophage cells.⁹⁾

Ananchenko VI et al.¹⁰⁾ studied the effects of ILBI on the clinical course and activity of energy enzymes of the peripheral blood lymphocytes in ischemic heart disease (IHD) patients. Study on the lymphocytic succinate dehydrogenase parameters and alpha-glycerophosphate dehydrogenase activity revealed increases in the medium cytochemical factor and the activity index of both enzymes. References regarding the effect of ILBI against angina can also be found.¹¹⁾

Khomeriki SG and Morozov IA¹²⁾ studied circulating neutrophilic granulocytes before and after laser therapy in 10 patients with ischemic heart disease and 5 healthy persons. The patients had severe cytoplasmic vacuolization, the number of specific granulocytes had increased, there was decreased thickness of the sub-membranous actins layer and a decreased surface volume ratio. The neutrophil indices in IHD patients became similar to those in donor cells after blood irradiation with a helium-neon laser. The outcomes of some forms of ischemic heart disease reactions indicate the normalizing effect of helium-neon laser irradiation on the mechanisms of non-specific reactivity.¹²⁾

Belousov SS et al.¹¹⁾ studied the clinical outcome of ILBI in stable and unstable stenocardia which are two pathophysiologically different forms of IHD. As a result, statistically significantly better outcomes were obtained for patients with unstable stenocardia. The patients of both groups showed a decrease in platelet self-aggregation up to 67%, and that of erythrocytes aggregation up to 17 %.

The experimental studies revealed significant changes in the morphological structure of peripheral blood based on the effect of ILBI. Following total irradiation of an animal with the HeNe laser (632.8 nm) reticulocytosis was seen together with some increase in the erythrocyte count with increased resistance.^{12), 13)} Even after a single treatment increases were seen in the count of blood band neutrophils (up to 192%), eosinocytes (up to 111%), basophils (up to 80%), lymphocytes (up to 19%) which all occurred within one hour, together with the simultaneous decrease in the monocyte and segmented neutrophil count (up to 62 and 19 % respectively). The authors correlated the increase of the above contents of band neutrophils with the leucopoiesis stimulation, and the increased number of lymphocytes, basophils and eosinocytes was associated with the migration of mature cells out of the bone marrow sinus, the spleen and vessels of

the lungs. The authors explained the decrease in the monocytes and segmented neutrophils count by accelerated extravasation into the tissue from the bloodstream. Similar changes in the morphological blood structure can be observed upon the irradiation of an individual target organ in an animal model, for example, irradiation of the heart. The conditions of exposure of the total organism to laser energy caused an ambiguous reaction of white blood cells to miscellaneous modes of irradiation: from leucopenia following single-phase irradiation to resistant leukocytosis following multiphase irradiation. Thus, against the background of the changes of the total leucocytes count there were detected considerable but unidirectional oscillations of the form of individual leukocytes: stable lymphocytosis and sharp reduction of the segmented leucocytes in blood, which became more stable in the case of repeated treatments with the HeNe laser radiation.^{14), 15)}

Influence on Blood Enzymes

A number of authors in many studies have remarked on the positive ILBI effect on the peroxidation of lipids (POL) in different diseases and pathological conditions.^{16), 17)} The first sessions of ILBI resulted in a significant increase of enzymes, kinins, and POL products in blood that were detected within 24 hours after each irradiation session. Interestingly, the POL level increased only in the plasma, whereas a progressive and significant decrease was seen in erythrocytes. The authors considered this phenomenon to be connected with the increase of the exodus rate of biologically active substances out of injured organs and tissues and their subsequent reactions with the blood flow. This phenomenon has also been confirmed by the results of clinical observations in which the best progress was seen in patients after laser therapy, in comparison with the control group. During the experiments some enhancement of catalase activity was determined, whose absorption spectrum was found to be near to the HeNe laser wavelength¹⁸⁾.

The medical properties of LLLT are becoming better understood. Following LLLT, the activity of the major intracellular bioenergetics enzymes increases.^{19), 20)} Moroz AM²¹⁾ asserts that the monochromatic red light from the HeNe laser with a power density of 25 mW/cm² is capable of increasing the blood glucose concentration, of reducing the pyruvic acid level, and raising levels of aldolase- and lactate dehydrogenase in rats during exposures of some 10 – 30 min. Some reviews have reported that HeNe laser radiation acti-

vates bioenergy processes in neural mitochondria²²⁾. It has also been determined that LLLT can stimulate the activity of major enzymes, *i.e.*, dehydrogenase and cytochrome-c oxidase,¹⁹⁾ catalase,²³⁾ and acidic and alkaline phosphatase.²⁴⁾

Lysenkov NV et al.,²⁵⁾ Djhuguryan MA,²⁰⁾ and Dreval VI²⁶⁾ investigated enzymes in their assays of lactate dehydrogenase whose activity level characterizes the intensity of glycolytic processes; glucose-6-phosphatdehydrogenase (G-6-PhDG) — the central enzyme of the henose-monophosphate shunt and esterase, and enzymes hydrolyzing ethers of carboxylic acids; lactate dehydrogenase (LDG) has many functions including the regulation of membrane permeability. After laser exposure a characteristic decrease in the sodium lactate contents was noted and levels of pyruvate increased up to normal in comparison with the initial level.

The enzymatic activity reaction as related to the different rates of laser irradiation was expressed more significantly during a 7-fold exposure. At the same time, the dynamics of LDG activity decreased and G-6-PhDG activity decreased in all experimental rats: these results allowed the authors to draw a conclusion regarding the relationships of the main pathways of the carbohydrate metabolism. The ratio of the quantitative characteristics of LDG activity / G-6-PhDG activity has a value much less than 1.0, that in turn means the preferential activation of the henose-monophosphate shunt. Thus activation of enzymatic processes responsible for respiration as well as the decrease in esterase following exposure to LLLT brings us to some conclusions regarding the influence of ILBI on metabolic processes in an organism. The data obtained completely corresponded to the outcomes of numerous studies.

Influencing Blood Proteins

LLLТ with the HeNe laser has been reported to achieve an increase in biosynthetic activity as shown by the increase of carbohydrates, proteins and nucleic acids in blood serum during experiments *in vitro*^{21), 28)} and in clinical studies.^{27), 28)} The positive effects of LLLT have been demonstrated in the saving of failing skin grafts.²⁹⁾ Lyone R³⁰⁾ proved decreased collagen contents in wounds subjected to laser irradiation in rat models.

Influencing the Blood Coagulation System

Influence on the coagulation process is demonstrated by the hypocoagulation effect, by increased blood fibrinolytic activity, decreased number of thrombocytes

and aggregation of erythrocytes, improved blood flow properties and the vasodilatation effect.^{8), 31- 33)}

In comparison with the initial data of an increase from the normal level of from 25 - 30%, ILBI resulted in a decrease of the fibrinogen level to 38% after the first procedure and to 51% after the whole treatment course³⁴⁾. In addition, ILBI has been shown to accelerate fibrinolysis and lower the prothrombin ratio. It is evident that all these processes result in improvement of blood flow properties and peripheral blood circulation.³⁵⁾

Influencing Hepatocytes

It has been determined, that treatment with the HeNe laser affects the stimulation of the division of both hepatocytes²⁶⁾ and fibroblasts.³⁷⁾

Influencing Biological Fluids

While studying the influence of 632.8 nm on the properties of ascitic fluid,³⁸⁾ my colleagues came to the conclusion that irradiation modifies the conformation of macromolecular aggregates. This was a quaternary pattern level in proteinaceous solutions stabilized by electrostatic interactions. It was noticed that the modifications of the protein structure influenced the fluid antigenic properties: the quantity of circulating immune complexes increased proportionally during the laser exposure. A number of studies^{39), 40)} used the crystalline status of biological fluids to estimate the individual receptivity and to predict the efficiency and optimization of LLLT modes. On the basis of their experimental and clinical studies the authors concluded that the effect of laser exposure on structure was exhibited not only in biological fluids subjected to direct irradiation but it was also revealed in biological fluids of organs located far from the irradiation zone in both pigmented and transparent systems. This is a further proof of one of the potential mechanisms behind the proven systemic effect of LLLT.

Influence on Oxygen

A significant effect of ILBI LLLT with red light on the transport and oxygen discharge ratio has been detected by many clinical specialists,^{8), 41), 42)} who found that laser irradiation of blood brought about amplification of the oxygen - transport function of blood due to modification of the affinity of hemoglobin for oxygen ; ILBI was shown to be accompanied by an increase of the O₂ contents and a reduction in the particle rate of

CO₂, testifying to the elimination of tissue hypoxia with concomitant improvement in tissue oxygenation improvement. These findings provided indirect evidence of normalization of the tissue metabolism through ILBI. ⁴³⁻⁴⁷⁾

Influence on Myocardial Ischemia

Experiments in the dog model involved occlusion of a coronary artery, followed by myocardial perfusion recovery using ILBI, but at the same time it was determined that the risk of cardiac fibrillation was reduced by 40%. The ischemia zone of the myocardium in the ILBI-treated animals was much less than that of the control animals, with more stable hemodynamics also noted. The authors considered that this was connected with the anti-ischemic effect of LLLT. ¹⁰⁵⁾ Furthermore, the clinical application of ILBI in many studies has pointed to high efficiency in various diseases of the myocardium. ^{48-51), 11), 52-61)}

Influence on the Vascular Wall and Microcirculation

The majority of studies have related to the analgesic and anti-ischemic effect of LLLT and the positive reaction of the blood rheological properties and microcirculation to irradiation with 632.8 nm. ^{50), 52), 54), 57)} The influence of LLLT has been demonstrated with enhancement of the permeability of the vascular wall. ⁶²⁾ Otherwise Musienko SM ⁴⁶⁾ showed that when the HeNe laser was used to treat skin injuries in patients with chronic venous insufficiency of the lower extremities, the pathological permeability of the vascular wall was markedly decreased, concomitantly with normalization of the transcapillary exchange. However, contradictory information exists regarding the influence of LLLT on microhemodynamics. ⁶³⁻⁶⁵⁾ Musienko SM ⁴⁶⁾ asserted that a microcirculatory link was a point of application in the mechanism of the therapeutic efficiency of laser radiation. The point has been made by other authors, confirmed by polarographic studies, that activation of energetic and biosynthetic processes occurred following red light LLLT. ^{66), 67)} Furthermore, the major importance of the microcirculation in the implementation of the biological effect of the red waveband, particularly of that around the HeNe laser, has been confirmed other studies. ⁶⁸⁾

A number of assays have confirmed the fact that ILBI stimulates the development of capillary tubes, eliminates vasospasm, ⁶⁹⁾ eliminates stasis and reverses blood flow. Moreover ILBI has been shown to decrease

capillary edema and to increase the number of functioning capillary tubes. ⁷⁰⁾

Formation of New Capillary Tubes

It has been shown that exposure to low levels of laser radiation actively formed new capillary tubes, thereby augmenting the oxygen delivery to tissues and optimizing tissue metabolism. ^{69), 71), 72)}

Diseases of Vessels

In the works of many authors, many references can be found to the possible use of LLLT for the treatment of acute thrombophlebitis ^{52), 73), 74)} and obliterating endarteritis ^{75), 76), 77-78), 79), 80)} of the lower limbs. Good results have been obtained in the treatment of trophic ulcers of the lower limbs t caused by chronic venous insufficiency. ^{30), 79), 81)} LLLT is well recognized for its successful treatment of venous diseases of the lower limbs and the consequences of venous trauma. HeNe LLLT for the treatment of acute thrombophlebitis of the superficial lower limbs has shown an extremely high efficacy. ^{52), 73), 74)}

Influence on the Lymphatic System

According to Livens P, ⁸²⁾ laser exposure results in a faster regeneration of the lymphatic system; this is the basis of the drainage and anti-edematous effects of LLLT. Along with the blood circulation stimulation, the effect of lymph circulation stimulation under the influence of LLLT in the visible area of the spectrum was detected by Levin YM et al. ⁸³⁾ These experimental studies determined the amplification of lymph circulation intensity; they also determined an increase in lymphatic vessels contractions, and an increased lymphocyte yield from the lymphocyte pool into a functioning lymphatic vessel lumen following visible red LLLT irradiation. The researchers attributed the detected effects to the influence of laser radiation on globular proteins resulting in an increase in the lymphatic optical density and the influence on the processes of the lymphocytic energy metabolism.

Influence on the Nervous System

Konovalov EP et al. ⁸⁴⁾ studied the influence of ILBI on the functional activity of a number of physiological systems. The analysis of the measurement of cardiac intervals showed that during the first two sessions of laser radiation increases were seen in the variational scope

(Δx), mode (Mo) and reduction mode (AMo) amplitude. And the pressure index (PI) in 71.5 % of patients. These data pointed to an enhancement of parasympathetic nervous system activity and the development of auto-regulation of the cardiac rhythm.

The studies of Skupchenko VV et al.⁸⁵⁾ showed ILBI-mediated changes in autonomic regulation towards parasympathetic tonus, an improvement in blood filling, decreased tonus, and decreased resistance in peripheral vessels. The data obtained by Udut VV et al.⁶⁷⁾ have very much in common with the outcomes of these studies. They showed that the intra-vascular laser therapy resulted in an increase of the parasympathetic nervous system tonus in 34% of patients, meanwhile resulting in the appearance of normal tonus in the autonomic nervous system in 60%.

In 1988 Serov VN et al.⁸⁶⁾ revealed the ability of HeNe LLLT first of all to restore and then to stimulate the impaired function of external sexual organ's receptors in kraurosis and vulvar leukoplakia. Rahishev AP et al.⁸⁷⁾ marked the activation of the myelination processes in neurons, thickening of axons and amplification of their regeneration. Increased amplitudes of action potentials in human forearm nerves following LLLT irradiation of the skin was observed by Walker JB et al.⁸⁸⁾ The increased synthesis of particular proteins and an elevated rate of axonal motion in neurons concomitant with the enhanced plasma circulation in innervated organs was reported following ILBI with the HeNe laser⁸⁷⁾ Following laser irradiation, induction of the functional activity of the nervous system was seen, accompanied by detection of the growth of microtubules in nerve fibers as the result of acceleration of the metabolic processes.

Rochkind S⁷⁷⁾ described the LLLT-mediated preservation of the functional activity of severely crush-injured neurons in experimental rats and furthermore demonstrated a decrease of the degenerative changes in motoneurons in transection injury spinal cord model. LLLT irradiation of the spinal cord, after severe injury and implantation of neural cells, promoted the fissile germination of axons in the injured area, resulting in partial recovery of locomotor function in injury-induced paraplegia.

Rochkind S, Nissan M, Alon M et al.⁷⁸⁾ applied transcutaneous LLLT to segments of the spinal cord after the crush injury of sciatic nerves in the rat model, immediately after closure of the wound, with a 16 mW, 632.8 nm, He-Ne laser. The laser treatment was repeated for 30 minutes daily during 21 consecutive days. This study suggested that LLLT applied directly to the spinal cord at the appropriate dorsal root could

improve recovery of injured peripheral nerves in a dermatomal-based approach. The results of the experiment strongly suggested that the process of retrograde degeneration of neurons became stable in the central part of the crosscut nerve much closer to the injured area (1.2 - 1.5 cm) after local exposure to LLLT; whereas in the control animals, the retrograde degeneration was tracked to within 2.5 cm from the level of the transected nerves.

Kositsyn RS et al.⁸⁹⁾ considered that an increased disintegration rate of nervous elements and resorption enhancement of nerve fragments formed new conditions for the acceleration of nerve regeneration. Thus, for example, the excretion of urine 5-hydro-indol-acetic acid has been studied, as the metabolism of serotonin.²⁹⁾ It was mentioned that increased excretion of this metabolite occurred under the influence of LLLT that proved the breakup of serotonin. The given data indicated a significantly clear laser effect, which was probably related to the laser effect on the humoral and inflammatory mechanisms of pain.

Another study evaluated the effect and mechanism of ILBI on brain injury. In this study, thirty-eight anesthetized Sprague Dawley rats underwent Feeney's model of traumatic brain injury through a left lateral craniectomy. It was found that ILBI-LLLT could improve posttraumatic memory deficits. Superoxide dismutase (SOD) activity, both as an antispasmodic and as an antioxidant, was higher in the treatment groups than in the control group, whereas the level of production of free radical-mediated malondialdehyde (MDA) was lower. These findings suggest that ILBI-LLLT produced a significant reduction in the damage to the brain caused by free radicals post-injury.⁹⁰⁾

Influence on the Neuroendocrine System

Numerous studies on the effect of HeNe LLLT on organisms have indicated some functional and morphological changes in the hypothalamic-hypophysis adrenal system⁹¹⁾. According to Serov VN et al.⁸⁶⁾ laser irradiation at certain parameters is capable of achieving hormonal modifications of pathological homeostasis by means of increasing an afferent stimulation of the diencephalic patterns of the brain. These authors then investigated the functional status of the central elements of the neuroendocrine with experimental animal models, and histochemical and cytophotometric analysis. The helium-neon laser (LG-38) with an output power of 50 mW was used. The duration of the exposure was 3 min. daily for 15 days. The results showed an accumulation of secretory substances in the

hypothalamic-epiphysis system and adenohipophys. With the increase of laser irradiation up to 10 days the stimulation phenomena also increased, but on extending LLLT up to 15 days, overstimulation occurred, causing functional-morphological modifications, and demonstrating the development of the exhaustion processes in neurosecretory elements and degeneration of neurosecretory cells. Exposure to LLLT of a reflexogenic zone of that group of animals during 5 days caused a considerable migration of neurohumoral products into the circulation system. The most significant reaction occurred in the supraorbital nucleus. An increase in both the cytoplasmic volume and the nucleus sizes in neurosecretory cells were registered. There was some decrease of delta basophils and the glycoprotein content in the adenohipophys.

The epiphysis is recognized as the coordinating gonadotrophic activity organ of the hypothalamus, therefore elucidation of the effect of LLLT on this organ is important. No changes were noted in the epiphysis structure after a single laser radiation. In the group which underwent 5 sessions of LLLT, some substantial modifications in the organ structure were found; those modifications were considered to be an accumulation of hormone-positive substance (HPS) and nucleic acids. After 10 sessions of laser radiation some laxity of the HPS and nucleic color was observed; it was estimated as the beginning of the secretory activity of the gland. After 15 sessions the volume of the epiphysis, cytoplasm and nuclei of pinealocytes increased, and the color of the HPS had significantly decreased; considerable activation of the secretory function of the gland was noted. The authors came to the conclusion that the epiphysis reacted with the phase changes of its pattern with regard to the duration of exposure; on the fifth day, inhibition was seen, and on the tenth to fifteenth days, some activation of the organ function was noticed. The most notable reaction was seen in the trophic-transport component of the gland.

The data obtained from the previously discussed experiment correlated with the data obtained by Grishenko LV, ⁹²⁾ whose outcomes showed that under clinical conditions, laser radiation with exposure of the external orifice of the uterus for 1 min during 6-8 days caused a decrease in the production of melatonin, and that this promoted the restoration of the production of hypothalamic neurohormones, as a result of which the recovery of menstrual function was in turn promoted.

Peshev D.P. et al. ⁹³⁾ studied the pituitary body and ovaries of female rabbits some of which were pregnant and others not pregnant after exposure of a cervical reflexogenic zone to HeNe LLLT at 20 mW for

10 min during the period of pregnancy. After the LLLT session the analyses of the rabbit pituitary bodies showed high DNA and RNA contents in all zones of the pituitary bodies. Analysis of the pregnant rabbits failed to show any endocrine bodies-related pathology of the investigated functional organs.

Koshelev VN et al. ^{94), 95)} indicated an increase in catecholamine, serotonin, histamine concentration and activation of the hypothalamus-adrenal system following red light LLLT. These data have been confirmed by the works of other authors. ⁶⁴⁾ Laser therapy with red light normalizes hormonal pathological irregularities in the menstrual-ovarian cycle in women. ⁹⁶⁾

Influence on the Immune System

Numerous studies have revealed the stimulating influence of laser irradiation on the indices of humoral and cellular immunity. The counts of a large number of related cells types, including macrophages, T-helpers, T-suppressors, and B-lymphocytes increase under the influence of laser therapy. ⁶⁾ The levels of immunoglobulins in blood are increased. The natural consequence of these processes is the acceleration of wounds, healing of torpid ulcers and wound healing in burn injuries. ²⁹⁾ The rather rare development of severe postoperative complications has also been successfully addressed with LLLT, such as purulent adhesions and postoperative wound infection. ⁹⁷⁾

ILBI results in an increase of the functional activity of B-lymphocytes in induction of the immune response. Both HeNe ILBI and transdermal semiconductor laser irradiation have been applied preoperatively and a combination of these approaches was trialled in 56 oncologic patients. The transdermal semiconductor laser irradiation proved to be the most effective, showing strong immunostimulation, tumor stasis and decreased postoperative complications. ⁶⁾

Discussion

The regulation and synchronization of the activity of all systems is the essential basis of any organism's activity, and it is not important how these goals can be reached. The more complicated the system is and the longer it functions, the more system failures will occur and mistakes will be made and accumulated. Living organisms are influenced during their entire lifetime by a set of negative factors - both external and internal. These negative impacts gradually accumulate and this consistently leads to the emergence of pathological changes at first at a molecular, and then at a cellular

and finally at a tissue level. This inevitably leads to the disturbance of the activity of a variety of the affected organism's systems. As a matter of fact, any illness represents a failure in one of the organism's systems concomitantly with a disturbance of its function. The outcome of the pathology and further activity of an affected organism depends on the organism's ability to restore the function of out-of-order systems. Any defect in the blood vascular system is one of the most severe defects any organism can suffer. This is confirmed by the fact that mortality rates associated with vascular diseases have now achieved the top score worldwide.⁹⁸⁾ Therefore, the maintenance of the functional activity of the blood vascular system is the most important problem of the modern medicine.

Irregularities in other systems can possibly be corrected by means of medicaments, but the use of only medicaments in the treatment of cardiovascular diseases is simply not enough. The advent of hypertension, malnutrition of the myocardium, the elasticity disorders in vessel walls and stenosis all arise after pathological dysfunctions have occurred in the vessel walls, which impair or destroy the ability of these vessels to contract and to pump the ever-essential blood to the recipient organs and tissues. The disturbance of the transport function of vessels can severely interrupt the delivery of oxygen, various cells, hormones and nutrients to their targets. In addition, the drainage function of blood and lymphatic vessels is broken, so that when impurities, waste matter and toxins are not efficiently drained from organs and tissue, dysfunction is inevitable.

The studies and accumulated literature of more than 30 years have proved that the visible red light in the waveband of 630-640 nm has a powerful influence on:

oxygen – 8), 41-47)
 blood cells – 8), 9), 11), 14), 15), 57), 99), 100)
 blood enzymes – 16-19), 21-24), 26), 28), 101), 102)
 blood proteins – 27-30)
 blood coagulation system – 8), 31-35)
 biological fluids – 27), 39), 40)
 vascular wall and microcirculation – 46), 50), 52), 54), 57), 62), 64-68) 70),

neomicrovascularization and neoangiogenesis – 69), 71),
 positive effects seen in the treatment of cardiovascular diseases and myocardial ischemia – 11), 48-54), 56), 58-61)
 vascular diseases – 30), 52), 72-76), 80), 81), 103)

The same visible red waveband has also demonstrated proven effects on the various systems which contribute to the organism's survival:

lymphatic system – 82), 83)
 nervous system – 29), 67), 89), 77), 78), 84-87), 90), 104)
 neuro-endocrine system – 64) 86), 91-94), 93), 96)
 immune system – 6), 29), 77), 97), 105)

The findings of all of these studies confirm that the visible red waveband at 630-640 nm has a local and systemic impact on all blood components, the blood vascular system and all the other systems of an organism. Relying on these studies and the results amassed by my colleagues and me since 1988, we have completely defined the indications and contraindications of ILBI, and determined the range of diseases for which this method is the most effective.⁴⁾ It is completely irrefutable that we use it successfully not only for the prevention of vascular and other systemic diseases, but also for increasing mankind's life span.

Conclusions

In summary, more than 25 years of experience in the use of low incident levels of laser energy for ILBI at 630-640 nm has shown that this waveband directly influences the parameters of all the cells in the blood, the status of the plasma and the blood coagulation system, in addition to all the structural components of the vascular wall.

Through its powerful effects on all aspects of blood and the vascular system ILBI can have a strong positive influence on cells of the immune system, hormones, the neuroendocrine system, and all exchange processes in an organism. Such influence allows us not only to improve the function of the vascular system, but also all the other systems of an organism. Ultimately, this will lead to a decrease in the incidence and number of vascular diseases, and indirectly to a reduction in the number of diseases in other organs and the organism's systems.

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