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Super Pulsed Laser Blood Irradiation as a Promising Treatment for COVID-19

LI Gusev*

Doctor of Medical Sciences, GBUZ SPC SMPD Them. V.F. Voino-Yasenetsky DZM, Moscow, Russia

***Corresponding Author:** LI Gusev, Doctor of Medical Sciences, GBUZ SPC SMPD Them. V.F. Voino-Yasenetsky DZM, Moscow, Russia.

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Abstract

All the effects of super pulsed laser blood irradiation (SPSPLBI) when exposed to laser radiation on the body and the methods of conducting therapy are described in detail. Exposure doses and exposure zones are given. All the effects of SPSPLBI when exposed to laser radiation on the body and the methods of conducting sessions are described in detail. Exposure doses and exposure zones are given. All these properties of SPSPLBI give rise to the use of this technique for coronavirus infection.

Keywords: *Therapeutic Laser Blood Irradiation; Coronavirus Infection; Photobiomodulation; Super Pulsed*

Introduction

Our arguments about the possibility of using super pulsed laser blood irradiation in the treatment of patients with COVID-19 are based on data from our study of the prevention of oral mucositis using super pulsed laser blood irradiation (SPSPLBI). The study included 110 children aged 1 to 17 years with malignant neoplasms. Of 260 courses of high-dose chemotherapy only one case (less than 1%) developed oral mucositis. No one else in the world has such results.

Shortly after our publication in the journal, The Attending Physician (2020, number 6) of the article "To the question of the possibility of using laser irradiation of blood, as a method of prevention and treatment of complications of coronavirus infection", in the United States have published data on the effectiveness of laser therapy in this disease. Dr. Scott A. Siegman of Lowell Hospital (US) has suggested the use of high-powered laser to treat severe pneumonia COVID-19. The single, unblinded case study demonstrated some positive outcomes and warrants further exploration. A larger, randomized clinical trial being performed by De Marchi., *et al*. in Brazil is current [1] concluding and data on the effectiveness of super pulsed laser on intubated COVID 19 patients will be available [https://clinicaltrials.gov/ct2/show/NCT04386694?term=multi+radiance+medical&draw=3&rank=14]. Our domestic experts however are still silent.

Purpose of the Study

The purpose of this publication is to provide evidence of the effectiveness of super pulsed laser irradiation of blood in coronavirus infection and methods of its application.

Materials and Methods

Let us consider in more detail how and how laser photohemotherapy affects the body of patients.

Experimental and clinical studies have shown that low-intensity, super pulsed laser therapy normalizes microcirculation: it activates the work of myocytes and endothelial cells, stimulates the functional activity of blood vessels by dilating them and opening reserve

capillaries. Improvement of microcirculation leads to accelerated elimination of toxins from the body (detoxification), increased oxygen delivery to tissues and organs (anti-ischemic effect). At the same time, cardiac output increases, coronary vessels expand, and exercise tolerance increases. The release of heparin by mast cells leads to blood thinning, which improves the blood supply to tissues and organs, especially in the microvascular bed.

The action of laser radiation on erythrocytes helps to stabilize their cell membrane and maintain their functional usefulness, they become more flexible and are able to penetrate into the smallest capillaries. The level of hemoglobin in the blood is a universal non-specific indicator of adaptation processes, processes of tension in the body in response to various external influences. So, a consequence of the action of such factors may be a decrease in the amount of hemoglobin in the blood or a violation of the structural and functional organization of the protein component of erythrocyte membranes. The result of such changes is a number of pathologies, and, as a consequence, a significant decrease in the adaptive capabilities of a person. Under the influence of laser radiation, hemoglobin in erythrocytes goes into a more favorable confirmation state and carries more oxygen.

When there is a shortage of energy in the body, there is a failure in immunity. In the blood of such patients, the histamine content rises sharply. This substance (a derivative of the amino acid histidine) causes smooth muscle spasm. What happens when the blood is exposed to laser radiation? Histamine and histamine- like substances bind and are removed from the body (antihistamine property of LH), which helps to normalize the functioning of internal organs. In addition, the number of lymphocytes increases and their functional activity increases. The effectiveness of LH is due to the ability of immune-correction by normalizing the intercellular relationships of the T-lymphocyte subpopulation and increasing the number of immunocompetent cells in the blood. This enhances the immune response.

When exposed to laser radiation on blood, macrophages (mononuclear phagocytes) and granulocytes, as well as platelets, actively capture and digest bacterium and fungal infection. Moreover, their "appetite" increases several times. As secretory cells, macrophages are involved in many complex immune and inflammatory reactions in the blood and tissues and release nitric oxide (NO), which plays a leading role in the regulation of blood pressure. The long-term effect of vasodilation (vasodilation) under the influence of NO helps to improve the delivery of nutrients to the skeletal muscles.

Results and Discussion

Experimental and clinical studies have proven that low-intensity laser radiation normalizes microcirculation: it activates the work of myocytes and endotheliocytes, stimulates the functional activity of the main ones due to their dilation and opening of reserve capillaries. Improvement of microcirculation leads to accelerated elimination of toxins from the body (detoxification), increased oxygen delivery to tissues and organs (anti- ischemic effect). At the same time, cardiac output increases, coronary vessels expand, and exercise tolerance increases. The release of heparin by mast cells leads to blood thinning, which improves the blood supply to tissues and organs, especially in the microvascular bed.

Numerous studies have shown that laser exposure stimulates fractions of T-lymphocytes, especially T-helpers, which synthesize various cytokines that regulate immune responses. Due to photic stimulation is an increase in the helper effects on cells, i.e. K. LILR influences the activation of protein kinase C, which in turn, enhances the production of helper factors and stimulating proliferation answer boiling cells and cells with enhanced sensitive Stu to cytokines.

In addition, laser irradiation changes the activity of T-suppressors. It should be noted that immunostimulatory effect of this action, manifesting into increased content of B-cells as well as increasing phagocytic mononuclear cells. Phagocytic activity of neutrophils increases dramatically compared to the control, reduced degradation microorganisms increases digestion index.

The effect of super pulsed photobiomodulation in the formation of nonspecific adaptation syndrome gets its expression in terms of measurable change in activity of ion transporting ATP and system of antioxidant protection, and the mechanism of this syndrome is as-

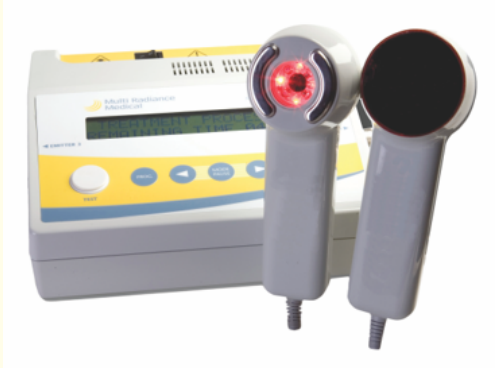
sociated with exposure to laser energy on cell membrane unit depends on the dose of radiation. The normal functioning of the body is largely determined by the optimal functioning of the cardiac and respiratory systems. Moreover, blood circulation is the main limiting link in the oxygen transport system during intense muscular work. Conducted laser hemotherapy sufficiently prepares the heart for extreme stress. Laser radiation affects the energy metabolism of the myocardiocytes, while exerting a unidirectional effect on the energy -generating structures of the cell under load conditions. Also observed: an increase in blood flow velocity, rheological and microcirculatory effects, coronary active, spasmolytic, metabolic effects. In addition to the above effects, it is noted: improved blood circulation, pain relief, decreased excitability of vegetative centers, lower cholesterol levels, improved myocardial trophism, as well as effects such as: anti-inflammatory, decongestant, antioxidant, etc.

It should be emphasized that the complex medical effects of low-intensity super-pulsed laser exposure has extravenosological, but, nevertheless, strictly defined pathogenetic orientation, based on the following basic reactions of the body of general and local profile.

Against the background of the laser action are set: the stimulation of the production of bioenergy enzymes with increasing content in the tissues of the main of energy substrate - adenosine triphosphate, photoactivation ceruloplasmin, adjusting the activity of catalase, alkaline phosphatase, and a number of enzyme in the blood system, liver and membrane-associated enzymes and enzyme systems brain tissue (glutamate dehydrogenase, ATP, etc.); renewal of membrane-bound components (lipid and protein) of receptors and ion channels, restoring their sensitivity to specific and non- specific inducers; modulation sodium-, calcium-, magnesium d- dependent biochemical processes with cells (including brain); restore the structure and function of erythrocyte level of hematopoiesis with activation products young, new cells and removing from circulation “old”.

The most important factor in the restoration of the structure of any damaged organ is the migration of stem cells to the damaged area. Under the influence of laser radiation, stem cells begin to more actively migrate from the bone marrow into the blood and more actively move from vessels to tissues, where they turn into cells of the damaged organ, thereby participating in the restoration of its structure [2].

Laser devices: In our study, we used the MR4 Super Pulsed Laser magneto-infrared laser therapeutic apparatus made by Multi Radiance Medical, the USA based manufacturer.



Consider the therapeutic potential of each of these types of radiation:

1. Pulsing red light: It has a beneficial effect by reducing the intensity of inflammatory processes, especially in areas with loose connective tissue. Clinical effects: local anesthesia, improved blood supply in the affected area, anti-edema effect, pronounced therapeutic effect in the area of tissues with a large amount of loose connective tissue.

2. Super pulsed infrared laser radiation penetrates deeply into tissues and has a powerful stimulating effect on blood circulation, membrane cell metabolism. Clinical effects: activation of protein synthesis, increase in enzyme activity, increase in ATP production, improvement of microcirculation, acceleration of tissue repair, enhancement of collagen synthesis, anti-inflammatory effect, anti-edema effect, analgesic effect, etc.

3. Pulsed infrared radiation, having a lower depth of penetration into tissues than laser radiation and a greater spectral width, has such clinical effects as: heating of tissue structures of surface layers, activation of microcirculation, enhancement of epithelium and skin recovery.

4. Static, constant magnetic field (PMF). Under the influence of PMF, the capillaries of the vascular bed expand. The vasodilating effect persists after a single exposure for 1 to 6 days. And after the course of procedures - 30 - 45 days. Clinical effects when acting on an inflammatory focus: analgesic, anti-inflammatory and regenerative effects. PMF enhances the penetration of laser radiation into tissues.

The peak power of the super pulsed devices is 25W, we need a power of 4 - 5W to carry out the laser blood irradiation, therefore we reduce the power to 25%. The effect of laser irradiation on the blood was carried out by imposing 2 emitters on the skin over large vessels: the zone of the carotid arteries, cubital, subclavian or popliteal.

The application is stationary, the exposure time for children percutaneously on large vessels is from 5 to 20 minutes with two emitters. For adults, depending on the blood volume, the laser blood irradiation session time is from 20 to 25 minutes with two emitters. Efficacy is achieved when therapeutic dose of the laser irradiation is achieved. The dose of laser radiation should not exceed 0.002 - 0.005 J/cm ^{2} [3]. Our dose of laser radiation for 1 minute is 0.006 J/cm^2. N When the light spot area of 4 cm^2, the dose per session 0.001 5 J/cm^2. But given that n When exposed to laser radiation to tissue created optical effects that are typical for the passage of light through the inhomogeneous medium: reflection, refraction, scattering and absorption. The skin reflection coefficient of electromagnetic waves in the optical range is 20 - 43% and depends on body temperature, pigmentation, angle of incidence of the beam, etc. The absorption coefficient of super pulsed laser for skin, soft tissues and bones is 25 - 64%. Thus, the total dose will be lower.

The main contraindications to the SPSPLBI (laser blood irradiation). This is a tendency to bleeding, hemorrhagic stroke, severe thrombocytopenia, pregnancy.

Analysis of treatment tactics Version 8. 03.09.2020. Anti-inflammatory drugs are recommended, immunomodulating, blood thinning, vasodilation. But all these properties are possessed by laser irradiation of blood.

Antiviral drugs and antibiotics. The advantage of super pulsed laser therapy is that laser radiation with equal success affects any flora that caused the pathology. The bacteriostatic and bactericidal effect of laser radiation on the microflora was recorded according to the results of an electron microscopic study [4].

In our study, the efficiency of phagocytic activity after SPLBI was also checked by bacteriological inoculation of microflora from the oral cavity. Crops of microflora from the oral cavity were taken before laser blood irradiation. Repeatedly these crops were taken on the 2nd day after SPLBI. A total of 34 microbiological studies were carried out using Bact/ALERT® FA media (France) for aerobic and anaerobic flora. Pathogenic microflora was sown: *Streptococcus salivarius, Streptococcus mitis, Streptococcus viridians, Neisseria* spp, *Moraxella catarrhalis, Enterobacter cloacae*, *Klebsiella oxytoca, Acinetobacter baumannii*, *Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella pneumonia, Morganella morganii*. After the SPSPLBI, in 100% of cases, this flora was not sown.

When the disease becomes more severe, a person develops pneumonia, that is, pneumonia. This can lead to a condition called acute respiratory distress syndrome (ARDS). In short, with ARDS, the lungs are damaged due to inflammation, they hold less air, the alveoli col-

lapse and oxygen cannot enter the blood in the required volume. As a result, the person has a severe shortness of breath and to officials comes less oxygen than needed. ARDS is the leading cause of death in the new coronavirus infection.

Analysis of sectional data of patients who died from COVID-19 indicates the presence, in addition to diffuse damage to the alveoli, a multitude of thrombosis of small vessels of the lungs and associated multiple hemorrhages in the alveoli. The thrombotic process in the lungs involves megakaryocytes, platelets, the forming blood clots are rich not only in fibrin, but also in platelets. There are signs of thrombotic microangiopathy in the lungs.

Electron microscopy data indicate the presence of significant damage to endothelial cells associated with penetration of SARS-CoV-2 cells, widespread thrombosis of small vessels, microangiopathy, occlusion of alveolar capillaries and signs of neo-angiogenesis (Taken from: "Methodological recommendations: prevention, diagnosis and treatment of new coronavirus infection (covid-19)". Version 8. 09/03/2020).

COVID-19 viruses, like chemotherapy, infect epithelial cells. And studies have shown that apoptosis of fibroblasts and endothelial cells develops much earlier than the death of epithelial cells [5]. These studies revealed that endotheliocytes produce keratinocyte growth factor (KGF) molecules. KGF is a trigger for the growth and differentiation of epithelial cells [6]. Direct diffusion of KGF from endothelial cells determines the normal development of the epithelial cover, respectively, the death of submucous endothelial cells stops the flow of physiological signals for the development of the epithelium and leads to its thinning.

Protection and stimulation of endothelial cells Version 8. 03.09.2020 does not provide. There is such a drug, this is the growth factor of keratinocytes-1 - Palifermin. This drug increases the thickness of the epithelium, stimulates the production of IL-13 and reduces apoptosis. The cost of the medication Palifermin (Kepivance) produced in Sweden exceeds 6410.00 USD. In addition to the high cost, the drug is very toxic. Complications in the form of a rash, fever, joint pain are possible. And its effectiveness is relatively low.

SPSPLBI manages with this problem very effectively. At low doses, laser radiation can prevent cell apoptosis, enhance the proliferation of fibroblasts [7], keratinocytes [8], endothelial cells [9] and lymphocytes [10,11].

Due to the fact that this stimulates endotheliocytes, which produce the growth factor of keratinocytes, in our study we have achieved such results.

But version 8 9/3/2020 suggests laser therapy. "From 12 - 14 days of illness in the absence of complications (bronchiectasis, atelectasis, etc.), subject to indications and contraindications, it is recommended to use individually dosed aeroinotherapy, infrared laser radiation with a wavelength of 890 to 910 nm, polychromatic polarized light." What is the power of the device, the dose of laser radiation, the impact zone, how many sessions should be carried out, nothing of this? Most likely, it is not carried out.

Conclusion

The main purpose of this publication was to attract the attention of specialists involved in the treatment of patients with coronavirus infection. Our study proved that super pulsed laser blood irradiation reliably dilates blood vessels, stimulates the phagocytic activity of leukocytes and platelets, as well as the functional activity of blood vessels due to their dilation and the opening of reserve capillaries. Oxygen delivery to tissues and organs is enhanced. The release of heparin by mast cells leads to blood thinning, which improves the blood supply to tissues and organs, especially in the microvascular bed.

There is no doubt that in order to introduce the SPLBI method into clinical practice, it is necessary to organize clinical trials, which is what we sincerely wish you!

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