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Effective Techniques of Low Level Laser Therapy

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EFFECTIVE TECHNIQUES OF LOW LEVEL LASER THERAPY

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The book includes the best-known techniques developed on the basis of the analysis of Russian and international clinical experience that were proven effective by international criteria and were approved by the Russian professional community (Low level laser therapy in treatment and rehabilitation and prevention programs: clinical recommendations. Moscow, 2015).

These techniques have been adapted for the Matrix and LASMIK laser physiotherapeutic devices, enabling to implement virtually all methods of laser intervention with maximum efficiency, aside from those presented in this publication.

For more information on the methodology of modern low level laser therapy refer to a special series "Effective Laser Therapy" (read more on our website http://lazmik.ru).

The book is intended for physical therapists, specialists in the field of medical rehabilitation and balneology, and doctors of other clinical specialties.

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ABBREVIATIONS

AOS – antioxidant system
AP – acupuncture point
CCBI – chronic cerebrovascular ischemia
CCI – craniocerebral injury
CI – confidence interval
CIC – circulating immune complexes
CVI – chronic venous insufficiency
DEP – dyscirculatory encephalopathy
DMW – decimeter waves
EAC-RFC – EAC-rosette forming cells of erythrocyte (E) – antibody (A) – complement (C) complex;
ED – energy density
EH – essential hypertension
NLBI – non-invasive (external, extravenous, transcutaneous, percutaneous) laser blood illumination
GAr – gonarthrosis (arthrosis of the knee)
HDL – high density lipoproteins
ILBI – intravenous laser blood illumination
IR – infrared (spectrum, band)
LDL – low density lipoproteins
LILI – low-intensity laser illumination
LLLT – low level laser therapy
LPO – lipid peroxidation
LUVBI® – laser ultraviolet blood illumination
MAH – major arteries of the head
MFPS – myofascial pain syndrome
MLLLT – magnetic low level laser therapy
MSS – musculo-skeletal system
OA – osteoarthrosis
OP – osteoporosis
PD – power density
PMF – permanent magnetic field
PsA – psoriatic arthritis
RA – rheumatoid arthritis
RCT – randomized controlled trial
TC – total cholesterol
TG – thermography
TPT – therapeutic physical training
USDG – ultrasonic Doppler examination
UST – ultrasound therapy
UV – ultraviolet (spectrum, band)
UVBI – ultraviolet blood illumination
VBI – vertebrobasilar insufficiency
WMD – weighted mean difference

INTRODUCTION

The application of low level laser therapy is possible only with the use of modern laser therapeutic equipment, allowing the fullest and most accurate implementation of the most effective techniques, which, in turn, should not only be based on scientific data relating to the understanding of the mechanisms of the biological and therapeutic effect of low-intensity laser illumination (LILI) but also be tested in a clinical setting in the process of conducting randomized placebo-controlled trials (RCTs) with a high level of reliability.

The methodology for developing the clinical guidelines is based on the principles of evidentiary health care, systematic and utmost objective generalization of scientific evidence of the effectiveness of treatment methods and the consensus of leading experts. Such techniques, taking into account the most current (modern) and reliable data, can significantly reduce the impact on decision-making by doctors of their intuition, qualification level, as well as sources of information, the conclusions of which are largely characterized by subjectivity and unreliability: the opinion of colleagues, recommendations of popular manuals, certain articles, etc.

The relevance and applicability of the available evidence depends on the methodological quality of the research and the characteristics of patient groups, where the study was conducted. In modern clinical medicine there is consensus on the hierarchy of levels of evidence that formed the basis of recommendations. The lower the probability of occurrence of a systematic error in the study, the more reliable the findings, and the more weight the study has when considering the total spectral evidence for effectiveness of a particular medical technology.

The book contains low level laser therapy techniques developed in accordance to modern international standards; the experience of the development of clinical guidelines of domestic and foreign colleagues is taken into account.

The modern approach to the implementation of low level laser therapy methods provides a comprehensive treatment of all categories of patients, including the combination of different options of low level laser therapy and other therapeutic methods (medication, physical therapy, TPT, etc.).

GENERAL ISSUES OF LOW LEVEL LASER THERAPY

Mechanisms of Therapeutic Effect of Low Level Laser Therapy

The process of therapeutic effects of low level laser illumination (coherent, monochromatic and polarized light) can be conventionally divided into three main stages:

1) primary effects (change of state of the electronic levels of the living matter molecules, the stereo-chemical rearrangement of molecules, the local thermodynamic shifts, the emergence of an increased concentration of calcium ions in the cytosol);
2) secondary effects (propagation of waves of increased Ca^{2+} concentration in the cell, between cells, stimulation or inhibition of biological processes at the cellular level, changes in the functional state of individual biological cell systems and the body as a whole);
3) residual after-effects (formation of tissue metabolism products, response of the immune, endocrine and neurohumoral regulation systems, etc.).

All this variety of the developing processes determine the widest range of the body's responses to laser illumination. Fig. 1 shows virtually the entire sequence of events starting from the initial act of photon absorption and finishing with effects at the level of the whole body. This explains numerous, if not all known phenomena in this field of biology and medicine.

It was shown previously that at the initial starting point of LILI, the biological effect is a local violation of thermodynamic equilibrium, causing the release of calcium ions from an intracellular store and propagation of a wave with increased concentration of Ca^{2+} in the cytosol of the cell, triggering Ca^{2+}-dependent processes (Moskvin S.V. System analysis of efficiency of controlling biological systems by low-energy laser illumination: Author's abstract of PhD thesis in Biology. Tula, 2008.) Then secondary effects develop, which are a complex of non-specific adaptive and compensatory reactions that occur in the tissues, organs and entire living body, among which the following: effects are distinguished most often:

– activation of cell metabolism and increase in their functional activity,
– stimulation of reparative processes,

– anti-inflammatory effect,
– activation of blood microcirculation,
– increase in tissue trophic support,
– analgesic and immunomodulatory effect,
– reflexogenic impact on the functional activity of various organs and systems.

Numerous studies have shown that LILI acts as an activator of cellular responses aimed at restoring and normalizing the bioenergetic status of the body's tissues and immune system. LILI increases the enzymatic and catalase activity, permeability of cytoplasmic membranes, contributing to the acceleration of metabolic and transport processes in tissues. Accelerated oxygen exchange reduces hypoxia accompanying inflammatory processes.

LILI activates the regenerative processes in pathological conditions (trauma, surgical procedures, transplantation) due to changes in the cellular composition in the area of the wound or ulcer by increasing the number of neutrophils, as well as by accelerating the growth of capillaries and accumulating collagen produced by them, which determines the speed and quality of wound or ulcer surface epithelialization. In addition, hormonal and neurotransmitter components of the adaptive mechanism

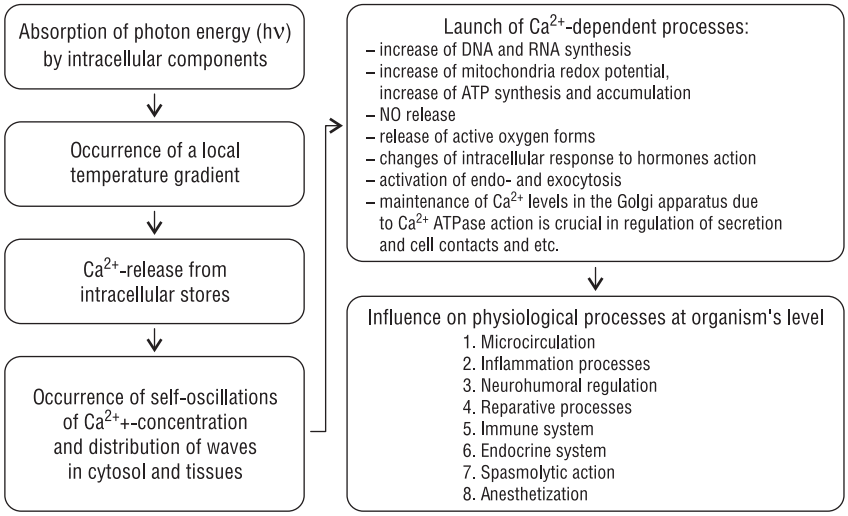

Fig. 1. The sequence of the developing biological effects of laser exposure

are activated. Increase in non-specific immunity of the body after LILI exposure is confirmed by the rising titer of hepagglutinin, hemolysins, lysozyme, activation of neutrophils and interferon, increased synthesis of immunoglobulins, changed function and structure of plasma membranes and the increase in the number of lymphocyte blast forms.

Laser illumination reduces the concentration of lipid peroxidation products in the blood, enhancing the antioxidant system, increases the level of catalase, activates the cellular elements of mononuclear phagocytes (macrophages) that stimulate cell proliferation, and accelerates restoration of morpho-functional state of the cell membranes.

In development of the body response, an important role is played by the impact of LILI on the blood, exerting a beneficial complex (systematic) influence caused by common hemocirculation. Studies using vital microscopy, computer capillaroscopy and photographic recording showed an increase in the number of functioning capillaries, acceleration of blood flow and normalization of microcirculation in general. Central hemodynamics is changing as well; it is proved that LILI has venomotor and artery dilation effects in case of initially decreased indicators.

Low level laser therapy, conducted before the start of surgery intervention in order to prevent infiltration and suppuration, improves local blood circulation, metabolism, oxygenation and maintenance of the trophic support of tissues, which stabilizes the postoperative course, reducing the probability of developing complications by several times.

LILI's ability to increase the content of neurohormones in tissues, to involve various specific proteins of cell membranes in the process which activates enzymes such as adenocyclase, adenylate cyclase, denyl cyclase, phosphodiesterase, and calcium ions, altering the intra- and extracellular metabolism, to affect sensitive components of intercellular spaces leads to the normalization of the local and general physiological response, contributes to the preservation or restoration of homeostasis and body adaptation to stress conditions.

Equipment for Low Level Laser Therapy

A variety of techniques and applications of low level laser therapy devices requires maximum versatility of the equipment used to ensure maximum efficiency of therapeutic effects, which, in turn, is ensured by the following procedures:

– (separate) use of LILI having different wavelengths;
– operation in modulated and pulsed modes;
– external illumination modulation (BIO mode, modulation by musical rhythm, etc.);
– illumination delivery with minimal losses through the light guides (ILBI, abdominal procedures);
– optimal spatial distribution of the laser illumination (providing optimum power density);
– reliable and continuous monitoring of the impact parameters.

The proposed modular design concept allows the successful solving of all of these tasks, according to which the laser therapeutic equipment is conventionally divided into four mating parts (Figure 2): 1 – the base unit (usually 2- and 4-channel); 2 – laser heads for different low level laser therapy techniques; 3 – optical and magnetic nozzles; 4 – Matrix-Bio biocontrol unit.

The base unit is a basis of each set; it is the power supply and control unit. Its main functions include setting emission modes with mandatory control of the parameters: frequency, session time, beam output power, etc.

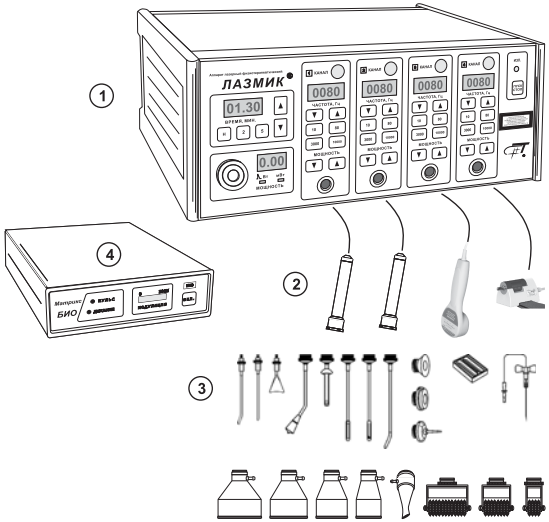

Fig. 2. Modular design concept of low level laser therapy equipment exemplified by series of Matrix and LASMIK devices

Control of the parameters not only insures against errors when selecting the initial values, but also provides the possibility of varying the exposure modes in a wide range, which, in turn, allows professionals to provide optimal treatment options.

Laser heads of various types with the appropriate nozzles (magnetic and optical) are connected to the base unit. In the advanced equipment, a provision is made for the external modulation of beam output power of heads, for example, by the patient's biorhythms.

The laser therapeutic devices of Matrix and LASMIK series are effective, easy to operate, have a modern design, enabling them to be applied successfully in the best medical centers. In addition, based on these devices, it is possible to create specialized highly efficient complexes, which have already proved themselves to be the best. Find more detailed information in a colour inset.

Peculiarities of Applying Various Low Level Laser Therapy Techniques

Low level laser therapy (LLLT) is a physiotherapy method, using electromagnetic illumination in the optical range – coherent light or low-intensity laser illumination (LLLI), generated by special sources – lasers are a healing factor. The main properties of laser light are their monochromaticity, coherence, polarization and directionality, due to which laser therapy – being a kind of physiotherapeutic light exposure – has unique healing properties and methodological features of practical application.

Monochromaticity (Greek *monos* – one, single, the only + *chroma* – color, paint) means illumination in a very narrow range of wavelengths. Illumination with a spectral width of less than 3nm may be known conventionally as monochromatic. This property offers the opportunity of selective action on the components of the structure of tissues and cells, triggering an entire cascade of primary biochemical and biophysical processes.

Coherence (Latin *cohaerens* – the state of being connected, related) is a consistent progress of several oscillatory wave processes of the same frequency and polarization in time and/or space.

Polarization is symmetry in the distribution of orientation of the electric and magnetic field vector relative to the direction of electromagne-

tic wave propagation. If two mutually perpendicular components of the electric field vector oscillate with a time-constant phase difference, such a wave is known to be polarized.

Directionality is an important property of the laser illumination, enabling, if necessary, to obtain a higher power of density (of incident energy) in comparison with other light sources.

Average capacities of physiotherapeutic lasers often are within the range of 1–100mW, pulse power varies from five to 100 W with a duration of light pulses being 100–130ns ($\sim 10^{-7}$s). The nature of the primary photobiological reactions is determined by the energy of quanta of optical radiation of less than 2eV for the red and near-infrared spectra; however, it is sufficient to enhance the oscillatory processes of molecules, initiating numerous secondary biophysical and biochemical processes. At present, an increasing number of scientific publications are devoted to the study of the effectiveness of LILI of the ultraviolet and green spectra with higher energy of quanta.

There are multiple RCTs available of domestic and foreign researchers, that are based on the data irrefutably proving the diverse medicinal properties of LILI defined by the following effects:

- microcirculation activation [114; 271; 275; 260; 339];
- immunomodulatory and anti-inflammatory effect [103; 256; 269; 271; 335; 338; 355];
- analgesic effect [253; 255; 261; 267; 269; 275; 234; 296; 302; 321; 322; 339; 343; 352];
- tissue proliferation and regeneration activation [77; 108; 106; 287; 306; 313; 332; 269];
- diversified action on the nervous tissue, including reflex action [3; 63; 67; 154; 188; 209; 225; 228; 258; 333; 334].

Low level laser therapy has found widespread application in clinical practice; the method is widely used in almost all fields of modern medicine. There is a large amount of factual material, confirming its high efficacy in the treatment of patients with diseases of the musculo-skeletal, cardiovascular, nervous systems and diseases of the ear, nose and throat, as well as in the rehabilitation of patients after injuries and surgery. At the same time there is a discrepancy in the recommended LILI parameters, making it difficult for clinicians to select the most effective technique in terms of evidentiary medicine. Only a comprehensive deep analysis of the

RCTs carried out by domestic and foreign researchers with an objective assessment of the results of the low level laser therapy course will help improve the quality of medical services.

Contraindications *(Laser therapy...:* clinical recommendations. Moscow, 2015). When ordering LLLT the following contraindications should be taken into account**:** hemorrhagic syndrome, neoplastic syndrome, hyperthermal syndrome (fever, the patient's body temperature above 38 °C), systemic (cardiac, vascular, respiratory, renal and hepatic) decompensation syndrome and multi-organ dysfunction syndrome (the patient's total heavy condition), cachectic syndrome (rapid cachexia), epileptic syndrome, hysterical syndrome, convulsive disorder. Dramatic worsening of synovitis with a high degree of inflammatory activity is a contraindication for LLLT in patients with arthropathy.

A non-randomized clinical study on the use of LLLT was conducted (LILI continuous mode, 635nm wavelength, 4mW power, one minute exposure, no more than 10 minutes in total) in the combined treatment of patients with hemophilia arthro-myologic lesions [118]. It was found that LILI reduces arthralgia and helps prevent the development of trophic disorders of the joints. Not a single case of adverse events has been revealed. However, despite the encouraging results of this pilot study, currently it is not recommended to apply LLLT to hemophilia patients *(Laser therapy...:* clinical recommendations. Moscow, 2015).

Low Level Laser Therapy Protocols

Fulfilling all the requirements for the implementation of low level laser therapy protocols is mandatory, since the need to set all the parameters of methods listed below has been proven and clearly stated. Even one wrong value will not allow patients to get predictable and adequate responses to laser light action and the desired therapeutic effect, respectively.

Setting energy parameters substantially depends on the laser operating mode and technique. The majority of Russian devices have a laser hazard Class 1M or 2M according to IEC 60825-1: 2007, while foreign lasers have mainly the laser hazard Class 3R, which greatly complicates their application. Moreover, most cases require minimal energy of LILI to successfully implement low level laser therapy techniques, and increased power and exposure (energy) can result in the inhibitory effect, i.e. complications.

All techniques of low level laser therapy must contain the following information.

1. Laser light wavelength as measured in nanometres [nm] (The International System of Units (SI), 8th edition. – Bureau International des Poids et Mesures, 2006.). Most wide-spread LLLT spectral ranges are:

- 365–405nm – ultraviolet (UV) spectrum,
- 440–445nm – blue spectrum,
- 520–525nm – green spectrum,
- 635nm – red spectrum,
- 780–785nm – infrared (IR) spectrum,
- 890–904nm – infrared (IR) spectrum.

It is inadmissible to illuminate one and the same area simultaneously with lasers of different wavelengths or incoherent light sources due to an inhibiting interference.

2. Laser operational mode: continuous, modulated, pulsed.

3. Beam output power.

An average power of continuous lasers operating in continuous and modulated modes is measured in milliwatts [mW], the impulse (peak) power of pulsed lasers is measured in watts [W].

4. The modulation frequency or pulse for pulsed mode is the number of vibrations (pulses) per unit time (second). It is measured in hertz [Hz, 1/s].

5. The most important parameter of pulsed lasers is the duration of the light pulse; it is a constant (usually making 100–150ns). An average power of pulsed lasers ($P_{av.}$) is directly proportional to the pulsed power (P_p), pulse duration (τ_p) and frequency (F_p): $P_{av.} = P_p \times \tau_p \times Fi_p$.

6. Illumination area is measured in square centimetres [cm^2].

The required area is almost always provided by the procedure without carrying out unnecessary measurements, for example, in the contact-mirror method the area is assumed to be 1cm^2. In matrix emitters, the laser diodes must be positioned so that the area of their impact would provide the multiplicity in power density. For example, 8 (most often) pulsed laser diodes having a power of 10W shall be disposed on the surface of 8cm^2, and in contact with the skin through a transparent tip PD will be 10W/cm^2, respectively. During laser acupuncture or intravenous laser blood illumination (ILBI) the area is not specified, as the exposed zone is too small, and the leading role is played by scattering and absorbing the laser light energy in the volume of biological tissues.

7. Power density is measured in watts (for pulsed lasers) or milliwatts per square centimeter [W/cm^2 or mW/cm^2].

8. The exposure (the exposure time) per one zone and total time for the procedure are measured in seconds [s] or minutes [min].

9. Localization of action (technique), the exposed zones should be specified.

10. The number of procedures per course and their frequency.

Calculations of energy, which is measured in Joules [J or W·s] or energy density [J/cm^2 or W·s/cm^2] *shall not be carried out*, because this information is not necessary to provide effective low level laser therapy.

It is appropriate to include one of the methods of overall impact into the protocol (laser acupuncture or ILBI), and methods for directly illuminating the affected area by zones (local, transcutaneous or abdominal procedures, as well as the combined method – laser phoresis).

Local LILI is conducted directly on the affected area, located close to the surface of the body, either in a contact way through the mirror nozzle or distantly, in a stable manner, at a short distance from the surface (1–2cm), if it is impossible provide a direct contact. Sometimes a combined physiotherapy method – magnetic low level laser therapy (MLLLT) is used, with laser beam acting through the opening of a permanent magnet with an induction of 35–50mT [35; 51; 85].

The following procedures are used most often for local laser exposure:

- continuous LILI of the red spectrum (635nm), PD – 10–15mW/cm^2,
- pulsed LILI of the red spectrum (635nm), PD – 4–5W/cm^2, pulse duration of 100–150ns, frequency of 80–10,000Hz,
- pulsed IR LILI (890–904nm), PD – 8–10W/cm^2, pulse duration of 100–150ns, frequency of 80–10,000Hz.

The frequency *for pulsed lasers* varies depending on the desired effect: regeneration – 80–150Hz, anesthesia – 3,000–10,000Hz. One area includes up to 2–3 local zones, the exposure for each zone being 2–5 minutes. It is strictly forbidden to illuminate one area for more than five minutes.

Local action of LILI on the projection of the affected organ of body differs from the surface illumination, as only pulsed infrared lasers are used, and matrix lasers are desirable to ensure a therapeutic effect at a depth of 15cm: wavelength 890–904nm, PD – 8–10W/cm^2, pulse duration

of 100–150ns, frequency of 80–10,000Hz. By increasing frequency in pulsed lasers, the average illumination power increases proportionally as well, which allows to influence the deeper areas. It is strictly forbidden to illuminate one area for more than five minutes.

Laser acupuncture (laserpuncture) is carried out by means of a special acupuncture nozzle designed for concentrating the laser light energy into a zone of 1–2 mm in diameter. The wavelength is 635nm (red spectrum), continuous or modulated modes are used, nozzle output power is 2–3mW, exposure per one corporal acupuncture point ranges from 20 to 40s, making it 5–10s per auricular point. It is unacceptable to exceed the specified exposure time.

Laser blood illumination provides for two options of the procedure: via an intravenous or via non-invasive (extravenous, external, percutaneous, transcutaneous) access. Accordingly, these are intravenous laser blood illumination (ILBI) and non-invasive (extravenous, transcutaneous, percutaneous) laser blood illumination (NLBI).

For ILBI, the LILI is always used in continuous mode, laser action is carried out intravenously through special disposable sterile light guides with a puncture needle [45]. To implement ILBI, differential techniques are currently applied using laser light of a different spectra:

ILBI-635 (wavelength 635nm, red spectrum, power 1.5–2mW, exposure of 10–20 minutes) has a universal effect, makes a positive impact on both the immune system, and provides for the trophic support of tissues.

ILBI-525 (wavelength 525nm, green spectrum, power 1.5–2mW, exposure of 7–8 minutes) is recommended to ensure maximum gain of trophic support of tissues.

ILBI-405 or ILBI-405 (wavelength 365–405nm, power 1.5–2mW, exposure of 3–5 minutes) or *laser ultraviolet blood illumination* (LUVBI®) preferably should be used for the correction of immune disorders of various etiologies.

Non-invasive laser blood illumination (NLBI) is carried out on large blood vessels, adjacent to the center of the lesion focus. Pulsed lasers, preferably of the red (635nm) and infrared (890–904nm) spectra and the matrix emitters (8 laser diodes) or, as an option, a single laser with a mirror nozzle is used mainly for NLBI [150]:

– pulsed LILI of the red spectrum (635nm), PD – 4–5W/cm^2, pulse duration of 100–150ns, frequency of 80Hz,

– pulsed infrared LILI (890–904nm), PD – 8–10W/cm^2, pulse duration of 100–150ns, frequency of 80Hz.

Frequency is fixed. It is possible to illuminate symmetric zones, the exposure for each zone being 2–5 minutes. It is strictly forbidden to illuminate one area for more than five minutes.

Intracavitary procedure is intended to deliver laser light energy to the affected area, located in a natural cavity (endonasal, endoauricular, etc.), via a special light guide instrument (optical fiber). A feature of this procedure is the need to introduce most of the energy in the fiber, followed by its distribution inside along the given indicatrix, however, since PD is not always determined in this case, the illumination power is set at the nozzle inlet, i.e. is measured without the nozzle. The following procedures are used most often for laser exposure:

– continuous LILI of red the spectrum (635nm), power – 10–15mW,
– pulsed LILI of red spectrum (635nm), power – 4–5W, pulse duration of 100–150ns, frequency of 80–150Hz,
– pulsed infrared LILI (890–904nm), power – 15–20W, pulse duration of 100–150ns, frequency of 80–10,000Hz.

To deliver pulsed IR LILI (890–904nm), it is required to only use the quartz-polymer fiber, as the polymer (PMMA) absorbs nearly all illumination with wavelengths longer than 830nm. It is strictly forbidden to illuminate one area for more than five minutes.

The infra-articular technique includes fine needle puncture of the joint through which the articular cavity is filled with oxygen. The joint puncture is made in a separate access with a needle having wider clearance (0.8 mm), through which a light guide is conducted, connected to the laser head of the device designed for ILBI. Under the control of the luminous spot flashing through the skin the light guide is applied to the affected area of the joint (the upper turn-up, in the area of alar ligaments) and each section of the joint is illuminated for 2–5 minutes. Over one procedure, 2–5 sections are affected. Continuous LILI is conducted with a wavelength of 635nm (red spectrum) and 5–10mW illumination power at the working end of the light guide. The procedure is repeated in 3–4 days. The total number of procedures is 4–6 [21]. It is possible to use LILI with other wavelengths. It is strictly forbidden to illuminate one area for more than five minutes.

Laser phoresis is one of the most modern methods of physical and pharmacological methods of combined percutaneous application of LILI

and medicinal preparations. As a result of LILI of the area which is previously applied with the biologically active substance in the form of gel or an aqueous solution, its penetration through skin (pores, hair follicles) is activated. Such percutaneous injection-free method of substance administration is possible only for low molecular weight (no more than 500 kDa) and hydrophilic compounds [149].

The technique parameters:

- continuous LILI of the red spectrum (635nm), PD – 10–15mW/cm^2,
- continuous infrared LILI (780–790nm), PD – 40–50mW/cm^2,
- pulsed infrared LILI (890–904nm), PD – 8–10W/cm^2, pulse duration of 100–150ns, frequency of 80Hz.

For pulsed lasers, the frequency does not change. One area may have up to 15–20 local areas, with exposure of 1–1.5 minutes for each zone, but not more than 20 minutes in total.

The presented principles of the formation of low level laser therapy procedures may be adjusted in some cases, except for the exposure. Varying the exposure time is not allowed, because it is determined by physiological rhythms, synchronization with which necessarily underlies any laser treatment techniques. In some cases, it is possible to adjust the LILI energy parameters, for example, for pain relief or suppression of excessive proliferation, it is required to set out extremely high frequencies – up to 10,000Hz (recommendation refers exclusively to the pulsed lasers with a pulse duration of 100–200ns and pulsed (peak) output power of up to 300W).

SPECIAL TECHNIQUES OF LOW LEVEL LASER THERAPY

Low Level Laser Therapy for Musculoskeletal Disorders

In the analysis of scientific literature assessing the effectiveness of LLLT in patients with musculoskeletal disorders, in terms of time, one can trace a change of attitude to this method of treatment. Conclusions of early reviews were controversial at times. The first meta-analyses indicated an imperfection of the techniques, lack of "standards", an optimal variant of power and other parameters of laser illumination, which was previously not allowed to be carried out by a comparative study [263; 292]. Until quite recently the quality meta-analyzes themselves, and the difficulty of choosing literature for studies have been criticized: there was a great difference in the parameters of the laser exposure techniques for the treatment of patients with the musculoskeletal disorders, methods of results evaluation and even in the terminology [315].

L. Brosseau and co-authors [272] in the survey of 2000 analyzed the results of 13 randomized placebo-controlled trials (454 patients with osteoarthrosis (OA) or rheumatoid arthritis (RA)). The authors' conclusions showed higher efficiency of LILI in patients with RA: pain reduction by 70% compared with the placebo, reduction of morning stiffness and an increase in mobility of joints. With regard to patients with osteoarthrosis, the findings were mixed, and the authors of the meta-analysis suggested a lack of refinement of radiotherapy techniques in these studies. Another review included six RCTs which resulted in pain reduction and a significant improvement in locomotor function in patients with various options of OA after the course of LILI [316]. The studies of Russian scientists on this issue also indicate the radiotherapy efficacy in patients with musculoskeletal disorders of inflammatory and degenerative-dystrophic nature, and in many RCTs, not only were the dynamics of clinical symptomatology and various subjective scales have been used as the performance criteria, but also modern diagnostic methods for evaluation of microcirculation, the immune system and the inflammation process have been applied [7; 29; 45; 50; 84; 103; 114; 144]. At the same time in the course of many RCTs improved radiotherapy techniques were perfected.

There are suggestions that under the influence of LILI, the favorable changes in clinical symptomatology of articular syndrome in patients with

RA and OA are the result of its immune-corrective effect. The clinical response in these patients is based on the high sensitivity of thymus-dependent lymphocytes to the laser light exposure [52; 103]. A positive impact of LILI on the level of glycosaminoglycans in patients with OA was also shown [215].

Currently, a large number of RCTs of high and average quality have already been carried out, confirming a higher efficiency of low level laser therapy compared to the "placebo" group of patients with OA of various localization and process stage. It should be noted that in the majority of studies that LLLT is conducted alongside a complex base treatment, including medication formulations according to treatment standards, and much more seldom therapeutic physical training, massages and other methods of physical therapy. Inclusion of LLLT in a comprehensive treatment program can significantly (by 3–4 times in 80% of patients) reduce the doses of administered intra-steroidal anti-inflammatory drugs (NSAIDs), glucocorticoids and hyaluronic acid products, which allows for much more long-term remission [61; 70; 168]. Several LLLT techniques with a high level of credibility of the evidence in the treatment of patients with OA are presented in the clinical guidelines for physical therapy of OA patients [316].

Also, according to the results of many RCTs, it is recommended to use different LLLT techniques in one procedure. For example, it is suggested to effectively combine local pulsed infrared LILI with laser acupuncture [7], ILBI-405 (wavelength 405nm, 1.5mW power, the exposure of five minutes) [29] and NLBI (wavelength 890–904nm, pulsed IR LILI, matrix head, power up to 80W, frequency 80Hz, two-minute exposure in the projection of large blood vessels) [215], as well as to combine it with a PMF induction 35mT [85; 193]. There is quite a controversial opinion that physical therapy and massage should be done only in the intervals between the LLLT courses as joint use leads to increased pain, build-up of tissue swelling and a significant reduction in the effectiveness of treatment [130].

Comparative evaluation showed that in patients of mid and old age with OA in the I-III stage, the combined action of pulsed infrared LILI (wavelength 890–904nm) with the PMF induction of 35mT is more efficient, compared with the basic modern methods of physiotherapy (ultrasound, DMW, inductothermy, sinusoidal modulated currents, low-frequency alternating magnetic field). Only MLLLT has a positive after-

effect (progressive reduction of residual pains in the joint after the end of treatment), as well as a longer period of the disease remission and a smaller list of contraindications for patients of this age group [85].

A number of RCTs were carried out with comparative studies of the effectiveness of continuous and pulsed modes of LILI in patients with OA. Discrepant data was obtained: a small therapeutic effect of continuous IR laser light [298; 345], or lack of it [344] was shown. In fact, this effect is comparable to high-power incoherent light [257], although it is believed that the increase in the power and energy of the laser light increases the technique efficiency [310]. Since no convincing evidence of the effectiveness of continuous operation of LILI was found, such a mode cannot be considered as a perspective one for practical application.

Using pulsed LILI mode for the treatment of patients with OA is recommended by the World Association of Laser therapy (WALT) [349], because there is quite a lot of publications (RCTs and meta-analyzes), proving the advantages of pulsed infrared lasers [254; 267; 271; 272; 273; 274; 291; 302; 319; 338]. However, long-term preservation of the therapeutic effect is only possible while ensuring the optimal parameters of the LLLT techniques [268].

A prospective, double-blind, randomized and controlled trial was conducted in patients with gonarthrosis (GAr). The effectiveness of a pulsed infrared laser light illumination (wavelength 904nm, pulse duration of 200ns, a frequency of 2500Hz, pulse power of 20W, the average power of 10mW, the light spot area of 1cm^2) was evaluated; exposures of three and five minutes in one zone for all otherwise identical parameters were compared. All patients received a total of 10 procedures on the TPT background during the entire study (14 weeks). Statistically significant improvements were noted in respect to all controlled parameters, such as pain, functional state of joints and quality of life, and the positive result was independent of the exposure in this range [296]. Rapid pain relief was shown in the other RCTs with similar parameters of the technique [291]. According to the results of one RCT, it was recommended to carry out LILI exposure on the knee area simultaneously by two laser heads from both sides [322].

The proof of the effectiveness of ILBI-635 (wavelength 635nm, power of 2–2.5mW, exposure of 15–20 minutes, 10 daily procedures per course) in patients with OA, in conjunction with NSAID administration is rather convincing. After managing reactive synovitis, the hemostasis

system is normalized, pain is significantly reduced – by 1.64 points, movements in the joints became much easier, painless, crepitus is reduced by 1.12 points, joint swelling decreases by 0.77 points, resulting in an increased range of motion in the joint. ILBI-635 stimulates the kallikrein generation system, which is accompanied by the kallikrein-dependent activation of fibrinolysis, normalization of activity of free plasmin, antithrombin III and fibrin stabilizing factor, euglobulin lysis time, there is a significant decrease in erythrocyte sedimentation rate ($p < 0.05$), and γ-globulin fraction to normal values ($p < 0.05$), sialic acids ($p < 0.05$), seromucoid ($p < 0.05$), fibrinogen ($p < 0.001$), glucose ($p < 0.001$) and uric acid ($p < 0.001$) [30; 66]. The results of another RCT indicate that the efficacy of ILBI-635 (wavelength 635nm, 6–1mW power, exposure for 20 minutes, five times a week) is comparable to the outer laser impact on joints by pulsed IR LILI and significantly higher than in the "placebo" group [38]. Other researchers draw a similar conclusion that it is more efficient to combine the pulsed IR laser LILI locally with laser blood illumination, but in the ILBI-405 option (wavelength 405nm, 1.5mW power, the exposure of five minutes) [29].

During polyosteoarthrosis it is also promising to combine ILBI-635 and percutaneous local laser exposure [52].

A number of trials were conducted to study the effectiveness of laser acupuncture in the treatment of patients with OA. Considering the peculiarities of the progress of the disease, sex, age of patients and hormonal condition, it is recommended to carry out laserpuncture by an individual scheme [7; 186], and also combine it with applications of dimethyl sulfoxide [240]. Numerous foreign RCTs also show the high efficiency of laserpuncture in the treatment of patients with GAr [253; 264; 354; 356].

In the RCTs of average quality the results of complex treatment were assessed with the inclusion of LILI in patients with OA of the shoulder joint showing an improvement of the overall therapeutic effectiveness in the intervention group [157]. In a small number of RCTs the results of applying LILI in arthrosis of small joints were analyzed. Thus, it is shown that LILI with a wavelength of 635nm and a minimum power (0.9–5mW) is ineffective in the treatment of patients with thumb arthritis [261], i.e. it is necessary to use continuous laser light of higher power or other LLLT techniques.

In the comparative aspect, promising results have been obtained when illuminating the area of joints with red LILI (wavelength 635nm, power density of 0.15–0.2mW/cm^2) and blue LILI (wavelength 488nm, power

density of 10–12mW/cm^2), the exposure time per one joint being five minutes and treatment course including at least 15 procedures. Positive results of treatment, manifested in analgesic and anti-inflammatory effects, were obtained in 82.1% of patients treated with the red spectrum LILI and in 85.7% of patients treated with the blue spectrum LILI (206 patients participated in the RCT) [66]. The technique developed by researchers has a low level of credibility (there is no "placebo" group).

Several high quality RCTs demonstrate high-performance of intra-articular laser exposure to red LILI (wavelength 635nm, light guide output power of 1.5–2mW, exposure of five minutes) in patients with GAr in conjunction with administration of cartilage protectors [218] or drugs of the glucocorticoid series [102]. It is shown that anti-inflammatory and analgesic effects are enhanced with a simultaneous reduction of the medicamental loading.

The therapeutic efficacy of percutaneous local exposure to LILI and ILBI-635 depends on the stage and severity of reactive synovitis. At the I and II stage of OA with subclinical and low-grade synovitis LLLT may be used alone. In other cases of OA with a reactive synovitis LLLT should be combined with NSAIDs. It is inappropriate to conduct low level laser therapy in patients with severe synovitis, particularly at the III stage of GAr, as well as in case of OA with a sharp violation of statics [197]. In this connection, it is advisable to recommend patients not to discontinue the use of canes, as the latter provide physiological unloading of the knee joints when walking [193].

The isolated use of low level laser therapy is indicated for patients younger than 65 years with moderate pain syndrome and 1–2 radiographic stages of OA. In patients older than 65 years, with severe pain syndrome and roentgen joint space narrowing ≤ 2 mm it is expedient to combine physiotherapy treatments with intra-articular administration of drugs (selection of treatment options depends, among other things, on the presence of comorbidities) [111].

Some foreign researchers attribute the effectiveness of low level laser therapy in treating patients with GAr to the level of credibility of evidence B (based on the analysis of the literature from 2000 to 2007), noting that it is effective to combine it with other kinds of physiotherapy treatment [304]. Other authors mark the advantages of laser intervention as compared to ultrasound therapy [331]. There is an opinion about the insufficient effectiveness of LLLT in the case of OA [330], due to an incorrectly chosen technique that did not give the desired result of treatment.

The analysis of the results of numerous RCTs leads to the conclusion about the validity and a high-level of evidence credibility for the effectiveness of some LLLT techniques in patients with OA (Tables 1–4).

Table 1

Technique 1. Osteoarthrosis. Locally, percutaneously by pulsed IR LILI. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	890–904 (IR)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	60–80	Matrix emitter
Power density, W/cm^2	6–8	Area on the surface of 10cm^2
Frequency, Hz	80–150	Increase of microcirculation, regenerative and antiedematous effects
	3000–10,000	Analgesic effect
Exposure per one zone, minutes	2–5	–
Number of the exposed zones	1–2	–
Localization	On the joint	–
Technique	Contact	Through a transparent nozzle in the projection of the joint space
Number of the exposed zones	10–15	Daily

Table 2

Technique 2. Osteoarthrosis. ILBI-635 + LUVBI®. Class of recommendation I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	365–405 (UV)	LUVBI®
	635 (red)	ILBI-635
Laser operational mode	Continuous	–
Power, mW	1.5–2	At the output of a disposable light guide
Exposure, minutes	3–5	LUVBI®
	10–20	ILBI-635
Localization	Median cubital vein (*v. mediana cubiti*)	–
Technique	Intravenously	Through a disposable sterile light guide
Number of the exposed zones	10–12	Daily, alternating ILBI-635 and LUVBI® every other day

Table 3

Technique 3. Osteoarthrosis. Laser acupuncture. Class of recommendation – IIa

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
Laser operational mode	Continuous	–
Power, mW	2–3	At the output of an acupuncture nozzle
Exposure per 1 acupuncture point, s	20–40	–
Number of the exposed zones	Up to 5	–
Localization	Acupuncture point	The recipe is chosen individually
Technique	Contact	Through an acupuncture nozzle
Number of the exposed zones	10–12	Daily

Table 4

Technique 4. Osteoarthrosis. Locally, percutaneously or intra-articularly by continuous LILI. Class of recommendation – IIa

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	440–445 (blue) or 520–525 (green)	Consequentially
	635	
Laser operational mode	Continuous	–
Power, mW	15–25	–
Power density, mW/cm^2	130–150	Laser diode in direct contact with the skin or at the output of a light guide inside the joint
Exposure per one zone, minutes	0.5–1.5	First LILI with a wavelength of 440–445nm (blue spectrum), then 635nm (red spectrum) on the same zones
Exposure per one zone, minutes	5	An intra-articular technique during affection of the knee joints
Number of the exposed zones	2–12	Total exposure time should not exceed 30 minutes
Localization	On the area of the most affected joints	–
Technique	Contact	Laser diode in direct contact with the skin
Number of the exposed zones	10–12	–

A large number of RCTs confirm the high efficiency of low level laser therapy in patients with a variety of options for RA. The features of the method of application are revealed according to the stage of the disease and the presence of comorbidities. Thus, it was found that the external illumination methods and ILBI-635 are effective only at the I and II degree of the inflammatory process activity [59; 197; 202; 226; 240].

Systematic review (in 2000–2007) showed that low level laser therapy of RA patients, especially when combined with administration of gamma-linolenic acid, is the most effective compared to other physiotherapy treatments [283]. It is more preferable to combine different methods of low level laser therapy with other physical therapy techniques [263].

The studies of the mechanisms of anti-inflammatory action LILI showed a reduction of CXCR4-receptor expression [355], modulation of inflammatory mediators (IL-1β, IL-6) and inflammatory cells (macrophages and neutrophils) [256] with the experimental RA in rats, which may be represented as factors of a LILI-induced reduction of inflammation. It is shown that the light of the pulsed Nd:YAG-laser (wavelength 1064nm) in the optimal mode enhances the synthesis of hyaluronic acid and protein in the synovial tissue culture explants [299].

The analysis of the RCT results (166 patients with RA) allows to draw a conclusion that the application of this LLLT technique leads to a substantial positive dynamic of majority of clinical symptoms, reflecting on the severity of joint damage and the functional status of patients. In RA patients, alongside each LLLT course, a statistically significant increase in hand grip strength ($p < 0.01$) was recorded; the circumference of the proximal interphalangeal joints ($p < 0.01$), modified Ritchie index ($p < 0.01$), the number of painful joints during palpation ($p < 0.01$), duration of morning stiffness ($p < 0.01$), pain at rest and during movement (according to Visual Analogue Scale) ($p < 0.01$) were reduced; the parameters of the functional tests (HAQ disability index and functional lateralization index) were improved ($p < 0.01$), in addition, lower levels of ESR ($p < 0.01$) and CRP ($p < 0.01$) and an increased level of the initially low (<110 g/l) hemoglobin ($p < 0,01$) were observed. Low level laser therapy significantly reduces the activity index, which was observed in 111 (85.4%) patients of the main group and only in 5 (17.2%) patients of the control group ($p < 0.001$). The thermography results indicate an anti-inflammatory effect of LLLT, according to which, after the treatment heat illumination over each

joint was significantly reduced in patients with RA. A significant decrease in the concentration of rFNOα-55R, rIL-2R and neopterin is marked in RA patients alongside LLLT, which is associated with the positive dynamics of the articular syndrome. Alongside LLLT, a normalization of initially low levels of a key antioxidant SOD enzyme in neutrophils ($p < 0.05$) and transferrin-bound iron in plasma ($p < 0.01$) is observed, which reflects the rebalancing of prooxidant-antioxidant system [84].

Favorable changes in clinical symptomatology of articular syndrome in patients with RA under the LILI action are the result of its immunecorrective effect. The high sensitivity of thymus-dependent lymphocytes to the laser light exposure is established and the application of low level laser therapy allows to significantly (3-fold in 80% of patients) reduce the dose of NSAIDs and glucocorticoids, while achieving a more prolonged remission [70; 168; 170]. After local exposure to the infrared LILI, the mechanical resistance of red blood cells increases in patients with RA [137], the state of the endocrine glands (thyroid, adrenal cortex and gonads) and the immune system is normalized [189], FNOα and IL-1β concentrations are reduced [24].

A fair amount of foreign studies (RCTs and meta-analyzes) have been published, proving the advantages of pulsed infrared lasers in the treatment of patients with RA [273; 294]. Continuous LILI is of limited use, because it is less effective and some studies even show a complete lack of positive clinical result [270; 300; 318].

Following the results of average quality RCTs, it was found that after an ILBI-635 course (wavelength 635nm, power of 1–2mW, exposure 20 minutes, the course consisting of 1–5 treatments per week) in patients with RA, the therapeutic effect of cytostatic agents is enhanced and their side effects are cancelled with long-term appointments, an improvement of immunological parameters and anti-inflammatory effect are observed [6], there is a positive effect on the coagulation and fibrinolytic activity of platelets [182], AOS is activated [59]. A pronounced immunomodulatory effect of ILBI-635 manifests in the fact that in patients with initially low levels of CIC laser procedure results in an increase in lymphocyte activity in the rosette formation test, whereas with a high content of the CIC and the initially high rosette formation ability of lymphocytes the latter is inhibited. With an initially high level of CIC and reduction of the absolute count of T-lymphocytes, ILBI promotes further reduction in the level of

E-rosette-forming lymphocytes and their functional activity [52]. It is recommended to use ILBI-635 with such parameters mainly in patients with RA characterized by minimal activity and seronegative form [197].

A RCT has shown that ILBI-635 by this method has lower efficacy in patients with RA, then when compared to the external illumination on the area of the joints with pulsed IR LILI (wavelength 890nm), and it is significantly higher than in the "placebo" group [50]. It follows from other RCTs, that ILBI-635 is more effective than local action of continuous the red spectrum LILI (wavelength 635nm, power density of 80–100mW/cm^2), and maximum therapeutic result was observed when combining two ways of illumination [99; 202].

In total, 132 persons took part in a high quality RCT. It was shown that 10 daily procedures of ILBI-635 (wavelength 635nm, output power of 1.5–2.0mW of disposable light guide, exposure of 15 minutes) and LUVBI® (wavelength 365nm, 1.0mW power, exposure 5 minutes) with alternation in a day in the complex treatment of patients with RA promotes accurate normalization of pro-inflammatory and anti-inflammatory cytokine count. The level of leptin, an anti-inflammatory cytokine, reduces; the content of glycosaminoglycans normalizes, which generally leads to a greater reduction in the disease activity, defined with the help of DAS28 index, and also helps to improve the quality of life of patients according to the specialized questionnaire HAQ [31].

Recent findings strongly suggest that the combination of ILBI-635 (wavelength 635nm, power of 1–2mW, exposure of 15–20 minutes) and LUVBI® (wavelength 405nm, power 1–2mW, exposure, five minutes) on alternate days (a total of 10 procedures per course) contributes best to the normalization of hemostasis parameters (activated partial thromboplastin time, prothrombin time, thrombin time, protein C, antithrombin III, von Willebrand factor), which is accompanied by a significant normalization of platelet aggregation, regardless of the source of initial disorders. The combined option of ILBI-635 + LUVBI® makes a normalizing impact on the intercellular relationships and the microcirculation system [110].

Non-invasive laser blood illumination, being no less effective than ILBI-635, is much more convenient and easier to implement [210]. RCT showed that NLBI efficiency (635nm, continuous mode, power 25mW, on the projection of the radial artery) was higher in RA patients than that of ILBI-635 under the standard technique. Immunological changes

after NLBI are determined by the immuno-stimulatory and immuno-corrective action, increasing the number of theophylline-sensitive cells, B lymphocytes, normalizing the functional activity of T-cells, increasing the level of neutrophilous EAC-rosette-forming cells and functional and metabolic activity of neutrophils, assessed by NBT-test. The effect was more pronounced in patients with initially normal or reduced quantitative immunological parameters (theophylline-sensitive, T-early, T and B lymphocytes, neutrophilous EAC-RFCs) and was absent when they were high, which should be considered when prescribing LLLT. An immuno-corrective effect on the immunological changes characteristic of RA, relatively long preservation of clinical remission, the possibility to reduce maintenance doses of glucocorticoids and NSAIDs allow attributing NLBI to the means of non-pharmacological basic RA therapy [197].

It was established that NLBI in terms of the mechanism of action has similarities with ILBI-635, which is reflected in the immunomodulatory effect on the background of activated antioxidant and neuroendocrine systems and is clinically manifested in reducing the severity of patients and decreasing the overall inflammatory activity of the rheumatoid process. NLBI acts as a synergist of symptomatic drug therapy (NSAIDs) and potentiates the action of basic therapy with alkylating and antimetabolite cytostatics levelling their side effects. NLBI is not combined with administration of glucocorticosteroid tablet forms of drugs due to cessation of their non-specific immuno-suppressive influence, which worsens the progress of the pathological process and clinical state of patients with RA. This method can be combined with pulsed infrared LILI action on the affected joints with proliferative changes [207].

The inclusion of LLLT conducted by the continuous red spectrum LILI (wavelength 635nm, power of 20–25mW, power density of 100–150mW/cm^2, topically on the joints) in complex treatment of patients with RA exerts a positive impact on the immune responsiveness parameters: peripheral blood lymphocyte count, EAC-RFC, T-suppressors, levels of serum IgA, IgG, IgM and CIC, [18; 158] hemodynamic parameters are improved as a whole [208], anti-inflammatory and analgesic effect is made [186]. In this case ILBI-635 (wavelength 635nm, power of 1–2mW, exposure 20 minutes, the course consisting of 1–5 treatments per week) is more efficient than topical exposure by the continuous red spectrum LILI [202].

The combined procedure using the blue (440–445nm) and red (635nm) laser light is efficient in the case of moderate and high activity of hyper-immune chronic RA [212]. If knee joints are affected by the inflammation of the II and III stage with periarticular tissue swelling and exudate accumulation in the joint cavity, it is required, in addition to the external laser illumination, to perform intra-articular laser exposure to the blue and red LILI via the light guide introduced using a biopsy needle, combining low level laser therapy diagnostic biopsy of the synovial fluid. 30 minutes before the combined laser exposure, 0.25 g of oxytetracycline diluted in 2 ml of a 2% novocaine solution is introduced in the cavity of the knee joint [21; 226].

RCT of average quality was carried out to justify the application of laser acupuncture in the treatment of patients with RA [240]. LLLT is performed topically and at the acupuncture points by an individual scheme.

The analysis of RCTs allows recommending several LLLT techniques with different levels of credibility to be prescribed to the patients with RA (Tables 5–9).

Table 5

Technique 1. Rheumatoid arthritis. Locally, percutaneously by pulsed IR LILI. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	890–904 (IR)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	60–80	Matrix emitter
Power density, W/cm^2	6–8	Area on the surface of 10cm^2
Frequency, Hz	80–150	Increase of microcirculation, regenerative and antiedematous effects
	1000–1500	Analgesic effect
Exposure per one zone, minutes	1–5	–
Number of the exposed zones	1–2	–
Localization	On the joint	–
Technique	Contact	Through a transparent nozzle in the projection of the joint space
Number of the exposed zones	10–12	Daily, 3 courses a year in 1–3 months

Table 6

Technique 2. Rheumatoid arthritis. ILBI-635 + LUVBI®. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	365–405 (UV)	LUVBI®
	635 (red)	ILBI-635
Laser operational mode	Continuous	–
Power, mW	1.5–2	At the output of a disposable light guide
Exposure, minutes	3–5	LUVBI®
	10–20	ILBI-635
Localization	Median cubital vein (*v. mediana cubiti*)	–
Technique	Intravenously	Through a disposable sterile light guide
Number of the exposed zones	10–12	Daily, alternating ILBI-635 and LUVBI® every other day

Table 7

Technique 3. Rheumatoid arthritis. NLBI. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	30–40	Matrix emitter
Power density, W/cm^2	3–4	Area on the surface of 10cm^2
Frequency, Hz	80	–
Exposure per one zone, minutes	2–5	–
Number of the exposed zones	2	Symmetrically
Localization	In the projection of large blood vessels close to the lesion	–
Technique	Contact	Through a transparent nozzle
Number of the exposed zones	8–10	Daily

Table 8

Technique 4. Rheumatoid arthritis. Locally, percutaneously or intra-articularly by continuous LILI. Class of recommendation – IIa

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	440–445 (blue) or 520–525 (green)	Consequentially
	635	
Laser operational mode	Continuous	–
Power, mW	15–25	–
Power density, mW/cm^2	130–150	Laser diode in direct contact with the skin or at the output of a light guide inside the joint
Exposure per one zone, minutes	0.5–1.5	First LILI with a wavelength of 440–445nm (blue spectrum), then 635nm (red spectrum) on the same zones
Exposure per one zone, minutes	5	An intra-articular technique during affection of the knee joints
Number of the exposed zones	2–12	Total exposure time should not exceed 30 minutes
Localization	On the area of the most affected joints	–
Technique	Contact-mirror	Laser diode in direct contact with the skin
Number of sessions per course	10–12	–

Table 9

Technique 5. Rheumatoid arthritis. Laser acupuncture. Class of recommendation – IIb

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
Laser operational mode	Continuous	–
Power, mW	2–3	At the output of an acupuncture nozzle
Exposure per 1 AP, s	20–40	–
Number of the exposed zones	Up to 5	–
Localization	AP	The recipe is chosen individually
Technique	Contact	Through an acupuncture nozzle
Number of the exposed zones	10–12	Daily

A number of works are devoted to the study of LLLT effectiveness in psoriatic arthritis (PsA). It was found that the topical exposure by pulsed IR LILI (wavelength 890nm, power of 5–7W, pulse duration of 100–150ns, a frequency of 1500–3000Hz, the exposure of 5 minutes, 10–15 daily procedures per course) in the complex treatment of patients with PsA corrects immune dysfunction and contributes to the stabilization of the clinical picture in case of mild and moderate inflammatory activity. In the case of high PsA activity, low level laser therapy reduces the severity of immune disorders: it corrects the ratio of lymphocyte subpopulations, reduces the activity of the humoral component of immune system and content of IL-6 and FNOα in the blood serum [15; 223]. LLLT by pulsed IR LILI enables to significantly reduce the doses of NSAIDs and glucocorticoids with longer remission [168].

The therapeutic effect is enhanced when combining topical LLLT with ointment ultra-phonophoresis (Peloidinum – 500.0, Analgin – 125.0, Vaseline – 125.0 and Lanolin – 500.0) [52] and laser puncture [140].

The scarcity of RCTs allows the recommendation of only one LLLT technique with a low level of credibility of the evidence of its effectiveness for patients with PsA (see Table. 10).

Table 10

LLLT technique. Psoriatic arthritis. Locally, percutaneously by pulsed IR LILI. Class of recommendation – IIb

Parameter	Value	Notes
Laser light wavelength, nm (locally)	890–904 (IR)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	60–80	Matrix emitter
Power density, W/cm^2	6–8	Area on the surface of 10cm^2
Frequency, Hz	80–150	Increase of microcirculation, regenerative and antiedematous effects
	3000–10,000	Analgesic effect
Exposure per one zone, minutes	2–5	–
Number of the exposed zones	1–2	–
Localization	On the joint	–
Technique	Contact	Through a transparent nozzle in the projection of the joint space
Number of sessions per course	10–15	Daily

There is an experimental justification for applying LLLT in urarthritis (UA). In the experiment in rats with artificially induced arthritis by urate crystals introduced into synovial fluid it was shown that after topical exposure to LILI on the joint region the initially increased level of plasma fibrinogen, prostaglandin E2 and TNFα concentration in blood is reduced to normal, indicating the pronounced anti-inflammatory action of LILI [275; 338].

LLLT combined with antacid systemic agent (trometamol) improves micro-circulation in the kidney parenchyma of patients suffering from gout complicated by nephropathy, leading to not only reduced level of uric acid in the blood serum by 23.7%, its increased urinary excretion by 59.6%, increased glomerular filtration rate (GFR) by 23%, but also to the full or partial litholysis in 87.2% of cases [9].

The RCT involved 104 gout sufferers randomized into several groups according to the duration of the course (5, 21 or more days). Some patients took NSAIDs (Diclofenac) 50 mg twice a day; the others were exposed to the pulsed IR LILI under the procedure presented in Table 11. A more pronounced result was established after a LLLT course (71.4%) as compared to the control group receiving only medicinal preparations (50% of cases) [338].

The minimal volume of RCTs allows recommending only one LLLT technique with a low level of credibility of the evidence of its effectiveness for patients with urarthritis (see Table. 11).

The meta-analysis of foreign publications leaves no doubt in the effectiveness of low level laser therapy in different variants of enthesopathies, however, they emphasize the necessity to pay special attention to the parameters of laser exposure, often in trials with positive results pulsed IR lasers (wavelength 904nm) were used [345].

In patients suffering from the calcaneal region enthesopathy (heel spur) low level laser therapy by pulsed infrared LILI (wavelength 890nm, power of 7–10W, pulse duration of 100–150ns; frequency of 1000Hz, exposure for two minutes, a course of 15 daily treatments topically) is most effective when combined with hydrocortisone ultra-phonophoresis [41].

Numerous RCTs prove the effectiveness of pulsed IR lasers in treating patients with lateral and medial epicondylitis [286; 312; 329; 339; 340; 346], to reduce pain in the shoulder during subacromial syndrome [250; 265].

Table 11

LLLT technique. Gouty arthritis. Locally, percutaneously by pulsed IR LILI. Class of recommendation – IIb

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	890–904 (IR)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	20–25	One laser diode
Power density, W/cm^2	–	Minimal area (150 μm^2) with laser beam divergence of not more than 6–8 degrees
Frequency, Hz	10,000	–
Exposure per one zone, minutes	2 or 5	–
Number of the exposed zones	2 or 4	–
Localization	On the joints symmetrically	–
Technique	Contact	Laser diode is in direct contact with a minimum area on the surface
Number of the exposed zones	15–20	Daily, the second course should be conducted in 1–1.5 months after the first one

A RCT has also shown that in treating patients with both medial and a lateral epicondylitis, the efficiency of pulsed IR LILI (904nm, 10W) is higher than that of the continuous red (633nm, 10mW) and infrared (830nm, 120mW) spectra [189]. It is effective to combine low level laser therapy by pulsed IR LILI (wavelength 890nm, power of 4–5W, light pulse duration of 100–150ns, the frequency of 1500Hz, PMF induction 35mT, contact-mirror technique, three zones topically on the joint, for two minutes each) and ILBI (wavelength 635nm, power 3.4mW, exposure for 20 minutes) [34].

Low level laser therapy is recommended by the Orthopedic Section of the American Physical Therapy Association (APTA), as part of the comprehensive treatment of patients with Achilles tendinitis, with references to successful RCTs given, where both continuous (820nm) and pulsed (904nm) IR lasers were used [276]. However, recent studies prove that continuous LILI (wavelength 850nm, power 100mW, exposure for 66 and 204 seconds) is ineffective in this disease [279].

In 100% of cases where low level laser therapy is used for calculous (concrementous) bursitis of the shoulder, it promotes the calcificate resorption, which is a proof that LILI has an effect on the peripheral circulation normalization. The treatment effectiveness is reduced along with the severity of degenerative dystrophic processes associated with patient's age. Exposure to LILI can be recommended as a prophylactic measure to prevent further development of the shoulder-blade periarthritis [39; 157].

A number of researchers recommend to use an infrared continuous laser light with a wavelength of 830nm, power up to 1000mW (topically) when treating enthesopathies [326; 328]. However, this approach can hardly be called promising due to the short duration of effect achieved, which occurs most likely as a consequence of a simple heating of the tissues, rather than due to the known mechanisms of the therapeutic action of LILI.

To date, there is no doubt in the effectiveness of pulsed LILI (wavelength 904nm), when treating tendinopathy of the elbow joint [269].

Numerous studies have shown the effectiveness of LT in case of rotator cuff syndrome [284; 350]. Pulsed IR lasers are advantageous [260; 309]. Continuous IR lasers are either much less effective (wavelength 850nm, power 100mW per minimum area) [284] or have no effect when compared to the placebo (830nm, 30mW [347; 352], 810nm, 60mW [341]). Continuous infrared LILI with similar parameters (840nm, 100mW) is inefficient in experimental muscle pain [293]. Attention should be paid to the need to provide a comprehensive treatment: LLLT should be an integral part of physical therapy and TPT [259; 260; 289], the efficiency is greatly enhanced when combining LLLT by IR pulsed LILI with injections of corticosteroids [309].

ILBI-635 is not included in clinical guidelines due to the lack of proper RCTs, but it is quite possible to apply this method in a complex low level laser therapy [34].

Laser acupuncture is indicated for treating patients with lateral epicondylitis [278; 297; 314]. In the case of adhesive capsulitis of the shoulder carrying out the procedure three times a week gives a quick effect which persists for two years [303].

Thus, there are rather good reasons to include percutaneous LLLT by pulsed LILI and laser acupuncture in the complex treatment of patients with enthesopathies (Table 12, 13).

Table 12

Technique 1. Enthesopathies. Locally, percutaneously by pulsed IR LILI. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	890–904 (IR)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	60–80	Matrix emitter
Power density, W/cm^2	6–8	Area on the surface of 10cm^2
Frequency, Hz	80–150	Increase of microcirculation, regenerative and antiedematous effects
	1000–1500	Analgesic effect
Exposure per one zone, minutes	1–5	–
Number of the exposed zones	1–2	–
Localization		–
Technique	Contact	Through a transparent nozzle in the projection of the joint space
Number of sessions per course	10–12	Daily, 3 courses a year in 1–3 months

Table 13

Technique 2. Enthesopathies. Laser acupuncture. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
Laser operational mode	Continuous	–
Power, mW	2–3	At the output of an acupuncture nozzle
Exposure per 1 AP, s	20–40	–
Number of the exposed zones	Up to 5	–
Localization	AP	The recipe is chosen individually
Technique	Contact	Through an acupuncture nozzle
Number of sessions per course	10–12	Daily

Low Level Laser Therapy for Neurological Disorders

Many researchers and clinicians have noted that in treating patients of a neurological profile, it is most effective to combine different me-

thods of low level laser therapy with other physiotherapy techniques and supplement it with pharmacotherapy [2; 81; 96; 105; 163]. Thus, the LLLT inclusion in the complex health resort treatment of patients with vertebrobasilar insufficiency (VBI) improves the clinical efficacy by 30.8%; moreover, volumetric rate of blood flow in the vertebrobasilar basin increases by 26% [170].

It was found that the greatest positive impact on the state of cerebral hemodynamics in patients with VBI is provided by prescribing drugs and combining physiotherapy techniques (transcranial electrostimulation and MLLLT), as evidenced by signs of normalization of the Doppler ultrasound parameters in 35.0% of cases, as compared to MLLLT or medications alone [20].

As a result of exposure to the red spectrum LILI (635nm) on the carotid sinus and the superior cervical sympathetic ganglion projection area in patients with ischemic brain lesions, the dominant factors, "metabolic markers" of cerebral protection action of LILI, were detected during ischemia and cerebral reperfusion, which can be arranged according to the degree their significance in the following descending order: phospholipid-neuro amino-acidic, phospholipid-adenosine, phospholipid-adenine nucleotide, phospholipid, phospholipid-glutamate, adenine nucleotide [135].

A large number of RCTs are focused on assessing the effectiveness of MLLLT alongside of complex treatment of various neurological disorders: cervical vertebral osteochondrosis [141], diabetic distal polyneuropathy [33], and lumbosacral spine dorsopathy [2; 81]. Long-term direct exposure to LILI after nerve neurolysis combined with electrostimulation enhances local blood flow, complete restoration of nerve conduction at the preservation of the nerve fibers and improves the effectiveness of the treatment as a whole [238; 247].

The RCTs of average quality (98 patients with intervertebral hernias of the lumbosacral spine) proved the effectiveness of the combined low level laser therapy technique: paravertebral exposure at the sciatic nerve exit site (4 points for 2 minutes on each side), along the sciatic nerve (the middle third of the posterior surface of the femur, the middle third of the posterior surface of the gastrocnemius muscle and the area ofthe foot on both sides) for two minutes per zone, or trigger points in the femoral and crural region, as well as in the inguinal and gluteal regions (for two minutes each), and additionally NLBI in inguinal and popliteal neurovascular bundles for 5 minutes per zone [177].

Low level laser therapy techniques, developed for the correction of a variety of neurological disorders are quite diverse. Thus, it was shown that for patients with chronic cerebral ischemia ILBI-635 is effective, as it significantly enhances the effect of antiplatelet agents and peripheral vasodilators [216].

Endonasal exposure to the continuous red spectrum LILI (635nm) significantly increases the effectiveness of treatment of patients with Sluder's syndrome (ganglionitis of the pterygopalatine ganglion) and trigeminal neuralgia [87].

A course of LLLT by pulsed IR LILI when exposed to suboccipital region in patients with VBI promotes significant decrease in the severity of neurological symptoms, depressive and hypochondriacal disorders, increase in blood supply to the vertebral arteries and reduction of their tone [121], it is also recommended to illuminate the carotid sinus area and the cervical sympathetic ganglions [27].

The meta-analysis of 16 RCTs (a total of 820 patients with acute pain in the cervical region) showed that in 95% of cases low level laser therapy reduces pain immediately after treatment, the effect lasts up to 22 weeks after the treatment completion in patients with chronic pain [280; 281; 282]. The analysis of the literature published in 2005–2007, carried out on CENTRAL, MEDLINE, CINAHL, EMBASE, AMED and Pedro databases, has shown that exposure to LILI significantly reduces back pain while preserving the effect for up to 6 months. [353]. Preference is given to the pulsed IR lasers (904nm) with a high pulse. The technique is summarized in Table 14.

The high-quality RCTs found that in the acute and early period of complex treatment of patients with vertebral-cerebrospinal injury the topical illumination by the continuous red spectrum LILI (635nm) stimulates actively reparative processes in the focus of the spinal cord contusion, which allows the restoration of motor and sensory functions of the damaged spinal cord by 1.2–1.6 times faster and achieving the pronounced regress of neurological symptoms, shortening the duration of the normal voiding restoration period by 2.4 times, reducing the number of urological complications by 3.7 times and avoiding the development of trophic disorders [219].

Local illumination of the exit site projection of the facial nerve and its branches by the red (635nm) continuous LILI is effective in the complex treatment of non-traumatic neuropathies of the facial nerve at the

Table 14

Technique 1. Patients with various neurological disorders. Locally, percutaneously by pulsed IR LILI. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	890–904 (IR)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	10–15	Single emitter
Illumination power, W	60–80	Matrix emitter
Power density, W/cm^2	6–8	Area on the surface of 10cm^2
Frequency, Hz	80–150	Increase of microcirculation, regenerative and antiedematous effects, reflex action
	1500–10,000	Analgesic effect
Exposure per one zone, minutes	1–5	–
Number of the exposed zones	Up to 10	–
Localization	Depending on the disease and the technique	–
Technique	Contact or contact-mirror	Directly or through nozzles
Number of the exposed zones	10–12	Daily, 3 courses a year in 1–3 months

acute stage (within the first week of the disease). These RCTs suggest normalization of regional blood flow and restoration of blood circulation in the facial nerve trunk, which leads to a more rapid regression of the deficit mimic syndrome [206; 245]. To increase the effectiveness of the treatment it is recommended prior to topical exposure to illuminate the region of segmental vegetative innervation of head – the superior cervical sympathetic ganglion – by pulsed infrared LILI (890–904nm) [206].

According to some sources, IR LILI in the pulsed mode illuminated topically influences more effectively on the regenerative processes of the neuromuscular system in patients with neurological manifestations of vertebral osteochondrosis than continuous red spectrum LILI [2]. The technique is given in Table 15.

The studies have shown that the clinical efficacy of complex treatment of patients with various forms of lumbar-sciatic syndromes including the LLLT course is significantly higher than in the group with conventional

Table 15

Technique 2. Neuropathies. Locally, percutaneously by pulsed IR LILI with variable frequency. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	890–904 (IR)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Power (pulsed), W	10–15	Single emitter
Variable frequency, Hz	80–150–300–600–1500–3000–10,000–3000–1500–600–150–80	Reflex action, analgesic effect
Exposure per one zone, minutes	2	–
Number of the exposed zones	Up to 10	–
Localization	Depending on the disease and the technique	–
Technique	Contact or contact-mirror	Directly or through nozzles
Number of the exposed zones	10–12	Daily, 3 courses a year in 1–3 months

treatment. LLLT of patients with myofascial pain syndrome (MFPS) can be carried out as a monotherapy or in addition to the basic treatment. Laser illumination is carried out on the trigger points [124].

The patients suffering from periodic migrainous neuralgia as a result of exposure to pulsed infrared LILI with variable frequency on three areas (topically orbitotemporal region and projection of the superior cervical sympathetic ganglion) demonstrated significantly reduced paroxysms series ($p < 0.05$), at the same time the functional state of subcortical-stem formations is normalized, as well as the imbalance of the endogenous opioid system is reduced ($p < 0.05$) [237].

The average quality RCTs revealed that the combination of the red and ultraviolet spectra ILBI on alternate days causes a significant reduction in chronic pain syndromes in patients with vertebral lumbar pain [194]. The technique is given in Table 16.

The RCTs studying the effectiveness of ILBI in neurological patients are the most numerous. It was found that in the acute and the most acute phase of ischemic cerebrovascular disorders, ILBI-635 accelerates the regression of cerebral symptoms and focal neurological manifestations; in patients with residual effects after suffering a stroke it contributes

Table 16

Technique 2. Patients with various neurological disorders. ILBI-635 + LUVBI®. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	365–405 (UV)	LUVBI®
	635 (red)	ILBI-635
Laser operational mode	Continuous	–
Power, mW	1.5–2	At the output of a disposable light guide
Exposure, minutes	3–5	LUVBI®
	10–20	ILBI-635
Localization	Median cubital vein (*v. mediana cubiti*)	–
Technique	Intravenously	Through a disposable sterile light guide
Number of the exposed zones	10–12	Daily, alternating ILBI-635 and LUVBI® every other day

to significant improvements in the psycho-effective sphere and is less significant for the regression of local neurological impairment. LLLT enhances cerebral circulation, which manifests itself in increasing its speed, enhancing the functioning of anastomoses, reducing inter-hemispheric asymmetry, it has a significant effect on the fibrinolytic system, promotes a moderate decrease in blood coagulation system activity, improves the arterio-venous difference due to the shift of the oxygen-hemoglobin balance curve to the right by 20%, which contributes to the enhanced oxygen utilization by the cerebral tissue. Under the influence of ILBI-635, due to the optimization of metabolic processes, there is a change in the bioelectric activity parameters in the form of electrophysiological characteristics: increase in the representation and expression of the alpha rhythm, reduction of inter-hemispheric asymmetry and intensity of slow rhythms [216]. In the acute phase of the ischemic stroke ILBI-635 has a positive effect on the cerebral blood flow, which manifests itself in the increased linear velocity of blood flow due to the enhanced functioning and development of blood circulation on the homolateral side of the affected body [38; 210].

Inclusion of ILBI-635 (wavelength 635nm, power of 1–2mW, 20 minutes, the course consisting of seven procedures on alternate days) and an antioxidant in the complex therapy of extracranial VBI enables to

improve the clinical efficacy of the therapy in young patients [75], and in patients of mid and old age [94]. ILBI-635 with similar parameters (5–7 daily procedures) is effective in complex treatment of patients with chronic cerebral ischemia (CCI) [95] and in men with initial manifestations of insufficient cerebral blood supply [173; 211].

ILBI-635 (wavelength 635nm, power of 2–3mW, 20 minutes, 10–15 procedures per a course daily) is indicated in treating patients with initial manifestations of cerebral blood supply insufficiency, transient ischemic blood circulation impairment, small strokes, ischemic strokes in the acute period with unexpressed motor functional defect, in case of dyscirculatory encephalopathy (DEP) of the I stage [142; 187], including in a complex of preventive measures [142]. In several RCTs it was proved that after ILBI-635, patients with DEP of I-II stages demonstrated significantly reduced hypoxic effects, improved hemodynamics, manifesting in the increased blood supply, decreased tone in arteries of small and medium caliber, improved venous return and reduced inter-hemispheric asymmetry; LPO indices reduced while SOD activity increased [174; 210]; the power of rapid wave activity spectrum strengthened and the overall energy level of the electrical activity of the brain increased [210], the lipoprotein composition of the blood plasma was normalized, excess cholesterol was eliminated in the membranes, the phospholipids/cholesterol ratio increased [187], and the risk of ACVE was significantly reduced.

After ILBI-635 the cerebral, asthenoneurotic and vestibulocerebellar syndromes, cerebral and asthenoneurotic ones in the III stage and only focal symptoms in the acute phase of the ischemic stroke are subject to the most regress [38; 210].

During dorsopathies the best clinical efficacy of ILBI-635 (wavelength 635nm, power of 1–2mW, exposure for 15–20 minutes, 10–15 procedures per a course daily) has been proved in patients with disease duration up to 10 years, by the I and II radiological stages. ILBI-635 makes anti-inflammatory and analgesic effects, allowing patients to do without nonsteroidal anti-inflammatory drugs, improving general clinical laboratory values and normalizing the CIC level. As combined with medication therapy LT results in reducing peripheral vascular and pulmonary vascular resistance [28; 123]. Low level laser therapy is indicated for patients with persistent radiculopathy syndrome with prevalence of vegetovascular disorders and it is less effective in case of pronounced musculo-tonic and trophic components [58].

In the treatment of patients with cervical vertebral osteochondrosis the best results are obtained by combining ILBI-635 with a topical illumination by pulsed IR LILI [68].

Efficiency of ILBI-635 in patients suffering from the vibration disease is confirmed by positive dynamics of clinical manifestations of the disease, the peripheral circulation state, bio-stimulating effect on the neuromuscular system, improved blood rheological properties, hypocoagulation effect, optimization of plasma Ca^{2+} concentration. ILBI-635 allows halving the length of hospital stay on average, it is recommended to administer repeated LLLT courses in 6–12 months, depending on the degree of disease severity [195].

According to several RCTs, ILBI-635 can be administered to the patients with CCI in all periods of the disease; the only limitation is the presence of a massive subarachnoid hemorrhage. It should be emphasized that ILBI-635 is allowed to be applied in complex intensive therapy of the acute period of severe CCI; laser blood illumination is carried out starting from the second or third postoperative day, subject to observing a thorough intraoperative hemostasis [47; 98]. During LLLT, oxygen partial pressure increases in the arterial blood and hemoglobin is saturated with oxygen, which improves gas exchange, and brain metabolism and corrects hypoxic hypoxia in patients with severe CCI. Improvements that increase the oxygen content in the arterial blood lead to the increase in arterio-venous difference with regard to oxygen and to the reduction of cerebral circulatory hypoxia [47]. ILBI-635 stimulates the antioxidant system, improves the rheological properties of the blood, has an immunomodulating and membrane stabilizing action [98], in particular, it normalizes the content of FNOα, IL-1β and IL-6 in the first 24 hours after CCI [323].

Comparison of the effectiveness of NLBI (890nm, pulsed mode, power of 8.5W, frequency of 80Hz, two minutes per each carotid sinus region symmetrically) and ILBI (635nm, 1–2mW, 20 minutes) consisting of 10 procedures in patients with atherosclerotic DEP showed a significant impact on the regression of neurological symptoms, improvement of cerebral blood flow, microcirculation, normalization of blood lipid composition and functional activity of the brain for both LLLT techniques. However, NLBI proved more effective than ILBI in case of the I-II stages of DEP and equally successful at the III stage. Studies prove that NLBI is an alternative to ILBI as it excludes a number of problems inherent in

the intravenous laser intervention method, such as invasiveness, injury rate, the need to use disposable light guides and needles [74].

It is advisable to carry out the course of NLBI by pulsed red LILI (635nm) to the DEP patients with concomitant clinical manifestations of vertebrogenic syndrome and compression radiculopathy, and the treatment is accompanied by a significant regression of pain and musculo-tonic disorders. Localization of intervention should be on the posterolateral surfaces of the neck in series (2 fields), the procedure is carried out in the position of the patient lying on the back, that depresses postural-tonic reflexes of the cervicothoracic level. It is advantageous to carry out NLBI at the early stage of DEP, before the widespread and/or pronounced stenoocclusive lesions of MAH are formed, since in the latter case, all kinds of LLLT are low- or ineffective due to hypo/areactivity of mechanisms regulating cerebral hemodynamics and microcirculation [122]. Pulsed IR LILI is less efficient for NLBI in patients with CCBI, even in case of applying MLLLT [88]. A similar conclusion can be drawn with regard to the continuous red spectrum LILI, which is applied most often in the projection of the cubital vein [128]. It is shown that matrix laser heads are the most effective [104; 122].

A RCT was conducted justifying NLBI administration to the patients of the first and second rehabilitation groups in an outpatient setting in the early recovery period of the ischemic stroke [244].

Two trials with a "placebo" control group showed a high performance of NLBI by pulsed IR LILI (890–904nm) to larger vessels, and additionally to the areas of segmental innervation (paravertebral sympathetic L-S ganglia), and the neurovascular bundle of the lower limbs in patients with diabetic neuropathies at all stages of the disease [92; 183].

It is shown that the mechanism of LILI action in the treatment of patients with disseminated sclerosis is associated with exposure to the remyelination processes (improvement of the nerve impulse propagation along the sensitive conductors within the CNS) and the immune system (normalization of immune status parameters, reduction of the severity of inflammation according to neuroimaging). When administering NLBI, it is required to take into account the duration of the disease, the severity of the pathological process and the nature of its progression. It is reasonable to administer a LLLT in the early stages, in case of remitting progression of disseminated sclerosis, and disease duration of not more than 7 years. LLLT is recommended in the combined treatment if motor disturbances

and cerebral trunk involvement symptoms prevail in the clinical picture [250].

During the complex treatment of patients with post-traumatic cerebral arachnoiditis application of NLBI in the projection of the common carotid artery at the Th_{IV} level improves microcirculation in the cerebral cortex, which is provided by the direct influence of LILI on the tone of brain vessels, a decrease in coagulation activity of the brain, increased fibrinolytic potential and improvement of its rheological properties. The positive effect of LLLT course manifests itself after 5–6 procedures, with the headache gradually decreasing both in terms of intensity and duration [165].

Trials were also conducted in children of preschool and younger school age on the efficacy of NLBI by pulsed IR LILI (890–904nm) with minimal brain dysfunction. LILI parameters were adapted with regard to the age: for 0.5 minute on the right and on the left in the vascular bundle region (in the sub-clavian area), as well as in inferior cervical sympathetic ganglia region (paravertebrally for cervical spine) on the right and on the left; 10 daily sessions of procedures per course of the treatment [12].

Summarizing generally the information about the efficacy of NLBI techniques obtained in a large amount of RCTs in neurological patients, the following parameters are recommended with high level credibility of the evidence (Table 17).

The level of evidence of laser acupuncture application in various neurological diseases is also quite high. Prescriptions, i.e. exposure localization and sequence, are determined depending on the disease.

The combined action of laser acupuncture and chromotherapy with individual selection of the colour spectrum, depending on the vegetative tone in students with a vegetative dysfunction contributes to the improvement of psycho-physiological and functional parameters of the body, resulting in a statistically significant increase in the rates of mental capacity by 37.7%, cognitive function by 2.5 times, as well as decrease in stress index by 1.6 times and mode amplitude by 2.5 times as well as improving the psychoemotional state, which indicates the complete restoration of the vegetative balance and compensatory and adaptive capabilities of the body [44].

It is possible to apply laser acupuncture for correction of the initial manifestations of cerebrovascular disorders [162] in patients with lumbar dorsalgia [201]. According to M.G. Satarov [201], laser acupuncture is a

Table 17

Technique 3. Patients with various neurological disorders. NLBI. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
	890–904 (IR)	
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	30–40	Matrix emitter
Power density, W/cm^2	3–4	Area on the surface of 10cm^2
Frequency, Hz	80	–
Exposure per one zone, minutes	2–5	–
Number of the exposed zones	2	Symmetrically
Localization	In the projection of large blood vessels close to the lesion	–
Technique	Contact	Through a transparent nozzle
Number of the exposed zones	8–10	Daily

highly effective treatment technique for patients with lumbar dorsalgia (94.3%), which is significantly more important than after the application of the classical reflexotherapy (77.1%) and medication therapy (60%). The results are confirmed by the data of remote observation, evidencing of achieved remission maintenance for a year in 80% of patients with lumbar dorsalgia.

While correcting vegetative-vascular disorders in case of cervical-cranial syndrome in patients with increased sympathetic activity, LLLT is the selected method, which includes illumination of the carotid sinus region, cervical-thoracic paravertebral areas and AP having sympatholytic and sedative effect [129].

Differentiated use of manual therapy and laser acupuncture shows good results in treating of the patients with neurological manifestations of lumbar osteochondrosis [80].

For patients with episodic tension-type headaches it is indicated to administer laser acupuncture at the corporal and auricular points, as well as at painful points of the scalp, in combination with post-isometric muscle relaxation. It is recommended to use the following set of acupuncture points when conducting laserpuncture [248; 249]:

– distal: GI4, GI11, E36, RP4, RP6, C3, C5, C7, MC5, MC6, MC7, TR5, VB34, VB41;
– cervical collar: V10, VI1, VB20, VB21, T14, T15, T16;
– cranial: E8, V3, V5, V8, V9, VB4, VB10, VB11, VB13, VB14, VB15, VB16, VB19, T17, T18, T19, T20, T23, T24, PC2, PC3, PC25/2;
– auricular: AP22, AP26a, AP25, AP28, AP29, AP33, AP34, AP35, AP36, AP37, AP41, AP55, AP59, AP82, AP87.

Laser acupuncture in patients with distal diabetic polyneuropathies of mild to moderate severity is effective in the prevention and stabilization of degenerative processes in the peripheral nervous system. The clinical effect is expressed in the substantial regression of pain and neurological symptoms, due to the recovery and acceleration of impulse propagation along the motor fibers of peripheral nerves, the improved peripheral circulation, as well as the increase in resistance of the body and the normalization of the main indicators of the immune status. Long-term results indicate stabilization of the diabetic polyneuropathy progression in the process of repeated courses of LLLT, the slowing of the progression of the disease [127].

Laser acupuncture is indicated in post-illumination vegetative sensory polyneuropathy [82]. In the first half of the day the intervention is performed on the distal points of the yang meridians of the hand and foot symmetrically. Sequence of points should be as follows: GI1, TR1, IG1, E45, VB44, V67 from both sides. At the second stage (including the results of pulse diagnosis) the sympathy points (shu-points) of small intestine meridian V27 are exposed on both sides. In the second half of the day, the distal points of the yin-meridians are exposed symmetrically. Sequence of points should be as follows: P11, MC9, C9, RP1, F1, R1. Then intervention on the sympathy points (shu-points) of the liver meridian V18 are performed symmetrically. Fourteen points are processed per one procedure and 28 AP per day. The technique parameters include: modulated red (wavelength 635nm) LILI, frequency 2Hz, power no more than 4mW. The exposure time for one AP (GI1, TR1, IG1, E45, VB44, V67, P11, MC9, C9, RP1, F1, R1) is 30 seconds, 10 seconds for V27 and 50 seconds for V18; in total 14 points are exposed per one procedure, daily, twice a day with an interval of 4–6 hours. The course includes 10–12 procedures.

Thus, there are various schemes for AP selection (prescription), but the most effective LILI parameters (according RCTs data) are given in Table 18.

Table 18

Technique 4. Patients with various neurological disorders. Laser acupuncture. Class of recommendation – IIa

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
Laser operational mode	Continuous	–
Power, mW	2–3	At the output of an acupuncture nozzle
Exposure 1 AP, s	20–40	–
Number of the exposed zones	Up to 5	–
Localization	AP	The recipe is chosen individually
Technique	Contact	Through an acupuncture nozzle
Number of the exposed zones	10–12	Daily

Low Level Laser Therapy for Cardiovascular Disorders

While reviewing the efficacy of LILI in patients with IHD, 11 RCTs were analyzed, including 5 placebo-controlled. Comprehensive treatment applying the ILBI-635 technique (wavelength 635nm) was evaluated in most cases [14; 18; 19; 42; 49; 97; 109; 138; 164].

Following the results of average quality RCTS after a course of ILBI-635, a statistically significant increase in platelet aggregation index up 1.28 ± 0.08 c.u. was found in 65.8% of patients ($p < 0,05$), and only a tendency to its increase was observed in the control group. A significant decrease in the vascular wall anticoagulation activity index was revealed (from 1.1 ± 0.04 c.u. down to 0.99 ± 0.02 c.u.; $p < 0.05$), whereas in the control group the anticoagulant activity of the vascular wall was not changed. The improvement in the microcirculation was observed as a result of exposure on the endothelial component of the vascular tone regulation ($p < 0.05$) [42; 97].

In another RCT, it was shown that the inclusion of ILBI-635 in the complex therapy of patients with unstable angina pectoris was accompanied by a significant decrease in total cholesterol (TC) ($p < 0.05$);

low-density lipoprotein (LDL) ($p < 0.05$). An increase in the activity of AOS enzymes was also established. Thus, the catalase content showed a statistically significant increase up to 436.67 ± 50.2 mcAb/l ($p < 0.05$), and ceruleoplasmin content grew up to 2.45 ± 0.2 mmol/l) ($p < 0.05$), which did not occur in the control group of patients who received only medication therapy [18].

Several RCTs studied the LLLT efficacy in patients with IHD during the exposure localization on the acupuncture points of the heart and pericardium meridians [1; 71; 86; 100; 210]. The results of these trials showed considerable improvement in the quality of patients' lives. An increased tolerance to physical exercise was noted, both according to the results of the bicycle exercise test ($p < 0.05$), and according to the 6-minute walk test data ($p < 0.05$). Frequency of angina pectoris attacks and intake of nitroglycerin and long-acting nitrates decreased ($p <$ from 0.01 to 0.05). A significant improvement in indicators of the microvasculature state, lipid metabolism, rheological properties and the blood clotting system was found.

A high-quality RCT was conducted, which included 107 patients with stable exertional angina of I-III FC [213]. The work is devoted to a comparative study of the effect of LILI of the red (635nm) and infrared (890nm) spectra. As a result of the course of treatment, an increase by 30% in cardiac performance power was noted in patients who were illuminated with the red (635nm) LILI ($p < 0.05$), and by 16% in patients illuminated with the IR (890nm) LILI ($p < 0.05$). It was found that when using the red spectrum LILI, favorable restructuring of central hemodynamics occurred only with the hyperkinetic circulation option, as evidenced by the decline in high-shock and cardiac indices ($p < 0.05$), whereas the infrared LILI treatment had a beneficial effect only in the case of the original hypokinetic option, due to reduced peripheral vascular resistance ($p < 0.05$). No statistically significant changes of the above indicators were revealed in the placebo group. Significant reduction in the initially elevated platelet aggregation induced by ADP and adrenalin was revealed only under the influence of IR LILI ($p < 0.05$). Laser illumination of both spectral bands, in contrast to the control, had a positive impact on the level of fibrinogen in the blood ($p < 0.01$) and SLA indicators ($p < 0.01$). Following the results of the research a differentiated approach to LILI selection was proposed: the use of the red spectrum is optimal for treating patients with angina pectoris of FC I and II, having

predominantly hyperkinetic circulation option, the infrared spectrum – for patients with angina FC I-III having mainly hypokinetic circulation who demonstrate an impairment of blood rheology, microcirculation in the myocardium and AOC.

One RCT investigates LLLT efficacy in the rehabilitation of patients after surgical myocardial revascularization. A positive impact of low level laser therapy on coagulation performance was found, which was reflected in the decreased level of fibrinogen ($p < 0.01$), reduction of elevated platelet aggregation induced by ADP and adrenalin ($p < 0.01$). No dynamics, except for the fibrinolytic activity indicator, was revealed in the placebo group. The capacity of the threshold load in patients treated with LLLT in the course of the integrated treatment increased from 375.0 ± 12.11% to 450.0 ± 8.13% ($p < 0.05$), while it only tended to increase in patients with the placebo exposure ($p < 0.1$) [156].

According to the results of several RCTs, it was concluded that conducting LLLT alongside basic medication therapy in patients with essential hypertension (EH) leads to increased myocardial, coronary reserves, improved performance of central hemodynamics and microcirculation, and also has a marked antihypertensive effect [5; 16; 220].

Thus, there were 82 patients with stage 2 EH and coronary insufficiency under the supervision of the placebo-controlled study [16; 100]. APs of heart and pericardium meridians were exposed to LLLT. Increased tolerance to physical exertion was marked after the therapy course. Capacity of the threshold load in patients who underwent laser puncture, increased from 437.9 ± 19.4% to 617.6 ± 21.7% ($p < 0.01$), and from 426.2 ± 15.8% to 434.5 ± 17.2% ($p > 0.1$) in patients receiving the placebo intervention. Miocardiac reserve improved under the influence of LLLT: cardiac index increased during the threshold load ($p < 0.01$), the indicator of double product at rest and during the standard load decreased ($p < 0.01$), indicating the economization of myocardial oxygen consumption. Patients receiving LLLT showed decreased level of TC from 9.9 ± 0.54 to 7.43 ± 0,81 mmol/l ($p < 0.01$), increased alpha cholesterol from 0.65 ± 0.03 to 1.65 ± 0.31 mmol/l ($p < 0.02$). No statistically significant changes in the blood lipid spectrum were revealed in the control group.

These findings are confirmed by another RCT (120 patients with hypertension who underwent ILBI-635 in combination with drug therapy [5]. Many researchers note that it is more efficient to combine LLLT with other physical therapy techniques [54; 56; 152; 199; 220; 229]. Thus,

in the course of high-quality RCT [218] it was found that MLLLT of patients suffering EH of the 1–2 stage reduces pain and asthenoneurotic syndromes, which increases the patients' quality of life. In addition, after a low level laser therapy course, a decrease in total peripheral vascular resistance was noted, leading to the reduction of average daily blood pressure. Lowered levels of TC and LDL in the blood serum were revealed, which indicates an improvement in lipid metabolism parameters [220].

Following the results of RCTs, the evidence of the LLLT efficacy was obtained in patients with vascular atherosclerosis of the lower extremities of the 1–2 stages of circulatory failure [111; 112; 113]. According rheovasography data, after the LLLT course positive changes in the state of the peripheral circulation were observed in the main group. According to thermography data, longitudinal temperature gradient was reduced by 26% ($p < 0.001$) down to the baseline, while in the placebo group, dynamics of this parameter were statistically insignificant. These results were also confirmed by the increase of tissue (muscle) blood flow by 28% ($p < 0.001$) in the main group. No considerable dynamics of the studied indicators were revealed in the placebo group.

Table 19

Technique 1. Cardiovascular disorders. Locally, percutaneously by pulsed IR LILI. Class of recommendation – IIa

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	890–904 (IR)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	5–10	–
Power density, W/cm^2	5–8	–
Frequency, Hz	80	Increase of microcirculation, regenerative and antiedematous effects
Exposure per one zone, minutes	1–5	–
Number of the exposed zones	1–6	–
Localization	In the projection of large blood vessels close to the lesion	–
Technique	Contact-mirror	–
Number of the exposed zones	10–12	Daily, 3 courses a year in 1–3 months

Thus, application of low level laser therapy in complex treatment of patients with IHD, EH and vascular atherosclerosis of the lower extremities have quite a serious scientific justification. The influence of different LLLT techniques on vascular tone, the myocardium state, blood pressure, hemorheological indexes and blood lipid profile was proved. In general, it can be argued that while treating patients with diseases of the cardiovascular system, LLLT has a high level of credibility of evidence IIa. The most effective options of LLLT techniques are given in Tables 19–21.

Table 20

Technique 2. Cardiovascular disorders. ILBI-635. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	ILBI-635
Laser operational mode	Continuous	–
Illumination power, mW	1.5–2	At the output of a disposable light guide
Exposure, minutes	10–20	ILBI-635
Localization	Median cubital vein (*v. mediana cubiti*)	–
Technique	Intravenously	Through a disposable sterile light guide
Number of the exposed zones	10–12	Daily, alternating ILBI-635

Table 21

Technique 3. Cardiovascular disorders. Laser acupuncture. Class of recommendation – IIb

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
Laser operational mode	Continuous	–
Illumination power, mW	2–3	At the output of an acupuncture nozzle
Exposure per 1 AP, c	20–40	–
Number of the exposed zones	Up to 5	–
Localization	AP	The recipe is chosen individually
Technique	Contact	Through an acupuncture nozzle
Number of the exposed zones	10–12	Daily

Low Level Laser Therapy for Ear, Nose, and Throat Disorders

Many researchers and clinicians have noted that it is most effective to combine different methods of laser therapy, as well as supplement and combine LLLT with other methods of physiotherapy and the intake of drugs [13; 35; 69; 76; 119; 132; 147; 159; 167; 181; 214; 221; 246].

The first official guidelines for LLLT in patients with inflammatory diseases of the upper respiratory tract (wavelength 635nm, 5–10mW/cm^2, endonasally, for 1–2 minutes) were approved a rather long time ago [46; 120]. High efficacy of LLLT was proved in the complex treatment of patients with acute otitis media [62], chronic suppurative otitis and after tympanoplasty [203] in patients with vasomotor rhinitis [91], atrophic rhinitis (ozena) [241], allergic rhinitis, pharyngitis and laryngitis [115], chronic tonsillitis [205], in acute and chronic maxilitis, rhinitis, adenoiditis and other sinusitis in children [172; 184; 230; 239], for wound healing after a surgical intervention [89; 107; 198; 198] and intubation tracheal trauma in children [125].

N.N. Lazarenko and co-authors [119] developed a medical treatment technique for patients with acute sensorineural hearing loss of the II degree, who were successfully exposed to low level laser therapy (wavelength 890–904nm, frequency of 150Hz, for two minutes per each field) in addition to the standard drug therapy, classical massage and vacuum therapy combined with a multi-channel electrical stimulation by bipolar-pulse currents.

It is proved that the application of electrical stimulation and LILI (890nm and 635nm) in the traditional schemes of complex treatment of patients with acute and chronic otitis media complicated by peripheral paresis of the facial nerve, considerably increases the efficacy of treatment and contributes to a more rapid and complete restoration of the disturbed functions, both of the middle ear, and facial muscles [132].

MLLLT (pulsed IR LILI, wavelength 890nm, power of 5–10W, frequency 80Hz and PMF by induction of 35–50mT, topically, percutaneously) is effective for chronic maxilitis [181], allergic rhinitis [83; 115], vasomotor rhinitis [51; 133], in acute otitis media [76], mareotitis [214], accelerates the healing of wounds after tonsillectomy [35].

The method of postoperative treatment of rhinogenous sinusitis is effective if combined with wound dialysis and laser illumination both by pulsed infrared (890–904nm), and a continuous red (635nm) LILI [13].

The medium-quality RCT data demonstrated the efficacy of the combined intervention by ILBI-635 and ultrasound in patients with peritonsillar abscess. This study presents strong evidence of immunocorrective effect of the developed technique [167].

Combining LLLT, UST with intake of drugs that have antiprotozoal and antibacterial effect proved to be the most effective in the treatment of patients with a decompensated form of chronic tonsillitis [69].

Combining topical illumination by continuous red LILI (wavelength 635nm, power of 5–10mW, exposure for 3–5 minutes) and UVBI gives good results when treating patients with chronic otitis media [246], and chronic purulent maxillary sinusitis [233].

The low level laser therapy applied in combination with halotherapy in children with allergic rhinitis and *S. aureus* bacteria carrying proved to be highly efficient, as evidenced by data from clinical and bacteriological studies [139].

LILI of three spectra (440–445nm, 635nm and 890–904nm) has immunomodulatory effect and influences both the immunocompetent blood cells and lymphoid tissue in the tonsils of patients with chronic tonsillitis. The effect of laser illumination depends not only on the wavelength but also on the energy density (ED) that is not equivalent for each spectrum. The higher the absorption, the less ED; the ratio for these wavelengths is 1:2:3, exposed for one minute. LILI immunomodulatory effect is manifested in the activation of functional possibilities of local and general immunity, rather than in stimulation of their quantitative parameters, which is indicated by the stimulation of blast transformation of T-and B-lymphocytes, enhanced viability and secretory function, increased number of marking receptors, as well as by the positive impact on the performance of non-specific resistance [224]. The combined procedure is given in Table 22.

External illumination by pulsed IR LILI (890–904nm) is effective in treating the patients with rhinosinusitis polyposa, it contributes to the normalization of mucociliary transport and IgA levels, correcting local immunity. Laser illumination reduces the permeability of vascular membranes, and stops leuko- and lymphopedesis, reduces the number of eosinophils. It is observed that there is resorption of the transudate, which leads to a decrease in polyp volume [179].

Prolonged clinical experience has shown the high efficacy of the combined LLLT in patients suffering from rhinosinusitis polyposa, allergic

Table 22

Technique 1. Ear, nose and throat disorders. Locally, externally or through the light guide by pulsed or continuous LILI. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	440–445 (blue)	Consequentially
	635 (red)	
	890–904 (IR)	
Laser operational mode	Continuous/pulsed	–
Power at the output of the light guide, mW	2–10	Depending on the patient's age and the type of the nozzle
Pulsed power for IR LILI, W	5–15	Depending on the patient's age
Pulsed power for red spectrum, W	5	–
Exposure per one zone, minutes	2	635nm (red spectrum) or 890–904nm (IR-spectrum)
Exposure per one zone, minutes (combined variant)	0.5–1.5	First LILI with a wavelength of 635nm (red spectrum), then 890–904nm (IR-spectrum) on the same zones externally
Number of the exposed zones	1–2	Total exposure time should not exceed 10 minutes
Localization	In the oropharynx area, endonasally, endoauricularly	–
Number of the exposed zones	10–12	–

and vasomotor rhinitis: first they were illuminated with continuous LILI with a wavelength of 635nm, power of 1–5mW, endonasal exposure for 0.5–1.5 minutes in each half of the nose, then by pulsed IR LILI (890–904nm), the power of 5–10W, pulse – 80Hz, exposure for 0.5–1 minute [126]. A similar technique is used in the treatment of patients with otitis externa, the intervention is carried out in an endoauricular way by red continuous LILI (635nm) and in the area of the ear externally by pulsed IR LILI (890–904nm) [134]. A follow-up study revealed that the positive effect of complex treatment of patients with acute rhinitis LILI combined with the applied LILI of the red and infrared ranges is maintained for 6–12 months, whereas this period is 2–4 months using only the IR-spectrum laser light. [116]. IR LILI is indicated in treating patients with chronic tonsillitis, anginas and post-tonsillectomy wounds [19].

The maximum effect of LLLT in the case of vasomotor rhinitis is achieved by the 10th day, by means of endonasal illumination with a continuous laser light of the red spectrum (635nm) [32; 37; 232], but after the external exposure to the pulsed red spectrum LILI (635nm) on the wings of the nose, a similar effect occurs by the 3rd–5th procedure [160; 161; 175]. The efficacy of pulsed red LILI is significantly higher compared to the IR spectrum in the treatment of children with chronic adenoiditis [176]. Low level laser therapy is especially efficient during neurovegetative vasomotor rhinitis [11; 73]. It is recommended to combine LLLT with drug administration during allergic rhinitis. Some trials showed the efficiency of the indication of cromoglicic acid in combination with pulsed IR LILI endonasally on the area of the maxillary antrum (genyantrum) sinuses projection and on the AP for 30 seconds; exposing no more than three pairs of AP per one procedure [190; 191]. The volume of drugs used to treat the main and concomitant diseases is reduced by 2–3 times [196].

Preventive course of low level laser therapy every 4–6 months is indicated to persons suffering from the compensated and decompensated form of chronic tonsillitis (decompensation is manifested as recurrent angina), chronic catarrhal, atrophic rhinitis and pharyngitis, vasomotor rhinitis, as well as to persons with frequent episodes of ARVD, as well as for practically healthy people, who have disorders of functional ability of upper respiratory mucosa, which decreases the chance of a recurrence by 1.6 times [48].

According to the results of a chance of a high quality RCT, illumination with continuous UV spectrum LILI (wavelength 337nm, power density of 5mW/cm^2, exposure for 10 minutes) in patients with chronic tonsillitis not only suppresses pathogens, but also affects the immune reactivity of the body. LILI also stimulates the sympatic division of the ANS and the adrenal cortex. The inflammatory reaction is suppressed and the morphological structure of the palatal tonsils is normalized at the LLLT background [79]. During combined intralacunar illumination of palatal tonsils with LILI of the red (635nm) and UV (337nm) spectra in patients with chronic tonsillitis, the serum IgG level decreases, while the IgA level and phagocytic activity of neutrophils increases [205]. Procedure of UV spectrum LILI application during ear, nose, and throat disorders is given in Table 23.

Table 23

Technique 1a. Ear, nose and throat disorders. Locally, through the light guide by continuous LILI of UV-spectrum. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm, spectrum	365–405nm (UV)	Consequentially
Laser operational mode	Continuous	–
Power at the output of the light guide, mW	5–10	Depending on the patient's age and the type of the nozzle
Exposure per one zone, minutes	2–5	–
Number of the exposed zones	1–2	–
Localization	In the oropharynx area, endonasally, endoauricularly	–
Number of the exposed zones	10–12	–

In children with allergic rhinitis (pollinosis), LLLT is carried out during the period of clinical remission 2–3 weeks prior to the blossom time of causally significant plants, illuminating the areas of direct contact with allergens and the reflexogenic zones of the respiratory tract of patients [169]. In this period laser reflexotherapy may be included (2–3 therapy courses shall be performed): GI4 (Hegu), GI11 (Quchi), TR5 (Waiguan), VB20 (Fengchi), V10 (Tianzhu), V12 (Fengmen), F3 (Taichong), VC12 (Zhongwan), VC16 (Zhongting), P7 (Lieque), CV22 (Tiantu), VC17 (Shanchung). Treatment will be completed in 1–2 weeks prior to the blooming period.

Laser acupuncture is quite effective in the treatment of patients with Meniere's disease and sensorineural hearing loss [236].

Foreign authors generally recommend laser acupuncture during various forms of rhinitis [252; 290; 325], also they show its influence on the increase in the immune response (IgA, IgG and IgM indicators are normalized) and the reduction of pain in chronic tonsillitis [285].

The technique is given in Table 24.

A lot of RCTs were conducted justifying the use of intravenous laser blood illumination at various disorders of ear, nose and throat. For patients with chronic decompensated tonsillitis ILBI-635 (wavelength 635nm, power of 1–3mW, 10 minutes exposure) causes pronounced reduction in tonsillitis and the growth of levels of immunoglobulins A, G, M in the blood [36], in case of sensorineural hearing loss and Meniere's

Table 24

Technique 2. Ear, nose and throat disorders. Laser acupuncture. Class of recommendation – IIb

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
Laser operational mode	Continuous	–
Illumination power, mW	2–3	At the output of an acupuncture nozzle
Exposure per 1 AP, s	20–40	–
Number of the exposed zones	Up to 5	–
Localization	AP	The recipe is chosen individually
Technique	Contact	Through an acupuncture nozzle
Number of the exposed zones	10–12	Daily

disease ILBI-635 results in lowering LPO parameters, increasing the AOC, improvement or the stabilization of hearing [117].

ILBI-635 (wavelength 635nm, power of 1–2mW, exposure for 10–15 minutes, 10 procedures per course) and phototherapy in patients with chronic tonsillitis complicated by pyelonephritis help restore normal biocenosis in the tissues of palatal tonsils, increased therapeutic efficacy of up to 88% compared to the drug therapy (59%), providing a stable and long-lasting remission in 86% of patients within a year and in 14% of patients – for 18 months. The method has a strong antibacterial effect, which is manifested in the decreased gram-positive staphylococci in the region of palatal tonsils in 96.4% of cases, *Escherichia coli* – in 83.3% and *Neisseria subflava* – in 52.4% of cases, which helps to restore normal biocenosis in the tissues of the palatal tonsils [17].

ILBI-635 has a positive influence on the content of biogenic amines and heparin when treating the patients with cochleovestibular dysfunction (Meniere's disease and sensorineural hearing loss); levels of histamine, serotonin, catecholamines reduce, free heparin is increased by more than twice, main hemorheological indicators (FA, PB, PTI, BPA, β-lipoproteins, AI, Ht, viscosity, ESR, pH, K^+) get normalized. The patients' dizzy spells are terminated, hearing is improved and tinnitus decreased [131]. Alongside ILBI-635, central hemodynamics parameters are improved, in particular, the tone of small arteries is effectively adjusted [148].

The ILBI procedure is given in Table 25.

Table 25

Technique 3. Ear, nose and throat disorders. ILBI-635 + LUVBI®. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	365–405 (UV)	LUVBI®
	635 (red)	ILBI-635
Laser operational mode	Continuous	–
Illumination power, mW	1.5–2	At the output of a disposable light guide
Exposure, minutes	3–5	LUVBI®
	10–20	ILBI-635
Localization	Median cubital vein (*v. mediana cubiti*)	–
Technique	Intravenously	Through a disposable sterile light guide
Number of the exposed zones	10–12	Daily, alternating ILBI-635 and LUVBI® every other day

The maximum anti-inflammatory and immune-stimulating effects of low level laser therapy in patients with decompensated form of chronic tonsillitis are formed during the combined intervention of LILI on the palatal tonsils and NLBI by pulsed IR LILI (Two minutes per one area). The achieved result persists within 1.5 years and the LLLT course [36].

NLBI and ILBI-635 showed a similar efficacy in the complex treatment of patients with peritonsillar abscess [167].

The NLBI procedure is given in Table 26.

A RCT showed that after the combined use of low level laser therapy and vacuum massage a hearing gain from 20,1 ± 1,2 to 41,3 ± 2,5 dB ($p < 0.05$) was revealed in 95% of patients with hearing loss after 6 months of observation. At the same time the subjective state of patients improved and cerebral circulation returned to normal. Patients tolerated the treatment well, there were no exacerbations of comorbidities and remission was maintained for 14 months. In the control group (standard treatment without LLLT), some improvement of the state was also achieved, though the hearing gain amounted to only 16.1 ± 2.4 dB in the same period, and remission was maintained for 10–12 months, being unstable in 22% of these patients [119; 221].

The technique is given in Table 27.

Table 26

Technique 4. Ear, nose and throat disorders. NLBI. Class of recommendation – IIa

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	30–40	Matrix emitter
Power density, W/cm^2	3–4	Area on the surface of 10cm^2
Frequency, Hz	80	–
Exposure per one zone, minutes	2–5	–
Number of the exposed zones	2	Symmetrically
Localization	In the projection of large blood vessels close to the lesion	–
Technique	Contact	Through a transparent nozzle
Number of the exposed zones	8–10	Daily

In the complex treatment of patients with pharyngomycosis it is efficient to apply laserphoresis of antifungal drugs. LILI enhances the effects of drugs and exerts a pathogenetic effect on the pharyngeal mucosa [8]. Laser phoresis of biologically active agents is efficient in treating the patients with chronic nonspecific tonsillitis [10].

The clinical and microbiological and cytological data are a rationale for the selection of pharmaceuticals for the laser phoresis. It is recommended to take: Furaginum in the presence of bacterial strains GR(+), GR(–) that are resistant to antibiotics and sulfanilamides; Chlorhexidine in a mixed flora, complicated cases, impossibility to select an adequate antibiotic; urea in severe edema syndrome and complicated breathing; Metronidazole in allergic component, high eosinophil count associated with lambliosis; propolis in case of sluggish processes and weakened immunity; Hydrocortisone during concomitant pollen allergy and perennial allergic rhinosinusitis; Mexidol during concomitant atrophic rhinosinusitis, sluggish inflammatory process [239].

LILI parameters for laser phoresis technique are given in Table 28.

Table 27

Technique 5. Ear, nose and throat disorders. Laser vacuum massage. Class of recommendation – IIb

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	890–904 (IR)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	5–10	–
Frequency, Hz	80–1000	–
Vacuum, kPa	5–10	–
Procedure time, minutes	7–10	–
Number of the exposed zones	2	Symmetrically
Localization	In the exit points of the I and II branches of the trigeminal nerve; in the projection of the VI cervical vertebra paravertebrally in the projection of lymph trunks arc, in the projection area of the vertebral artery in the projection of the suboccipital triangle and in the projection of the exit of the greater occipital nerve over trapezius muscle; from affected side – in the area of the ear, parotid muscle and temporal muscle	–
Technique	Contact, stable	–
Number of the exposed zones	8–10	Daily

Table 28

Technique 6. Ear, nose and throat disorders. Laser phoresis. Class of recommendation – IIb

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	780–785 (IR) or 890–904 (IR)	–
Laser operational mode	Continuous or pulsed	–
Duration of the light pulse for the pulsed mode, ns	100–150	–
Power for the continuous mode, mW	40–50	–
Power for the pulsed mode, W	15–20	–
Power density, mW/cm^2	20–25	–
Power density, W/cm^2	7–12	–
Frequency for the pulsed mode, Hz	80	–

Table 28 ending

Parameter	Value	Notes
Exposure per one zone, minutes	1–2	–
Number of the exposed zones	1–2	–
Localization	On the affected area	–
Technique	Contact/distant	Through a nozzle
Number of the exposed zones	5–6	Daily

Thus, the analysis of the results of the RCTs dedicated to the application of different LLLT techniques in treating disorders of the ear, nose and throat suggest a fairly high level of credibility of evidence on the efficacy of laser intervention, especially if combined with the drug therapy.

Low Level Laser Therapy for Surgical Disorders

According to many clinicians, it is most effective to combine different methods of low level laser therapy in surgical practice, as well as to supplement them with other physiotherapy techniques [22; 23; 57; 60; 64; 90]. In particular, the combined illumination with laser light and EHF-radiation is quite common [155; 166].

A RCT has shown that MLLLT (pulsed IR LILI, wavelength 890nm, power of 10–15W, frequency 80Hz, exposure for two minutes, PMF by induction of 25mT) effectively activates transcapillary metabolism in the wound area during the complex treatment of patients with complicated forms of erysipelas, helps restore the structure and function of the microvasculature of the affected area by increasing the myogenic activity of smooth muscle cells of arterioles and precapillaries, normalizing arteriolo-venous relationships, which ensures the nutritional blood flow efficacy as a whole [22]. It is efficient to combine topical exposure and ILBI-635 [60].

The combined use of copper nanoparticles and LLLT topically (wavelength 635nm, pulse mode, the matrix transducer, frequency of 80Hz, power density of 4.5W/cm^2, exposure for two minutes) in the surgical treatment of infected thermal cutaneous injuries enables to speed up arresting infectious and inflammatory process in the wound by 6.2 ± 0.5 days; the appearance of granulation and epithelialization of the wound is recorded by 11.8 ± 1.0 days of the treatment [64].

According to the data of clinical, morphological and pathophysiological studies, during the regenerative treatment of patients with purulent wounds of soft tissues of the maxillofacial region, the illumination with pulsed IR LILI (890nm) topically is superior to traditional methods of treatment [192].

Numerous foreign studies show that topical illumination with LILI of different spectra after surgical interventions significantly reduces the pain, improves the quality of wound healing, makes anti-inflammatory effect and improves microcirculation. Continuous red (635nm) and pulsed IR (904nm) LILI are used most frequently [277; 288; 301; 305; 307; 308; 311; 327; 342; 348]. It is also recommended to combine ILBI-635 and local illumination of wounds of different origin [320].

An effective decubitus ulcer debridement technique is worked out, depending on the clinical form and stage of development, through consistent topical exposure to red (635nm) and infrared (890nm) LILI, giving an increase in speed and the percentage of epithelialization by 4.9 times and enabling to achieve complete wound healing in 49% of cases within 32 days. In case of deep decubitus ulcers at the necrotic, necrotic-inflammatory and inflammatory-regenerative stage, this technique makes it possible to obtain healing in 29.4% of cases. In case of superficial decubitus ulcers at the primary reaction stage, as well as at the regenerative and cicatrization stages application of only continuous red laser light (635nm) promotes their complete healing in 57% of cases [219]. The technique is given in Table 29.

As a result of a high-quality RCT, it was shown that the ILBI-405 technique (wavelength 405nm, power of 1–2mW) is effective in the correction of microcirculatory disorders in patients with chronic obliterating diseases of lower limb arteries. According to the data of clinical, laboratory and instrumental studies, this method is superior to the conventional therapy in terms of its therapeutic efficacy and may be recommended for implementation in wide clinical practice. ILBI-405 enhances the functional activity of the microvasculature, normalizes blood rheology indicators and lipid metabolism, which allows improving the efficiency of the complex treatment up to 83% compared to 60.0% in the case of the standard therapy [40].

In another RCT, a similar technique was used effectively in patients with purulent necrotic processes in diabetic foot syndrome. ILBI-405 activates the transcapillary metabolism, helps restore the microvascu-

Table 29

Technique 1. Surgical disorders. Locally by continuous or pulsed LILI. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
	890–904 (IR)	
Laser operational mode	Continuous/Pulsed	–
Duration of the light pulse for the pulsed mode, ns	100–150	–
Average power for the continuous mode, mW	10–15	Single emitter
Pulsed power for the pulsed mode, W	10–15	Single emitter
Pulsed power for the pulsed mode, W	60–80	Matrix emitter
Power density, W/cm^2	6–8	Area on the surface of 10cm^2 foe a matrix emitter
Frequency for the pulsed mode, Hz	80–150	Increase of microcirculation, regenerative and antiedematous effects, reflex action
	1000–1500	Analgesic effect
Exposure per one zone, minutes	1–5	–
Number of the exposed zones	1–2	–
Localization	On the affected area (wound, trophic ulcer, area of inflammation, etc.)	–
Technique	Contact for matric emitters, contact-mirror or distant for single emitters	Through a transparent and mirror nozzle
Number of the exposed zones	10–12	Daily, 3 courses a year in 1–3 months

lature structure and function by increasing the myogenic activity of the smooth muscle cells of the arterioles and precapillaries and normalizing arteriolo-venous relations, which ensures the increase in the partial pressure of oxygen in the foot tissues by 13.7% from the baseline, facilitates the rapid purification of wound surface from necrotic purulent detritus, normalization of microcirculation, there was recorded the accelerated formation and maturation of the granulation tissue and epithelialization of the wound by 1.3 times, compared to the conventional technique [217].

The high effect of ILBI-635 and special wound dressing was shown in patients with burns of varying severity. The method allows earlier achievement, compared to the traditional method of treatment, healing of superficial and deep burns, reducing the cost of infusion therapy, medications, decreasing the time of hospital stay by 1.4 times and cost of treatment of burn patients as a whole [57].

ILBI-635 is also indicated during reconstructive operations on the abdominal aorta and the arterial vessels of the lower limbs: it enables to reduce the number of postoperative complications fourfold, to shorten the length of patients' stay in the recovery room by 1.5 times and increase the time period of the postoperative pain syndrome occurrence twofold [101].

In patients with appendicular infiltrate it is recommended to combine topical illumination with continuous LILI of the red spectrum (wavelength 635nm, 15–20mW, exposure for two minutes) with ILBI-635 (wavelength 635nm, power of 1–2mW, exposure for 20 minutes), which allows the reduction of the length of the patients' stay in hospital from 19.6 ± 2.9 to 12.4 ± 3.2 bed-days, and the abscess formation rate from 17.9% to 3.4% [23].

Combined therapy of patients with sterile pancreatic necrosis by applying ILBI-635 in combination with a topical (transcutaneous) low level laser therapy with the pulsed IR LILI, after mini-invasive and endoscopic interventions, enables the prevention of infecting lytic lesions in 67.7% of cases, decrease the time of in-patient treatment and reduce mortality by 13.2% compared to the control group. In patients with infected pancreatic necrosis, after the adequate surgical sanitation of purulonecrotic foci alongside basic therapy, conducting ILBI-635 and topical percutaneous LLLT reduces mortality from 42.8 to 23.1% [60].

The combined potentiation of the traditional treatment of patients with purulent peritonitis with laser technologies (intraoperative abdominal sanitation using PDT and postoperative ILBI-635), contributes to the achievement of the better treatment outcomes without additional pharmacological patient load as compared to the traditional protocols. According to the RCT results, in the main group of patient's, mortality made 5.5% in the case of local peritonitis, 11.8% in the case of diffuse peritonitis and 23.8% in the case of generalized peritonitis; making the control groups: 8.3%; 19.4% and 45%, respectively [153].

It is known that in the acute and early periods of spinal cord injury, immunodeficiency develops in 91.5–100% of patients, and ILBI-635 is an

effective method for the correction of this state. Laser blood illumination can be used in any of the periods of traumatic spinal cord disease. In the controlling immunodeficiency disorders of patients in the acute and early periods of vertebral cerebrospinal trauma it is most effective to combine ILBI-635 with topical illumination by pulsed IR LILI (890nm), which results in the normalization of non-specific and cellular factors of the body by 21st day since the date of injury. ILBI-635 also has immunocorrective influence and contributes to the relief of immunodeficiency by the 30th day since the date of injury. In the complex treatment of purulent septic complications in patients with spinal cord injuries daily intravenous laser blood illumination with consistent exposure to infrared LILI locally from 5 to 7 procedures allows arresting the immunodeficiency state and the purulent septic process within a fortnight [219].

ILBI-635 and LUVBI® techniques are given in Table 30.

Table 30

Technique 2. Surgical disorders. ILBI-635 + LUVBI®. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	365–405 (UV)	LUVBI®
	635 (red)	ILBI-635
Laser operational mode	Continuous	–
Power, mW	1.5–2	At the output of a disposable light guide
Exposure, minutes	3–5	LUVBI®
	10–20	ILBI-635
Localization	Median cubital vein (*v. mediana cubiti*)	–
Technique	Intravenously	Through a disposable sterile light guide
Number of the exposed zones	10–12	Daily, alternating ILBI-635 and LUVBI® every other day

One RCT showed that the direct intervention by the continuous red LILI (635nm, 10mW/cm^2, five minutes) and NLBI by the pulsed IR LILI (890nm) on the trophic ulcer in patients with CVI mainly affects the clinical signs of the disease – pain and cramps, clinical efficacy of LLLT makes 51.5% [90].

Table 31

Technique 3. Surgical disorders. NLBI. Class of recommendation – IIb

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	30–40	Matrix emitter
Power density, W/cm^2	3–4	Area on the surface of 10cm^2
Frequency, Hz	80	–
Exposure per one zone, minutes	2–5	–
Number of the exposed zones	2	Symmetrically
Localization	In the projection of large blood vessels close to the lesion	–
Technique	Contact	Through a transparent nozzle
Number of the exposed zones	8–10	Daily

According to the results of an average quality RCT, it is recommended to illuminate by the pulsed IR LILI in the projection of the internal organs in the combined treatment together with the intake of cytokines in patients suffering from purulent-inflammatory complications of disorders of retroperitoneal organs [158]. The technique is given in Table 32.

A small number of RCTs are devoted to the substantiation of laserpuncture during surgical disorders. Prescriptions, i.e. exposure localization and sequence, are determined depending on the disease.

Topical illumination with the pulsed IR LILI (890–904nm) locally and laser acupuncture in the complex treatment of patients with diabetic foot syndrome in outpatient conditions contribute to the rapid cleansing of the wound surface from necrotic purulent detritus, enhanced phagocytosis, normalized microcirculation, weakened the inflammatory infiltration, enhanced macrophagal reaction, fibroblast proliferation and angiogenesis, stimulation; accelerated formation and maturation of the granulation tissue and epithelialization of the wound by 1.3 time, in comparison to the conventional technique [136].

A similar procedure in patients with trophic ulcers in case of CVI activates transcapillary metabolism, helps restore the microvasculature structure and function by increasing the myogenic activity of the smooth muscle cells of the arterioles and precapillaries and normalizing arteriolo-

Table 32

Technique 4. Surgical disorders. Pulsed IR LILI in the projection of the internal organs. Class of recommendation – I

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	890–904 (IR)	–
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Illumination power, W	50–60	Matrix emitter
Power density, W/cm^2	5–6	Area on the surface of 10cm^2
Frequency, Hz	80	–
Exposure per one zone, minutes	2–5	–
Number of the exposed zones	2	Symmetrically
Localization	In the projection of the affected organ	–
Technique	Contact	Through a transparent nozzle
Number of the exposed zones	8–10	Daily

venous relationship, which accelerates the formation and maturation of the granulation tissue and epithelialization of wounds by 2.1 times as compared to the conventional method [151]. The laserpuncture technique is given in Table 33.

Table 33

Technique 5. Surgical disorders. Laser acupuncture. Class of recommendation – IIb

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
Laser operational mode	Continuous	–
Power, mW	2–3	At the output of an acupuncture nozzle
Exposure per 1 AP, s	20–40	–
Number of the exposed zones	Up to 5	–
Localization	AP	The recipe is chosen individually
Technique	Contact	Through an acupuncture nozzle
Number of the exposed zones	10–12	Daily

Thus, there are numerous foreign and domestic RCTs, irrefutably proving the high efficacy of LLLT in patients with pain syndromes, microcirculation and trophism disorders, inflammatory processes, immune imbalances in various surgical diseases. A conclusion can be drawn about a high level of credibility of the evidence presented in the current sources relating to LLLT application in a surgical practice, based on the analysis of the RCTs.

CONCLUSION

The presented clinical guidelines are based off of the data of scientific studies on the effectiveness of different methods of low level laser therapy in the treatment and rehabilitation of patients with arthropathy, ear, nose and throat disorders, cardiovascular and nervous disorders, as well as in surgical patients. Practical use of standardized low level laser therapy protocols is based on the objective evidence of numerous trials, that will allow to improve the efficiency of any comprehensive treatment, achieving long-term remission of chronic diseases and carrying out the prevention of complications.

These guidelines should help specialists in complicated issues to choose the most efficient laser exposure technique. The ability of the physician to get orientated in a variety of traditional and innovative methods of physical therapy, the use of the principles of evidentiary medicine in assessing the efficacy of various physical factors are indicators of their high professionalism.

REFERENCES

1. *Abdrakhmanova A.I.* The use of low-intensity laser irradiation in the treatment of stable angina in conjunction with different combinations of drugs: Abstract of the thesis. Candidate of medical sciences. Izhevsk, 2004. 24. [in Russian]
2. *Abdulkina N.G.* Optimization of physical therapy in rehabilitation of patients with diseases of the peripheral nervous system: Abstract of the thesis. Doctor of medical sciences. Tomsk, 2000. 41. [in Russian]
3. *Adzhimolayev T.A., Zubkova S.M., Laprun I.B.* Structural and functional changes in nerve cells under laser irradiation. *Means and methods of quantum electronics in medicine*. Saratov: Publishing house of Saratov State University, 1976: 156–159. [in Russian]
4. *Akunts N.G.* The combination of biomechanical spine relief and magnetic laser in regenerative therapy of lumbosacral dorsopathies: Abstract of the thesis. Candidate of medical sciences. M., 2008. 24. [in Russian]
5. *Aleksandrova O.M.* The effect of intravenous laser blood irradiation on endothelial function, microcirculatory disorders and some indicators of hemostasis in patients with essential hypertension: Abstract of the thesis. Candidate of medical sciences. Vladikavkaz, 2008. 22. [in Russian]
6. *Alikhanov B.A.* Laser irradiation, hemosorption, taktivin and immunosuppressive drugs in the treatment of rheumatoid arthritis: Abstract of the thesis. Doctor of medical sciences. M., 1993. 42. [in Russian]
7. *Alopina N.O.* Indicators of pituitary-gonadal system and glycosaminoglycans metabolism in patients with primary osteoarthrosis and their dynamics under the influence of laser puncture: Abstract of the thesis. Candidate of medical sciences. Ufa, 1997. 21. [in Russian]
8. *Al'-Mamari K.A.* Laser in complex treatment of pharyngomycosis: Abstract of the thesis. Candidate of medical sciences. Samara, 1994. 14. [in Russian]
9. *Annenkov A.V.* Optimization of treatment of urolithiasis in patients with gout complicated by nephropathy: Abstract of the thesis. Candidate of medical sciences. M., 2012. 26. [in Russian]
10. *Antipenko V.V.* Conservative and surgical treatment of chronic nonspecific tonsillitis: Abstract of the thesis. Candidate of medical sciences. SPb., 2009. 18. [in Russian]
11. *Anyutin R.G., Frolov V.M.* Treating patients with chronic hypertrophic rhinitis by low-energy laser exposure. *Proceedings of the 3d International Conference "Current issues of laser medicine and surgical endoscopy"*. M.–Vidnoye, 1994: 224–225. [in Russian]
12. *Artifeksov I.V.* Clinical and functional characterization of minimal brain dysfunction in preschool and primary school children and its treatment by laser exposure: Abstract of the thesis. Candidate of medical sciences. Ivanovo, 2001. 21. [in Russian]
13. *Afon'kin V.Yu.* Combined method of postoperative treatment of rhinogenous sinusitis using wound dialysis and laser exposure: Abstract of the thesis. Candidate of medical sciences. SPb., 1995. 22. [in Russian]
14. *Babushkina G.V.* A stage laser therapy of patients with ischemic heart disease (clinical and pathogenetic, catamnestic aspect): Abstract of the thesis. Doctor of medical sciences. M., 1995. 36. [in Russian]
15. *Badalov N.G., Tupitsyn N.N., Grigor'eva V.D.* Immunological phenotype of skin lymphoid cells in patients with psoriatic arthritis during rehabilitation. *Vopr Kurortol Fizioter Lech Fiz Kult*. 2003; 5: 8–12. [in Russian]
16. *Badtiyeva V.A.* Laser therapy in hypertensive patients with coronary insufficiency: Abstract of the thesis. Candidate of medical sciences. M., 1995. 18. [in Russian]
17. *Balkarov I.O.* Optimization of treatment of comorbidity in ENT practice by physical factors: Abstract of the thesis. Candidate of medical sciences. M., 2013. 21. [in Russian]
18. *Bezrukavnikov Yu.A.* The use of low-intensity laser irradiation for the correction of disorders of lipid metabolism in patients with unstable angina: Abstract of the thesis. Candidate of medical sciences. Voronezh, 2007. 24. [in Russian]

19. *Ben Mukhamed R.K.* The effectiveness of the use of low-energy laser irradiation in the treatment of chronic tonsillitis, sore throat, and wounds after tonsillectomy: Abstract of the thesis. Candidate of medical sciences. SPb., 1998. 20. [in Russian]
20. *Bendlin I.D.* Transcranial electrostimulation and magnetic laser therapy in patients with vertebrobasilar insufficiency: Abstract of the thesis. Candidate of medical sciences. SPb., 2015. 22. [in Russian]
21. *Berglezov M.A., Vyal'ko V.V., Ugnivenko V.I.* Invasive laser therapy methods in traumatology and orthopedics / Guidelines. M., 1995. 21. [in Russian]
22. *Biserov O.V.* Magnetic laser therapy in complex treatment of patients with complicated forms of erysipelas: Abstract of the thesis. Candidate of medical sciences. M., 2007. 24. [in Russian]
23. *Boboyev B.D.* Diagnostics and treatment tactics of appendicular infiltrate: Abstract of the thesis. Candidate of medical sciences. Dushanbe, 2006. 20. [in Russian]
24. *Bogdanova O.M.* Changes in the level of IL-1β and tumor necrosis-α factor in complex treatment of patients with rheumatoid arthritis using electromagnetic SHF fields of UHF-band and magnetic laser therapy: Abstract of the thesis. Candidate of medical sciences. SPb., 2001. 21. [in Russian]
25. B*ogdanovich U.Ya., Karimov M.G., Krasnoshchokova E.E.* Lasers in traumatology and orthopedics. Kazan: Publishing House of Kazan State University, 1978. 104. [in Russian]
26. *Boychev O.D.* Complex clinical and hemorheological evaluation of the effectiveness of treating patients with angina using laser blood irradiation: Candidate Thesis in Medicine. M., 2002. 123. [in Russian]
27. *Brodovskaya A.M.* Low-intensity laser irradiation in complex treatment of patients with initial manifestations of insufficient brain blood supply: Abstract of the thesis. Candidate of medical sciences. Odessa, 1989. 15. [in Russian]
28. *Bugrova O.V.* Complex therapy of patients with Bekhterev's disease using intravenous laser blood irradiation: Abstract of the thesis. Candidate of medical sciences. Yaroslavl, 1992. 22. [in Russian]
29. *Burdina N.S.* The effectiveness of treating osteoarthritis patients with cardiovascular disorders and metabolic syndrome. *Journal of New Medical Technologies*. 2012; 2: 247–249. [in Russian]
30. *Burdina N.S., Vasil'yeva L.V.* Treating patients with osteoarthritis in combination with metabolic syndrome by intravenous laser therapy. *Journal of New Medical Technologies*. 2010; 17 (2): 102–104. [in Russian]
31. *Burduli N.N.* The effect of intravenous laser blood irradiation on cytokines indicators, the level of leptin, glycosaminoglycans in patients with rheumatoid arthritis: Abstract of the thesis. Candidate of medical sciences. Vladikavkaz, 2014. 22. [in Russian]
32. *Burkina B.P., Voytsekhovich S.S., Osokin V.V.* Complex laser treatment of acute and chronic purulent sinusitis. *Proceedings of the 3d International Conference "Current issues of laser medicine and surgical endoscopy"*. M.–Vidnoye, 1994: 225–226. [in Russian]
33. *Busalayeva E.I.* The use of vibrotermotesting and magneto-infrared laser therapy in the diagnostics and treatment of diabetic distal polyneuropathy: Abstract of the thesis. Candidate of medical sciences. Kazan, 1999. 23. [in Russian]
34. *Vaynshteyn K.A.* Combined laser therapy of shoulder epicondylitis: Abstract of the thesis. Candidate of medical sciences. M., 2002. 15. [in Russian]
35. *Vakhrushev S.G.* Optimization of wound healing after tonsillectomy by magnetic laser irradiation: Abstract of the thesis. Candidate of medical sciences. SPb., 1993. 25. [in Russian]
36. *Volotov P.N.* Low-intensity laser therapy in complex treatment of patients with chronic tonsillitis: Abstract of the thesis. Candidate of medical sciences. SPb., 2006. 16. [in Russian]
37. *Vorkushin A.I.* Materials for the justification of helium-neon laser therapy of vasomotor rhinitis: Abstract of the thesis. Candidate of medical sciences. Samara, 1994. 19. [in Russian]
38. *Vyrypayeva O.V.* Laser therapy in complex treatment of cerebral circulation disorders: Abstract of the thesis. Candidate of medical sciences. M., 1997. 17. [in Russian]
39. *Vyal'ko V.V.* Complex treatment of patients with shoulder-scapular periarthritis under outpatient treatment using optical quantum generator LG-75: Abstract of the thesis. Candidate of medical sciences. M., 1985. 21. [in Russian]

40. *Gagarin E.N.* Laser technologies in the correction of microcirculatory disorders in patients with chronic obliterating diseases of lower limb arteries: Abstract of the thesis. Candidate of medical sciences. M., 2011. 23. [in Russian]
41. *Gadzhinova L.D.* Clinical and instrumental characteristics and treatment of heel areas enthesopathies with seronegative spondyloarthritis: Abstract of the thesis. Candidate of medical sciences. M., 1997. 25. [in Russian]
42. *Gazdanova A.A.* Influence of laser therapy on endothelial function, microcirculation and some indicators of hemorheology in patients with stable angina: Abstract of the thesis. Candidate of medical sciences. Vladikavkaz, 2009. 21. [in Russian]
43. *Galeyeva O.P.* Cranio-cerebral infusion and endovascular laser exposure for acute cerebral hypoxia: Abstract of the thesis. Candidate of medical sciences. M., 1992. 24. [in Russian]
44. *Gallyamova E.V.* The combined effect of laser puncture and chromotherapy in the correction of vegetative dysfunction: Abstract of the thesis. Candidate of medical sciences. Ufa, 2014. 24. [in Russian]
45. *Geynits A.V., Moskvin S.V.* New technologies of intravenous laser blood irradiation: "ILBI + UVBI" and "ILBI-405". Tver: Triada, 2010. 96. [in Russian]
46. Helium-neon laser irradiation in complex treatment of ozena patients. Guidelines. A.I. Bikbayev, R.A. Sharipov. Approved by the Educational and Methodological Board Presidium of the USSR Ministry of Health 11.02.1988. M., 1988. 13. [in Russian]
47. *Germanovich V.V.* Laser blood irradiation in the acute period of severe craniocerebral trauma: Abstract of the thesis. Candidate of medical sciences. SPb., 1997. 19. [in Russian]
48. *Gerus P.D.* Laser prevention of tonsillitis and ARVI in metallurgical plant workers: Abstract of the thesis. Candidate of medical sciences. Kuibyshev, 1986. 15. [in Russian]
49. *Gireyeva E.Yu.* Dynamics of indicators of homocysteine, endothelial function, lipid peroxidation and hemostasis in patients with stable angina under the influence of low-intensity laser irradiation: Abstract of the thesis. Candidate of medical sciences. Vladikavkaz, 2010. 25. [in Russian]
50. *Gladkova N.D.* Clinico-pathogenetic evaluation of low-level laser therapy for chronic diseases of the joints: Abstract of the thesis. Doctor of medical sciences. M., 1997. 46. [in Russian]
51. *Golovanov A.I.* Combined magnetic laser treatment of vasomotor rhinitis: Abstract of the thesis. Candidate of medical sciences. M., 1995. 17. [in Russian]
52. *Golovizin M.V.* The immune status of patients with rheumatoid arthritis by intravenous laser blood irradiation: Abstract of the thesis. Candidate of medical sciences. M., 1993. 26. [in Russian]
53. *Golovina N.V.* Correction of cerebral hemodynamics in hypertensive patients with low-intensity laser irradiation: Abstract of the thesis. Candidate of medical sciences. Voronezh, 2002. 23. [in Russian]
54. *Goncharova I.A.* The use of laser and chromo therapy in treatment of essential hypertension with concomitant somatic pathology: Abstract of the thesis. Candidate of medical sciences. Voronezh, 2012. 24. [in Russian]
55. *Gorgots O.V.* Laser therapy in complex treatment of injuries of peripheral nerve trunks: Abstract of the thesis. Candidate of medical sciences. Alma-Ata, 1992. 19. [in Russian]
56. *Gor'kova T.A.* The use of low-intensity laser irradiation of red and infrared spectrum in the complex therapy of patients with ischemic heart disease: Candidate Thesis in Medicine. M., 2002. 145. [in Russian]
57. *Grebennik S.F.* Intravenous laser blood irradiation and wound covering "Foliderm" in the complex treatment of patients with thermal trauma: Abstract of the thesis. Candidate of medical sciences. M., 2009. 23. [in Russian]
58. *Grishanova Yu.D.* Intravenuos laser therapy of patients with persistent lumbar sciatic syndromes after discectomy: Abstract of the thesis. Candidate of medical sciences. Nizhny Novgorod, 1995. 22. [in Russian]
59. *Grunina E.A.* Lipid peroxidation in assessing the effectiveness of intravascular laser therapy of rheumatoid arthritis: Abstract of the thesis. Candidate of medical sciences. Yaroslavl, 1994. 22. [in Russian]
60. *Gulmuradova N.T.* The use of laser technology in the treatment of acute destructive pancreatitis: Abstract of the thesis. Doctor of medical sciences. M., 2011. 37. [in Russian]

61. *Gutikova L.V.* Methodology of low-intensity corrected laser therapy of a number of internal diseases, deforming and post-traumatic osteoarthritis: Abstract of the thesis. Candidate of medical sciences. M., 1994. 15. [in Russian]
62. *Dekhtyaruk V.Ya.* The use of a helium-neon laser irradiation in complex treatment of patients with acute otitis media: Abstract of the thesis. Candidate of medical sciences. Kiev, 1989. 15. [in Russian]
63. *Dzevitskaya M.T., Aken'shina G.V.* Electrical conductivity of the skin of the auricle depending on the nature and pathology during laser physiotherapy. *Means and methods of quantum electronics in medicine*. Saratov: Publishing house of Saratov State University, 1976: 165–166. [in Russian]
64. *Dobreykin E.A.* Experimental study of combined use of copper nanoparticles and low-intensity laser irradiation in the surgical treatment of cutaneous infected burn wounds: Abstract of the thesis. Candidate of medical sciences. Voronezh, 2014. 24. [in Russian]
65. *Dolgikh G.B.* Cerebral arterial and venous dystonia in children (mechanisms, clinical manifestations and treatment): Abstract of the thesis. Doctor of medical sciences. Kazan, 2009. 43. [in Russian]
66. *Domnikov A.D.* Laser therapy of gonarthrosis and its impact on the system of Hageman factor: Abstract of the thesis. Candidate of medical sciences. M., 1988. 15. [in Russian]
67. *Dosayev T.M.* Morphometric assessment of nerve cells during stimulation. *The biological action of laser radiation (experimental and clinical aspects)*. Alma-Ata, 1977: 57–58. [in Russian]
68. *Dochiya A.A.* Laser therapy of tunnel syndromes in patients with osteochondrosis of the cervical spine: Abstract of the thesis. Candidate of medical sciences. M., 2000. 24. [in Russian]
69. *Dukayev S.Kh.* Comparative clinical and immunological evaluation of the effectiveness of treatment of decompensated form of chronic tonsillitis by helium-neon laser, ultrasound and metranidazol: Abstract of the thesis. Candidate of medical sciences. SPb., 1992. 19. [in Russian]
70. *Yevstratova E.F.* Clinical and pathogenetic mechanisms of the effectiveness of low-intensity laser irradiation and antibodies to tumor necrosis factor alpha in patients with rheumatoid arthritis and osteoarthritis with concomitant diseases of internal organs: Abstract of the thesis. Doctor of medical sciences. Voronezh, 2009. 47. [in Russian]
71. *Yelizarov N.A.* Adaptation cardioprotection by physical factors in the treatment and prevention of ischemic heart disease: Abstract of the thesis. Doctor of medical sciences. M., 2007. 44. [in Russian]
72. *Yeliseyev A.P.* Microsurgery in the treatment of isolated and associated injuries of peripheral nerves: Abstract of the thesis. Doctor of medical sciences. M., 1993. 38. [in Russian]
73. *Yeliseyev I.V., Rudelev S.A.* The use of laser irradiation in the treatment of vasomotor rhinitis. *Abstracts of the Conf. "The use of lasers in medicine"*. M., 1985: 9–10. [in Russian]
74. *Yel'tsova G.N.* Comparative efficacy of cutaneous and intravenous laser therapy in patients with atherosclerotic dyscirculatory encephalopathy: Abstract of the thesis. Candidate of medical sciences. M., 2000. 18. [in Russian]
75. *Yel'chaninov A.P.* Genetic and acquired factors of thrombophilia and chronic brain ischemia therapy in young people: Abstract of the thesis. Doctor of medical sciences. SPb., 2002. 32. [in Russian]
76. *Yenin I.V.* Pathogenetic aspects of cochlear injury and hearing rehabilitation in acute otitis media (clinico-experimental research): Abstract of the thesis. Candidate of medical sciences. M., 2009. 20. [in Russian]
77. *Zharov V.P., Karu T.I., Litvinov Yu.O., Tiflova O.A.* Photobiological effect of semiconductor laser in near infrared region. *Quantum Electronics*. 1987; 14 (11): 2135–2136. [in Russian]
78. *Zhukova S.N.* On the possible involvement of catecholamines in the process of regeneration in laser therapy of chronic tonsillitis. *Application of the methods and means of laser techniques in biology and medicine*. Kiev: Naukova dumka, 1981: 134–135. [in Russian]
79. *Zhukova S.N.* Laser therapy of patients with decompensated form of chronic tonsillitis: Abstract of the thesis. Candidate of medical sciences. M., 1984. 21. [in Russian]
80. *Zabarovskiy V.K.* Differentiated use of manual therapy and laser puncture in the treatment of patients with neurological manifestations of lumbar degenerative osteochondrosis: Abstract of the thesis. Candidate of medical sciences. Minsk, 1991. 24. [in Russian]

81. *Zainchukovskaya L.P.* Integrated differentiated physical rehabilitation of neurological manifestations of spine degenerative lesions: Abstract of the thesis. Candidate of medical sciences. Ufa, 1998. 22. [in Russian]
82. *Zakharov Ya.Yu.* Magnetic-infrared-laser therapy in medical rehabilitation of patients with vegetative-sensory post-radiation polyneuropathy: Abstract of the thesis. Candidate of medical sciences. M., 2002. 19. [in Russian]
83. *Ivanova O.S.* Optimization of treatment of allergic rhinitis in children with the use of low-intensity laser irradiation: Abstract of the thesis. Candidate of medical sciences. Stavropol, 2013. 24. [in Russian]
84. *Ilich-Stoyanovich O.* Pathogenetic justification and effectiveness of pulsed infrared laser therapy in patients with rheumatoid arthritis: Abstract of the thesis. Doctor of medical sciences. M., 2000. 45. [in Russian]
85. *Illarionov V.Ye.* The combined magnetic laser effect on the joints in the treatment and prevention of osteoarthritis progression: Abstract of the thesis. Doctor of medical sciences. M., 1990. 27. [in Russian]
86. *Il'ina O.V., Kudayeva L.M.* The effectiveness of combined therapy with the use of laser puncture in cardiovascular diseases. *Journal of New Medical Technologies*. 2012; 19 (4): 36–40. [in Russian]
87. *Isayev V.M.* Laser therapy of pterygopalatine ganglion for vasomotor rhinitis and some facial pain syndromes: Abstract of the thesis. Candidate of medical sciences. M., 1990. 22. [in Russian]
88. *Iseyeva D.R.* The use of magnetic therapy in complex treatment of patients with dyscirculatory encephalopathy: Abstract of the thesis. Candidate of medical sciences. M., 2012. 23. [in Russian]
89. *Iskandarov S.A.* Comparative evaluation of the application of biopolymer and carbon application sorbents and helium-neon laser in complex treatment of post-traumatic and postoperative wounds of ENT-organs: Abstract of the thesis. Candidate of medical sciences. M., 1991. 17. [in Russian]
90. *Istomina I.S.* Physical factors in the treatment of chronic venous insufficiency of the lower limbs: Abstract of the thesis. Doctor of medical sciences. M., 2008. 48. [in Russian]
91. *Kalashnik M.V.* Comparative evaluation of surgical, laser and combined treatments of chronic vasomotor rhinitis in view of microcirculation: Abstract of the thesis. Candidate of medical sciences. Kiev, 1987. 16. [in Russian]
92. *Kalinina O.V.* The use of low-intensity laser irradiation of near infrared spectrum in the treatment of distal diabetic polyneuropathy: Abstract of the thesis. Candidate of medical sciences. Ivanovo, 1997. 18. [in Russian]
93. *Kalinina O.V.* Physiotherapy of neurological manifestations of lumbar osteochondrosis in view of spinal biorhythms and topography of nonspecific reflex-muscular syndromes: Abstract of the thesis. Candidate of medical sciences. Tomsk, 2006. 21. [in Russian]
94. *Kandyba D.V.* Ischemic cerebral circulation disorders with the pathology of extracranial arteries: Abstract of the thesis. Doctor of medical sciences. SPb., 2007. 45. [in Russian]
95. *Karneyev A.N.* Cerebral resistance to oxidative stress in patients with chronic brain ischemia: Abstract of the thesis. Doctor of medical sciences. M., 2007. 50. [in Russian]
96. *Kartamyshev I.P.* Acupuncture and low-energy infrared laser irradiation in complex treatment of vibration polyneuropathy: Abstract of the thesis. Candidate of medical sciences. SPb., 2000. 20. [in Russian]
97. *Kekhoyeva A.Yu.* Effect of low-intensity laser irradiation on endothelial function, microcirculation and some indicators of hemorheology in patients with ischemic heart disease with concomitant type 2 diabetes: Abstract of the thesis. Candidate of medical sciences. Vladikavkaz, 2010. 24. [in Russian]
98. *Klimova L.V.* Intravenous laser blood irradiation in complex intensive therapy of severe traumatic brain injury: Abstract of the thesis. Candidate of medical sciences. Rostov-on-Don, 1998. 23. [in Russian]
99. *Klushin Yu.I.* Low-energy laser blood irradiation of blood circulation and joints in the treatment of patients with rheumatoid arthritis: Abstract of the thesis. Candidate of medical sciences. Yaroslavl, 1990. 22. [in Russian]

100. *Knyazeva T.A., Badtiyeva V.A.* Physiobalneotherapy of cardiovascular disease. M., 2008. 272. [in Russian]
101. *Kovyrshin A.V.* Spinal-epidural anesthesia in combination with intravascular laser blood irradiation in reconstructive operations on the abdominal aorta and the arterial vessels of the lower limbs: Abstract of the thesis. Candidate of medical sciences. Irkutsk, 2006. 29. [in Russian]
102. *Kozhevnikov Ye.V.* Intra-articular helium-neon laser irradiation in treatment of gonarthrosis: Abstract of the thesis. Candidate of medical sciences. Novosibirsk, 1995. 22. [in Russian]
103. *Konchugova T.V.* Optimized laser exposure in improving functional reserves of the organism during stressful dysaptation (experimental-clinical research): Abstract of the thesis. Doctor of medical sciences. M., 2007. 47. [in Russian]
104. *Kosmynin A.G.* The use of therapeutic laser matrixes for atherosclerotic vascular encephalopathy: Abstract of the thesis. Candidate of medical sciences. M., 2005. 27. [in Russian]
105. *Kochetkov A.V.* Therapeutic physical factors at an early stage of rehabilitation of patients with cerebral stroke: Abstract of the thesis. Doctor of medical sciences. M., 1998. 47. [in Russian]
106. *Koshelev V.N.* Lasers in wound healing. Saratov: Publishing house of Saratov State University, 1980. 120. [in Russian]
107. *Krotov Yu.A.* "Closed" sanitizing surgery and laser therapy in the early postoperative period of chronic purulent attic disease: Abstract of the thesis. Candidate of medical sciences. Kuibyshev, 1990. 16. [in Russian]
108. *Kryuk A.S., Mostovnikov V.A., Khokhlov I.V., Serdyuchenko N.S.* Therapeutic efficacy of low-intensity laser irradiation. Minsk: Science and technology, 1986. 232. [in Russian]
109. *Kryuchkova A.V., Poletayeva I.A., Grosheva Ye.S.* Change of clinical and laboratory parameters under the influence of laser therapy in coronary heart disease patients with concomitant asthma. *Journal of New Medical Technologies*. 2013; 20 (2): 243–246. [in Russian]
110. *Kulova L.A., Burduli N.M.* Efficacy of low-intensity laser irradiation on intercellular interactions, endothelial function and hemostasis in patients with rheumatoid arthritis. Laser Medicine. 2014; 18 (2): 5–7. [in Russian]
111. *Kul'chitskaya D.B.* Optimization of physical therapy effects using pulsed and continuous infrared laser irradiation in atherosclerotic lesions of the lower limbs: Abstract of the thesis. Candidate of medical sciences. M., 1996. 17. [in Russian]
112. *Kul'chitskaya D.B., Konchugova T.V., Minenkov A.A.* The identification of the optimal frequency characteristics for pulsed infrared laser exposures in atherosclerotic lesions of the leg arteries. *Vopr Kurortol Fizioter Lech Fiz Kult*. 1994; 5: 11–15. [in Russian]
113. *Kul'chitskya D.B., Konchugova T.V., Minenkov A.A.* Comparative assessment of the effects of laser irradiation of red and infrared range on regional hemodynamics in patients with atherosclerosis of leg vessels. *Physical, resort and rehabilitation medicine*. 1994; 2: 32–33. [in Bulgarian]
114. *Kul'chitskaya D.B., Konchugova T.V., Minenkov A.A., Kolbaya L.I.* The use of the medical rehabilitation technology for the correction of microcirculatory disorders in the patients presenting with gonarthrosis. *Vopr Kurortol Fizioter Lech Fiz Kult*. 2012 (1): 14–16. [in Russian]
115. *Kurbanova L.I.* Current diagnostics and treatment of allergic diseases of upper respiratory tract with the use of laser therapy: Abstract of the thesis. Candidate of medical sciences. Kiev, 1993. 20. [in Russian]
116. *Kurochkin A.A., Moskvin S.V., Anikin V.V.* Low-intensity laser irradiation in complex treatment of children and adolescents (cardiology, dermatology, ENT diseases, sickly children). M.: TOO Firma "Tekhnika", 2000. 112. [in Russian]
117. *Kucherov A.G.* The use of laser blood irradiation for sensorineural hearing loss, and Meniere's disease: Abstract of the thesis. Candidate of medical sciences. M., 1996. 31. [in Russian]
118. *Kushnir M.A.* Physiotherapy methods of treatment of arthromyalgia lesions in the complex therapy of hemophilia: Abstract of the thesis. Candidate of medical sciences. Leningrad, 1991. 19. [in Russian]
119. *Lazarenko N.N., Supova M.V., Kokoreva S.A., Gerasimenko M.Yu.* Physical factors in complex rehabilitation program. *Russian otorhinolaryngology*. 2009; 2 (39): 116–118. [in Russian]

120. *Laser therapy* of inflammatory diseases of the upper respiratory tract in workers of cotton mill and other industrial plants. Guidelines. B.I. Psakhis, L.A. Toropova. Approved by the Ministry of Health of the RSFSR. Krasnoyarsk, 1986. 12. [in Russian]
121. *Lapochkin O.L.* Magnetic-laser therapy in patients with circulatory insufficiency in the vertebrobasilar system: Abstract of the thesis. Candidate of medical sciences. M., 2004. 21. [in Russian]
122. *Leyderman N.Ye.* Laser therapy using pulsed matrices 0.63 μm in the treatment of patients with dyscirculatory encephalopathy: Abstract of the thesis. Candidate of medical sciences. M., 2010. 21. [in Russian]
123. *Lerner L.A.* Evaluation of the effectiveness of laser therapy in the treatment of seronegative spondyloarthritis: Abstract of the thesis. Candidate of medical sciences. M., 1989. 21. [in Russian]
124. *Liyev A.A., Apakidze T.V., Kovalenko V.V. et al.* Laser therapy of myofascial lumbar sciatic syndromes. Guidelines. Kislovodsk, 1996. 19. [in Russian]
125. *Lipilina L.I.* Intubation trauma of larynx in children, prevention and rehabilitation: Abstract of the thesis. Candidate of medical sciences. M., 1990. 20. [in Russian]
126. *Likhacheva Ye.V., Alekseyev Yu.V., Marchenko V.V.* The use of red and infrared laser irradiation in treatment of allergic and vasomotor rhinitis and rhinosinusitis. *Proceedings of the 3d International Conference "Current issues of laser medicine and surgical endoscopy"*. M.–Vidnoye, 1994: 232–233. [in Russian]
127. *Luk'yanyuk Ye.V.* Clinical and physiological rationale for the use of laser puncture with distal diabetic neuropathy: Abstract of the thesis. Candidate of medical sciences. M., 1992. 15. [in Russian]
128. *Lutoshkina Ye.V.* Dynamics of neuropsychological status and "quality of life" as the criterion of the efficacy of the differential complex treatment of patients with chronic cerebral ischemia: Abstract of the thesis. Candidate of medical sciences. Saratov, 2005. 22. [in Russian]
129. *Lyutkevich A.A.* Changes in vegetative regulation and cerebral hemodynamics in cervicalcranial syndrome, correction methods: Abstract of the thesis. Candidate of medical sciences. Novosibirsk, 2008. 21. [in Russian]
130. *Mazurkevich Ye.A.* Photo-laser therapy of diseases and injuries of the musculoskeletal system (clinico-experimental research): Abstract of the thesis. Doctor of medical sciences. SPb., 2001. 43. [in Russian]
131. *Makova Z.S.* The effect of intravenous laser blood irradiation on the content of biogenic amines and heparin in the treatment of patients with cochleovestibular dysfunction: Abstract of the thesis. Candidate of medical sciences. Cheboksary, 2000. 19. [in Russian]
132. *Mal'chenko O.V.* Complex treatment of sensory and motor disorders in the face and head area caused by ENT-diseases with the use of low-intensity laser irradiation and electrical stimulation: Abstract of the thesis. Candidate of medical sciences. M., 2004. 29. [in Russian]
133. *Mamedov A.F.* Clinical and functional assessment of the effectiveness of treatment of vasomotor rhinitis by infrared laser irradiation in a constant magnetic field: Abstract of the thesis. Candidate of medical sciences. SPb., 1991. 18. [in Russian]
134. *Mamedov M.M.* Pecularities of otitis externa treatment: Abstract of the thesis. Candidate of medical sciences. M., 1993. 19. [in Russian]
135. *Manucharyan G.G.* Mechanisms of neuroprotective and correcting action of physical factors in ischemic brain lesions (clinico-experimental research): Abstract of the thesis. Doctor of medical sciences. Yerevan, 1996. 43. [in Russian]
136. *Marayev V.V.* Laser irradiation in complex treatment of patients with diabetic foot syndrome in outpatient conditions: Abstract of the thesis. Candidate of medical sciences. M., 2007. 24. [in Russian]
137. *Martyukhina G.D.* The clinical significance of changes in the physical resistance of erythrocytes in patients with rheumatoid arthritis under the influence of infrared magnetic laser therapy (λ = 0,89 μm): Abstract of the thesis. Candidate of medical sciences. M., 1996. 23. [in Russian]
138. *Martsiyash A.A.* Low-level laser therapy in complex regenerative treatment of patients with myocardial infarction at sanatorium and outpatient rehabilitation stages: Abstract of the thesis. Candidate of medical sciences. Tomsk, 2005. 39. [in Russian]

139. *Matveyeva N.I.* Clinical-bacteriological and immunological characteristics of allergic rhinitis in the North and the influence of environmental factors of dwellings on them: Abstract of the thesis. Candidate of medical sciences. Surgut, 2005. 22. [in Russian]
140. *Matulis A.A., Vasilenkaytis V.V., Raystenskiy I.L. et al.* Laser therapy and laser puncture for rheumatoid arthritis, deforming osteoarthritis and psoriatic arthropathy. *Therapeutic Archives*. 1983; 55 (7): 92–97. [in Russian]
141. *Makhanyok O.V.* Clinical and immunological efficacy criteria of magnetic laser therapy in the treatment of neurological manifestations of osteochondrosis of the cervical spine: Abstract of the thesis. Candidate of medical sciences. M., 2005. 22. [in Russian]
142. *Makhovskaya T.G* Intravascular laser therapy for ischemic cerebrovascular disorders: Abstract of the thesis. Candidate of medical sciences. Perm, 1993. 24. [in Russian]
143. *International Classification* of Functioning, Disability and Health. Geneva: WHO, 2001. 342. [in Russian]
144. *Men'shikova I.V.* Current approaches to diagnostics and treatment of knee osteoarthritis: Abstract of the thesis. Doctor of medical sciences. M., 2010. 51. [in Russian]
145. *Midlenko A.I.* Acute period of brain concussion in children (clinical and immunological diagnostics and immunocorrective therapy): Abstract of the thesis. Candidate of medical sciences. SPb., 2000. 23. [in Russian]
146. *Milevskaya S.G., Rodionova T.F.* Laser therapy combined with the phonophoresis of pelan ointment in the treatment of psoriatic arthritis. *Vopr Kurortol Fizioter Lech Fiz Kult*. 1991; 2: 52–54. [in Russian]
147. *Mishen'kin N.V., Tikhomirov V.V., Krotov Yu.A. et al.* Low-energy lasers in otology. Novosibirsk: Publishing House of Novosibirsk State University, 1991. 136. [in Russian]
148. *Morenko V.M.* Methods of electrophysical effects in treatment of sensorineural hearing loss: Abstract of the thesis. Doctor of medical sciences. Stavropol, 2000. 37. [in Russian]
149. *Moskvin S.V., Minenkov A.A., Konchugova T.V.* Mechanisms of action of percutaneous laser phoresis of hyaluronic acid, the justification of optimal parameters of the procedure. *Plastic surgery and cosmetology*. 2011; 3: 519–524. [in Russian]
150. *Moskvin S.V., Nasedkin A.N., Kochetkov A.V. et al.* Therapy by matrix pulsed lasers of red spectrum. Tver: Triada, 2007. 112. [in Russian]
151. *Musayev M.M.* Low-intensity laser irradiation in complex treatment of patients with venous trophic ulcers in outpatient conditions: Abstract of the thesis. Candidate of medical sciences. M., 2008. 24.
152. *Musiyeva Kh.Z.* The impact of drug and magneto-infrared laser therapy on circadian blood pressure profile and the quality of life in patients with hypertension: Abstract of the thesis. Candidate of medical sciences. Rostov-on-Don, 2008. [in Russian]
153. *Mustafayev R.D.* Modern laser technologies in the treatment of peritonitis: Abstract of the thesis. Doctor of medical sciences. M., 2014. 46. [in Russian]
154. *Mynzhanova N.Sh.* Changing of the physiological characteristics of an intact motor nerve excitability when exposed to laser irradiation. *Biological effect of laser irradiation (experimental and clinical aspects)*. Alma-Ata, 1977: 31–32. [in Russian]
155. *Nabiyev A.F.* Laser therapy and super radiofrequency therapy of purulent wounds: Abstract of the thesis. Candidate of medical sciences. M., 2010. 25. [in Russian]
156. *Nagapet'yan V.K.* The use of infrared laser light in the rehabilitation of patients with ischemic heart disease after surgical myocardial revascularization: Abstract of the thesis. Candidate of medical sciences. M., 1995. 25.
157. *Nazarenko G.F.* Complex conservative medical rehabilitation of patients with lesions osteoarthrosis of shoulder girdle: Abstract of the thesis. Candidate of medical sciences. M., 1992. 25. [in Russian]
158. *Nazarov S.B.* Cytokino- and laser therapy in complex treatment of patients with purulent-inflammatory complications of diseases of the retroperitoneal space: Abstract of the thesis. Candidate of medical sciences. Ulyanovsk, 2014. 24. [in Russian]

159. *Nasedkin A.N.* Experimental and clinical justification for the use of various types of laser irradiation in otorhinolaryngology: Abstract of the thesis. Doctor of medical sciences. M., 2000. 32. [in Russian]
160. *Nasedkin A.N., Moskvin S.V.* Laser therapy in otorhinolaryngology. M.–Tver: Triada, 2011. 208. [in Russian]
161. *Nasedkin A.N., Petlev A.A.* Clinical use of laser irradiation of visible spectral range in pulsed mode for treatment of various diseases of the ear, nose and throat. *Laser medicine*. 2000; 4 (4): 56–57. [in Russian]
162. *Nevmerzhitskaya I.V.* The use of frequency-modulated system of magnetic laser acupuncture for regenerative correction of initial manifestations of cerebrovascular disorder: Abstract of the thesis. Candidate of medical sciences. M., 2007. 25. [in Russian]
163. *Nedz'ved' G.K.* Some questions of the etiology, pathogenesis and treatment of neurological manifestations of lumbar osteochondrosis: Abstract of the thesis. Candidate of medical sciences. M., 1991. 42. [in Russian]
164. *Nikitin A.V., El'zhurkayev A.A.* Over venous low-intensity laser irradiation in complex treatment of ischemic heart disease. *Journal of New Medical Technologies, eEdition*. 2013 (1): 88. [in Russian]
165. *Novikov A.G.* The use of low-intensity laser irradiation in complex treatment of patients with post-traumatic cerebral arachnoiditis: Abstract of the thesis. Candidate of medical sciences. Saratov, 1998. 24. [in Russian]
166. *Ovsyannikov V.S.* Laser and super radiofrequency therapy in the prevention of wound complications after appendectomy: Abstract of the thesis. Candidate of medical sciences. M., 2014. 28. [in Russian]
167. *Oganesyan S.S.* Clinical and immunological evaluation of the effectiveness of ultrasound and laser blood irradiation in complex treatment of paratonsillitis and peritonsillar abscess: Abstract of the thesis. Candidate of medical sciences. SPb., 1996. 19. [in Russian]
168. *Orlova Ye.V.* Correction of immunosuppressive disorders in patients with articular syndrome by low-intensity laser irradiation: Abstract of the thesis. Candidate of medical sciences. Voronezh, 2007. 24. [in Russian]
169. *Osin A.Ya.* Preventive laser therapy of pollinosis in children. *Laser medicine*. 2001; 5 (2): 14–18. [in Russian]
170. *Pavlovskaya L.I.* Interval normobaric hypoxytherapy in the complex sanatorium treatment of patients with chronic vertebrobasilar insufficiency: Abstract of the thesis. Candidate of medical sciences. Tomsk, 2006. 21. [in Russian]
171. *Panteleyev V.S., Nartaylakov M.A., Musharapov D.R., Bayazitova G.R.* Antimicrobial photodynamic therapy in combination with laser activation of antibiotics in patients with suppurative cholangitis. *Medical Bulletin of Bashkortostan*. 2010; 5 (5): 42–46. [in Russian]
172. *Pekli F.F.* Use of helium-neon laser in the treatment of acute and chronic sinusitis in children: Abstract of the thesis. Candidate of medical sciences. M., 1995. 16. [in Russian]
173. *Penzina Ye.B.* Neuro-immune disorders and their correction by means of low-intensity laser irradiation in men with initial manifestations of insufficient brain blood supply: Abstract of the thesis. Candidate of medical sciences. Ekaterinburg, 2008. 29. [in Russian]
174. *Perminova L.G.* Clinical and physiological characteristics of patients with dyscirculatory encephalopathy during intravenous laser therapy: Abstract of the thesis. Candidate of medical sciences. Nizhny Novgorod, 1994. 19. [in Russian]
175. *Petlev A.A., Nasedkin A.N., Moskvin S.V.* Evaluation of the effectiveness of non-invasive method of pulsed LILI exposure of red spectrum (λ = 0,63–0,65 microns) in otorhinolaryngology. *Collection of scientific papers "Modern laser medicine. Theory and practice*". M., 2007; 1: 105–115. [in Russian]
176. *Petlev A.A., Nasedkin A.N., Moskvin S.V., Grishina M.E.* Comparison of the effectiveness of low-intensity pulsed and continuous laser irradiation of red and infrared spectra in the treatment of chronic adenoiditis in children. Laser medicine. 2003; 7 (3–4): 27–30. [in Russian]

177. *Petrova N.N.* Differentiated approach to laser therapy in treatment of spinal disc herniations of the lumbosacral spine: Abstract of the thesis. Candidate of medical sciences. M., 2012. 24. [in Russian]
178. *Polkovnikova T.N., Bogova A.V., Litvin G.D. et al.* The use of laser irradiation in treatment and rehabilitation of patients with allergic diseases: Guidelines (manual for physicians). Kislovodsk–M.: Invest, 1994. 25. [in Russian]
179. *Ponomareva L.I.* The use of low-energy laser irradiation in anti-relapse treatment of polypous rhinosinusitis: Abstract of the thesis. Candidate of medical sciences. M., 1995. 16. [in Russian]
180. *Popel' S.L.* Morphofunctional state of the microvasculature and nerve fibers of the facial nerve under normal conditions, in experimental neuropathy and under laser irradiation: Abstract of the thesis. Candidate of medical sciences. Kiev, 1993. 16. [in Russian]
181. *Popov V.V.* The use of magnetic laser therapy in the treatment of chronic sinusitis: Abstract of the thesis. Candidate of medical sciences. SPb., 1992. 24. [in Russian]
182. *Poroshenko M.A.* Coagulation and fibrinolytic activity of platelets in patients with rheumatoid arthritis: Abstract of the thesis. Candidate of medical sciences. Kiev, 1992. 20. [in Russian]
183. *Protas'yeva L.G.* Development of the method of low-intensity infrared laser therapy of microcirculatory disturbances in patients with diabetic angioneuropathy: Abstract of the thesis. Candidate of medical sciences. Obninsk, 2000. 23. [in Russian]
184. *Psakhis G.B.* Laser therapy of children suffering from chronic adenoiditis associated with rhinitis and sinusitis: Abstract of the thesis. Candidate of medical sciences. Kiev, 1989. 19. [in Russian]
185. *Putilina M.V.* Complex treatment of patients with sequelae of cerebral circulation disorder in the late recovery period: Abstract of the thesis. Doctor of medical sciences. Voronezh, 2001. 33. [in Russian]
186. *Raystenskiy I.L.* Clinical and experimental study of laser irradiation action in diseases of the joints: Abstract of the thesis. Candidate of medical sciences. Minsk, 1988. 21. [in Russian]
187. *Rassomakhin A.A.* Clinical-biochemical and clinical-immunological parallels in endovascular laser therapy in patients with dyscirculatory encephalopathy: Abstract of the thesis. Candidate of medical sciences. Saratov, 1996. 23. [in Russian]
188. *Rakhishev A.R.* The action of laser light on the peripheral mechanisms of nerve regeneration. *Means and methods of quantum electronics in medicine*. Saratov: Publishing house of Saratov State University, 1976: 155–156. [in Russian]
189. *Revazova A.A.* The effectiveness of laser therapy in the complex treatment of patients with rheumatoid arthritis: Abstract of the thesis. Candidate of medical sciences. Vladikavkaz, 2002. 22. [in Russian]
190. *Rogacheva G.I., Mel'nikova G.I., Gavryuchenkova A.G. et al.* Comparative efficacy of topical treatment of allergic rhinitis in children. *Laser medicine*. 2002; 4 (2): 40–41. [in Russian]
191. *Rogacheva G.I., Nechayeva Ye.I. LILI* in the treatment of ENT diseases in children. *Laser medicine*. 1999; 3 (1): 41–42. [in Russian]
192. *Rodionov A.D.* Low-intensity laser therapy in the rehabilitative treatment of purulent wounds of soft tissues of maxillofacial area: Abstract of the thesis. Candidate of medical sciences. M., 2012. 24. [in Russian]
193. *Rozhkov M.S.* The results of treatment and rehabilitation therapy for the improvement of quality of life of patients with osteoarthritis of knee joints. *Omsk Scientific Bulletin. Medical sciences*. 2013; 2 (124): 65–70. [in Russian]
194. *Romanenko V.Yu.* UV and laser blood irradiation in complex treatment of low back pain: Abstract of the thesis. Candidate of medical sciences. Saratov, 2000. 21. [in Russian]
195. *Rudakova I.Ye.* Pathogenetic justification of laser therapy by intravenous laser blood irradiation (ILBI) for vibration disease from exposure to the "local" vibration: Abstract of the thesis. Candidate of medical sciences. M., 1996. 23. [in Russian]
196. *Ryzhova Ye.G.* Preventive laser therapy of pollinosis in children// Laser therapy in the Far East. Vladivostok, 1993: 91–93. [in Russian]
197. *Sagandykov B.B.* Clinical and immunological justifiaction of laser therapy for rheumatoid arthritis: Abstract of the thesis. Doctor of medical sciences. Almaty, 1996. 42. [in Russian]

198. *Sambulov V.I.* The peculiarities of diagnostics, clinical management and selection of rational surgical treatment of children with cholesteatoma otitis media: Abstract of the thesis. Candidate of medical sciences. M., 1992. 18. [in Russian]
199. *Sapozhnikova S.Yu.* Correction of changes of respiratory function in patients with ischemic heart disease using magnetic laser therapy: Abstract of the thesis. Candidate of medical sciences. Cheboksary, 2007. 24. [in Russian]
200. *Sarychev P.V.* Managing the process of rehabilitation of patients with ischemic heart disease after angioplasty and stenting: Abstract of the thesis. Candidate of medical sciences. Voronezh, 2008. 20. [in Russian]
201. *Satarov M.G.* Application photopuncture using low-intensity laser irradiation of infrared range in patients with lumbar dorsalgia: Abstract of the thesis. Candidate of medical sciences. M., 2012. 24. [in Russian]
202. *Satinayeva O.I.* Immediate and long-term results of laser therapy for rheumatoid arthritis: Abstract of the thesis. Candidate of medical sciences. Yaroslavl, 1991. 21. [in Russian]
203. *Svistushkin V.M.* Effective use of helium-neon laser in the treatment of chronic suppurative otitis and tympanoplasty: Abstract of the thesis. Candidate of medical sciences. M., 1993. 19. [in Russian]
204. *Semenov F.V.* Drug correction of regenerative processes and laser exposure in the surgical treatment of patients with chronic suppurative otitis media: Abstract of the thesis. Doctor of medical sciences. M., 1996. 38. [in Russian]
205. *Senku Ye.I.* Laser irradiation in the treatment of patients with chronic tonsillitis: Abstract of the thesis. Candidate of medical sciences. Kiev, 1991. 17. [in Russian]
206. *Sergeyev V.V.* Optimization of diagnostics and treatment of neuropathies of the facial nerve in the acute and recovery period: Abstract of the thesis. Candidate of medical sciences. M., 1998. 24. [in Russian]
207. *Sidorov V.D., Pershin S.B.* Noninvasive hemo-laser therapy in patients with rheumatoid arthritis. *Physiotherapy, balneology and rehabilitation*. 2011 (1): 8–18. [in Russian]
208. *Simonova T.A.* Clinical and immunological assessment of the differentiated approach to the use of laser therapy in complex treatment of patients with rheumatoid arthritis: Abstract of the thesis. Candidate of medical sciences. Kiev, 1988. 22. [in Russian]
209. *Sisabekov K.Ye.* The change of myoneural synapses under the influence of monochromatic red polarized light. Biological effects of laser irradiation (experimental and clinical aspects). Alma-Ata, 1977: 33–37. [in Russian]
210. *Solov'yeva Ye.L.* Optimization of medical treatment of ischemic heart disease by laser therapy: Abstract of the thesis. Candidate of medical sciences. Cheboksary, 2006. 24. [in Russian]
211. *Solodyankina M.Ye.* Theoretical and clinical aspects of prevention programs and staged medical rehabilitation of working-age men with early forms of chronic cerebrovascular pathology on the background of arterial hypertension: Abstract of the thesis. Doctor of medical sciences. Ekaterinburg, 2008. 40. [in Russian]
212. *Soroka N.F.* Clinical and biochemical aspects of rheumatoid arthritis and ways of treatment: Abstract of the thesis. Doctor of medical sciences. M., 1992. 40. [in Russian]
213. *Sorokina Ye.I., Kinevich N.A., Zubkova S.M., Minenkov A.A.* The comparative action of laser radiation in different spectra on patients with ischemic heart disease. *Vopr Kurortol Fizioter Lech Fiz Kult*. 1997; 4: 11–13. [in Russian]
214. *Sotnikov I.L.* Infrared magnetic laser therapy in sanatoriun-resort care of patients with mareotitis: Abstract of the thesis. Candidate of medical sciences. SPb., 2004. 16. [in Russian]
215. *Starodubtseva I.A.* The effect of low-intensity laser irradiation on indicators of glycosaminoglycans in patients with osteoarthritis: Abstract of the thesis. Candidate of medical sciences. Voronezh, 2008. 22. [in Russian]
216. *Steblyukova I.A.* Clinical efficacy of intravenous laser therapy and its combination with drugs in cerebrovascular ischemic lesions: Abstract of the thesis. Candidate of medical sciences. M., 1989. 24. [in Russian]

217. *Steshin A.V.* Treatment of patients with purulent necrotic processes in diabetic foot syndrome by intravenous laser blood irradiation (405 nm): Abstract of the thesis. Candidate of medical sciences. M., 2011. 22. [in Russian]
218. *Storozhenko N.V.* Complex treatment of deforming arthrosis of the knee joint in the outpatient surgical departments: Abstract of the thesis. Candidate of medical sciences. M., 2001. 21. [in Russian]
219. *Stupak V.V.* Low-intensity laser irradiation in complex treatment of patients with spinal cord injury: Abstract of the thesis. Doctor of medical sciences. M., 1997. 43. [in Russian]
220. *Stupnitskiy A.A.* Magnetic laser therapy in complex treatment of patients with essential hypertension: Abstract of the thesis. Candidate of medical sciences. SPb., 2004. 24. [in Russian]
221. *Supova M.V.* Laser therapy and vacuum massage in complex treatment of patients with sensorineural hearing loss: Abstract of the thesis. Candidate of medical sciences. M., 2011. 26. [in Russian]
222. *Surskaya Ye.V.* Catamnesis of patients operated for traumatic subdural hematomas: Abstract of the thesis. Candidate of medical sciences. Krasnoyarsk–M., 1997. 23. [in Russian]
223. *Tarasova T.K.* Clinical and immunological efficacy of infrared pulsed laser irradiation in complex treatment of psoriatic arthritis: Abstract of the thesis. Candidate of medical sciences. Kursk, 2002. 22. [in Russian]
224. *Taukeleva S.A.* Immunomodulatory effect of low-energy lasers for tonsillar disease: Abstract of the thesis. Doctor of medical sciences. SPb., 1997. 36. [in Russian]
225. *Toygambayeva A.Z.* The effect of laser irradiation on some indicators of nerve regeneration. *Biological effects of laser irradiation (experimental and clinical aspects).*Alma-Ata, 1977: 28–30. [in Russian]
226. *Tupikin G.V.* The use of low-energy laser irradiation (argon with $\lambda = 488$ nm and helium-neon with $\lambda = 632$ nm) in the treatment of patients with rheumatoid arthritis: Abstract of the thesis. Doctor of medical sciences. M., 1984. 28. [in Russian]
227. *Tyumentseva V.V.* Intensive physiotherapy courses with the use of energy exchange regulator in patients with neurological manifestations of lumbar osteochondrosis: Abstract of the thesis. Candidate of medical sciences. Tyumen, 2009. 23. [in Russian]
228. *Uzdenskiy A.B.* The reaction of the isolated neuron on focused laser irradiation of its parts. *Means and methods of quantum electronics in medicine*. Saratov: Publishing house of Saratov State University, 1976: 161–163. [in Russian]
229. *Uryas'yev O.M., Isayeva I.A.* Intravenous lasertherapy and interval normobaric hypoxytherapy effectiveness in asthma and comorbid essential hypertension complex therapy. *Academician I.P. Pavlov Russian medical and biological bulletin*. 2014; 2: 111–115. [in Russian]
230. *Feniksova L.V.* Microcirculatory disorders of acute and chronic sinusitis in children: Abstract of the thesis. Candidate of medical sciences. M., 1989. 20. [in Russian]
231. *Physical therapy* of patients with osteoarthritis: clinical guidelines / Scientific Society of Physical and Rehabilitation Medicine. M., 2015. 44. [in Russian]
232. *Filatov V.F., Kalashnik M.V.* Microcirculation in patients with vasomotor rhinitis and its dynamics before and after application of therapeutic laser irradiation. *Bulletin of otorhinolaryngology*. 1986 (6): 63–66. [in Russian]
233. *Filatova I.V.* Comparative evaluation of the effectiveness of treatment of chronic purulent maxillary sinusitis by laser-oxygen exposure and ultraviolet blood irradiation: Abstract of the thesis. Candidate of medical sciences. Kiev, 1990. 29. [in Russian]
234. *Firsova N.P.* The complex approach to rehabilitation of patients with arterial hypertension associated with neck and shoulder syndrome: Abstract of the thesis. Candidate of medical sciences. Tula, 2005. 26. [in Russian]
235. *Khamzayev R.I.* Results of surgical treatment of injuries of the sciatic nerve and its branches: Abstract of the thesis. Candidate of medical sciences. SPb., 2009. 24. [in Russian]
236. *Khandzhiyev G.R.* Causes, characteristics and methods of treatment of subjective tinnitus: Abstract of the thesis. Candidate of medical sciences. M., 1993. 24. [in Russian]

237. *Khasan A.* Clinical manifestations and hormonal-metabolic disorders in patients with periodic migraine neuralgia: Abstract of the thesis. Candidate of medical sciences. M., 1994. 17. [in Russian]
238. *Khodeyb A.I.* Clinical picture, diagnostics and treatment of gunshot wounds of nerves in peacetime: Abstract of the thesis. Candidate of medical sciences. SPb., 1994. 15. [in Russian]
239. *Khrykova A.G.* Laser therapy and new dressings in the treatment of children with maxillary sinusitis: Abstract of the thesis. Candidate of medical sciences. M., 2007. 21. [in Russian]
240. *Chernov A.S.* Clinical value of combined therapy with the use of laser puncture and dimethyl sulfoxide applications in patients with rheumatoid arthritis and osteoarthritis: Abstract of the thesis. Candidate of medical sciences. Volgograd, 1994. 25. [in Russian]
241. *Sharipov R.A.* Helium-neon laser irradiation in complex treatment of ozena patients: Abstract of the thesis. Candidate of medical sciences. Kiev, 1987. 24. [in Russian]
242. *Sharipova E.Sh.* Optimization of regenerative treatment of injuries of the upper and lower extremities, complicated by nerve damage: Abstract of the thesis. Candidate of medical sciences. Ufa, 2007. 24. [in Russian]
243. *Shevchenko K.V.* Dysfunction of nonspecific brain systems in sleep-wake cycle of absence epileptic seizures in children and the possibility of its correction by magnetic laser irradiation: Abstract of the thesis. Candidate of medical sciences. Perm, 1997. 16. [in Russian]
244. *Shtobbe A.A.* Clinical and functional changes in ischemic stroke in rehabilitation programs follow-up: Abstract of the thesis. Candidate of medical sciences. Novosibirsk, 2007. 21. [in Russian]
245. *Shcherbonosova T.A.* Low-intensity laser irradiation in complex treatment of facial nerve neuropathies of nontraumatic origin: Abstract of the thesis. Candidate of medical sciences. Ivanovo, 1998. 22. [in Russian]
246. Yusef Yu.A. Laser-oxygen exposure and ultraviolet blood irradiation (UVBI) in the treatment of patients with chronic otitis media: Abstract of the thesis. Candidate of medical sciences. Khar'kov, 1991. 13. [in Russian]
247. *Yakovenko I.V.* The dynamics of blood flow in operated nerves and methods of its correction: Abstract of the thesis. Candidate of medical sciences. Leningrad, 1990. 23. [in Russian]
248. *Yakupova A.A.* Clinical and electroneurophysiological features and treatment of episodic tension headache: Abstract of the thesis. Candidate of medical sciences. Kazan, 1997. 21. [in Russian]
249. *Yakupova A.A.* Chronic tension headache (clinical and neurophysiological characteristics, mechanisms, treatment): Abstract of the thesis. Doctor of medical sciences. Kazan, 2011. 47. [in Russian]
250. *Yausheva M.V.* Potential of low-intensity laser irradiation in the treatment of patients with multiple sclerosis: Abstract of the thesis. Candidate of medical sciences. Kazan, 2005. 21. [in Russian]
251. *Abrisham S.M., Kermani-Alghoraishi M., Ghahramani R. et al.* Additive effects of low-level laser therapy with exercise on subacromial syndrome: a randomised, double-blind, controlled trial. *Clin Rheumatol*. 2011; 30 (10): 1341–1346.
252. *Ailioaie L., Ailioaie C., Topoliceanu F.* Self-organizing phenomena at membrane level and low-level laser therapy of rhinitis. *Laser Florence'99. International Society for Optics and Photonics*, 2000: 309–315.
253. *Al Rashoud A.S., Abboud R.J., Wang W., Wigderowitz C.* Efficacy of low-level laser therapy applied at acupuncture points in knee osteoarthritis: a randomized double-blind comparative trial. *Physiotherapy*. 2014; 100 (3): 242–248.
254. *Alfredo P.P., Bjordal J.M., Dreyer S.H. et al.* Efficacy of low level laser therapy associated with exercises in knee osteoarthritis: a randomized double-blind study. *Clin Rehabil*. 2012; 26 (6): 523–533.
255. *Alghadir A., Omar M.T., Al-Askar A.B., Al-Muteri N.K.* Effect of low-level laser therapy in patients with chronic knee osteoarthritis: a single-blinded randomized clinical study. *Lasers in Medical Science*. 2014; 29 (2): 749–755.
256. *Alves A.C.A., Vieira R.P., Leal-Junior E.C.P. et al.* Effect of low-level laser therapy on the expression of inflammatory mediators and on neutrophils and macrophages in acute joint inflammation. *Arthritis Research & Therapy*. 2013; 15: R116: http://arthritis-research.com/content/15/5/R116

257. *Ammar T.A.R.A.* Monochromatic infrared photo energy versus low level laser therapy in patients with knee osteoarthritis. *Journal of Lasers in Medical Sciences*. 2014; 5 (4): 176–182.
258. *Anders J.J., Geuna S., Rochkind S.* Phototherapy promotes regeneration and functional recovery of injured peripheral nerve. *Neurol. Res*. 2004; 26 (2): 233–239.
259. *Awotidebe A.W., Inglis-Jassiem G., Young T.* Low-level laser therapy and exercise for patients with shoulder disorders in physiotherapy practice (a systematic review protocol). *Syst. Rev*. 2015; 4: 60.
260. *Bal A., Eksioglu E., Gurcay E. et al.* Low-level laser therapy in subacromial impingement syndrome. *Photomedicine and Laser Surgery*. 2009; 27 (1): 31–36.
261. *Basford J.R., Sheffield C.G., Harmsen W.S.* Laser therapy: a randomized, controlled trial of the effects of low-intensity Nd:YAG laser irradiation on musculoskeletal back pain. *Archives of Physical Medicine and Rehabilitation*. 1999; 80 (6): 647–652.
262. *Basford J.R., Sheffield C.G., Mair S.D., Ilstrup D.M.* Low-energy helium neon laser treatment of thumbosteoarthritis. *Archives of Physical Medicine and Rehabilitation*. 1987; 68 (11): 794–797.
263. *Beckerman H., de Bie R.A., Bouter L.M. et al.* The efficacy of laser therapy for musculoskeletal and skin disorders: a criteria-based meta-analysis of randomized clinical trials. *Physical Therapy*. 1992; 72 (7): 483–491.
264. *Berman B.M., Lao L., Langenberg P. et al.* Effectiveness of acupuncture as adjunctive therapy in osteoarthritis of the knee: a randomized, controlled trial. *Ann Intern Med*. 2004; 141: 901–910.
265. *Bingöl U., Altan L., Yurtkuran M.* Low-power laser treatment for shoulder pain. *Photomedicine and Laser Surgery*. 2005; 23 (5): 459–464.
266. *Bjordal J.M.* Re: "Low-level laser therapy and lateral epicondylitis" Maher S. Phys. Ther. 2006; 86: 1161–1167. *Physical Therapy*. 2007; 87 (2): 224–225.
267. *Bjordal J.M., Couppé C., Chow R.T. et al.* A systematic review of low level laser therapy with location-specific doses for pain from chronic joint disorders. *Aust. J. Physiother*. 2003; 49 (2): 107–116.
268. *Bjordal J.M., Johnson M.I., Lopes-Martins R.A. et al.* Short-term efficacy of physical interventions in osteoarthritic knee pain: a systematic review and meta-analysis of randomised placebo-controlled trials. *BMC Musculoskelet Disord*. 2007; 8: 51.
269. *Bjordal J.M., Lopes-Martins R.A., Joensen J. et al.* A systematic review with procedural assessments and meta-analysis of low level laser therapy in lateral elbow tendinopathy (tennis elbow). *BMC Musculoskelet Disord*. 2008; 9: 75.
270. *Bliddal C., Hellesen P., Ditlevsen P. et al.* Soft-laser therapy of rheumatoid arthritis. *Scand J Rheumatol*. 1987; 16 (4): 225–228.
271. *Brosseau L., Robinson V., Wells G. et al.* WITHDRAWN: Low level laser therapy (Classes III) for treating osteoarthritis. *Cochrane Database Syst Rev*. 2007; (1).
272. *Brosseau L., Welch V., Wells G. et al.* Low level laser therapy (classes I, II and III) for the treatment of osteoarthritis. *Cochrane Database Syst Rev*. 2000; (2).
273. *Brosseau L., Welch V., Wells G. et al.* Low level laser therapy for osteoarthritis and rheumatoid arthritis: a metaanalysis. *J Rheumatol*. 2000; 27 (8): 1961–1969.
274. *Brosseau L., Wells G., Marchand S.* Randomized controlled trial on low level laser therapy (LLLT) in the treatment of osteoarthritis (OA) of the hand. *Lasers in Surgery and Medicine*. 2005; 36 (3): 210–219.
275. *Campana V.R., Moya M., Gavotto A. et al.* Laser therapy on arthritis induced by urate crystals. *Photomedicine and Laser Surgery*. 2004, 22 (6): 499–503.
276. *Carcia C.R., Martin R.L., Houck J., Wukich D.K.* Achilles tendinitis: Clinical guidelines. USA, 2010. 50.
277. *Carvalho R.L., Alcântara P.S., Kamamoto F. et al.* Effects of low-level laser therapy on pain and scar formation after inguinal herniation surgery: a randomized controlled single-blind study. *Photomedicine and Laser Surgery*. 2010; 28 (3): 417–422.
278. *Chang W.-D., Wu J.-H., Yang W.-J., Jiang J.-A.* Therapeutic effects of low-level laser on lateral epicondylitis from differential interventions of Chinese-Western medicine: systematic review. *Photomedicine and Laser Surgery*. 2010; 28 (3): 327–336.

279. *Chang Y.P., Chiang H., Shih K.S. et al.* Effects of therapeutic physical agents on achilles tendon microcirculation. *J Orthop Sports Phys Ther*. 2015; 3: 1–28.
280. *Chow R., Armati P., Laakso E.-L. et al.* Inhibitory effects of laser irradiation on peripheral mammalian nerves and relevance to analgesic effects: a systematic review. *Photomedicine and Laser Surgery*. 2011; 29 (6): 365–381.
281. *Chow R.T., Barnsley L.* Systematic review of the literature of low-level laser therapy (LLLT) in the management of neck pain. *Lasers in Surgery and Medicine*. 2005; 37 (1): 46–52.
282. *Chow R.T., Johnson M.I., Lopes-Martins R.A., Bjordal J.M.* Efficacy of low-level laser therapy in the management of neck pain: a systematic review and meta-analysis of randomised placebo or active-treatment controlled trials. *Lancet.* 2009; 374 (9705): 1897–1908.
283. *Christie A., Jamtvedt G., Dahm K.T. et al.* Effectiveness of nonpharmacological and nonsurgical interventions for patients with rheumatoid arthritis: an overview of systematic reviews. *Physical Therapy*. 2007; 87 (12): 1697–1715.
284. *Dogan S.K., Ay S., Evcik D.* The effectiveness of low laser therapy in subacromial impingement syndrome: a randomized placebo controlled double-blind prospective study. *Clinics (Sao Paulo)*. 2010; 65 (10): 1019–1022.
285. *Eid M.M., Waked I.S., Wahid A.R.A.* The beneficial effects of low-intensity laser acupuncture therapy in chronic tonsillitis. *Indian Journal of Physiotherapy & Occupational Therapy*. 2012;6 (2): 54–59.
286. *Emanet S.K., M.D., Altan L.I., Yurtkuran M.* Investigation of the effect of GaAs laser therapy on lateral epicondylitis. *Photomedicine and Laser Surgery*. 2010; 28 (3): 397–403.
287. *Enwemeka C.S.* Laser biostimulation of healing wounds: specific effects and mechanisms of action. *The Journal Of Orthopaedic And Sports Physicaltherapy*. 1988; 9 (10): 333–338.
288. *Enwemeka C.S., Parker J.C., Dowdy D.S. et al.* The efficacy of low-power lasers in tissue repair and pain control: a meta-analysis study. *Photomedicine and Laser Surgery*. 2004; 22 (4): 323–329.
289. *Eslamian F., Shakouri S.K., Ghojazadeh M. et al.* Effects of low-level laser therapy in combination with physiotherapy in the management of rotator cuff tendinitis. *Lasers Med. Sci*. 2012; 27 (5): 951–958.
290. *Fleckenstein J., Raab C., Gleditsch J. et al.* Impact of acupuncture on vasomotor rhinitis: a randomized placebo-controlled pilot study. *J. Altern. Complement Med*. 2009, 15 (4): 391–398.
291. *Fukuda V.O., Fukuda T.Y., M. Guimarães et al.* Short-term efficacy of low-level laser therapy in patients with knee osteoarthritis: a randomized placebocontrolled, double-blind clinical trial. *Rev. Bras. Ortop*. 2011; 46 (5): 526–533.
292. *Gam A.N., Thorsen H., Lønnberg F.* The effect of low-level laser therapy on musculoskeletal pain: a metaanalysis. *Pain*. 1993; 52 (1): 63–66.
293. *Glasgow P.D., Hill I.D., McKevitt A.-M. et al.* Low-intensity monochromatic infrared therapy: A preliminary study of the effects of a novel treatment unit upon experimental muscle soreness. *Lasers in Surgery and Medicine*. 2001; 28 (1): 33–39.
294. *Goldman J.A., Chiapella J., Casey H. et al.* Laser therapy of rheumatoid arthritis. *Lasers in Surgery and Medicine*. 1980; 1 (1): 93–101.
295. *Gupta A.K., Filonenko N., Salansky N., Sauder D.N.* The use of low energy photon therapy (LEPT) in venous leg ulcers: a double-blind, placebo-controlled study. *Dermatol Surg*. 1998; 24 (12): 1383–1386.
296. *Gür A., Cosut A., Jale Sarac A. et al.* Efficacy of different therapy regimes of low-power laser in painful osteoarthritis of the knee: a double-blind and randomized-controlled trial. *Lasers in Surgery and Medicine*. 2003; 33 (5): 330–338.
297. *Haker E., Lundeberg T.* Laser treatment applied to acupuncture points in lateral humeral epicondylalgia: a double-blind study. *Pain*. 1990; 43 (2): 243–247.
298. *Hegedűs B., Viharos L., Gervain M., Gálfi M.* The effect of low-level laser in knee osteoarthritis: a double-blind, randomized, placebo-controlled trial. *Photomedicine and Laser Surgery*. 2009; 27 (4): 577–584.
299. *Herman J.H., Khosla R.C.* Nd:YAG laser modulation of synovial tissue metabolism. *Clin. Exp. Rheumatol*. 1989; 7 (5): 505–512.

300. *Heussler J.K., Hinchey G., Margiotta E. et al.* A double blind randomised trial of low power laser treatment in rheumatoid arthritis. *Ann. Rheum. Dis*. 1993; 52 (10): 703–706.
301. *Hopkins J.T., McLoda T.A., Seegmiller J.G., Baxter D.G.* Low-level laser therapy facilitates superficial wound healing in humans: a triple-blind, sham-controlled study. *J. Athl. Train*. 2004; 39 (3): 223–229.
302. *Hsieh R., Lo M.T., Lee W., Liao W.* Therapeutic effects of short-term monochromatic infrared energy therapy on patients with knee osteoarthritis: a double-blind, randomized, placebo-controlled study. *J. Orthop. Sports Phys. Ther*. 2012; 42 (11): 947–956.
303. *Ip D., Fu N.Y.* Two-year follow-up of low-level laser therapy for elderly with painful adhesive capsulitis of the shoulder. *J. Pain. Res*. 2015; 25 (8): 247–252.
304. *Jamtvedt G., Dahm K.T., Christie A. et al.* Physical therapy interventions for patients with osteoarthritis of the knee: an overview of systematic reviews. *Physical Therapy*. 2008; 88 (1): 123–136.
305. *Kajagar B.M., Godhi A.S., Pandit A., Khatri S.* Efficacy of low level laser therapy on wound healing in patients with chronic diabetic foot ulcers-a randomised control trial. *Indian J. Surg*. 2012; 74 (5): 359–363.
306. *Karu T., Tiphlova O., Esenaliev R. et al.* Two different mechanisms of low-intensity laser photobiological effect on Escherichia coli. *Journal of Photochemistry and Photobiology B: Biology*. 1994; 24 (2): 155–161.
307. *Kaviani A., Djavid G.E., Ataie-Fashtami L. et al.* A randomized clinical trial on the effect of low-level laser therapy on chronic diabetic foot wound healing: a preliminary report. *Photomed. Laser Surg*. 2011; 29 (2): 109–114.
308. *Kaviani A., Fateh M., Yousefi Nooraie R. et al.* Low-level laser therapy in management of postmastectomy lymphedema. *Lasers Med. Sci*. 2006; 21 (2): 90–94.
309. *Kelle B., Kozanoglu E.* Low-level laser therapy and local corticosteroid injection in the treatment of subacromial impingement syndrome: a controlled clinical trial. *Clin. Rehabil*. 2014; 28 (8): 762–771.
310. *Kheshie A.R., Alayat M.S., Ali M.M.* High-intensity versus low-level laser therapy in the treatment of patients with knee osteoarthritis: a randomized controlled trial. *Lasers Med. Sci*. 2014; 29 (4): 1371–1376.
311. *Kopera D., Kokol R., Berger C., Haas J.* Low level laser: does it influence wound healing in venous leg ulcers? A randomized, placebo-controlled, double-blind study. *Br. J. Dermatol*. 2005; 152 (6): 1368–1370.
312. *Lam L.K.Y., Cheing G.L.Y.* Effects of 904-nm low-level laser therapy in the management of lateral epicondylitis: a randomized controlled trial. *Photomedicine and Laser Surgery*. 2007; 25 (2): 65–71.
313. *Lopes A.L., Rigau J., Zangaro R.A. et al.* Comparison of the low level laser therapy effects on cultured human gingival fibroblasts proliferation using different irradiance and same fluence. *Lasers in Surgery and Medicine*. 2001; 29 (2): 179–184.
314. *Lundeberg T., Haker E., Thomas M.* Effect of laser versus placebo in tennis elbow. *Scand. J. Rehabil. Med*. 1987; 19 (3): 135–138.
315. *Maher S.* Low-level laser therapy and lateral epicondylitis. Physical Therapy. 2006; 86 (8): 1161–1167.
316. *Marks R., de Palma F.* Clinical efficacy of low power laser therapy in osteoarthritis. *Physiother. Res. Int*. 1999; 4 (2): 141–157.
317. *Meersman P., Calderhead R.G.* The battle of laser therapy against medication in musculoskeletal disorders: collaboration, alliance or enemy? *Laser Therapy.* 2006; 15 (3): 119–134.
318. *Meireles S.M., Jones A., Jennings F. et al.* Assessment of the effectiveness of low level laser therapy on the hands of patients with rheumatoid arthritis: a randomized double-blind controlled trial. *Clin. Rheumatol*. 2010; 29 (5): 501–509.
319. *Mokmeli S., Abbasi Kh., Hosseini S.M. et al.* Comparing the effect of low level laser therapy (LLLT) with Celecoxib in knee osteoarthritis (OA). *Conference WALT. Abstacts*. Bergen, Norway, 2010: 80–81.

320. *Mokmeli S., Daemi M., Shirazi ZA. et al.* Evaluating the efficiency of low level laser therapy (LLLT) in combination with intravenous laser therapy (IVL) on diabetic foot ulcer, added to conventional therapy. *Journal of Lasers in Medical Sciences*. 2010; 1: 8–13.
321. *Momenzadeh S.* Low level laser therapy for painful joints. *Journal of Lasers in Medical Sciences*. 2013; 4 (2): 67–69.
322. *Montes-Molina R., Madroñero-Agreda M.A., Romojaro-Rodríguez A.B. et al.* Efficacy of interferential low-level laser therapy using two independent sources in the treatment of knee pain. *Photomedicine and Laser Surgery*. 2009; 27 (3): 467–471.
323. *Moreira M.S., Velasco I.T., Ferreira L.S. et al.* Effect of phototherapy with low-intensity laser on local and systemic immunomodulation following focal brain damage in rat. J. *Photochem. Photobiol. B*. 2009; 97 (3): 145–151.
324. *Moreira M.S., Velasco I.T., Ferreira L.S. et al.* Effect of laser phototherapy on wound healing following cerebral ischemia by cryogenic injury. *Journal of Photochemistry and Photobiology B: Biology*. 2011; 105 (3): 207–215.
325. *Moustafa Y., Kassab A.N., El Sharnoubi J., Yehia H.* Comparative study in the management of allergic rhinitis in children using LED phototherapy and laser acupuncture. *Int. J. Pediatr. Otorhinolaryngol*. 2013; 77 (5): 658–665.
326. *Musha Y., Kaneko T., Shigemitsu T. et al.* The effectiveness of low level laser therapy (LLLT) for shoulder periarthritis. *Laser Therapy*. 2009; 18 (1): 39–43.
327. *Nesioonpour S., Mokmeli S., Vojdani S. et al.* The effect of low-level laser on postoperative pain after tibial fracture surgery: a double-blind controlled randomized clinical trial. *Anesth Pain Med*. 2014, 4 (3): e17350.
328. *Ohkuni I., Ushigome N., Harada T. et al.* Low level laser therapy (LLLT) for shoulder joint contracture. *Laser Therapy*. 2009; 18 (2): 97–101.
329. *Özkan N., Altan L., Bingöl U. et al.* Investigation of the supplementary effect of GaAs laser therapy on the rehabilitation of human digital flexor tendons. *J. Clin. Laser Med. Surg*. 2004; 22 (2): 105–110.
330. *Peter W.F.H., Jansen M.J., Hurkmans E.J. et al.* Physiotherapy in hip and knee osteoarthritis: development of a practice guideline concerning initial assessment, treatment and evaluation. *Acta Reumatol. Port*. 2011; 36 (3): 268–281.
331. *Rayegani S.M., Bahrami M.H., Elyaspour D. et al.* Therapeutic effects of low level laser therapy (LLLT) in knee osteoarthritis, compared to therapeutic ultrasound. *Journal of Lasers in Medical Sciences*. 2012; 3 (2): 71–74.
332. *Rigau J., Sun C.-H., Trelles M.A., Berns M.W.* Effects of the 633-nm laser on the behavior and morphology of primary fibroblast culture. *SPIE Proceedings*. 1996; 2630: 38–42.
333. *Rochkind S., Nissan M., Lubart R.* A single transcutaneous light irradiation to injured peripheral nerve: comparative study with five different wavelengths. *Lasers in Medicine Science*. 1989; 4 (3): 259–263.
334. *Rochkind S., Shahar A., Nevo Z.* An innovative approach to induce regeneration and the repair of spinal cord injury. *Laser Therapy*. 1997; 9 (4): 151–152.
335. *Rubio C.R., Cremonezzi D., Moya M. et al.* Helium-Neon laser reduces the inflammatory process of arthritis. *Photomedicine and Laser Surgery*. 2010; 28 (1): 125–129.
336. *Simunovic Z., Trobonjaca T., Trobonjaca Z.* Treatment of medial and lateral epicondylitis tennis and golfer's elbow with low level laser therapy: a multicenter double blind, placebo-controlled clinical study on 324 patients. *J. Clin. Laser Med. Surg*. 1998; 16 (3): 145–151.
337. *Soleimanpour H., Gahramani K., Taheri R. et al.* The effect of low-level laser therapy on knee osteoarthritis: prospective, descriptive study. *Lasers Med Sci. 2014*, 29 (5): 1695–1700.
338. *Soriano F., Campana V., Moya M. et al.* Photobiomodulation of pain and inflammation in microcrystalline arthropathies: experimental and clinical results. *Photomedicine and Laser Surgery*. 2006; 24 (2): 140–150.
339. *Stasinopoulos D.I., Johnson M.I.* Effectiveness of low-level laser therapy for lateral elbow tendinopathy. *Photomedicine and Laser Surgery*. 2005; 23 (4): 425–430.
340. *Stergioulas A.* Effects of low-level laser and plyometric exercises in the treatment of lateral epicondylitis. *Photomedicine and Laser Surgery*. 2007; 25 (3): 205–213.

341. *Stergioulas A.* Low-power laser treatment in patients with frozen shoulder: preliminary results. *Photomedicine and Laser Surgery*. 2008; 26 (2): 99–105.
342. *Tam G.* Low Power Laser Therapy and Analgesic Action. *Journal of Clinical Laser Medicine & Surgery*. 1999; 17 (1): 29–33.
343. *Tascioglu F., Armagan O., Tabak Y. et al.* Low power laser treatment in patients with knee osteoarthritis. *Swiss Medical Weekly*. 2004; 134 (17–18): 254–258.
344. *Trelles M.A., Rigau J., Sala P. et al.* Infrared diode laser in low reactive-level laser therapy (LLLT) for knee osteoarthrosis. *Laser Therapy*. 1991; 3 (4): 149–153.
345. *Tumilty S., Munn J., McDonough S. et al.* Low level laser treatment of tendinopathy: a systematic review with meta-analysis. *Photomedicine and Laser Surgery*. 2010; 28 (1): 3–16.
346. *Vasseljen O. Jr., Høeg N., Kjeldstad B. et al.* Low level laser versus placebo in the treatment of tennis elbow. *Scand. J. Rehabil. Med*. 1992; 24 (1): 37–42.
347. *Vecchio P., Cave M., King V. et al.* A double-blind study of effectiveness of low-level laser treatment of rotator cuff tendinitis. *Br. J. Rheumatol*. 1993; 32 (8): 740–742.
348. *Woodruff L.D., Bounkeo J.M., Brannon W.M. et al.* The efficacy of laser therapy in wound repair: a meta-analysis of the literature. *Photomedicine and Laser Surgery*. 2004; 22 (3): 241–247.
349. *World* Association of Laser Therapy (WALT). Consensus agreement on the design and conduct of clinical studies with low-level laser therapy and light therapy for musculoskeletal pain and disorders. *Photomedicine and Laser Surgery*. 2006; 24 (6): 761–762.
350. *Yavuz F., Duman I., Taskaynatan M.A., Tan A.K.* Low-level laser therapy versus ultrasound therapy in the treatment of subacromial impingement syndrome: a randomized clinical trial. *J. Back Musculoskelet Rehabil*. 2013; 27 (3): 315–320.
351. *Ye L., Kalichman L., Spittle A. et al.* Effects of rehabilitative interventions on pain, function and physical impairments in people with hand osteoarthritis: a systematic review. *Arthritis Res Ther*. 2011; 13 (1): R28. doi: 10.1186/ar3254.
352. *Yeldan I., Cetin E., Ozdincler A.R.* The effectiveness of low laser therapy on shoulder function in sub-acromial impingement syndrome. *Disabil. Rehabil*. 2009; 31 (11): 935–940.
353. *Yousefi-Nooraie R., Schonstein E., Heidari K. et al.* Low level laser therapy for nonspecific low-back pain. *Cochrane Database Syst. Rev*. 2008; 16 (2): CD005107.
354. *Yurtkuran M., Alp A., Konur S. et al.* Laser acupuncture in knee osteoarthritis: a double-blind, randomized controlled study. *Photomedicine and Laser Surgery*. 2007; 25 (1): 14–20.
355. *Zhang L., Kajiwara H., Kuboyama N., Abiko Y.* Reduction of CXCR4 expression in rheumatoid arthritis rat joints by low level diode laser irradiation. *Laser Therapy*. 2011; 20 (1): 53–58.
356. *Zhao L., Shen X., Cheng K. et al.* Validating a nonacupoint sham control for laser treatment of knee osteoarthritis. *Photomedicine and Laser Surgery*. 2010; 28 (3): 351–356.

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2. The extremely reliable connectors TRS 6.35 mm stereo, made in accordance with the unique 3-wire LASMIK® technology are impossible to break!

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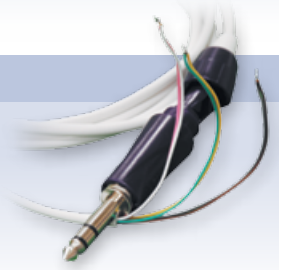
3. Each of the three control lines is duplicated with a double wire which completely eliminates any accidental breakage and greatly increases the reliability of the device as a whole.



4. Foreign laser diodes from the world's leading manufacturers have a warranty period of the continuous operation up to 150 thousand hours! It is unreasonable to save on reliability.

5. The remote power supply unit certified in accordance with the European standards for medical equipment (EN60601-1) eliminates the high voltage in the device itself and increases its reliability.

Control panels of “Matrix” and “LASMIK” devices have slight functional differences.

Parameters	“Matrix” and “Matrix-Urolog”	“LASMIK” and “LASMIK-ILBI”
Laser illumination pulse repetition rate, Hz:		
• Fixed	10, 80, 600, 3000	10, 80, 3000, 10 000
• Optional	0,5–3000	0,5–10 000
Time of the illumination exposure of the device, min.:		
• Fixed	1; 10 and “H”	2; 5 and “H”
• Optional	0,1–90	0,1–90
• External modulation mode	Availability	Availability

The main advantages of “LASMIK” and “LASMIK-ILBI” devices

- The frequency range has been extended up to 10 000 Hz.
- The availability of the option with the vacuum channel for laser-vacuum technique (“LASMIK”).
- The power control and the possibility to set up the frequency from 0,5 up to 10 000 Hz in each of the channels.
- For the first time pulsed lasers can operate at the frequency of 10 000 Hz.
- The wavelength and power limit indication on all laser heads.
- The measurement and digital indication of the pulse and average illumination power within the range of wavelengths from 365 to 960 nm.
- The continuous, pulse, modulated, multi-frequency and bioresonance operation mode of laser emitting heads is ensured.
- The fixed timer values of 2 and 5 min allow quick and unmistakable choosing of the required mode, which is used in most laser therapy techniques.
- The maximum choice of laser emitting heads for all laser therapy techniques.
- Convenient and extremely reliable LASMIK® connectors for the attachment of the heads, which are of different colours according to the wavelength of the laser used.
- The coloured fastening straps of laser emitting heads for ILBI together with the colour differentiation of the connectors allow avoiding mistakes while choosing the wavelength required for the procedure.
- The devices for ILBI are unified with general therapy devices, all laser therapy techniques can be implemented on all devices.
- The devices are maximally unified to be combined with other physiotherapy devices and to implement conjoined and combined techniques.
- The minimum weight allows moving the devices to any department of the medical center.
- The protection against any unauthorized change of the operation mode during the procedure.
- Modern design and increased reliability.
- 5-year device warranty and for the first time the warranty for IR-laser emitting heads.

Specifications of “LASMIK” and “LASMIK-ILBI” devices

The number of concurrent channels for emitting heads	1, 2 or 4
Control and indication of the illumination power and wavelength of the laser sources	There is
The illumination wavelength for laser emitting heads, nm	365–1300 (is defined by the type of the exchangeable remote emitter)
The illumination wavelength for EHF range, mm	4,9; 5,6; 7,1 (is defined by the type of the exchangeable remote emitter)
The method of setting of the timer value and pulse repetition frequency	fixed or optional
The timer (automatic mode)	
fixed values, min	2; 5 and “N” (not limited)
optional choice, min	0,1–90
The frequency of the modulation and repetition of the pulses, Hz	
fixed values	10, 80, 3000, 10 000
optional choice	0,5–10 000
The illumination power adjustment	from 0 to maximum value
Weight, g	
LASMIK-01 (2 laser channels)	800
LASMIK-02 (4 laser channels)	4200
LASMIK-03 (1 laser and vacuum channel)	950
Dimensions, mm:	
LASMIK-01 (2 laser channels)	280×210×105
LASMIK-02 (4 laser channels)	345×260×150
LASMIK-03 (1 laser and vacuum channel)	280×210×105
Electrical safety class	II, B type (grounding is not required)
Laser safety class	1M
Power:	
Voltage, V	90–250
Frequency, Hz	47–65
Maximum power consumption, VA	
LASMIK-01 (2 laser channels)	10
LASMIK-02 (4 laser channels)	15
LASMIK-03 (1 laser and vacuum channel)	12
The average operation period without maintenance service, h	5000
The warranty*	5 years

* For the base unit and IR-pulsed laser emitting heads, 12 months for the rest products.

The Comparison of the Parameters

of the laser emitting heads for the devices of new and previous generation

The devices of new generation of LASMIK® ("LASMIK", "Agiur", "LASMIK-ILBI", "LASMIK-BIO", etc.) technology			The devices of previous generation ("Matrix", "Matrix-Urolog", "Mustang-2000", etc.)		
	Parameters			Parameters	
Head name	Wave-length, nm	Power	Head name	Wave-length, nm	Power
ML01K (ML-904-80)	904	50 W (matrix)	ML01K	890–904	50 W (matrix)
ML01KM (ML-904-200)	904	200 W (matrix)	–	–	–
ML01KP (ML-635-40)	635	35 W (matrix)	ML01KR	650–670	35 W (matrix)
ML-650-100	650	100 mW (matrix)	–	–	–
LO-890-10 (LO-904-10)	904	10 W	LO1	890–904	5 W
LO-890-15 (LO-904-15)	904	15 W	LO2	890–904	10 W
LO-890-20 (LO-904-20)	904	20 W	LO3	890–904	15 W
LO-890-25 (LO-904-25)	904	25 W	LO4	890–904	20 W
LO-890-100 (LO-904-100)	904	100 W	LO7	890–904	90 W
LOK2 (LO-635-5)	635	5 W	LOK2	650–670	5 W
KLO-405-120	405	120 mW	KLO-405-120	405	120 mW
KLO-450-50 (KLO-445-50)	445–450	50 mW	–	–	–
KLO-530-50 (KLO-525-50)	520–530	50 mW	–	–	–
KLO-635-5	635	5 mW	KLO1	635	5 mW
KLO-635-15	635	15 mW	KLO3	635	10 mW
KLO-635-40	635	40 mW	KLO4	635	40 mW
KLO-635-50 (NLBI)	635	50 mW	–	–	–
KLO-650-50	650	50 mW	KLO2	650	40 mW
KLO-650-200	650	200 mW	–	–	–
KLO-780-90	780–785	90 mW	KLO-780-90	780–785	90 mW
KLO-808-200	808	200 mW	KLO6	808	200 mW
KLO7	1300	5 mW	KLO7	1300	5 mW
KL-ILBI-365-2 (for UVBI)	365–400	1,5–2 mW*	KL-ILBI-365	365–400	1,5–2 mW*
KL-ILBI-405-2	405	1,5–2 mW*	KL-ILBI-405	405	1,5–2 mW*
KL-ILBI-450-2 (KL-ILBI-445-2)	445–450	2 mW*	–	–	–
KL-ILBI-450-20 (KL-ILBI-445-20)	445–450	20 mW*	–	–	–
KL-ILBI-530-2 (KL-ILBI-525-2)	520–530	2 mW*	–	–	–
KL-ILBI-530-20 (KL-ILBI-525-20)	520–530	20 mW*	–	–	–
KL-ILBI-635-2	635	2 mW*	KL-ILBI	635	2 mW*
KL-ILBI-635-20	635	20 mW*	KL-ILBI-M	635	20 mW*
KL-ILBI-808-40	808	40 mW*	KL-ILBI-IR	808	40 mW*

* At the output of the light guide KIVL-01 produced by the Research Center "Matrix" under TR 9444-005-72085060-2008.

Laser emitting heads of new generation

With one laser
on the left

The heads are used for the external exposure through the local contact with the mirror nozzle, distant or contact without a nozzle, and with optic and magnetic nozzles. The heads are made in accordance with brand new technologies from special heavy-duty plastic, do not break, crack or crash – they are more reliable than those made from metal.
Designation: TYPE (LO – pulsed, KLO – continuous) – wavelength – power.
For example, LO-904-20 – pulsed laser emitting head with the wavelength of 904 nm (IR) and maximum power of not less than 20 W (can be adjusted downwards).

Matrix
in the middle

Designation: TYPE (ML) – wavelength – power.
Matrix emitting heads with 8 pulsed laser diodes of IR (904 nm) or red spectrum are most often used. Detailed information is given further.

For intravenous laser blood illumination (ILBI)
on the right

Designation: KL-ILBI – wavelength – power.
Detailed information is described below.

All laser emitting heads are attached to the device with the help of convenient, modern and extremely reliable LASMIK® connectors specially designed for laser therapy devices.

Matrix laser emitting heads

These are necessary for the optimization of the impact area and the energy density of the impact, laser diodes are located on the surface so that the light fields created by them separately when combining ensure the best spatial-energy parameters of the technique as a whole [Moskvin S.V., 2008, 2014].

Such heads have maximum versatility and can be implemented practically in all the laser therapy techniques, except acupuncture, that is why they are included in the simple kits of the equipment. They are used for the external application as well as for the impact on the projection of the internal organs, located at the depth up to 15 cm (IR-lasers).

Parameters	ML-904-80 (ML01K)	ML-904-200 (ML01KM)	ML-635-40 (ML01KR)
Wavelength, nm	904	904	635
Spectrum (colour)	IR	IR	red
Number of laser diodes, pcs.	8	8	8
Pulse power, W	80	200	40
Impact area, cm^2	8–50	8–50	8–50
Available analogues	Conditionally	No	No

Laser diodes in the modern matrix laser heads ML-904-80, ML-904-200 and ML-63540 are made under the LASMIK® technology, and are located right on the surface, not behind any glass (no distance), which can significantly improve the efficiency of impact efficiency with a lower number of laser sessions. The square of the light spot, according to which the power density is calculated, at the distance up to 0,5 cm from the LD is 8 cm^2, that is 8 light sources can be presented with the sum of 8 laser heads with one laser and mirror nozzle. At the distance of 7 cm (limit) a pretty much rectangular area with the size of 5×10 cm is formed and the power density is calculated taking into consideration the aggregate capacity of all the laser diodes on the square of 50 cm^2.

The laser emitting head ML-635-40 (ML01KR) is mostly used for the technique of non-invasive (external, transdermal) laser blood illumination with the unique efficiency and for the illumination of the pathological focuses at the depth of up to 5 cm.

The laser emitting head LO-LLNP contains 4 separate blocks with 3 continuous red and 2 pulsed IR LDs, so, in this case the matrix emitter is not flat, but volumetric. The boards are on the flask opposite each other, as a result, all sides of a penis are equally illuminated.

Matrix emitting heads with continuous laser diodes are rarely used.

Laser emitting heads for intravenous laser blood illumination (ILBI)

Name	Wavelength, nm	Power*, mW
Laser emitting head KL-ILBI-365-2 (for UVBI)	365–400	2
Laser emitting head KL-ILBI-405-2	405	2
Laser emitting head KL-ILBI-450-2 (KL-ILBI-445-2)	445–450	2
Laser emitting head KL-ILBI-450-20 (KL-ILBI-445-20)	445–450	20
Laser emitting head KL-ILBI-530-2 (KL-ILBI-525-2)	520–530	2
Laser emitting head KL-ILBI-530-20 (KL-ILBI-525-20)	520–530	20
Laser emitting head KL-ILBI-635-2	635	2
Laser emitting head KL-ILBI-635-20	635	20
Laser emitting head KL-ILBI-808-40	808	40

* At the output of the light guide KIVL-01 produced by the Research Center "Matrix".

- **Only lasers for the laser blood illumination!** (No cheap and inefficient LEDs or outdated lamps are used!)
- **Laser light energy is better brought into the light guide** (the greater the power, the better the effect).
- **The convenient housing** (allows easy inserting and removing of the light guide).
- **Has a special laser illuminator** (it does not have contact with the patient and does not cause negative feelings).
- **Optimal dimensions** allow using shorter light guides (to 20 cm) while keeping polarization of light.
- **A special reliable and durable strap** (can be disinfected and sterilized).
- **Straps and connectors match the colour (wavelength) of the laser source** (to avoid mistakes while choosing the head during the procedure).

Heads for non-invasive (external) laser blood illumination (NLBI)

Our studies (1997–2014) have proven that the best option for non-invasive (external) laser blood illumination (NLBI) is the application of the matrix emitting head ML01KR (ML-635-40) on the projection of large blood vessels close to an injured area, in which pulsed lasers in the red spectrum (635nm) are used [Moskvin S.V., 2014; Moskvin S.V. et al., 2007].

Nevertheless, some specialists prefer to illuminate exactly the projection of the cubital vein, the area through which ILBI is most often implemented. In this case it is necessary to have a special emitting head with much more power as the laser light energy is ten times weakened under such method of delivery.

KLO-635-50 (NLBI)

Basic features

- Laser wavelength – 635 nm (red spectrum).
- Average power – 50 mW.
- Fastened with a special strap on the arm or on the knee above the projection of the vessels.
- A special appliance for power density optimization and stabilization.

Laser-LED matrix emitting head MLS-1 (Effect)

This head is more often used for the systematic exposure on the body, for external laser illumination technique or colour therapy.

Basic features

- The availability of several light sources with a different wavelength (colour).
- The total area of the light spot at the distance of 1 cm – to 40 cm^2.
- The possibility of the modulation of the LED illumination of any frequency, set on the base unit.
- The possibility of LED or laser switching when all the other light sources are disconnected.
- The use of pulsed lasers of infrared (IR) or red spectrum.

The parameters of the light sources of the emitting head MLS-1 (Effect)

Colour	Wavelength, nm	Type	Number, pcs.	Illumination mode	Total illumination power
Blue	470	LED	12	cont./mod.	20 mW*
Green	530	LED	3	cont./mod.	10 mW*
IR	850–960	LED	4	cont./mod.	60 mW*
Red	635	Laser	3	Pulsed	15 W**
IR	904	Laser	1	Pulsed	10 W**

* For the continuous illumination mode, for the modulated mode the average power is two times decreased.
** Pulse power.

LASMIK® connectors – maximum reliability

Name	Wave-length, nm	Connector (colour)
Matrix laser emitting head ML01K (ML-904-80)	904	
Matrix laser emitting head ML01KM (ML-904-200)	904	
Laser emitting head LO-890-10 (LO-904-10)	904	
Laser emitting head LO-890-15 (LO-904-15)	904	
Laser emitting head LO-890-20 (LO-904-20)	904	
Laser emitting head LO-890-25 (LO-904-25)	904	
Laser emitting head LO-890-100 (LO-904-100)	904	
Laser emitting head KLO-780-90	780–785	
Laser emitting head KLO-808-200	808	
Laser emitting head KLO7	1300	
Laser emitting head KL-ILBI-808-40	808	
Laser emitting head KLO-405-120	405	
Laser emitting head KL-ILBI-405-2	405	
Laser emitting head KL-ILBI-365-2 (for UVBI)	365–400	
Matrix laser emitting head ML01KR (ML-635-40)	635	
Laser emitting head LOK2 (LO-635-5)	635	
Laser emitting head KLO-635-5	635	
Laser emitting head KLO-635-15	635	
Laser emitting head KLO-635-40	635	
Laser emitting head KLO-635-50 (NLBI)	650	
Laser emitting head KLO-650-50	650	
Laser emitting head KLO-650-200	650	
Laser emitting head KL-ILBI-635-2	635	
Laser emitting head KL-ILBI-635-20	635	
Laser emitting head KLO-450-50 (KLO-445-50)	445–450	
Laser emitting head KL-ILBI-450-2 (KL-ILBI-445-2)	445–450	
Laser emitting head KL-ILBI-450-20 (KL-ILBI-445-20)	445–450	
Laser emitting head KLO-530-50 (KLO-525-50)	520–530	
Laser emitting head KLO-530-50 (KLO-525-50)	520–530	
Laser emitting head KL-ILBI-530-20 (KL-ILBI-525-20)	520–530	

Universal equipment stand LASMIK-SF

The development of laser physiotherapy requires several devices to be implemented in a conjoined and combined procedure in one workplace. The techniques of laser-vacuum massage, EHF-laser therapy, vibromagnetic laser massage, local laser negative pressure (LLNP), laser biorevitalisation have been actively developing, and recently are gaining more and more popularity. For their successful implementation it is necessary to have different devices, nozzles, gels, etc. at hand. A new specialized equipment stand has been designed for physiotherapy rooms in medical institutions and cosmetology centres (salons).

Special holders are designed for the emitting heads and nozzles for laser and physical therapy devices “Matrix”, “LASMIK”, “Agiur”, “Matrix-ILBI”, “Matrix-Urolog”, “Matrix-VM”, etc.

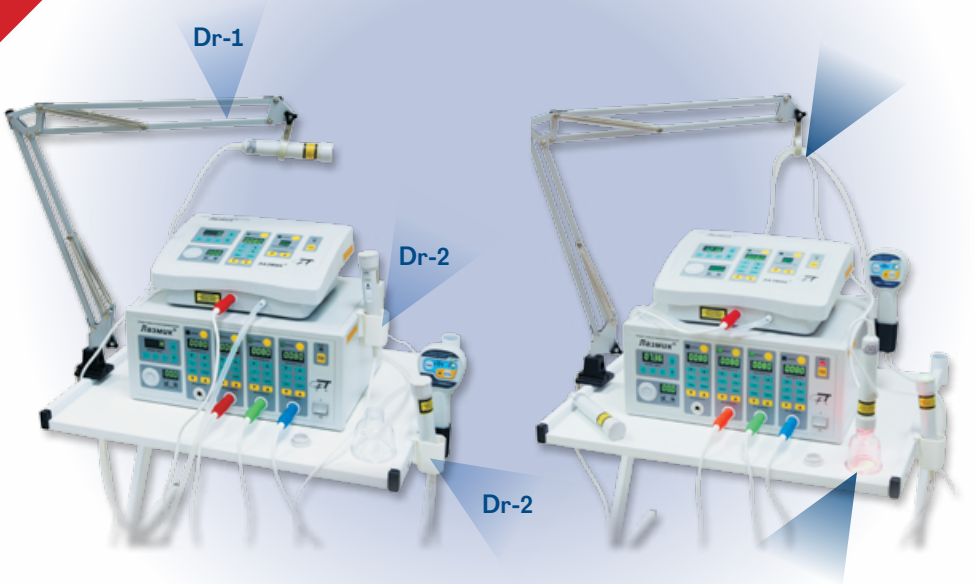
The characteristics of the equipment stand LASMIK-SF

- It allows the setting of several different devices (laser, vacuum, BIO, etc.) in one place and combining (conjoining) different types of physiotherapy exposure.
- It is convenient and ergonomical.
- Methodical references and records are always at hand.
- There are several shelves for nozzles, accessories and storage of the supplies.
- There are specific holders for 5 laser emitting heads.
- Castors make the stand easy to move around the medical centre.

Emitting head holder

BRAND NEW!

The holder is designed to clasp the emitting heads at the place of the illumination or to keep (fix) them between procedures, there are two options available: Dr-1 and Dr-2.



Holder Dr-1 is designed to arrange an emitting head on the place of the implied exposure, for this purpose it is fixed in a special ring (the photo on the left at the top), it is also used for the vertical fixation of the power cord of an emitting head and a vacuum tube (the photo on the right with the arrow up) while implementing laser-vacuum massage procedures (the photo on the right the arrow down). Illumination from above eliminates patients' unpleasant feelings caused by the cord and tube slipping on the body and increases the reliability of the operation of the laser-vacuum apparatus.

Holder Dr-2 is fixed to the metal surface of the 4-channel option of "Matrix", "LASMIK" and "Matrix-Urolog" devices or to the side surface of the stand with the magnetic lock, it is designed to fix (keep) the emitting heads between procedures, for this purpose they are located in the holder cavity.

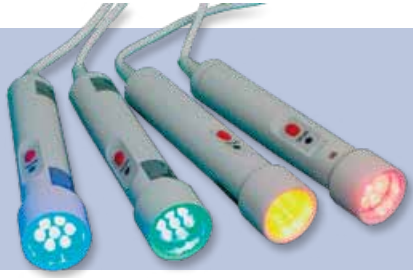
You should not direct a laser emitting head to the eyes or to the glare surfaces of the surrounding things with the help of the Dr-1. It is necessary to shut the emitting heads with a special protective cover while fixing (keeping) them in Dr-2.

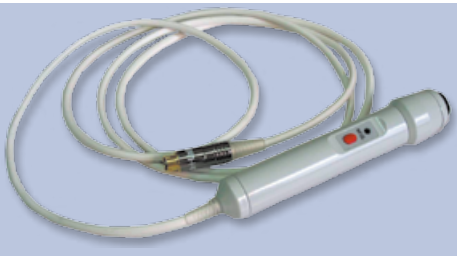
Special emitting heads

BRAND NEW!

The IR (wavelength – 904 nm) pulsed laser emitting head of the increased power (up to 300 W) ML01KM is designed to treat diseases such as gout, psoriasis, prostate adenoma, etc.

We continue producing matrix LED heads for all the devices of "Matrix" and "LASMIK" series. They are much less efficient than laser light sources, but are used in some techniques for psycho- and colour therapy.





The emitting heads of EHF-range can be connected to all devices of "Matrix" series. The conjunction and combination of different physical healing factors make it possible to increase efficiency of the treatment.

A special acupuncture nozzle (concentrator) is used to implement EHF-acupuncture.

Expendable materials and nozzles for individual use

The advantages of individual flasks for the local laser negative pressure (LLNP) technique or for the laser-vacuum massage

1. A patient's complete safety is ensured with the use of the individual flasks.
2. Patients are more willing to undergo the procedure having been informed about such a possibility.
3. The use of the individual flasks is an additional income for the medical centre.

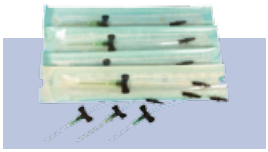
New vacuum cup attachments for laser-vacuum massage (KB-5) – now 7 pieces!

The nozzles for the operation on a face – FVM-25 and FVM-15, diameter of 25 and 15 mm correspondingly, are additionally supplied.

Most patients prefer procedures implemented with the help of individual nozzles (cups), that is why there is a possibility to buy nozzles with a discount.

Slot nozzle FVM-S

Light guides KIVL-01 for the intravenous laser blood illumination (ILBI)



The peculiarities of the sterile light guides KIVL-01 of the Research Centre "Matrix" produced in accordance with TR 9444-005-72085060-2008:

- super-sharp injection needles are painless and ensure patients' maximum comfort;
- the light guide with the diameter of 500 μm ensures stable exposure parameters while preserving the initial illumination polarization and maximum therapeutic effect;
- the high ratio of the input of the laser light into the fiber ensures high and stable power at the light guide output;
- does not damage the laser diode in the emitting head.

ATTENTION! Only light guides KIVL-01 produced in accordance with TR 9444-005-72085060-2008 can be used with "Matrix" and "LASMIK" devices! Other light guides cannot ensure the stable illumination power and positive results of the treatment, and can cause emitting head failure.

A disposable filtration system F-1 for the vacuum therapy devices "Matrix-VM" or laser-vacuum therapy "LASMIK-03"

The filter is designed to protect the device from the penetration of foreign substances (oil, lotion, saliva etc.) inside the pump. The filter works within the period of 7 to 30 days, depending on the intensity and operating conditions, that is why it is recommended to change the filter weekly. Late filter replacement can cause the device to fail, and the necessity to repair it (which is expensive).

Laser physiotherapy device LASMIK®

This is the only medical device which has 8 wavelengths for laser cosmetology and medicine – 405, 445, 525, 635, 785, 808, 904, 1300 nm.

The laser emitting head KLO-780-90 (780–785 nm, 90 mW) and cosmetology transparent attachment LASMIK® is designed to implement laser phoresis (biorevitalization according to LASMIK® technology).

Now the set of vacuum cups attachments for the vacuum and laser-vacuum massage KB-5 contains special nozzles for the face FVM-25 and FVM-15 with the diameter of 25 and 15 mm. Special shockproof material on the basis of polycarbonate is used for the production of the nozzles. The nozzles cannot be broken or scratched, they are easy to wash and sterilize. Optimum geometric dimensions allow achieving the maximum technique effect.

Special apparatus gels and masks:
LASMIK® hyaluronic acid gel;
LASMIK® anti-cellulite gel;
LASMIK® revitalizing mask.

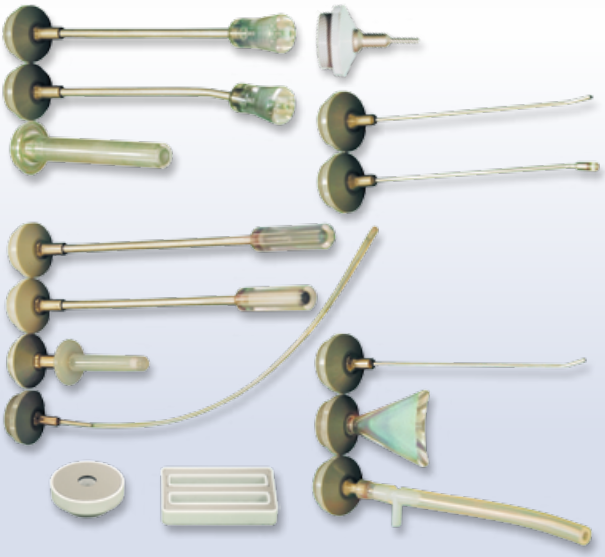
New formula – better quality!

Prices are now lower, and there are discounts available to regular customers.

Attachments, “Matrix-BIO”, protective glasses

Optic and magnetic attachments

These attachments allow the implementation of laser illumination with a pathological focus. This results in minimal loss, and with the required shape and field area, allow the implementation of magnetic laser therapy.



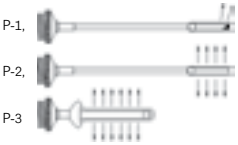
External modulation unit “Matrix-BIO”

It can operate with all the devices, and increases the efficiency of laser therapy through the synchronization of the exposure with a patient’s biorhythms.

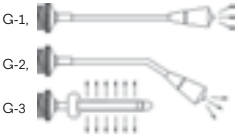
Protective glasses

The glasses are used to protect the medical staff from the reflected illumination during the procedure; the glasses are of modern design, light and comfortable.

Proctology nozzles

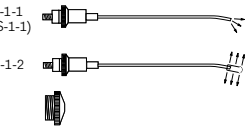


Gynecology nozzles

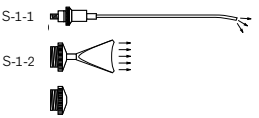


U-1 Urology nozzle for the heads of LO type

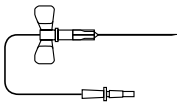
The set of otolaryngology nozzles: a – L-1-1 (S-1-1); b – L-1-2; c – adapter



The set of stomatology nozzles: a – S-1-1, b – S-1-2, c – adapter

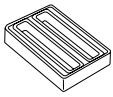


A disposable light guide with a needle for ILBI



A mirror magnet nozzle attachment ZM-50 for the heads of LO and KLO type

Mirror magnet nozzle attachment MM-50



Mirror nozzle attachments

Acupuncture nozzle attachment A-3

“Matrix-ILBI” laser therapy device (upgraded)

Digital indication of the laser illumination wavelength.

The connector under TRS standard 6.35 mm stereo (LASMIK®), the colour of the connectors and fastening straps of the KL-ILBI heads corresponds with the laser illumination wavelength. This helps to avoid mistakes during procedures and the use of all types of laser emitting heads for ILBI.

The operation with pulsed laser emitting heads is allowed. Now it is possible to carry out not only intravenous laser blood illumination procedures (ILBI) with the help of specialized disposable sterile light guides with KIVL-01 needle under TR 9444-005-72085060-2008, but also other laser therapy techniques: external illumination, non-invasive (transdermal) laser blood illumination (NLBI), acupuncture, projection on to the internal organs, para-verbal, intracavitary illumination, etc.

Name	Wavelength, nm	Spectral range	Illumination power at the output of the light guide KIVL-01 TR 9444-005-72085060-2008, mW
KL-ILBI-365-2 (for UVBI)	365	UV	2 mW
KL-ILBI-405-2	405	UV	2 mW
KL-ILBI-445-2	445–450	Blue	2 mW
KL-ILBI-450-20	445–450	Blue	20 mW
KL-ILBI-525-2	520–525	Green	2 mW
KL-ILBI-525-20	520–525	Green	20 mW
KL-ILBI-635-2	635	Red	2 mW
KL-ILBI-635-20	635	Red	20 mW
KL-ILBI-808-40	808	IR	40 mW

“Matrix-Urolog” laser therapy device

“Matrix-Urolog” device (apparatus) is made under the block principle [Moskvin S.V., 1993–2003], according to which the complex is most often located on the stand LASMIK-SF, it consists of three parts: base unit, emitting heads and nozzles (magnetic and optical).

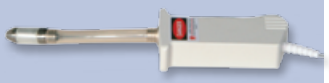
Name of the equipment recommended in the set	Number, pcs.
ALT “Matrix-Urolog” (3-channel specialized base unit)	1
Vibromagnetic laser head VMLH10 to cure prostatitis	1
Laser emitting head LO-904-20 (pulsed IR, 890–904 nm, 15–20 W)	2
Laser emitting head KLO-635-15 (continuous red, 635 nm, 15 mW)	1
Laser emitting head ML-904-80 (pulsed IR, 890–904 nm, matrix)	1
Attachments/nozzles (set): P-1, P-2, P-3, U-1, ZN-35 (2 pcs.), MM-50, ZM-50	1
The book: Laser therapy in urology. – M., 2009. – 132 p.	1
“Matrix-VM” vacuum massage apparatus	1
The laser emitting head LO-LLNP to cure the patients with erectile disfunction and prostatitis (matrix, 12 continuous lasers of 635 nm, power ≥60 mW and 10 IR lasers, pulsed, ≥70 W). Made under new technology, operates up to the frequency of 10 000 Hz, TRS 6.35 mm stereo connectors.	1
The flask for the local laser negative pressure technique B-LLNP (3)	2

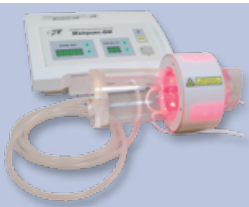
The emitting heads and nozzles of “Matrix-Urolog” complex

It is possible to expand the set with different emitting head and nozzles, which will allow for a more efficient treatment together with the use of the base emitting heads recommended for “Matrix-Urolog” laser therapy device.

Vibromagnetic laser head VMLG10

The unique vibromagnetic laser head of VMLG10 complex, which is used to cure the patients with prostatitis, is a rectal attachment with a ring magnet with the induction of 25 mT and a laser illumination diffuser (wavelength of 635 nm, power of 10 mW).





“Matrix-LLNP” complex

It is possible to include the set for the treatment of the patients with erectile disfunction with the help of local laser negative pressure technique into “Matrix-Urolog” complex. “Matrix-LLNP” complex contains:

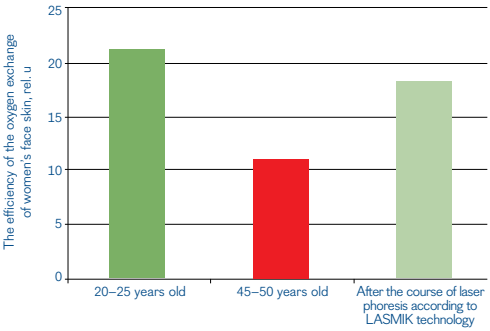
- “Matrix-VM” or “LASMIK-03” vacuum massage apparatus;
- the laser emitting head LO-LLNP;
- special flasks B-LLNP (2 pcs.).

ATTENTION! The lasers of red and IR spectrum are precisely used in LO-LLNP emitting head while ineffective cheap light diodes are used in “analogues”. Moreover, laser illumination of the red and the infrared spectrum is alternated in accordance with the biological rhythms, which ensures a more adequate response of important regulatory, vascular and immune systems.

“LASMIK-Cosmetolog” complex

This unique medical device has eight wavelengths for laser cosmetology and medicine – 405, 445, 525, 635, 785, 808, 904, 1300 nm and the most comprehensive set of special nozzles.

The low price of the basic kit allows for the significantly expanding number of potential clients!



The effects of laser biorevitalization under LASMIK® technology are scientifically substantiated!

The results of the research conducted have proved that the efficiency of the oxygen exchange of skin cells, which decreases dramatically with age, can recover up to the particular to people who are 20–25 years younger. The lipofuscin content is decreased and the structure of collagen and elastin is improved.

Laser emitting heads KLO-780-90 (wavelength of 780–785 nm) and KLO-405-120 (wavelength of 405 nm) with a cosmetology nozzle for the laser biorevitalization and hyaluronoplasty techniques.
LASMIK® gel with hyaluronic acid
LASMIK® anti-cellulite gel
LASMIK® revitalizing mask
Glasses for eye protection from laser illumination during face procedure

The unique training and methodological support, master classes, specialization in laser medicine, field training, individual training, books, training videos, etc.

LASMIK-Slim laser weight loss program without any diet or fitness

LASMIK-Slim is a unique body shape corrector and weight loss program which gives patients the opportunity to not only improve their body shape and skin properties, but also to lose weight and keep it off for a long time without any diets or excessive physical activity. It is based on physiotherapy procedures, the exposure is implemented with the low-intensity (low-energy, "cold") lasers, that is why the tissue is not heated up, the fat is not "melted" or "burned", but rather, optimal conditions for its release from adipocytes with further disposal have been created.

The exposure with the low-intensity ("cold") laser is implemented with the aim to release fats from adipocytes (to reduce fat deposits) with the simultaneous activation of the system of circulation and the metabolising of fatty acids, correction of the energy regulation within the physiological norm.

The LASMIK-Slim program is not only designed to create a slimmer body, but is also the solution to people carrying extra weight as a whole. As a result of the physiotherapy procedures and a patient's implementation of some simple recommendations the shift of the whole complex of the energy balance and the process of metabolism regulation occurs, the transition to the condition under which any spontaneous excess accumulation of fats is not allowed for a long time (up to 6–12 months) is achieved.

Laser physiotherapy complex for LASMIK-Slim program of the body shape correction:

1. **"Matrix-4k"** laser therapy device – 1 pc.
2. **"LASMIK-03"** laser therapy device – 1 pc.
3. Special laser emitting heads – 6 pcs.
   Laser emitting head **KLO-635-5** – 1 pc.
   Laser matrix emitting heads **ML-635-40** – 1 pc.
   Laser emitting head **KLO-650-50-1** – 2 pcs.
   Laser emitting head **KLO-650-50-4** – 2 pcs.
4. Cosmetology nozzles – 15 pcs.
5. Emitting head clamps on the body of a patient – 1 set.
6. **LASMIK-SF** stand with the emitting head holders – 1 pc.
7. The guidelines and individual training.

Laser medicine references

Title
Moskvin S.V., Achilov A.A. **Basics of laser therapy.** – M., 2008. – 256 p.
Series: Experimental magnetobiology. – M.–Tver–Tula, 2006–2007 (for 1 book).
Nasedkin A.A., Moskvin S.V. **Laser therapy of patients with heroin addiction.** – M., 2004. – 48 p.
Ivanchenko L.P., Kozdoba A.S., Moskvin S.V. **Laser therapy in urology.** – M., 2009. – 132 p.
Moskvin S.V., Kupeev V.G. **Laser chromo- and colourtherapy.** – M., 2007. – 95 p.
Baybekov I.M. et al. **Normal erythrocytes, pathologies and under laser exposure.** – M., 2008. – 256 p.
Moskvin S.V., Nasedkin A.N., Osin A.Y., Khan M.A. **Laser therapy in pediatrics.** – M., 2009. – 480 p.
Fedorova T.A., Moskvin S.V., Apolikhina I.A. **Laser therapy in obstetrics and gynecology.** – M., 2009. – 350 p. – M., 2009. – 350 p.
Geynits A.V., Moskvin S.V. **Laser therapy in cosmetology and dermatology.** – M., 2010. – 400 p.
Babushkina G.V., Moskvin S.V. **Laser therapy in the complex therapy of the patients with arterial hypertensia.** – M., 2013.
Ryazanova E.A., Moskvin S.V. **Laser therapy of alopecia.** – M., 2010. – 72 p.
Moskvin S.V., Amirkhanyan A.N. **Combined and conjoined laser therapy techniques in dentistry.** – 2011. – 208 p.
Nasedkin A.N., Moskvin S.V. **Laser therapy in otorhinolaryngology.** – M., 2011. – 208 p.
Geynits A.V., Moskvin S.V., Achilov A.A. **Intravenous laser blood illumination.** – M., 2012. – 336 p.
Kochetkov A.V., Moskvin S.V., Karneev A.N. **Laser therapy in neurology.** – M., 2012. – 360 p.
Moskvin S.V. et al. **Laser phoresis, laser biorevitalization, LASMIK® lipolytic and anticellulite programs.** – 2012. – 120 p.
Collected articles on laser physiotherapy in cosmetology. – M., 2012. – 40 p.
Moskvin S.V., Ponomarenko G.N. **Laser therapy with "Matrix" and "LASMIK" series devices.** – 2015. – 208 p.
Laser-vacuum massage in rehabilitation and sports medicine // Guidance manual. – M., 2012. – 28 p.
Laser phoresis in rehabilitation and sports medicine // Guidance manual. – M., 2012. – 22 p.
Flash-card with the lectures of Moskvin S.V., articles on laser medicine and cosmetology, books, etc.
Uts S.R., Shnider D.A., Moskvin S.V. et al. **Collection of legal documents on laser medicine.** – 2014. – 212 p.
Moskvin S.V. et al. **LASMIK® laser-vacuum massage in medicine and cosmetology.** – M., 2014. – 150 p.
Moskvin S.V. **Laser therapy efficiency.** Series "Effective laser therapy". – M., 2014. – Vol. 2. – 896 p.
Laser therapy of patients with osteoarthritis // Guidance manual. – M. 2015. – 32 p.
Laser therapy in treatment and rehabilitation, and preventive programs: clinical guidelines (Official document). – M., 2015. – 80 p.

The organization of training for the medical staff with higher and secondary education, short-term professional development on the program "Laser medicine"

Research Center “Matrix”

Research Center «Matrix» designs and produces physiotherapy equipment, carries out scientific research and does everything to implement the most efficient techniques. Dozens of patients, scientific articles, guidelines, books, theses, etc. prove the leadership of the centre in this field of medicine and cosmetology.

Laser therapy devices of the “Matrix” and “LASMIK” series are the most versatile. Laser physiotherapy complex does not have any analogues and is successfully used by specialists for the treatment of prostatitis, erectile dysfunction, etc. “Matrix-Cosmetolog” and “LASMIK” have been used for many years by cosmetologists and dermatologists in their practice, these are the only devices for laser biorevitalization, which are registered in Russia as medical devices. “Matrix-ILBI” device allows implementation of intravenous laser blood illumination with red and ultraviolet spectrum (ILBI+LUVBI technique). Our center is the only one which produces the laser emitting head KL-ILBI-365 for LUVBI. Long-term clinical studies carried out together with the leading medical centers proved the unprecedented high efficiency of the method. Scientific developments of the center ensure the professionals’ successful work. We do not stop there, doctors collaborating with us can take part in conferences and seminars, can constantly get consultations on the most efficient latest therapy techniques and books from new “Effective laser therapy” series.

The scientific supervisor is **Sergey V. Moskvin**, Doctor in Biology, Candidate of Engineering Sciences, leading researcher of the State Research Center of Laser Medicine FMBA of Russia, Professor at the Department of Rehabilitation Medicine of the Institute of Professional Development FMBA of Russia, Professor of Samara Medical Institute “REAVIZ”. He is the author of more than 30 patents for invention and 500 scientific studies, including 50 monographs mainly in the sphere of the research of the mechanisms of biological effect of low-intensity laser illumination and clinical application of laser therapy (in co-authorship with the leading specialists in different fields of medicine). The email address to contact for any advice on laser therapy application: 7652612@mail.ru

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