Low-level laser therapy for pets

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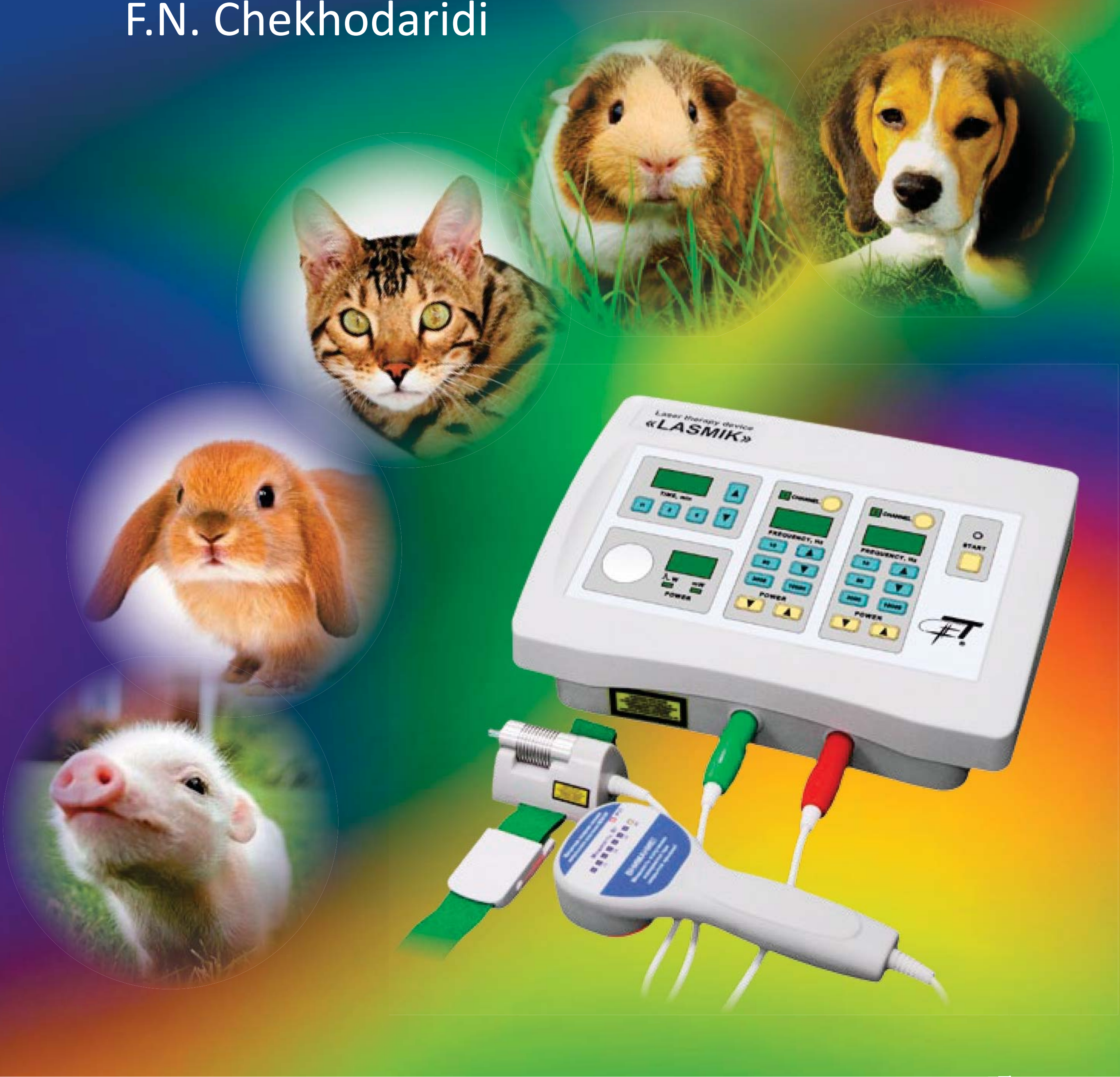

Before treatment


Eosinophilic Plaques and Scratches


Miliary Dermatitis

Hyperpigmentation and Alopecia

S.V. Moskvin, F.N. Chekhodaridi

LOW-LEVEL LASER THERAPY FOR PETS

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Low-level laser therapy has long and very successfully been used in medical and veterinary practice for treating both domestic and farm animals. Special emphasis is placed in the book on the low-level laser therapy techniques for cats and dogs with frequent and difficult-to-treat diseases.

Only Russia has a veritable scientific and practical school of using lasers in medicine. In-depth scientific rationale underpins the most effective low-level laser therapy methods, which are well elaborated and demonstrate excellent treatment results.

The LASMIK®-VET kit devices are easy to use and absolutely safe; therefore, they can be used by pet owners unassisted without special training at home. Various intravenous laser blood illumination options, primarily ILBI-525 and LUVBI®, have already demonstrated their effectiveness in a hospital setting. Only LASMIK®, the unique device for low-level laser therapy, enables to implement these techniques.

This book is intended for veterinarians and for everyone interested in new effective methods for treating pets.

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LIST OF ABBREVIATIONS

ANS	–	autonomic nervous system
AP	–	acupuncture point
ATP	–	adenosine triphosphate
BA	–	biomodulating action
CBF	–	cerebral blood flow
CM	–	continuous mode
CNS	–	central nervous system
EMR	–	electromagnetic fields
IgE	–	immunoglobulin
ILBI	–	intravenous laser blood illumination
iNOS	–	inducible nitric oxide synthase
IR	–	infrared (range, spectrum)
LED	–	Light Emitting Diode
LILI	–	low-intensity laser illumination
LLLT	–	low-level laser therapy
LUVBI®	–	laser ultraviolet blood illumination
MLLLT	–	magnetic low-level laser therapy
MM	–	molecular mass
MSS	–	musculoskeletal system
NLBI	–	non-invasive (extravenous, transcutaneous, percutaneous) laser blood illumination
NO	–	nitric oxide
PD	–	power density
PM	–	pulsed mode
RCTs	–	randomized controlled trials
REG	–	rheoencephalography
SARZ	–	subatlantal reflexogenic zone
SG	–	sweat gland
TPLO	–	tibial plateau leveling osteotomy.
UV	–	ultraviolet (range, spectrum)
UVBI	–	ultraviolet blood illumination
WBC	–	white blood cell

INTRODUCTION

According to the INTERFAX.RU data (https://www.interfax.ru/russia/631927), published for the World Animal Day on October 4, 2018, the number of pets in Russia increased by 6.3 million, or 14%, over three years. There are approximately 33.7 million domestic cats in Russia; which is almost twice as many dogs (18.9 million). Russia has the third highest number of cats and the fifth highest number of dogs in the world. Fifty-five million Russian households (53% of the total population) have pets; moreover, 15% of the respondents have both a cat and a dog. At the end of 2019, the Russian Public Opinion Research Center (VTsIOM) reported even more impressive figures – 68% of Russian families surveyed have pets. Meanwhile, the world leaders are the United States and China, with 86 and 85 million cats, respectively. In terms of dogs' population, China (141 million), the United States (78 million), Brazil (42 million), and Mexico (19.3 million) are ahead of Russia.

It is gratifying to note that Russians are quite responsible for the welfare of their pets by feeding them and providing veterinary services to them. Almost 68% of dog owners take their pets to a veterinarian more than once a year.

Unfortunately, traditional methods frequently used for treating domestic animals not only fail to lead to recovery but can even cause various complications and long-lasting disease progression, resulting in chronic pathological processes. These challenges have been solved by advanced sciences and technologies, among which low-level laser therapy (LLLT) techniques are one of the most effective methods that demonstrates high therapeutic outcomes even in cases where doctors cannot help in the recovery process.

Low-power laser light was first used as a highly effective therapeutic agent in Russia more than 50 years ago. Nowadays, LLLT is developing mainly due to the efforts of Russian scholars and physicians, and it has become increasingly widespread and recognized in other countries. Over several decades, hundreds of treatment and prevention techniques for overcoming the recurrence of various diseases have been developed in Russia in almost all areas of medicine. Thus, Russia boasts of the most effective LLLT techniques and the best LLLT equipment in the world. Foreign experts are gradually beginning to recognize the effectiveness of LLLT, and they are predicting its active implementation in all areas of medicine. However, their understanding of LLLT methodology and mechanisms is limited [Kemper K.J., 2018].

The mechanism of the therapeutic action of low-intensity laser illumination (LILI), which is thermodynamically triggered by Ca^{2+}-dependent processes, made it possible to consider the problem of increasing the effectiveness of LLLT and methodological approaches for selecting general treatment tactics. Currently, there is a profound scientific basis, which describes in detail the processes that occur during low-intensity laser light absorption. Based on this fact, we were able to develop the LLLT technology. As a result, the strict implementation of a certain sequence of fairly simple manipulations with the initially set-up parameters almost guarantees the necessary therapeutic effect. This allows professionals to understand the modes and characteristics of the technique (wavelength, power, LILI pulse repetition rate, operational mode of the laser, exposure time, and localization) that should be varied to enhance the effect.

The life-giving, literally, or, as they say in scientific circles, the biomodulating action (BA) of LILI was first discovered in animal experimentation, which for a long time served as an excellent argument against the often-expressed doubts about the effectiveness of LLLT. We often heard statements such as "All these measures are just a placebo and nothing else. No one has ever conducted randomized controlled clinical trials," from foreign colleagues in the 1980s and 1990s. However, what kind of neuroinduction can animals have when the laser beam is invisible and not felt, and animals recover after being subjected to LLLT?

Animals have made an invaluable contribution to the development of clinical medicine, including LLLT; therefore, they deserve this safe and highly effective treatment method in veterinary practice.

Over the fifty-year period, numerous laser therapy devices have been developed and continuously improved, which, in turn, has contributed to the development of the LLLT technique. The state-of-the-art LASMIK® devices allow for the most effective implementation of almost all techniques, including various options for intravenous laser blood illumination (ILBI) and laser acupuncture. As a rule, these devices are used in the hospital environment. Meanwhile, it is often necessary to work in "field" conditions, for example, with farm animals or in the case of a house-call.

There are small-sized self-powered devices for field operations, for example, LASMIK®-VET and LASMIK®-AP. The kit has been designed to treat sport horses and keep their fit. It also allows for the most effective treatment of other domestic and farm animals. The key features and benefits of LLLT include:

- highly efficient treatment with the actual absence of contraindications;
- painless and short-term procedures;
- significantly shortened treatment time and reduced costs;
- good treatment results in severe cases when other methods are ineffective;
- effective prevention of diseases and the best animal rehabilitation results, for example, after a surgical intervention;
- increased endurance and performance of animals;
- reduced drug load and eliminated negative effects of drugs on the animal's body;

– possibility of applying this technique in veterinary clinics, at home, and on the farm.

It is preferable to administer LLLT in conjunction with traditional treatments, including good nutrition, care, and medication, to achieve the best results. We also draw attention to one more important issue. The parameters of the selected techniques (power, frequency, exposure time, and localization), which are given in this book, are basic. The techniques may and should be adjusted with regard to the differences in the individual “sensitivity” of the animals to laser exposure, the severity of the disease, and other factors. Accordingly, it is necessary to take specialized courses or attend lectures by LLLT experts.

The authors hope that this book will be useful to readers. Please feel free to contact us with questions by email: 7652612@mail.ru, you may enroll in training courses by tel. +7 (985) 765-2612. For basic information, please visit our https://www.matrixmed.ru.

GENERAL ISSUES OF LOW-LEVEL LASER THERAPY APPLICATION

Mechanisms of Biomodulating and Therapeutic Action of Low-Level Laser Therapy

The process of therapeutic action 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 of molecules, the stereo-chemical rearrangement of molecules, the local thermodynamic shifts and 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 a cellular level and 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, neurohumoral and endocrine regulation systems, etc.).

All this variety of the developing processes determines 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 'whole body' level. This explains numerous, if not all known phenomena in this field of biology and medicine.

It was previously shown that the initial starting moment of the biological action of LILI is a local violation of the thermodynamic equilibrium, causing the release of calcium ions from the intracellular store and the propagation of waves with an increased concentration of Ca^{2+} in the cytosol of the cell, triggering Ca^{2+}-dependent processes [Москвин С.В., 2003, 2008, 2014, 2016]. Then secondary effects develop, which are a complex of the 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 the cell metabolism and increase in its 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 enzymatic and catalase activity, permeability of the cytoplasmic membranes, contributing to the acceleration

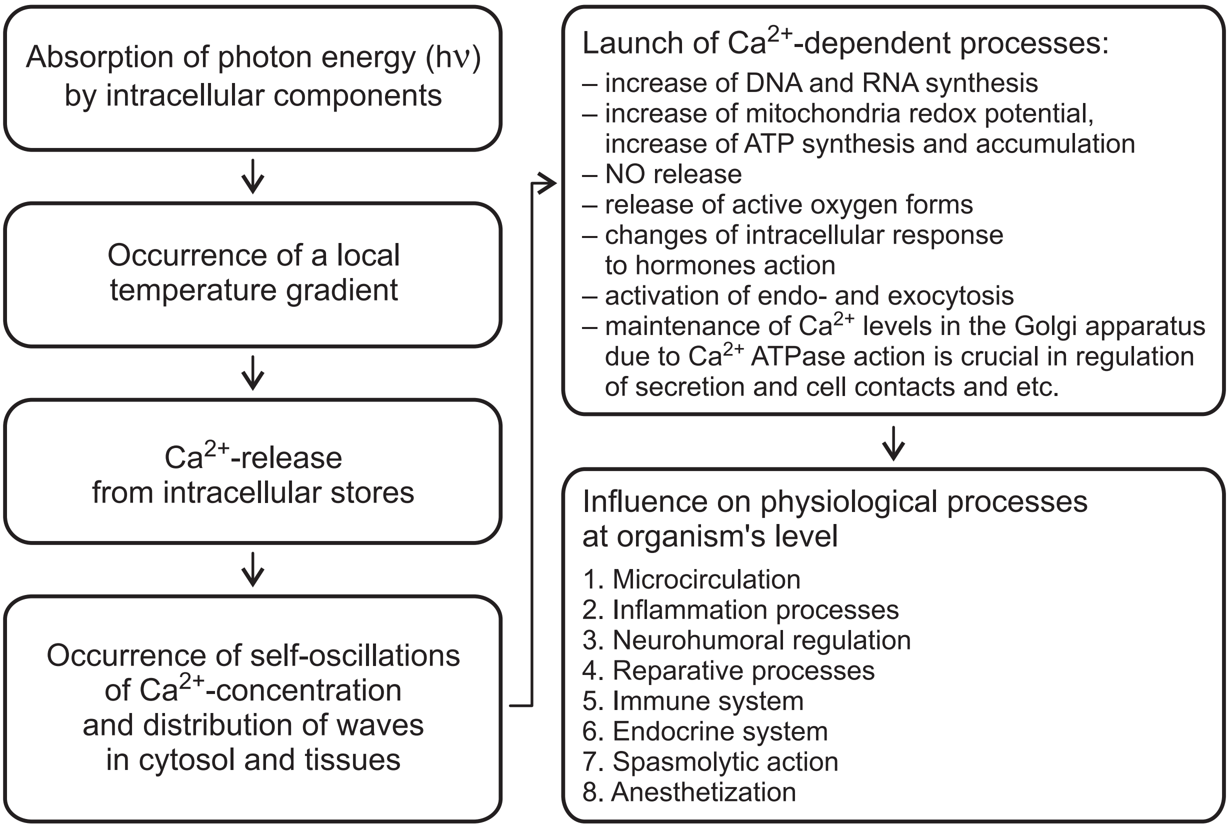

Fig. 1. The sequence of development of biological effects after exposing living bodies to LILI

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 are activated. An 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 interferons, increased synthesis of immunoglobulins and changed function and structure of plasma membranes and 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 of erythrocytes and lymphocytes.

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.

Low-level laser therapy, conducted before the start of any 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 activate 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 require maximum versatility of the equipment used to ensure maximum efficiency of the therapeutic effects, which, in turn, is ensured by the following procedures:

- (separate) use of LILI with 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 (Fig. 2): 1 – the base unit (usually 2 – and 4-channel); 2 – laser emitting heads for different low-level laser therapy techniques; 3 – optical and magnetic nozzles; 4 – Matrix-Bio biocontrol unit.

The base unit is the basis of each set; it is a 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.

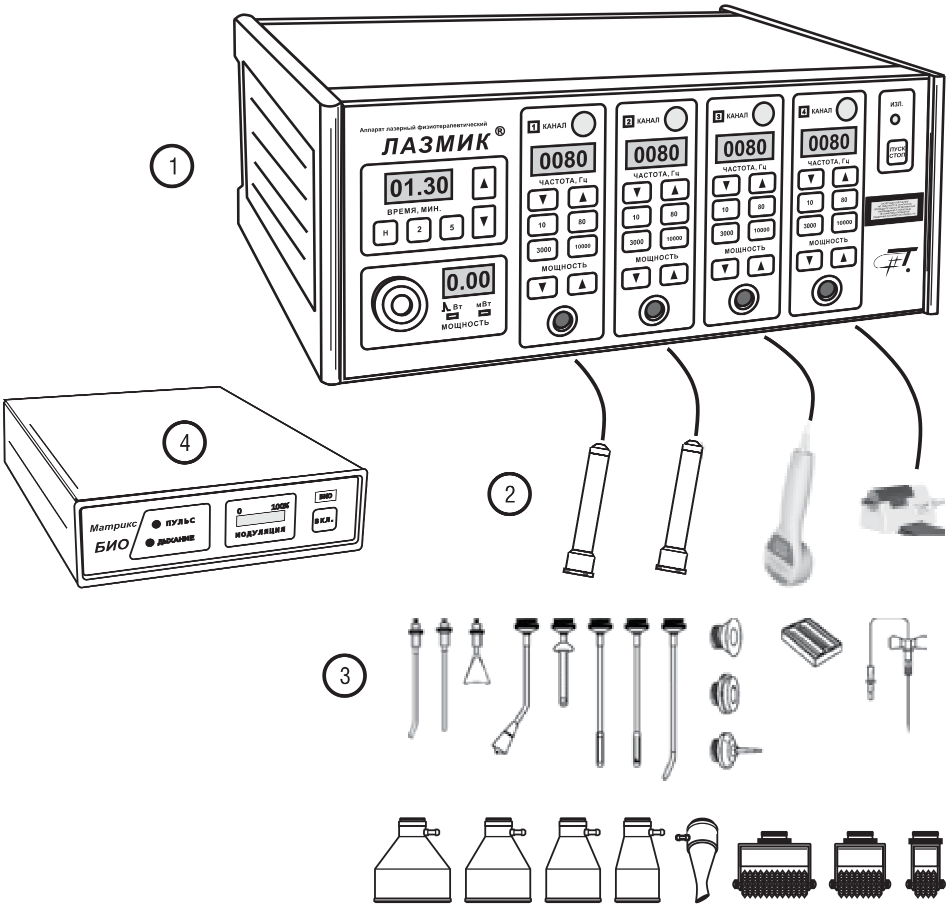

Fig. 2. The modular design concept of low-level laser therapy equipment as exemplified by the Matrix and LASMIK® series, where:
1 – the base unit (usually a 2-channel and 4-channel);
2 – laser emitting heads for various LLLT techniques;
3 – optical and magnetic nozzles;
4 – the biocontrol unit Matrix-BIO

Control of parameters not only insures against errors in 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 emitting 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.

Laser therapeutic devices of the 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 highly efficient specialized complexes, which have already proved themselves as the best. Find more detailed information in a color inset.

The 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-level laser illumination (LLLI), generated by special sources. These lasers are a healing factor. The main properties of laser light are the monochromaticity, coherence, polarization and directionality, due to which low-level 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 within a spectral width of less than 3 nm may be taken conventionally as monochromatic. This property offers the opportunity for selective action on the structural components 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 the orientation of electric and magnetic field vectors relative to the direction of the electromagnetic wave propagation. If two mutually perpendicular components of the electric field vector oscillate with a time-constant phase difference, this wave is polarized.

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

The average capacities of physiotherapeutic lasers are often within the ranges of 1–100 mW, pulse power varies from 5 to 100 W with duration of light pulses being 100–130 ns (~10–7 s). The nature of the primary photobiological reactions is determined by the energy of quanta of optical illumination of less than 2eV on 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 on the ultraviolet and green spectra with higher energy of quanta.

There are many randomized controlled trials (RCTs) by a number of researchers that are based on the data that irrefutably proved the diverse medicinal properties of LILI are defined by the following effects [Москвин С.В., 2014, 2016]:

– microcirculation activation;
– immunomodulatory and anti-inflammatory effect;
– analgesic effect;

– tissue proliferation and regeneration activation;
– diversified action on the nervous tissue, including reflex action.

Low-level laser therapy has found widespread application in clinical practice. There is a large amount of factual material, confirming its high efficacy in the treatment of patients with diseases of the musculo-skeletal, cardiovascular and nervous systems, as well as diseases of the ear, nose and throat, and also 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. Therefore, in 2015, a group of leading specialists in the field of low-level laser therapy prepared and approved the corresponding Clinical Recommendations, which formulated the rules (protocols) and basic principles for the implementation of low-level laser therapy techniques.

Low-Level Laser Therapy Protocol Requirements

Fulfilling all the requirements for the implementation of the low-level laser therapy protocols is mandatory, since the need to set all the parameters of methods listed below is clearly proved. Even one wrong value will not allow getting a predictable and adequate response to laser light action and the desired therapeutic effect, respectively.

Setting energy parameters substantially depends on the laser operating mode and technique. A majority of Russian devices have a laser hazard Class 1M or 2M according to IEC 60825-1: 2007, while foreign lasers mainly have 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 an inhibitory effect.

All techniques of low-level laser therapy must contain the following information (Tables 1–7).

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

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

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

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

Table 1

Parameters of contact-mirror and distant low-level laser therapy techniques

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	445 (blue), 525 (green), 635 (red), 780, 808, 904 (IR)	Emitting head with one laser
Laser operational mode	Continuous	445, 525, 635, 780, 808 nm
	Pulsed	635 and 904 nm
Duration of the light pulse, ns	100–150	For pulsed mode
Power	10–40 mW	Continuous mode
	5–25 W	Pulsed mode
Power density (More absorption – less value)	5–40 mW/cm^2	Continuous mode
	5–15 W/cm^2	Pulsed mode
Frequency, Hz	80–150	For pulsed mode
Exposure per one zone, min	2 or 5	–
Number of the exposed zones	1–4	–
Localization	On affected area	–
Technique	Contact-mirror	With the use of a mirror (ZN-35 or ZN-50) or magnetic nozzle ZM-50
Number of procedures per course	5–12	Daily or on alternate days

Table 2

Parameters of contact technique for matrix laser emitting heads

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	–
	904 (IR)	
Laser operational mode	Pulsed	Matrix emitter consisting of 8 laser diodes of the total surface area of 10 cm^2
Duration of the light pulse, ns	100–150	For pulsed mode
Power, W	35–40	635 nm
	60–80	904 nm
Power density, W/cm^2	4–5	635 nm
	8–10	904 nm
Frequency, Hz	80–10,000	Depending on the depth of the intended exposure and wavelength
Exposure per one zone, min	1.5–2 or 5	–
Number of the exposed zones	1–4	–
Localization	On the affected area and the projection of the internal organs	–
Technique	Contact	Through a transparent nozzle PMN
Number of procedures per course	5–12	Daily or on alternate days

Table 3

Parameters
of contact low-level laser therapy technique

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	780, 808, 904 (IR)	Emitting head with one laser
Laser operational mode	Continuous	780 nm and 808 nm
	Pulsed	904 nm
Duration of the light pulse, ns	100–150	For pulsed mode
Power	100–200 mW	780 and 808 nm
	80–100 W	904 nm
Power density	–	The maximum possible
Frequency, Hz	3000–10,000	For pulsed mode
Exposure per one zone, min	5	In some techniques exposure is allowed up to 30 min
Number of the exposed zones	1–4	Most often symmetrically
Localization	On affected area	–
Technique	Contact	Directly touching the surface with the laser diode
Number of procedures per course	15–20	Generally, daily. The course is repeated in a month

Table 4

Parameters
of laser acupuncture technique

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	525 (green)	On auricular AP
	635 (red)	On corporal AP
Laser operational mode	Continuous or modulated	–
Frequency, Hz	In a recipe	Only for modulated mode
Power*, mW	0.5–1	525 nm
	2–3	635 nm
Exposure per 1 AP, s	5–10	On auricular AP
	20–40	On corporal AP
Number of the exposed zones	Up to 15	–
Localization	In a recipe	On auricular AP
	In a recipe	On corporal AP
Technique	Contact	Through an acupuncture nozzle
Number of procedures per course	10–12	Daily

Note. * – at the output of an acupuncture nozzle.

3. Beam output power.

The 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 repetition frequency for pulse 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 (most commonly 100–150 ns). The average power of pulsed lasers ($P_{av.}$) is directly proportional to the pulsed power (Pp), pulse duration (τp) and frequency (Fp): $P_{av.} = Pp \times \tau p \times Fp$.

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

The required area is almost always provided by the procedure without carrying out unnecessary measurements, for example, in contact-mirror method the area is assumed to be 1 cm^2. In matrix emitters laser diodes must be positioned so that the area of theirimpact would provide the multiplicity in power density. For example, 8 (most often) pulsed laser diodes having a power of 10 W shall be disposed on the surface of 8 cm^2, and in contact with the skin through a transparent tip PD will be 10 W/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 absorption of the laser light energy in the volume of biological tissues.

7. Power density (PD) 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).

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 $W \cdot s/cm^2$] shall not be carried out, because this information is not necessary to provide effective low-level laser therapy.

It is recommended to include one of the methods of overall impact into the protocol (laser acupuncture or ILBI), and the 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 administered directly on the affected area, located close to the surface of the body, either through direct contact through the mirror nozzle or by distance, in a stable manner, at a short distance from the surface (1–2 cm), if it is impossible to provide direct contact. Sometimes a combined physiotherapy method – magnetic low-level laser therapy (MLLLT) – is used with a laser beam acting through the opening of a permanent magnet, with an induction of 35–50 mT [Москвин С.В., 2016].

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

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

The frequency for *pulsed lasers* varies depending on the desired effect: regeneration – 80–150 Hz, anesthesia – 3,000–10,000 Hz. 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 5 minutes.

Local action of LILI on the projection of the affected organ of body differs from surface illumination, as only pulsed infrared lasers are used, and matrix lasers are desirable to ensure a therapeutic effect at a depth of 15 cm: wavelength 890–904 nm, PD – 8–10 W/cm^2, pulse duration of 100–150 ns, frequency of 80–10,000 Hz. By increasing the frequency in pulsed lasers, the average illumination power increases proportionally as well, which allows the influencing of deeper areas. It is strictly forbidden to illuminate one area for more than 5 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 635 nm (red spectrum), continuous or modulated modes are used, nozzle output power is 2–3 mW, exposure per one corporal acupuncture point (AP) ranges from 20 to 40 s, making it 5–10 s per auricular acupuncture point (AP).

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

The Matrix and LASMIK® devices (Fig. 3) allow carrying out both intravenous and non-invasive laser blood illumination, as well as other methods of laser exposure. The maximum effectiveness of treatment is also based on the optimized design of the laser heads, e.g. a special system of fixing disposable light guides and the heads on the arm is used for ILBI (Fig. 3, bottom left), matrix emitting heads are used for NLBI (Fig. 3, bottom right, and Fig. 4).

For ILBI, the LILI is always used in continuous mode, laser action is carried out intravenously through special disposable sterile light guide with a puncture needle (Fig. 5) most often in the cubital vein (Fig. 6) [Гейниц А.В., Москвин С.В., 2009; Гейниц А.В. и др., 2012].

Fig. 3. Laser therapeutic device LASMIK®

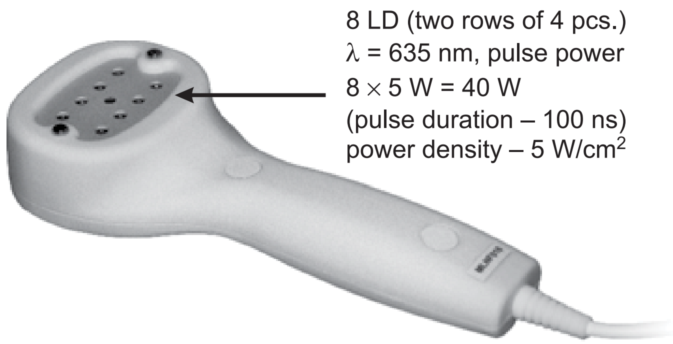

Fig. 4. Matrix laser emitting head ML-635-40

To implement ILBI, different techniques are currently applied using laser light of different spectra (Tables 5, 6):

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

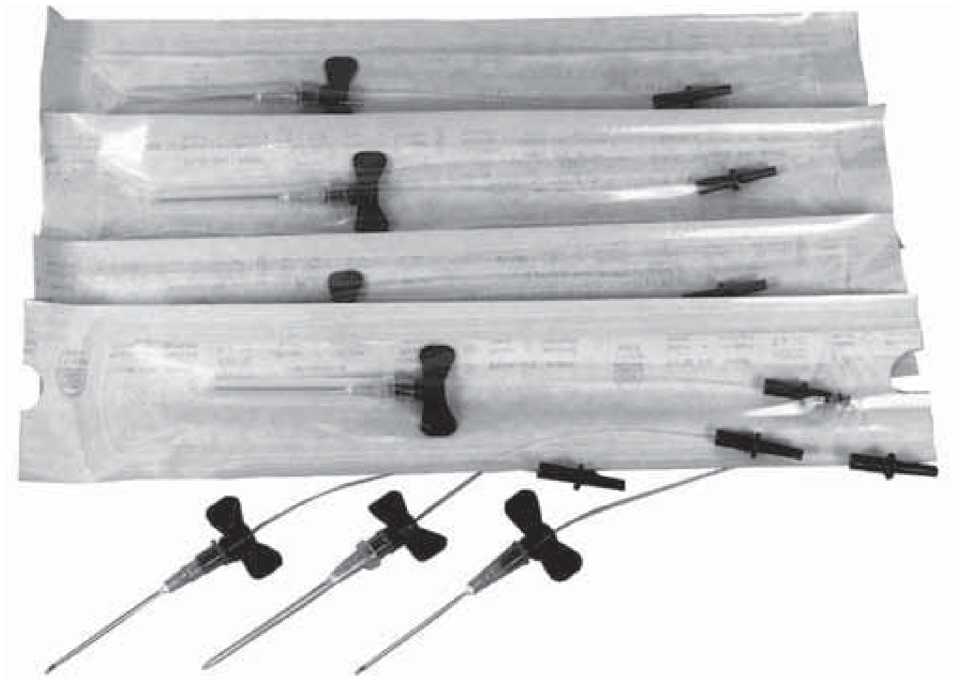

Fig. 5. Disposable sterile light guides for ILBI

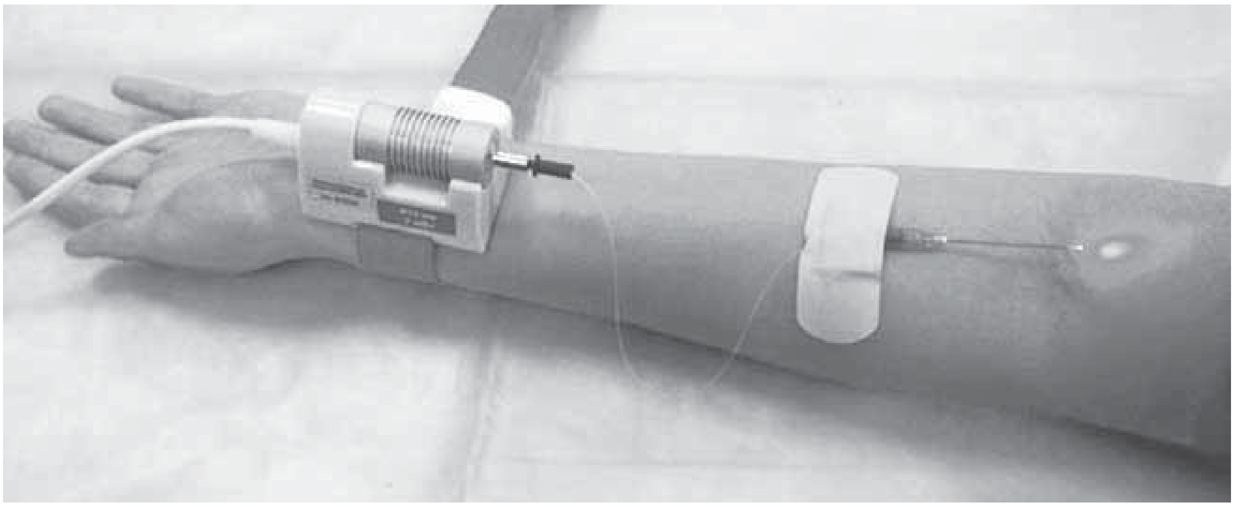

Fig. 6. The ILBI Procedure

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

Laser ultraviolet blood illumination (LUVBI®, wavelength 365–405 nm, power is 1.5–2 mW, exposure for 3–5 minutes) should be preferably used for the correction of immune disorders caused by illness or injury.

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

Table 5

Parameters of ILBI-525 + LUVBI® technique (basic)

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	365–405 (UV)	LUVBI®
	520–525 (green)	ILBI-525
Laser operational mode	Continuous	–
Power, mW	1.5–2	At the output of a disposable light guide
Exposure, min	3–5	LUVBI®
	7–8	ILBI-525
Localization	Median cubital vein (*v. mediana cubiti*)	–
Technique	Intravenously	Through a disposable sterile light guide
Number of procedures per course	10–12	Daily, alternating ILBI-525 and LUVBI® every other day

Note. Here and in Table 6: * – at the output of the KIVL-01 disposable light guide produced by Research Center Matrix (TU 9444-005-72085060-2008).

Table 6

Parameters of ILBI-635 + LUVBI® technique

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, min	3–5	LUVBI®
	10–20	ILBI-635
Localization	Median cubital vein (*v. mediana cubiti*)	–
Technique	Intravenously	Through a disposable sterile light guide
Number of procedures per course	10–12	Daily, alternating ILBI-635 and LUVBI® every other day

the red (635 nm) and infrared (890–904 nm) spectra and matrix emitters (8 laser diodes) or, as an option, a single laser with a mirror nozzle are used mainly for NLBI (Table 7) [Москвин С.В. и др., 2007]:

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

Table 7

Parameters of NLBI technique

Parameter	Value	Notes
Laser light wavelength, nm (spectrum)	635 (red)	NLBI-635
	904 (IR)	NLBI-904
Laser operational mode	Pulsed	–
Duration of the light pulse, ns	100–150	–
Power, W	30–40	Matrix emitting head, NLBI-635
	60–80	Matrix emitting head, NLBI-904
Power density, W/cm^2 (surface area 10 cm^2)	3–4	NLBI-635
	6–8	NLBI-904
Frequency, Hz	80–150	–
Exposure per one zone, min	2–5	–
Number of the exposed zones	2–4	Symmetrically
Localization	On the projection of large blood vessels close to the lesions	Refer to the text
Technique	Contact	Through a transparent nozzle
Number of procedures per course	10–12	Daily

The following exposure localizations are used for NLBI:

– projection of the common carotid artery (sinocarotid zone) symmetrically;
– projection of the vertebral artery symmetrically;
– left supraclavicular area;
– vascular bundles in groin symmetrically;
– popliteal fossa symmetrically.

In large animals, NLBI is carried out in the projection of the jugular vein, and in small animals, most often in the projection of the femoral vein [Стикина Е.О., Притула Е.А., 2000].

Pulse repetition frequency is fixed (80–150 Hz), the question of possibility and admissibility of increasing the frequency (i.e. the average power for pulsed lasers) has not been studied at present. It is recommended to illuminate symmetrical zones, the exposure for each zone needs to be 2–5 minutes. It is strictly forbidden to illuminate one area for more than 5 minutes!

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

To deliver pulsed IR LILI (890–904 nm), it is required to use only the quartz-polymer fiber, as the polymer (PMMA) absorbs nearly all the illumination with wavelengths longer than 830 nm.

Laser phoresis is one of the more modern practices of physical and pharmacological methods of the combined percutaneous application of LILI and medicinal preparations. As a result of LILI, 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. This percutaneous injection-free method of substance administration is possible only with low molecular weight (no more than 500 kDa) and hydrophilic compounds [Москвин С.В., Кончугова Т.В., 2012].

The parameters of the technique:

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

For pulsed lasers frequency is not changed. One area may have up to 15–20 local areas, with an exposure time of 1–1.5 minutes for each zone, but no more than 20 minutes in total.

The presented principles of the low-level laser therapy procedures formation 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 LILI energy parameters, for example, for pain relief or suppression of excessive proliferation it is required to set up extremely high frequencies – up to 10,000 Hz (recommendation refers exclusively to the pulsed lasers with pulse duration of 100–200 ns and pulsed (peak) output power up to 300 W).

LASMIK®-VET Kit for Veterinary Medicine

Initially, LASMIK®-VET was developed to specifically treat and rehabilitate horses and maintain their fitness. Still, the capabilities of the devices are much greater, allowing for the most effective treatment of other domestic and farm animals.

The kit includes two low-level laser therapy devices with an autonomous battery power supply (Fig. 7).

Fig. 7. LASMIK®-VET, a low-level laser therapy kit for veterinary medicine

LASMIK®-VET

The device is a matrix pulsed laser, an analogue of the ML-904-80 laser emitting head for Matrix and Lasmik laser therapeutic devices. It is intended for local exposure.

Main technical characteristics of the device:

– wavelength – 904 nm;
– operating mode – pulsed;
– light pulse duration – 100 ns;
– power – 80 W;
– number of laser diodes – 8 pcs.;
– frequencies: 80 and 10,000 Hz;
– timer: 0.5, 1, 2, 5 min.

LASMIK®-AP

It is designed for laser acupuncture and local illumination.

Main technical characteristics of the device:

– wavelength – 635 nm;

– power – 5–10 mW;
– number of laser diodes – 1 pc.;
– mode of operation – continuous work;
– timer – 30 s.

Optical attachments

Acupuncture nozzle A-3 – 1 pc.
PMN nozzle (transparent protective) – 1 pc.
Mirror attachment ZN-35 – 1 pc.
MM-50 attachment (magnetic 50 mT) – 1 pc.
ZM-50 attachment (magnetic 50 mT) – 1 pc.

Additionally

Charger – 1 pc.
Charging cord – 2 pcs.
Book "Low-level laser therapy for sports horses" (in Russian and English) – 1 set.
Book "Low-level laser therapy for pets" (in Russian and English) – 1 set.
Bag – 1 pcs.

Quite often, customers also purchase LASMIK® laser therapeutic device with KL-ILBI-525-2 and KL-ILBI-365-2 laser emitting heads for intravenous laser blood illumination in addition to kit to implement the most effective version of the combined technique ILBI-525 + LUVBI®.

Our specialists provide consultations via email concerning the application of low-level laser therapy in veterinary medicine: 7652612@mail.ru

Laser Acupuncture in Veterinary Medicine

In this section, we supplement the information from the relevant chapter of the book devoted to sport horses' treatment [Москвин С.В., Ягупов Н.А., 2020; Moskvin S.V., Yagupov N.A., 2020]; we recommend you to familiarize with the available material. The basic acupuncture points (AP), according to the latest recommendation of the International Veterinary Acupuncture Association, are shown in Table 8 and Fig. 8 [Canine acupuncture points, 2020; Koh R., 2019]. Basic prescriptions (Table 9) are taken from other publication [Xie's Veterinary Acupuncture, 2007]. There are plenty of publications on this subject matter [Нифонтов К.Р., 2009; Рябуха В.А. и др., 2006, 2009; Пат. 2704472 RU; Самороковский А.В., 2007; Chan W.W. et al., 2001; Fry L.M. et al., 2014; Habacher G. et al., 2006; Rose W.J. et al., 2017; Roynard P. et al., 2018; Ruffoni P., Pozzi R., 2020].

CONCLUSION

Long ago, at the dawn of civilization, man tamed wild animals for the purposes of hunting and foraging. Subsequently, selective breeding the types of animals designed for the specialized purposes. Without animals, man could not survive, and now is the time to take better care of them, since farm and domestic animals, unfortunately, become sick. However, in the case of farm animals, it is still more a matter of economics; moral suffering and worries about the fate of pet are the main motivators for veterinary medicine development.

LLLT optimizes the healing process, especially in cases where traditional medication fails to achieve positive results. This applies to a greater extent to such manifestations of conditions as paresis, paralysis, cardiovascular failure, arthritis, and various injuries; however, this is not a complete list. Moreover, the selected techniques of LLLT presented in this book are only elementary. They can be significantly improved, the effectiveness of treatment can be increased, and the scope of the method can be expanded.

Studies that assess the safety and effectiveness of new treatment methods are first tested on animals; therefore, low-level laser therapy being so widespread in the clinical environment is largely due to experimental work. It is time to apply effective techniques previously designed for humans to treat our pets.

We hope that this book and laser therapy devices will allow professionals and pet owners to release our pets from suffering.

APPENDIX 1

LASMIK® laser phoresis technology: mechanisms and therapeutic experience

Percutaneous[1] laser phoresis is a well-known[2] and very effective technique for the combined use of various therapeutic physical factors[3] [A.c. 1012923; Миненков А.А., 1989].

The mechanisms of percutaneous laser phoresis, the ways and conditions for the penetration of biologically active substances, based on an understanding of the skin structure, function and physiology, have been thoroughly researched.

Substances can penetrate through the skin in three main ways:

- transepidermal;
- intercellular;
- and an additional one, through shunts: substances are transported through the sweat glands and hair follicles.

One of the main functions of the skin is to protect the body from external exposure; therefore, transepidermal penetration of aqueous solutions of various substances, (i.e., literally directly through the layer of epidermal cells), is practically impossible [Михайлов И.Н., Виноградова Е.В., 1982]. The third way is undoubtedly most important for the penetration of major substances; therefore, it is crucial to understand the properties which macromolecules must have in order to be able to penetrate into the skin. In addition, there are other factors that influence penetration:

- specific cutaneous factors (place and area of application; human age, skin condition, temperature and degree of hydration; blood supply intensity, etc.);
- characteristics of the substance (molecular weight, chemical structure, conformation, hydrophilicity);
- available external factors (frequency and type of electromagnetic radiation, energy characteristics and exposure).

Whereas the transepidermal route through the intercellular spaces is practically impossible, the situation with cutaneous appendages is completely different. The duct of the sweat gland (SG) has dermal and epidermal parts, it opens

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[1] This refers to the area of application in the context of the article; however, laser phoresis is also actively used for intraoral, rectal or intravaginal administration of drugs.

[2] This refers to Russia, which has an almost 200-year history of the development of physiotherapy and balneology as scientific areas in medicine.

[3] Electromagnetic fields (EMR) of various frequencies are implied; several dozen options are currently used.

on the top of the skin combs, the pore diameter is 60–80 μm, and the gaps are 14–16 μm in diameter [Цветкова Г.М., 1999]. According to different authors, the SG density ranges from 64 to 431 per 1 cm^2 depending on the localization and national identity of a person; it is greatest on the face – up to 174 per 1 cm^2, and on the palms – up to 424–431 per 1 cm^2, and their total amount is from 2 to 5 million. Assuming that the total area of the lumens of the excretory ducts is less than 1% of the skin surface (57–94 cm^2 (i.e.), the secretory surface of all SGs has an area of up to 5 m^2, i.e., 3 times larger the total area of the epidermis. The skin layer in which the sweat-gland glomeruli are located is 1.3–3.12 mm thick, and the entire volume this layer amounts to 3200 cm^3 [Калантаевская К.А., 1972; Куно Яс, 1961; Cage G.W., Dobson R.L., 1965; Gordon R.S., Jr., Cage G.W., 1966; Montagna W., 1962].

According to different authors, the density of hair follicles varies widely in different parts of the skin, from 60 ± 40 on the scrotum skin to 830 ± 100 on the cheeks of men depending on age, gender, hair color, nationality, etc. The number of visible hairs is much smaller or they are completely absent in some parts of the body (palms, feet, etc.) [Калантаевская К.А., 1972; Человек. Медико-биологические данные…, 1977; Szabo G., 1967].

Thus, we see that there are more than 1000 potential "inputs" for macromolecules of significant size on the human body per 1 cm^2 of the surface, and this is quite enough for the required amount of substance to penetrate. Further, the process gets more active due to an increase in the area of contact with glandular and epithelial cells. Moreover, the fact of the molecular penetration through the entrance does not automatically mean their further advancement, since it is necessary to pass through the cells of the glands and/or epithelium.

The mechanism that allows this to be implemented is well known; it is called transcytosis (pinocytosis) and involves a process that combines the signs of exo- and endocytosis. An endocytic vesicle (endosome) forms on one surface of a cell; this endosome is transferred to the opposite edge of the cell, becoming an exocytotic vesicle and releasing its contents into the extracellular space. The entire process (complete passage of the substance) takes no more than 1 min. This mechanism is known as the main one, which ensures the absorption of small drops of water, proteins, glycoproteins and macromolecules with a maximum size of up to 1000 nm (1 μm) by cells and provides the work of the endocrine glands [Glebov R.N., 1987; Tammi R. et al., 1991]. The Nobel Prize in Physiology or Medicine 2013 was awarded jointly to James E. Rothman, Randy W. Schekman and Thomas C. Südhof "for their discoveries of machinery regulating vesicle traffic, a major transport system in our cells" [The Nobel Prize in Physiology or Medicine 2013. https://www.nobelprize.org/prizes/medicine/2013/summary/].

Therefore, to implement laser phoresis, the substance must be hydrophilic and have fragments up to 1 μm in size. It is clear that no problems should arise (nor do any arise) in the case of laser phoresis of aqueous solutions of low-molecular weight compounds, which are mainly used in medicine [Миненков А.А., 1989]. The situation is different with hyaluronic acid (HA), which in its natural state is prone to form long filaments, for example, ranging from 450 nm (0.45 μm) to 4200 nm (4.2 μm) in a cartilage. However, in an aqueous solution, the same HA molecule (1000 kDa), having an extended length of 2500 nm (2.5 μm), forms a sphere of only 200 nm in diameter [White A. et al., 1973].

It is known that thermodynamic triggering of Ca^{2+}-dependent processes is the primary mechanism of biomodulating action of low-intensity laser light (LILL). During LILL absorption, a local short-term violation of thermodynamic equilibrium occurs, which results in Ca^{2+} ions release from the intracellular depot and their consequent propagation in the form of waves throughout the cell, initiating the activation of Ca^{2+}-dependent processes [Москвин С.В., 2008], which, in particular, are endo- and exocytosis [Глебов Р.Н., 1987; Carafoli E. et al., 2001; Plattner H. et al., 1997]. Thus, Ca^{2+} ions release induced by LILL leads to transcytosis activation in general; this is the principal process in the laser phoresis mechanism.

Most notably, laser phoresis is not only the easiest and economically feasible method to implement, but it is also the most a very effective procedure. Fig. 11 shows the comparison between the effectiveness of various physical factors affecting the penetration of carbochromene through the cell membrane, which demonstrates the indisputable advantages of laser phoresis [Миненков А.А., 1989].

Although we are cognizant aware of the laser phoresis mechanisms, an extremely important question refers to the molecular mass (MM) of HA molecules, which can be introduced percutaneously, and to the result which can be obtained.

It has been shown that in women HA concentration in the skin decreases with aging, which is especially pronounced after 60 years [Ghersetich I. et al., 1994]. Over time skin gets severely dehydrated, the fragility of blood vessels increases, new wrinkles appear and current wrinkles deepen, resulting in decreased skin thickness and turgor. Presumably this is associated, inter alia, with HA deficiency, which serves as a justification for HA introduction into the skin.

It is known that high-molecular weight HA (more than 2000–6000 kDa) is applied to intradermal injections; in contrast, HA with a molecular weight of up to 600 kDa can penetrate directly through the skin [Tammi R. et al., 1988, Tammi R. et al., 1991]. The research by M. Farwick et al. (2008) showed that HA possesses skin-friendly properties that can be controlled by the use of HA with various MM. Thus, low-molecular weight HA (50 kDa) is better transported through the skin cover than HA with high MM (800 kDa); it also activates a larger number of keratinocyte genes, including genes responsible for the differentiation of keratinocytes and the formation of complexes of intercellular

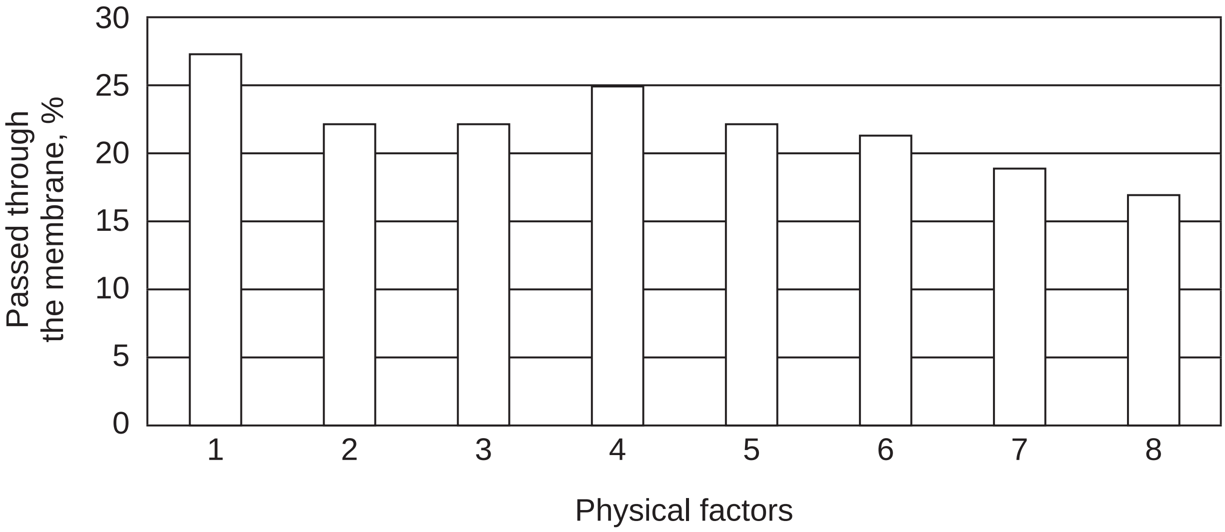

Fig. 11. The impact of various physical factors on the phoretic mobility of carbochromene in various physical fields (5 min exposure): 1 – helium-neon laser illumination (wavelength 633 nm, power 20 mW); 2 – short-wave ultraviolet illumination (254 nm, lamp power 220 W); 3 – ultrasound illumination (0.88 MHz, 0.6 W/cm^2); 4 – EMR (460 MHz, 2 W); 5 – EMR (40.7 MHz, 15 W); 6 – alternating magnetic field (50 Hz, 35 mT); 7 – permanent magnetic field (30 mT); 8 – direct electric current (electrophoresis) (Миненков А.А., 1989; Москвин С.В., Миненков А.А., 2012)

contacts, which decreases in photo-damaged and aging skin. The moisturizing effect and increased skin elasticity are more inherent in high-molecular weight HA, while low-molecular weight HA showed the wrinkle-tightening effect. The authors explain the increase in activity with the decreasing molecular weight of HA through better transepidermal penetrating ability for smaller HA molecules.

We developed custom hyaluronic acid (2% sodium hyaluronate) with a molecular weight of 250–750 kDa that is applied by LASMIK® technology. A mix of HA with different MM enables getting a quickly visible result in the form of tightened fine wrinkles, and provides a long-term effect that lasts up to 1–3 months [Москвин С.В. и др., 2010; Рязанова Е.А., 2007]. This will be discussed further.

Laser phoresis, including HA-based preparations, has long been successfully used in medicine (Table 14). However, it is cosmetology and dermatology that are the main areas of application of this technique [Гейниц А.В., Москвин С.В., 2010; Москвин С.В., Кончугова Т.В., 2012].

Thus, an understanding of the mechanisms of laser phoresis and biological action (BA) of LILI at the cellular and tissue levels, as well as the long-term experience of thousands of specialists, allow us to confidently formulate the basic requirements for substances and parameters of the laser illumination technique that provide the most effective implementation of LASMIK® laser phoresis [Москвин С.В., Хадарцев А.А., 2016; Хадарцев А.А. и др., 2016].

Table 14

Fields of application of laser phoresis

Fields of application	Reference
Andrology and urology	Москвин С.В., Силуянов К.А., 2018; Иванченко Л.П. и др., 2009
Gynecology	Фёдорова Т.А. и др., 2009; Хадарцев А.А. и др., 2013, 2016
Dermatology and cosmetology	Гейниц А.В., Москвин С.В., 2010; Круглова Л.С., 2012; Москвин С.В., 2003; Мухина Е.С. и др., 2013; Рязанова Е.А., 2007; Рязанова Е.А., Хадарцев А.А., 2006
Diseases of the musculoskeletal system	Беляева Е.А. и др., 2017, 2019
Cardiology (arterial hypertension)	Горячева А.А., 2008
Neurology	Кочетков А.В., Москвин С.В., 2004; Кочетков А.В. и др., 2012; Фадеева Р.С., 2010
Otorhinolaryngology (sinusitis, tonsillitis)	Антипенко В.В., 2009; Хрыкова А.Г., 2007; Хрыкова А.Г. и др., 2012
Pediatrics	Москвин С.В. и др., 2010; Хрыкова А.Г., 2007
Sports medicine	Бехтерева Т.Д. и др., 2004; Хадарцев А.А., 2012; Хадарцев А.А. и др., 2016
Dentistry (TMJD, stomatitis, periodontitis)	Амирханян А.Н., Москвин С.В., 2008; Болатова Л.Х., 2010; Васильева Е.В., 2002; Жданов Е.В., 2004; Митрофанов И.В., 2006; Прикулс В.Ф., 2001, 2009; Прикулс В.Ф. и др., 2008; Хохлова Ж.В., 2007
Surgery	Асхадулин Е.В. и др., 2018; Герасименко М.Ю. и др., 2008; Рак А.В., 2013
Endocrinology	Андреева Ю.В. и др., 2012

1. Substances penetrate into the skin through sweat glands and hair follicles by means of transcytosis. Since transcytosis is a Ca^{2+}-dependent process and the mechanism of BA of LILI is also based on their activation [Москвин С.В., 2008, 2014], laser phoresis justifiably is the most effective way to enhance transdermal transport, which is possible only for hydrophilic molecules with molecular masses up to 750 kDa.
2. The concentration of HA in an aqueous solution should not exceed 2–3%, since a large amount of water is necessary for its penetration.
3. Optimum wavelengths (tested by us) make 405, 525, 780 and 904 nm. Each wavelength has its own positive qualities; it is rather difficult to identify the most optimal one.
4. The optimal power density is 20–50 mW/cm^2 for continuous mode and depends on the wavelength. More often, a continuous laser mode is used, however, modulation with a frequency of 10 Hz significantly increases

the efficiency of the technique. Pulsed lasers with a frequency of 80 Hz and a power density of 8–10 W/cm^2 can also be used.

5. The area of the substance application should be illuminated for no more than 1 min; furthermore, it is necessary to remember that the total time of the laser illumination should not exceed 20 minutes.
6. It is required to take a course consisting of at least 5 daily or alternate-day laser phoresis procedures.

In conclusion, we draw special attention to the fact that for LASMIK® laser biorevitalization it is necessary to use only *lasers* in accordance with the well-known (in Russia) rules of low-level laser therapy procedures [Moskvin S.V., 2017, 2017(1)]. Unfortunately, we had to face with discrediting of the procedure for many times when incoherent light sources and/or unacceptable illumination parameters were used.

CONTENTS

S.V. Moskvin, F.N. Chekhodaridi

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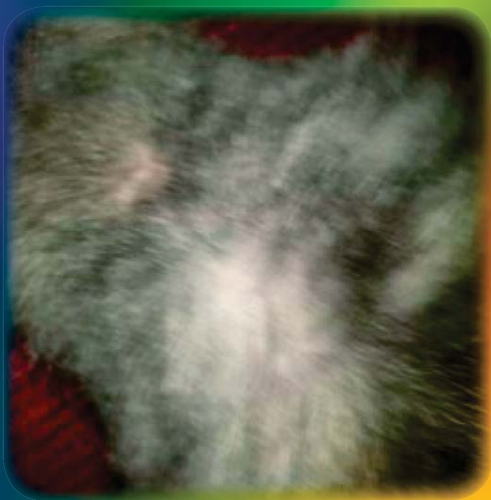
After treatment



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