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Using the Laser in Modern Medicine: World Trends

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ABSTRACT

Already the beginning of the 20th century was marked by the greatest achievements of the human mind. May 7, 1895 at a meeting of the Russian Physico-Chemical Society AS Popov demonstrated the device he invented without wires, and a year later a similar device was proposed by the Italian technician and businessman G. Marconi. So the radio was born. At the end of the outgoing century, a car with a gasoline engine was created, which replaced the invention invented back in the 18th century. The steam car. By the beginning of the 20th century metro lines were already operating in London, New York, Budapest, Vienna. December 17, 1903, the American engineer's brothers Orville and Wilbor Wright flew 260m on the world's first airplane created by them, and 12 years later the Russian engineer II Sikorsky designed and built the world's first multimotor aircraft, giving him the name "Ilya Muromets." Equally striking were the achievements in physics. Only in one decade at the turn of the two centuries, five discoveries were made. In the year 1895, the German physicist V. Roentgen discovered a new type of radiation, later named after him; for this discovery he received in 1901. Nobel Prize, thus becoming the first Nobel laureate in history. In the year 1896, French physicist Antoine Henri Becquerel discovered the phenomenon of radioactivity - the Nobel Prize in 1903. In 1897, the English physicist JJ Thomson discovered the electron and in the following year measured its charge - the Nobel Prize of 1906. December 14, 1900 at a meeting of the German Physical Society Max Planck gave a derivation of the formula for the emissivity of a black body; this conclusion was based on completely new ideas, which became the foundation of quantum theory - one of the basic physical theories of the twentieth century. In 1905 the young Albert Einstein - he was then only 26 years old - published a special theory of relativity. All these discoveries produced a staggering impression and plunged many into confusion - they did not fit into the framework of the existing physics, they demanded a revision of its basic ideas. As soon as it began, the 20th century ushered in the birth of a new physics, marked the invisible frontier behind which the former physics, called the "classical", remained. And today the man has at his disposal an almighty laser beam. What will he use this new conquest of the mind? What will become a laser: a universal tool, a reliable helper or, on the contrary, a formidable space weapon, another destroyer?.

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INTRODUCTION

The laser is a device that converts pump energy (light, electric, thermal, chemical, etc.) into the energy of a coherent, monochromatic, polarized and narrowly directed radiation flux. The physical basis of the laser is the quantum mechanical phenomenon of stimulated (induced) radiation. The laser beam can be continuous, with a constant

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amplitude, or pulsed, reaching extremely high peak powers. In some circuits, the laser working element is used as an optical amplifier for radiation from another source. There are a large number of types of lasers using all aggregate states of matter as the working medium. Some types of lasers, for example lasers on dye solutions or polychromatic solid-state lasers, can generate a whole set of frequencies (modes of an optical resonator) in a wide spectral range. The dimensions of the lasers differ from the microscopic ones for a number of semiconductor lasers to the size of a football field for some neodymium-glass lasers. The unique properties of laser radiation have allowed them to be used in various fields of science and technology, as well as in everyday life, from reading and writing CDs to research in the field of controlled thermonuclear fusion. The physical basis of laser operation is the phenomenon of stimulated (induced) radiation [1-8]. The essence of the phenomenon is that an excited atom can emit a photon under the action of another photon without its absorption, if the energy of the latter is equal to the difference in the energy levels of the atom before and after radiation. In this case, the emitted photon is coherent to the photon that caused the radiation (is its "exact copy"). Thus, the light intensifies. This phenomenon differs from spontaneous emission, in which the emitted photons have a random direction of propagation, polarization and phase.

Helium-neon laser. A glowing beam in the center is not actually a laser beam, but an electric discharge that generates a glow, just as it does in neon lamps. The beam is projected onto the screen on the right as a luminous red dot. The probability that a random photon will cause induced radiation from an excited atom is exactly equal to the probability of absorption of this photon by an atom in an unexcited state. Therefore, to enhance light, it is necessary that there are more excited atoms in the medium than the unexcited (the so-called population inversion). In the state of thermodynamic equilibrium this condition is not fulfilled, therefore various systems of pumping of the active medium of the laser (optical, electrical, chemical, etc.) are used. The primary source of generation is the process of spontaneous emission, therefore, to ensure the continuity of photon generations, it is necessary to have a positive feedback, due to which the emitted photons cause subsequent acts of induced radiation. To do this, the active medium of the laser is placed in an optical resonator. In the simplest case, it consists of two mirrors, one of which is semitransparent - through it the laser beam partially leaves the resonator. Reflecting from the mirrors, the radiation beam repeatedly passes through the resonator, causing induced transitions in it. The radiation can be either continuous or pulsed. At the same time, using various instruments (rotating prisms, Kerr cells, etc.) to quickly turn off and turn on feedback and thereby reduce the pulse period, it is possible to create conditions for generating very high-power radiation (so-called giant pulses.

This mode of laser operation is called modulated Q-switching. The radiation generated by the laser is monochromatic (of a single or discrete set of wavelengths), since the probability of emission of a photon of a certain wavelength is larger than the closely spaced emission associated with the broadening of the spectral line, and accordingly the probability of induced transitions at this frequency also has a maximum. Therefore, gradually in the process of generation, photons of a given wavelength will dominate all other photons. In addition, because of the special arrangement of the mirrors in the laser beam, only those photons that propagate in a direction parallel to the optical axis of the resonator at a small distance from it remain, the remaining photons quickly leave the volume of the resonator. Thus, the laser beam has a very small divergence angle. Finally, the laser beam has a strictly defined polarization. To this end, different polaroids are introduced into the resonator, for example, they can be flat glass plates placed at the Brewster angle to the direction of propagation of the laser beam.

Classification of lasers:

• Solid-state lasers based on luminescent solid media (dielectric crystals and glasses). As activators, ionic earth ions or iron Fe ions are commonly used. Optical pumping and semiconductor lasers are carried out on a three- or four-level scheme. Modern solid-state lasers are capable of operating in pulsed, continuous and quasi-continuous modes.

• Semiconductor lasers. Formally they are also solid-state, but are traditionally separated into a separate group, since they have a different pumping mechanism (injection of excess charge carriers through a pn junction or heterojunction, electric breakdown in a strong field, bombardment by fast electrons), and quantum transitions occur between allowed energy bands, and not between discrete energy levels. Semiconductor lasers are the most commonly used kind of laser in everyday life. In addition, they are used in spectroscopy, in pumping systems of other lasers, as well as in medicine (see photodynamic therapy).

• Dye lasers. Type of lasers, using as an active medium fluorescent solution with the formation of broad spectroscopic dyes. Laser transitions occur between different vibrational sublevels of the first excited and ground singlet electronic states. Pumping optic, can work in continuous and pulsed modes. The main feature is the possibility of tuning

the wavelength of radiation in a wide range. They are used in spectroscopic studies.

• Gas lasers - lasers, whose active medium is a mixture of gases and vapors. They are characterized by high power, monochromaticity, and also a narrow radiation direction. Operate in continuous and pulsed modes. Depending on the pumping system, gas lasers are divided into gas-discharge lasers, gas lasers with optical excitation and excitation by charged particles (for example, nuclear-pumped lasers, in the early 1980s, anti-ballistic missile systems were tested on their basis, however, without much success), gas-dynamic and chemical lasers. By the type of laser transitions, gas lasers are distinguished on atomic transitions, ion lasers, molecular lasers on electronic, vibrational and rotational transitions of molecules and excimer lasers.

Gas-dynamic lasers are gas lasers with thermal pumping, population inversion in which is created between excited vibrational-rotational levels of heteronuclear molecules by adiabatic expansion of a moving gas mixture at high speed (more often $N_2 + CO_2 + He$ or $N_2 + CO_2 + H_2O$, working substance - CO_2).

• Excimer lasers - a kind of gas lasers working on energy transitions of excimer molecules (dimers of noble gases, as well as their monohalides) that can exist only for some time in an excited state. Pumping is carried out by passing a beam of electrons through the gas mixture, under the action of which the atoms go into an excited state with the formation of excimers, which in fact represent a medium with inversion of populations. Excimer lasers are characterized by high energy characteristics, a small spread in the generation wavelength, and the possibility of smooth tuning in a wide range.

• Chemical lasers - a kind of lasers, the source of energy for which are chemical reactions between the components of the working medium (gas mixture). Laser transitions occur between excited vibrational-rotational and basic levels of composite molecules of reaction products. To carry out chemical reactions in the medium, the constant presence of free radicals is necessary, for which various methods of influencing molecules for their dissociation are used. They are distinguished by a wide spectrum of generation in the near-IR region, high power of continuous and pulsed radiation.

• Free-electron lasers are lasers whose active medium is the flux of free electrons that vibrate in an external electromagnetic field (due to which radiation is carried out) and propagate with a relativistic velocity in the direction of the radiation. The main feature is the possibility of a smooth wide-range tuning of the generation frequency. Distinguish between deuterons and scatrons, the pumping of the first is carried out in the spatially periodic static field of the undulator, the second - by the powerful field of the electromagnetic wave. There are also masers at cyclotron resonance and strobothrons based on bremsstrahlung of electrons, as well as flimatrons using the effect of Cerenkov and transitional radiations. Since each electron emits up to 108 photons, free-electron lasers are, in fact, classical devices and are described by the laws of classical electrodynamics.

• Quantum cascade lasers - semiconductor lasers that emit in the middle and far infrared range. In contrast to conventional semiconductor lasers emitted through forced transitions between allowed electron and hole levels separated by a forbidden semiconductor zone, the emission of quantum cascade lasers arises in the transition of electrons between layers of the semiconductor heterostructure and consists of two types of rays, the secondary ray having very unusual properties and does not require much energy.

• Other types of lasers, the development of principles of which at the moment is a priority task of research (X-ray lasers, gamma lasers, etc.).

Lasers in medicine

With the advent of industrial lasers, a new era in surgery began. At the same time, the experience of specialists in laser processing of metals was useful. Laser welding of an exfoliated retina is a point-to-point contact welding; laser scalpel - autogenous cutting; Bone welding - butt welding melting; the connection of the muscle tissue is also contact welding. In order for laser radiation to have any effect, it is necessary that the tissue absorbs it. The most popular laser in surgery is carbon dioxide. Other lasers are monochromatic, that is, they heat, destroy or weld only certain biological tissues with a completely defined color. For example, the beam of an argon laser freely passes through the frosted vitreous body and gives its energy to the retina, whose color is close to red. Carbon dioxide laser is suitable in most cases, for example when it is necessary to cut or weld to each other fabrics of different colors. However, this raises another problem. The tissues are saturated with blood and lymph, contain a lot of water, and the radiation of the laser in water loses energy. You can increase the energy of the laser beam, but this can lead to burning tissues. The creators of surgical lasers have to resort to all sorts of tricks, which greatly increases the cost of the equipment.

It has long been known to metal welding specialists that when cutting a package of thin metal sheets, it is necessary that they fit tightly to each other, and in case of spot welding, additional pressure is necessary to closely contact the welded parts. This method was used in surgery: Professor OI Skobelkin and his co-authors suggested that when welding tissues they should be squeezed slightly to

replace blood. To implement the new method, a whole set of tools was created, which is used today in gastrointestinal surgery, in operations on the biliary tract, spleen, liver, lungs.

Stomatology

Analysis of literature data on the treatment of diseases of the mucous membrane of the mouth and periodontium shows that some agents, especially antibiotics and steroid preparations, change the oxidation-reduction potential of saliva, weaken the activity of lysozyme, promote the development of allergic reactions, and reduce the resistance of the organism to pathogenic influences. All this complicates the course and treatment of the pathological process in the mucosa of the mouth and periodontium. These factors cause the need to find new methods of treatment - without the use of medicines. One of them is physiotherapy, and among the most effective - low-intensity laser radiation. Laser radiation significantly increases the proliferative activity of cells in 1,3-3,5 times. It was found that LILS has an anti-inflammatory effect on the traumatic defect of the oral mucosa, promotes the acceleration of epithelialization and organ-specific restoration of mucosal tissues in the area of the defect. This effect, first of all, is due to the intensification of the synthesis of DNA cells. It is established that at the time of irradiation, the intensity of blood supply increases by 20%. The optimal vasoconstrictive dose of irradiation was 100 mW / cm2 (for GNL) with an exposure of 2 min (12 J / cm2) [. Aleksandrov MT, Prokhonchukov AA, 1981]. With the development of a constrictor reaction, some researchers also relate the analgesic effect of laser irradiation observed in the clinic. In the experiment on the model of posttraumatic regeneration of the mucous membrane of the tongue, faster and better epithelization of the wound after exposure to light with a helium-neon laser (power density 200 mW / cm2 at a single and 1 mW / cm2 with daily exposure) was noted [Vinogradov AV et al., 1990]. Studies of the ultrastructure of the gum after 1, 3 and 6 sessions of daily exposure to light by the GNL showed a pronounced response from the main elements of the gum. In the epithelial cells of the stratum corneum, the number of light vacuoles and strongly osseous lumps increases, and in the granular layer the number of osmoned granules increases. In muscle fibers appears a large number of mitochondria, in the blood vessels are determined accumulations of erythrocytes. All this indicates an intensification of the synthesis of substances in cells under the influence of LILI [Zazulevskaya L.Ya. et al., (1990)]. Based on the results of the studies, the spectrum of action and parameters for continuous radiation with a wavelength of 0.63 μm (laser head KLO4 for ALT Matrix), providing anti-inflammatory (vascular), stimulating cellular proliferation and inhibitory effects were determined. Thus, stimulation of cell proliferation is observed at a power density of 10 to 100 mW / cm2, exposure to one field from 30 s to 5 min; anti-inflammatory and analgesic action - at a power density of 100-200 mW / cm2, exposure to one field of 2-5 min; inhibitory effect - at a power density of 100-400 mW / cm2 and an exposure of 1-6 min. It should be noted that these laser radiation power densities are achieved by means of special light guides. Pulsed semiconductor lasers, in particular, the emitting heads of the infrared spectrum (LO4) to the ALT "Matrix", allow in most cases to dispense with and without light guides. When the impact is carried out on the projection of the affected area using mirror and mirror-magnetic nozzles. This is often more efficient and does not require such high power densities. Peculiarities of pulsed infrared (IR) radiation make it possible to realize laser therapy methods with higher efficiency at a significantly lower energy load (power density). It is shown that laser pulsed IR radiation stimulates the proliferative activity of cellular structures at a dose of 0.03-0.86 J / cm2 with the maximum effect at a dose of 0.22 J / cm2.

While for GNL (continuous emission of red spectrum) the maximum effect is achieved at 3 J / cm2. The use of combined radiation with both types of radiation in complex treatment of patients with odontogenic phlegmons allows to obtain the best results of treatment, to shorten the duration of incapacity for work by an average of 8 days [Platonova VV, 1990]. Pulsed IR laser radiation in combination with a constant magnetic field of 35-50 mTl can be effectively used at all stages of orthodontic treatment. Absence of complications and relapses, increase in labor productivity of doctors and nurses as a whole gives a general economic effect of 36-43% [Kuznetsova MA, 2000]. The use of low-intensity pulsed laser light at the expense of general (general health) action expands the indications for orthodontic treatment of dentoalveolar anomalies:

• at various unfavorable conditions (gingivitis with close position of the teeth, insufficient oral hygiene, juvenile, traumatic, periodontitis);

• when expressed inflammatory-degenerative complications in the periodontium movable teeth, as well as in children with weakened immune status (immunodeficiencies, allergic phenomena, sensitization, hormonal and immunological disorders, etc. AP.);

• in preparation for active orthodontic treatment. LILS statistically reliably allows to stop inflammatory processes 1.6 times faster (on average 4-6 days) in comparison with traditional methods, which in turn reduces the preparatory stage by 2.3 times, creating optimal conditions for the initiation of orthodontic treatment;

• when individual permanent teeth are removed by orthodontic indications, exposing crowns of retouched teeth, plasty of the tongue bridle and bridle lips, deepening the vestibule of the oral cavity. The use of low-intensity pulsed infrared LIL in anti-inflammatory and regeneration-stimulating doses makes it possible to accelerate the healing of postoperative wounds of soft tissues of the oral cavity without the formation of cords and scar changes on average by 4-5 days compared to conventional methods;

• For removal of dentoalveolar anomalies using modern permanent art laser therapy can eliminate pain after fixation and activation elements of the apparatus, to prevent possible retaliatory traumatic inflammation in the area of application of orthodontic forces, facilitating the physiological and psychological adaptation to orthodontic appliances and reducing (by an average of 6 ± 1.2 months compared with conventional methods) the total duration of treatment.

LT, providing reliable retention, significantly it allows to fix in position displaced trailing teeth and reduce the period of treatment (an average of 4-6 months) accelerates detained in eruption of teeth in the jaws 4,7 times without surgical intervention is often the method of choice . Simultaneous combined application of low-intensity pulsed IR LLLT and constant magnetic field significantly improves the preventive and therapeutic efficacy displacement primordia stragglers teeth (changing the position of the jaws in the direction setting and eruption) and accelerates their eruption 5.3 times without surgical intervention. These properties allow the laser radiation differentially apply it in dentistry for diseases of the oral mucosa, which are accompanied by the destruction of the epithelium, slow regeneration, inflammation, pain, as well as viral lesions genesis (photodynamic effect).

With inflammation, laser radiation causes general and local effects. Common effects are expressed in an increase in nonspecific humoral defense factors (complement, interferon, lysozyme), a general leukocyte reaction, stimulation of bone marrow hematopoiesis, an increase in the phagocytic activity of micro- and macrophage systems. There is a desensitizing effect, activation of the immunocompetent system, cellular and humoral specific immunological defense, an increase in the general protective-adaptive reactions of the organism. Local effects are determined by the main elements of the inflammatory reaction: exudation, alteration, proliferation. Exudation: dilatation of vessels, activation of microcirculation with subsequent vasoconstriction - prevention of development of microcirculation phase disturbances and normalization of blood circulation in combination with normalization of vascular wall permeability (vascular-tissue barrier), reduction of edema of tissue. Under the influence of LILI radiation, optimal formation of neutrophilic and monocytic barriers, an increase in the phagocytic activity of micro- and macrophages, the production of bactericidal substances and growth stimulants, stimulation of proliferation, activation of barrier properties of the oral mucosa occur. Alteration: activation of functions of mitochondria and other organelles of cells, metabolism with increasing oxygen consumption and activation of tissue respiration. At the same time, anaerobic processes are suppressed, the development of acidosis and secondary dystrophic changes is prevented, as a result, regeneration of damaged tissues is facilitated. Proliferation: stimulation of the DNA-RNA-protein system, increase in the mitotic (proliferative) activity of the cells, activation of the connective tissue reaction. Morphologically, the cellular reaction manifests itself in the acceleration and enhancement of the formation of the fibroblastic barrier (against the background of the release of growth stimulants), stimulation of the formation of granulation tissue, acceleration of maturation of fibroblasts, activation of collagen fibers and ripening of granulation tissue. As a result, rapid and more physiological epithelization occurs, accelerated and full-fledged regeneration of the mucous membrane in the lesion area. The therapeutic effect (stimulation) of tissue regeneration processes is expressed in the activation of the DNA-RNA protein system, the enhancement of the synthesis of nucleic acids and nuclear proteins, the increase in the mass of the nucleus, the increase in the synthesis of cytoplasmic proteins, and their accumulation during the interphase period to a critical level. There is a stimulation of mitoses, accelerated and increased multiplication of cells of connective tissue, epithelium. The therapeutic effect of laser exposure to tissues of a living organism is greatly enhanced in a constant magnetic field (PMP) due to the enhancement of metabolic processes. Magnetolaser therapy (MLT) was proposed in the late 70's. and was most widely used due to the high therapeutic efficiency due to the potentiation of the action of the magnetic field and laser radiation [Mostovnikov VA et al., 1991; Polonsky A.K. and others, 1981]. When combined magnetolaser action, especially in the treatment of deep pathological foci, the use of LILR of the near infrared part of the spectrum (wavelength 0.8-1.3 m) is more effective for the following objective reasons. First, the maximum transmission of human skin by electromagnetic radiation is in this range. Secondly, the SMS, orienting dipoles in one line along the light wave collinearly, promotes resonant interaction of biological structures and enhances the light absorption in the infrared range. Impulse IR (λ = 0.89 μm) laser radiation has a greater effect on the

stability of cell membranes, whereas in combination with PMP this factor exerts a pronounced effect on microcirculatory processes [Zubkova SM. et al., 1991]. When MLT is used, special magnetic nozzles with the optimal shape of the field are used, which frees the physician from the need to take into account the specific action of the north and south poles of the magnet. The optimum time for the MLT is 1.5-2 minutes with a PMP of 15-75 mTl and the power of a pulsed infrared LIL 10-15 W; the number of procedures from 5 to 10. To stimulate the peripheral blood flow, the optimal is the PMP with induction of 50 mT. MLT has a hypocoagulant, mild sedative and hypotensive effect, positively affects certain components of the immune system [Builin VA, 1997; Moskvin SV, Buylin VA, 2005]. Indications for laser therapy: periodontitis in the stage of exacerbation, periodontitis (hyperesthesia), herpes lips and herpetic stomatitis of adults, Melkersson-Rosenthal syndrome, chronic recurrent aphthous stomatitis, desquamative glossitis, chronic gingivitis, ulcerative gingivitis, traumatic damages of the oral mucosa, multiform erythema exudative and other.

Contraindications: all forms of leukoplakia, as well as proliferative phenomena on the mucous membrane of the mouth (papillomatosis, limited hyperkeratosis, rhomboid glossitis); Severely leaking diseases of the cardiovascular system (atherosclerotic cardiosclerosis with severe violation of the coronary circulation, cerebral sclerosis with impaired cerebral circulation of the II-III stage), hypertension III stage, hypotension; severe and severe degree of emphysema; tuberculous intoxication; malignant tumors; benign tumors with localization in the head and neck; severe diabetes mellitus in uncompensated condition or with unstable compensation; blood diseases; state after myocardial infarction (within 6 months after kurtosis).

Surgery

It is now difficult to imagine progress in medicine without laser technology, which opened up new opportunities in resolving numerous medical problems.

The study of the mechanisms of the action of laser radiation of different wavelengths and energy levels on biological tissues makes it possible to create laser medical multifunctional devices whose range of application in clinical practice has become so wide that it is very difficult to answer the question: what kind of diseases do lasers not use? The development of laser medicine goes in three main branches: laser surgery, laser therapy and laser diagnostics. Our field of activity are lasers for applications in surgery and cosmetology, having enough power for cutting, vaporization, coagulation and other structural changes in biological tissues.

IN LASER SURGERY

... Sufficiently powerful lasers with an average radiation power of tens of watts are used, which are capable of strongly heating the biotissue, which leads to its cutting or evaporation. These and other characteristics of surgical lasers cause the use in surgery of various types of surgical lasers operating on different laser active media. The unique properties of the laser beam make it possible to perform previously impossible operations with new effective and minimally invasive methods. Surgical laser systems provide: effective contact and non-contact vaporization and destruction of tissue;

- dry operating field;
- minimal damage to surrounding tissues;
- effective hemo- and aerostasis;
- relief of lymphatic ducts;
- high sterility and abstability;
- compatibility with endoscopic and laparoscopic instruments

This makes it possible to effectively use surgical lasers for performing a variety of surgical interventions in urology, gynecology, otorhinolaryngology, orthopedics, neurosurgery, etc. We are convinced that the best choice for a surgeon in its physical properties is a holmium laser. Therefore, we pay the main attention to Holmium lasers in surgery.

Vascular diseases of the skin

Treatment of a wide range of dermatological diseases and percutaneous non-invasive vascular surgery can be effectively performed using a cosmetic KTP laser:

- Wine stains
- Hemangiomas
- Teleangiectasia
- Angiomas
- Pink acne
- Venous malformations
- "Coffee" stains
- Lentigo
- Freckles
- Nevus
- Seborrheic keratosis
- Carbon tattoos

KTP - laser

is a well-known neodymium garnet laser (Nd: YAG) paired with a non-linear crystal of titanyl potassium phosphate (KTP), which doubles the frequency of emitted light to obtain a wavelength of 532 nm located in the green region of the spectrum. Laser treatment of vascular disorders is based on the thermal effect of laser radiation on vessels without

changing the structure of adjacent tissues. The green radiation from the KTP laser penetrates the surface layers of the skin and is well absorbed by the hemoglobin of the blood. As a result, a large amount of heat is released in the damaged blood vessel, the blood coagulates, and the inner wall collapses. Later the pathological vessel overcomes the connective tissue, and the skin acquires a natural color. In practice, it is important to take into account the thermal relaxation time of the vessel, which corresponds to the period necessary to transfer heat beyond the vessel. This time depends, first of all, on the diameter of the vessel and can vary from 1 ms (for a vessel with a diameter of 50 μm) to 80 ms (for a vessel with a diameter of 400 μm). When a very intense laser is irradiated by a very short pulse, a blood vessel absorbs a sufficiently large amount of energy that does not have time to dissipate. Because of this, the temperature and pressure significantly increase inside the vessel, which leads to the rupture of its wall and to microburning. Clinically, this manifests itself in the form of purpura or microhemorrhagia. With an increase in the duration of the laser pulse, one can obtain a regime of selective coagulation, when a gradual increase in the temperature of the vessel wall causes its soldering and disappearance. The pulse duration in this case must be greater than the relaxation time of the vessel, but limited, otherwise large amounts of heat are vapors scattered outward, and considerable changes can occur in the vast area of the surrounding dermis. At the site of laser action, the natural color of the skin is restored. The tissues around the vessel practically do not absorb the laser radiation and remain intact, so there is no scar formation after the operation.

Photo rejuvenation of the skin

With the absorption of radiation from the KTP laser by blood hemoglobin, in addition to photocoagulation of blood vessels and skin cleansing from pigment and vascular lesions, another effect can be obtained - skin photo rejuvenation. Photo rejuvenation is a visible improvement in the condition of the skin with a laser or other light source. What happens directly in the skin when it is irradiated with powerful light pulses? When light is absorbed and the walls of the vessels are heated, they in turn transmit heat to the outside. Selective heating of dermal collagen (up to a temperature of 55 ° C) causes stimulation in the connective tissue of special cells - fibroblasts, which begin to actively synthesize new collagen. Thus, new fibers of collagen and elastin appear in the fading skin, and it again acquires a young, fresh appearance. Synthesis of new collagen is a biochemical process that requires a certain time, so the result becomes noticeable not immediately. A total of 3 to 6 sessions may be required with an interval of 3 weeks. After the course of procedures, skin color and structure improve, the face is tightened, its contours are improved, and the pores are narrowed. Thanks to a general lifting, small and medium wrinkles are smoothed out. Thus, photo rejuvenation using a CTE laser is a new and effective non-invasive method of skin rejuvenation with minimal risk and without a long recovery period for the patient.

Laser technology for dermatology *CO2 - and erbium lasers*

- surface resurfacing and polishing of the skin
- Smoothing wrinkles on the skin of the face, neck, hands
- removal of scars, scars
- Smoothing of acne craters
- pigment spots (lentigo, nevi, chloasma, etc.)
- Wart removal, papillomas
- keratoses, keloids, fibromas, xantelasms

Laser dermabrasion is:

- low traumatism of operations;
- minimal thermal damage and rapid restoration of the skin;
- minimal risk of postoperative relapse and complications;
- rapid wound healing

Mechanism of action of exfoliation

This is based on the skin's ability to fast self-healing. Any traumatic effect - burn, abrasion, cut - causes an immediate reaction of the body. At the slightest trauma, all efforts are rushed to defense - the process of regeneration begins. However, when restoring the skin, the old materials are not used. The thing is that when a trauma occurs, the deformed cells are destroyed, and the activity of young and healthy people is encouraged more than ever. Of course, in addition to regeneration, other processes of renewal are continuously proceeding in the skin. This, for example, is the program of activity of keratinocytes - the main cells of the epidermis. In fact, the epidermis consists of layers of keratinocytes of different ages. And each layer fulfills its physiological task (for example, the uppermost horny one is a dense protective barrier from dead cells). Over the years, the life cycle of keratinocytes may begin to malfunction, then the cells, together with the accumulated damage, are retained in the intermediate layer. Outgoing from them negative (as infectious diseases) inevitably affects the activity of other cells.

As a result, cell division in living tissues slows down (they become thinner), and the horny layer, on the contrary, thickens, giving the skin the appearance of parchment. In this situation, peeling will also do a good job, while creating the prerequisites for thorough cleaning of the upper barrier and facilitating a controlled renewal process. Called

exfoliation of the skin as an artificial damage to the epidermis, is carried out by selective-careful techniques, without pain and discomfort. If regeneration occurs normally, the skin after rehabilitation looks much better. The keratinized layer becomes more thin and uniform, and the dermis is elastic.

In recent years, significant progress has been made in the method of laser tattoo removal. During this time, a huge amount of clinical material has been obtained, and laser methods have become the most advanced, if not the only acceptable in terms of the resulting cosmetic result, methods of removing tattoos. To destroy the dyes that make up the base of the tattoo, the laser should emit such light that is absorbed by this dye. For this purpose, a special "Q-switched" laser mode is used, which allows achieving a high power of laser pulses due to shortening of their duration. To output radiation in such lasers, a hinged mirror light guide is used, which makes it possible to deliver laser radiation to the working instrument of the doctor. The tattoo dye granules selectively absorb laser radiation, break into small fragments and are gradually removed through the lymphatic system. Compared to other methods, laser tattoo removal is a safer method, since laser radiation affects only the dye, not the surrounding skin. The laser allows you to remove tattoos without scars and scars. For the complete removal of most tattoos and dermal pigmentation requires holding 2 - 5 sessions. To remove large tattoos, you may need more than 10 sessions. The number of sessions depends on several factors, such as the age of the tattoo, its size and location, the depth, type and color of the pigment. Difficult for removing green and yellow tattoos. Usually professionally performed tattoos require more sessions to remove them than amateur ones. There are such persistent types of dyes that remain prominent after a series of procedures, although they significantly discolor.

Laser application in the treatment of ENT diseases

Currently, laser radiation is increasingly being used in medicine, including the treatment of ENT diseases. The positive characteristics of the application of the laser are that it reduces the inflammatory reaction, has a pronounced analgesic (analgesic) effect, and also a more active recovery of the affected tissue occurs. The laser radiation regimes used in medicine do not adversely affect the organism as a whole. The destruction of tissues by the laser is virtually bloodless, which is associated with coagulation (coagulation) of blood in the capillary lumen in the zone of coagulation necrosis and the formation of a so-called laser clot. Among the pathological states of the pharynx requiring laser correction, the most interesting are the various neoplasms, chronic hypertrophic lateral and granulosa pharyngitis (inflammation of the pharynx), the remains of the tonsils after the previous tonsillectomy (removal of the glands), and rhonchopathy.

The use of a laser for the treatment of pharyngeal pathology is much more effective than traditional methods of surgery:

• Intervention does not give complications in the postoperative period,
• it is easily tolerated by patients,
• is as gentle as possible to the tissues,
• does not require carrying out antibacterial and anti-inflammatory therapy in the postoperative period,
• does not impair the ability of the patients to work.

A diode laser is widely used for endoscopic correction of the pathology of the nasal cavity. It has been successfully used to treat such diseases as:

• chronic hypertrophic rhinitis, especially with an increase in the middle and posterior ends of the nasal concha,
• scar processes of the nasal cavity after previous surgical interventions and injuries,
• polyposive etmoiditis (inflammation of the sinus, combined with the presence of polyps in its cavity),
• recurrent nasal polyposis,
• recurrent nasal bleeding,
• neoplasm.

Laryngeal laser surgery has been widely used recently. The laser helps to cope with such pathology as various benign and malignant neoplasms of the larynx, the effects of chronic inflammatory diseases of the larynx, as well as various forms of disturbance of its innervation, i.e. paralysis and paresis. Granulation or scar tissue of the larynx is completely "evaporated" by the laser. At the same time for visual control of the laser surgery process, endoscopic technique is used. After an operation such as tracheotomy, as well as manipulation such as intubation of the trachea, a long-term cannula or an endotracheal tube in the larynx may form a so-called granuloma on its surface. Treatment of postintubation and post tracheotomy granulomas of the larynx and trachea with a laser is also very effective, since. in most cases it allows to completely restore the airway clearance.

The use of laser surgery in the treatment of such ear disorders as:

• neoplasms,
• post-traumatic deformities,
• chronic purulent otitis media.

In the surgery of ENT diseases there are a large number of methods and methods for correcting hyper-plastic processes that are characterized by proliferation of pathological tissue, as well as narrowing and various defects of the external and middle ear. Laser surgery is widely used to treat

this pathology. In the area of the external auditory canal, the most common are papillomas and hemangiomas, which are easily removed by the laser. The same method of laser surgery removes polyps and granulations (proliferations of connective tissue) from the middle ear cavity with large defects of the tympanic membrane in a disease such as chronic suppurative otitis media. A special place in the surgery of the hyperplastic processes of the outer ear is occupied by the keloid scars of the auricles. Traditional surgery is not capable of completely solving this problem. In this case, there is a large number of relapses. Introduction to the practice of laser surgery treatment of keloid scars has become more effective. Using a laser and an operating microscope, in many cases it is possible to very economically excise a keloid scar with a good cosmetic effect. At the same time, the risk of relapse in the postoperative period is low. Very valuable endoscopic interventions with the laser are in microsurgical operations in the tympanic cavity, when it is necessary to remove microscopic sections of pathological tissues with great accuracy without destroying the integrity of the thin anatomical structures of the middle and inner ear. Some of us suffer from permanent reddening of the eyes (when visible red veins), even if you have a good sleep! Some try to apply various medications, but without success. Moreover, we are sure that redness itself is not caused by dry eyes or an allergic reaction to a product. What do leading ophthalmologists say about this .

Ophthalmology

First, everyone needs to know that if you see red wreaths in the eye - this is quite normal phenomenon, and from this it is unnecessary to make a tragedy! Some, as soon as they see red wreaths, try to use various drugs that "promise" to cope with this problem, and forget to consult a doctor. But according to experts, the use of certain drugs (for example, known to all Visin) that reduce wreaths, make them less visible, can lead to a completely opposite result: after completion of the drug, the veins can expand and become more visible. Vein enlargement is an eternal problem faced by people who constantly use (abuse!) Some eye medications. Causes of permanent redness of the eyes: Chronic redness of the eyes can be caused by a certain kind of irritation. The most common reddening of the eyes is their dryness and allergy. Dry eyes are not always able to cause their redness. In addition, with dry eyes (in the early and middle stages) are perfectly handled special drops against dry eyes. For people suffering from severe form of dry eyes, the clinic offers a special procedure (puncture obturation). In this procedure, a small plastic "cork", resembling a miniature mark for a ball in golf, is placed in one of the two channels, which runs from the eye to the nose. This septum prevents the tear from falling into the nose, thereby holding it longer in the eye itself. Allergy is another typical cause of eye redness. The most optimal treatment for eye redness of allergic origin is to keep the patient in conditions where there are no objects capable of causing allergies.

However, as you know, sometimes it is very difficult to determine what caused the allergy. Sometimes the allergies can be provoked by the lenses you wear. There are medicines on the market that reduce some allergic reactions. If the redness is caused by lenses, then today there is such a service as laser treatment. As a result, vision is almost completely restored, and there is no need to use lenses or glasses. The redness of the eyes can also be caused by heavy eye strain, sitting at the computer for hours, lacking vitamin A. In any case, before taking any drops that remove the redness of the eyes, you should definitely consult a doctor, take a survey and only then go to pharmacy for medicines.

CONCLUSION

Light was used to treat a variety of diseases from time immemorial. It's not for nothing that Aesculapius, the god of medicine, was the son of the god of light, Phoebus Apollo. The ancient Greeks and Romans often "took the sun" as a medicine. And the list of diseases that were attributed to treatment with light, was large enough. Nowadays laser is an important device, without which we are not presenting our life. Science develops in wide strides. We need only to monitor its successes and apply achievements in everyday life. One of the main innovations in medicine is associated with lasers. After all, now with their help you can conduct operations without large incisions, without fear of infecting. This type of treatment will allow patients to take fewer pills and drugs, which will reduce the burden on their liver and kidneys. In the end, I would like to say that I have the hope that in the future, if I need medical help, it will be provided with a laser.

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