USE OF LOW-ENERGY LASER RADIATION IN CHILDREN WITH SELECTED SURGICAL DISEASES

Guidelines for Physicians

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Использование низкоинтенсивного лазерного излучения при рябе хирургических заболеваний у детей

Методические рекомендации

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INTRODUCTION

At the present time, there is a pressing need for clinical adoption of new alternative therapeutic methods in health care practice. Numerous reasons for it include a steadily rising morbidity rate in Russia's population of children because of increasingly greater impacts of adverse endogenous and exogenous factors, a serious change in resistance of children, insufficient efficacy of conventional therapies and a high percentage of major disease entities progressing to a chronic course. The most promising approach today is reliance on new research-intensive treatment methods.

Experience with lasers in different areas of medicine has shown their high efficacy which is related to a broad range of beneficial effects of laserlight, but these methods have not found proper use in pediatric practice, as interaction of photon energy with biologic objects has not been adequately elucidated and a scientifically validated approach to use of low-energy lasers is lacking, even though their clinical effectiveness is already apparent.

These guidelines are based on extensive experience of use of low-energy laser therapy and magnetic-laser therapy in large patient populations with different surgical diseases. Various techniques of it include treatment of reflexogenic zones, reference points, blood, inflammatory sites, skin autografts, etc.

Therapy results have been verified using instrumental, endoscopic, biochemical, cytologic, electron microscopic and radiographic studies.

FORMULA OF THE METHODOLOGY

New methods have been designed in pediatric surgical practice for treatment of children with various urinary tract diseases accompanied by cystitis and
enuresis and patients with burns, peritonitis of appendiceal origin and complicated acute pneumonia. These methods are based on unique biologically active properties of low-intensive laser light and magnetic-laser radiation which have biostimulating, antioxidant, anti-inflammatory, desensitizing, anti-inflammatory, analgesic and other effects. No counterpart therapeutic methodologies are available thus far.

The addition of low-energy laser and magnetic-laser therapy to surgical management of children with the mentioned diseases has appreciably improved therapy results for the first time in Russia's pediatric surgical practice. Besides, these methodologies are simple, safe for patients and the medical personnel; they cause no complications and allow drug intake reduction.

### LOGISTICS OF THE METHODOLOGY

Uzor-A-2K laser therapeutic device, Voskhod factory, Kaluga; registration No. 94/271-122. Multifunctional therapeutic arsenide-gallium device with a semiconductor near infrared laser emitter with a 890 nm wavelength. Average output power is regulated from 0 to 2 mW. The device has a pulsed operation mode with pulse recurrence frequencies of 80, 150, 300, 600, 1,500 and 3,000 Hz. Automatically set laser radiation exposures are 4, 8, 16, 32, 128 and 256 seconds.

RIKTA-01 magnetic-infrared laser therapeutic device with an inbuilt radiation test, MILTA-PKP GIT, Moscow, registration No. 93/199-92. It is a semiconductor laser with a 890 nm wavelength and diode-emitted light with wavelengths in the range of 890-950 nm. Controlled power of diode-emitted pulsed infrared light is 0 to 130 mW. Average pulse power is 5 mW at 1,000 Hz frequency and 5 uW at 5 Hz frequency. Pulse recurrence rates of RIKTA-01 are 5, 50 and 1,000 Hz. Static magnetic field induction in the working plane of the emitter of the device's handpiece is 40-60 mT.

### TECHNOLOGY OF USING THE METHODOLOGY

#### TREATMENT OF PATIENTS WITH NONSPECIFIC CYSTITIS

**EQUIPMENT.** A semiconductor laser therapeutic device with pulsed mode operation in the infrared wavelength range.

**PATIENT PREPARATION.** No special preparation is required for laser treatment of patients with cystitis. Girls should come to the treatment session with a filled urinary bladder so that it displaces the uterus backward; otherwise the fundus overlying the empty bladder will be irradiated.

**TECHNIQUE.** The procedure of transcutaneous laser light therapy of any clinical form of cystitis at its any phase is standard. The supine patients keeps the feet on the coach and the knees slightly apart (the abdominal wall is relaxed). The emitter with a mirror mount is snugly pressed into the upper pubic area of the anterior abdominal wall. Without relieving the pressure, the emitting part of the laser is directed toward the small pelvic cavity by making the angle between the emitter and the abdominal surface sharp.

The bladder is irradiated by 50-150 Hz pulses. Exposure durations vary from 60 to 120 seconds depending on the anterior abdominal wall thickness. Treatment sessions are held daily or at a one-day interval. A course of laser therapy is 2-4 sessions for acute and 4-10 sessions for chronic cystitis.

The first procedure usually relieves or reverses pain, decreases the micturition frequency and increases
bladder effective capacity. Cystitis symptoms subside with more treatments. The final procedure is given in the absence of clinical symptoms.

Laser therapy can be added to the management of chronic cystitis associated with a primary disease or be used alone in the presence of acute nonspecific primary cystitis. The choice depends on the extent and morphologic presentations: local catarrhal or ulcerous cystitis may be treated without drugs.

Treatment of hemorrhagic and radiation cystitis does not differ from that of other forms. Complete reversal of cystitis is seen after three to five treatment sessions and confirmed by cystoscopic and biochemical studies.

Therefore, transcutaneous laser therapy of cystitis is an effective intervention for patients with urinary tract diseases. When urinary tract malformations are treated surgically, this method of bladder treatment is useful in preoperative preparation as a deterrent of severe postoperative complications.

**INDICATIONS.** Nonspecific cystitis of various origins.

**CONTRAINDICATIONS.** Patients with malignant tumors are not eligible for laser treatment, as biostimulation can promote tumor growth and metastasis.

**EFFICACY OF THE METHODOLOGY**

Experience with low-energy laser therapy in more than 200 children in urology and nephrology clinics has shown its high effectiveness in reversal of inflammation and in patient preparation for surgery.

After a course of therapy, cystoscopy usually shows a clean, pink urinary bladder mucosa without hyperemia, edema, fibrinous deposits, lesions or vascular injections. Bullae resolve in most cases.

This methodology alone can be used to treat primary cystitis. Its use allows tapering the drug dosage. Low-energy laser therapy can be successfully used as a single intervention in patients with allergy. Therapeutic effects are mediated by immunostimulation in this case.

The methodology is safe and simple. All of these advantages make it recommendable for use by urologists of pediatric centers, as it is well tolerated by children and causes no negative response.

No complications of low-intensive laser therapy have been seen.

**TREATMENT OF CHILDREN WITH ENURESIS USING LOW-ENERGY LASERS**

**EQUIPMENT.** Semiconductor laser devices with a 890 wavelength are used.

**TECHNIQUE.** If cystic mucosal inflammation is present and is a cause of hyperreflexia, infrared light is applied to the bladder as described above during four-five treatment sessions.

The reflex therapy is continued without intervals by application of light guide of the semiconductor laser to reference points. Exposure of one point is ten seconds and the pulse frequency 1,000 Hz. Light flow power of this treatment is 2-5 mW.

**Points are selected on two sides symmetrically:**

1. Paravertebrally at the level of the 2nd-4th sacral vertebral foramina.

2. One-two centimeters anteriorly on the external-lateral surface of the foot and the same distance beneath the anterior external ankle.

3. One cm above the upper margin of the external ankle.

4. Depression between the shin bone and the upper calf bone.

5. Anal sphincter: exposure is 60 seconds, treatment is delivered without contact from a 5 cm distance.

6. The lower external point of the ear antihelix.

7. Angle between the first and second wrist bones.
Ten treatment sessions make a course of therapy which is repeated two-three times a year at an interval of four-six months.

**INDICATIONS.** Enuresis, micturition disorders.

**CONTRAINDICATIONS.** The only contraindication for low-energy laser therapy in these patients is the presence of a tumor.

**EFFICACY OF THE METHODOLOGY**

Laser treatment stops enuresis or makes its episodes less frequent. The bladder volume increases 20-25 percent in almost all cases.

Our experience of laser therapy of 286 children has shown that drug withdrawal was affordable in 30 percent of the group. Microcirculation and tissue blood flow were evaluated by biomicroscopy with photography of conjunctival small vessels. Pretreatment microcirculation disorders in this population were of grades II-III. Eight-ten laser treatments improved microcirculation to grades 0-1. There were no complications of therapy.

The treatment methodology is simple and physiologic. It allows a significant decrease in the drug intake, an especially important benefit for children with enuresis and proneness to allergy. The high clinical efficacy of low-energy laser therapy is determined by improvement of urinary tract tissue nutrition and neurotransmission, reversal of bladder mucosal inflammation and general stimulating effects on the organism.

**LASER THERAPY OF CHILDREN WITH PERITONITIS**

Two major pathogenetically relevant actions of photon energy in patients with peritonitis are stimulation of gastrointestinal tract motility and improvement of peritoneal regeneration processes.

**EQUIPMENT.** The Russian-made infrared laser devices Uzor and RIKTA with a 890 nm wavelength, pulse frequencies of 50 and 150 Hz and average power of 5 and 3 W respectively are used in clinical practice.

The first and second postoperative days are the best time for laser treatment. Exposure of each treated area is 1 minute. Four fields are irradiated: the right iliac, right mesogastric, epigastric and left mesogastric areas. Two-three daily sessions of laser therapy usually prove sufficient.

**INDICATIONS.** Dynamic ileus in the presence of appendiceal peritonitis.

**CONTRAINDICATIONS.** Contraindications for laser therapy in children with peritonitis are:

1. inadequate abdominal pus elimination and drainage during the operation;
2. intraabdominal abscesses and residual pustules,
3. focal secondary omentitis,
4. doubt about complete elimination of preoperative adhesion ileus.

**EFFICACY OF THE METHODOLOGY**

Low-energy laser therapy produces no subjective sensations of patients. Its effects on intestinal motility are evaluated clinically and radiographically. The effectiveness of treatment was confirmed in some of our patients by direct small intestinal electromyography. Pretreatment electromyograms recorded by an implanted electrode showed low-altitude waves in the presence of intestinal aperistalsis. The electromyograms showed high-amplitude waves with an adequate rapid component and spike potential as early as after the first treatment session. Intestinal motility registration at 30 minutes, one hour and three hours following the treatment indicated stable and prolonged stimulation of peristalsis in the presence of peritonitis.
An explanation for the positive effect is the additive action of local and general biologic effects of infrared laser light on the body. Local effects occur as activation of energy production in cells of the gastrointestinal neural apparatus which are sites of action of neurohumoral factors, while the generalized biologic effect indirectly stimulates higher vegetative regulation centers of the adrenosympathetic system.

Use of laser therapy in the management of 27 children with appendicitis-related peritonitis (on rigorous indications) was found to stimulate intestinal motility. This made postoperative progress smoother and averted many complications.

**USE OF LOW-ENERGY LASERS IN TREATMENT OF CHILDREN WITH SEVERE THERMAL INJURY**

Energy of laser light is used in pediatric combustiobiology for closure of burn surfaces using autodermoplasty, preparation of sluggishly granulating wounds for autodermoplasty and promotion of skin autograft assimilation in the postoperative period.

**EQUIPMENT.** Semiconductor laser devices RIKTA and UZOR with a 890 nm wavelength in combination with magnetic treatment.

**TECHNIQUE.** Skin flaps from donor surfaces are perforated 1:2 or 1:4 and irradiated during autodermoplasty with an arsenide-gallium laser with 890 nm wavelength, 10 mW power and 1,000 Hz pulse frequency for 60 seconds.

**TECHNIQUE.** After two treatments using the same regimen (see above), torpidly granulating wounds debride of purulent detritus, get a bright color and show prominent marginal epithelialization.

Such wounds heal faster because of a higher phagocyte activity and an increase in numbers of orthogonal capillaries.

Blood photomodification is used during preparation of patients with extensive burns for autodermoplasty surgery and in treatment of children with slowly granulating wounds. This method significantly improves the patient's condition and wound healing.

**TECHNIQUE.** Transcutaneous blood photomodification uses a laser light guide which is not inserted intravenously but is fixed to the skin above any of superficial vein. Light beam power is 5-10 W; exposure varies from 15 to 30 minutes depending on the patient's age, clinical condition, the surface area and quality of thermal injury. The exposure duration is 10 minutes for children under five years, 15 minutes for children younger than 10 and 20 minutes at ages under 15.

This treatment mode is convenient in that it requires no special antiseptic treatment of the light guide (rubbing it with 70-96 percent alcohol is enough), is noninvasive and easily tolerated by patients who do not feel the procedure.

The procedure is carried out with the patient supine in order to avoid orthostatic collapse due to blood redistribution. Laser irradiation improves organic and tissue blood flow, which is observable rheographically as change in vessel blood filling.

Semiconductor pulsed lasers are used in transcutaneous blood photomodification. Pulse frequency is 1,000 Hz. Three to ten sessions make a treatment course. We saw no complications of the blood photomodification therapy.

In the postoperative period, the burn surface is irradiated with 890 nm arsenide-gallium lasers of different modifications (RIKTA or UZOR) which combine infrared light and the magnetic field.
TECHNIQUE. Durations of laser irradiation in our patient population varied from 60 to 300 seconds, depending on the burn surface area. The pulse frequency was 1,000 Hz. Laser treatment was given at a one-day interval during wound redressing.

INDICATIONS. Thermal burns with different surface areas and depths.

CONTRAINDICATIONS. Chemical skin burns. Laser treatment of extensive poorly granulating wounds for repair stimulation has the role of an adjunct procedure during the preparation for autodermoplasty.

EFFICACY OF THE METHODOLOGY

Laser irradiation of the skin autograft during the operation induced complete assimilation of it in most of patients. Use of laser light during initial autograft lysis stopped this process and facilitated assimilation with activation of granulation and subsequent epithelialization without rough scarring, i.e. the tissue became organ-specific.

Cytologic evaluation of burn wound repair has shown that regular laser treatment (with wound redressing at a one-day interval) returned the cell pattern in the wound area to normal and hastened repair, with change of its phases once within three-four days.

Electron microscopy of fluid samples from wounds revealed fibroblasts, activated phagocytes (macrophages) with prominent pseudopodia and abundant phagosomes (intense cell vacuolation) with inclusions of detritus fragments and digested microorganisms.

Use of low-energy lasers in more than 300 patients with burns for blood photomodification and biostimulation of isolated donor skin grafts during autodermoplasty and of graft sites in the postoperative period appreciably improved therapy results and shortened the hospital stay of children by a mean seven days.

TREATMENT OF CHILDREN WITH COMPLICATED ACUTE PNEUMONIA

EQUIPMENT. Semiconductor lasers with sources of the static magnetic field are used in treatment of patients with complicated forms of acute pneumonia, such as lobitis and pleuroneumonia. The combination of three physical factors - low-energy infrared laser light, low-energy diode-emitted incoherent red light and a weak static magnetic field (40-60 mT) - yields prominent therapeutic effects by improving the blood flow and reversing inflammation.

TECHNIQUE. Magnetic-laser treatment using RIKTA and Uzor devices is conducted at three chest projections of the inflammatory site at 4 mW and 50 to 1,000 Hz during 5-6 minutes. Apart from the effects of the above mentioned physical factors, this treatment duration is consistent with the ultradian chronobiologic rhythm, which is five minutes, and with biorhythms of the integral intracellular circuity and blood redistribution.

Procedures are carried out daily or at a one-day interval. The course is 6-10 treatments.

In the presence of refractory postpneumonia bronchial obstruction, energy of infrared laser light is symmetrically applied to Head zones: 1) - forearm; 2) median axillary lines at the level of fourth intercostal spaces; 3) scapular lines of the 6th intercostal spaces.

The treatment uses the RIKTA quantum therapeutic device. The pulse frequency is 1,000 Hz. A zone is treated from a five centimeter distance (if the divergence angle of the laser beam is 45-60 degrees). Static magnetic field induction is 40-60 mT. A total of ten treatments are given.

Reference points are treated by applying the cross section of the light guide to each point for 30 seconds. The 1,000 Hz pulse frequency and 2-5 mW power of the semiconductor infrared laser are used in therapy.

The points are selected symmetrically:

1 - paravertebrally at the level of the 5th-10th vertebral processes;
2 - nostril grooves;
3 - nasal mucosa (near the nostril opening, without contact);
4 - each tonsil through the mouth (30-second treatment without contact);
5 - uppermost point of the external ear anthelix;
6 - uppermost part of the sternal jugular fossa, one point (children under 5);
7 - center of the sternum, one point (children older than 5);
8 - angle between the 1st and 2nd hand bones.

**INDICATIONS.** Indications for magnetic-laser therapy are acute segmental, polysegmental and lobar pneumonia, pleuropneumonia and persistent bronchial obstruction.

**CONTRAINDICATIONS.** Purulent destructive complications.

**EFFICACY OF THE METHODOLOGY.**

Mass spectrometric and gas analytic evaluation of external respiration and gas exchange in 60 patients showed that these functions significantly improved after six-eight procedures. Lung diffusion capacity, the ventilation equivalent, oxygen uptake rate and blood gas delivery improved twofold as compared to these findings in control groups. Apart from clinical and radiographic improvement, this indicates a fuller recovery of respiratory membrane function after magnetic-laser therapy.

Microcirculation studies in these patients suggested that the combination of magnetic and laser radiation restores a normal inflow-outflow ratio in capillaries by improving their tone on the one hand and the blood rheology on the other, a change which is not invariably obtainable by infusion of rheologically active substances. This in turn facilitates a more rapid inflammation reversal.

Laser therapy produced no complications.

This methodology proved effective in 80 percent of children with persistent obstruction and allergy. In addition, it allowed a significant tapering of the drug intake.
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Guidelines for Physicians

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These guidelines present pathogenetically relevant methodologies of low-energy laser therapy of children with urinary tract diseases, appendiceal peritonitis, burns and complicated acute pneumonia. Indications and contraindications for low-energy laser therapy and its optimum dosage have been defined for surgical management of these patient groups. The guidelines are oriented toward surgeons of regional hospitals, medical educational centers and research institutes.