QUANTUM MEDICINE ASSOCIATION
INSTITUTE OF QUANTUM MEDICINE
MILTA-PKP GIT COMPANY
Moscow Institute of Pediatrics and Pediatric Surgery

Health Without Drugs Series

QUANTUM THERAPY IN PEDIATRIC
COMBUSTIOLOGY

Guidelines for Physicians

Moscow 2003
THE USE OF LOW-ENERGY LASER RADIATION
IN PEDIATRIC COMBUSTIOLOGY

Guidelines for Physicians

Moscow 1999

These guidelines present pathogenetically relevant methodologies of quantum therapy of children with the burn disease, indications and contraindications for quantum therapy and optimal doses during its use in the surgical management of these patients.

The guidelines are oriented toward surgeons of pediatric units of regional hospitals, associates of chairs of medical universities and research institutes.
# CONTENT

1. INTRODUCTION 5  
2. DESCRIPTION OF THE METHODOLOGY 8  
3. LOGISTICS OF THE METHODOLOGY 9  
4. TECHNOLOGY OF USE OF THE METHODOLOGY 10  
   4.1. Quantum photomodification of autoblood, autoblood plasma, donor blood and blood substitutes 10  
   4.2. Quantum biostimulation during conservative treatment of limited and extensive granulating burn lesions 12  
   4.3. Quantum photostimulation of the skin autograft after autodermoplasty 15  
5. INDICATIONS AND CONTRAINDICATIONS FOR QUANTUM THERAPY 18  
6. EFFICACY OF THE METHODOLOGY 18  
7. LITERATURE 19
1. INTRODUCTION

Pediatric combustiologists have been intensively developing new modes of treatment of children with burns. The great social importance of this type of trauma explains the focus on problems of the treatment of it. In conditions of peaceful life, children incur burns in household and street accidents. Flame burns and chemical burns are characteristic for preschool and school children as well as teenagers because of their high activity, little life experience, exploratory leanings and a wont for extreme entertainment (making bonfires, setting incendiary and explosive substances on fire, making explosives, etc.).

The most common cause of burn lesions in young children is skin contact with boiling fluids. As a rule, little children get burns through the fault and incaution of parents (they tumble the boiling water or plates with hot food on themselves).

Burns of degrees I - II - IIIA are more superficial and cause no cause scars or leave inconspicuous scars that are not cosmetic defects. Burns of degrees III and IV usually require the operative management.

The burn disease is associated with diverse pathophysiological changes and is characterized not only by skin lesions, pain and cosmetic defects, but also by severe coagulation disorders, immune impairment, symptoms of "peroxidation" stress and abnormalities of the microvascular system. The latter present as circulatory disorders, such as arteriovenous shunting, the sludge syndrome and spasticity of peripheral vessels.

These events aggravate the disease progress and the prognosis, as a probability of septicemia, septicopyemia, encephalopathy, cardiopathy, intestinal diseases and stress-induced ulcers of the gastrointestinal tract is high during impairment of general body resistance.

A complex of operative measures must be rapidly used for the effective treatment of the burn disease. These are:
1. early necrectomy;
   - tangential necrectomy;
- tangential debridement;
- fascial necrectomy;
- combined necrectomy.

2. Early necrectomy combined with autodermoplasty and the grafting of cultivated fibroblasts.

These interventions avert lesion infection and gross scar deformation of tissues by contractures.

Despite significant successes achieved by pediatric combustiologists, problems of effective treatment of children with burns have not been fully solved. For instance, cultivated fibroblast grafting has, despite all its doubtless advantages, a number of contraindications related to:

1. Insufficient preparation of the lesion surface (high microbial colonization - more than 10 microbial bodies per gram of the tissue, inadequate ablation of necrotic tissues, the risk of secondary necrosis.

2. An extremely grave condition of a patient related to the onset of severe infection complications of the burn disease (sepsis).

Cultivated allofibroblasts actually do not engraft on the lesion surface in these conditions.

Autodermoplasty using a split-thickness sieve graft is a major method of closing lesions in children with deep burns. However, despite the extensive experience with this mode of treatment of children with severe burns, its results prove unsatisfactory in a percentage of cases. Different clinics have reported partial or complete lysis of grafts in 8 to 15 percent of children.

For instance, autodermoplasty using the split-thickness graft is inappropriate in the period when torpidly granulating burn surfaces are coated by fibrin or purulent necrotic deposits and when conventional methods of the burn lesion management yield no results. Such progress of the burn disease is related to the fact that the long persisting lesion grows "sour" (there is an acid shift of pH), i.e. strong chemical bonds of hydrogen atoms with free radicals (H-S, H-N) form in the connective tissue and the epithelium of the lesion. Traditionally used chemical drugs are
unable to dissociate the hydrogen bonds, which prolongs the disease and makes the prognosis worse.

These circumstances have made clinicians look for new, effective and pathogenetically relevant methods of treatment of children with severe burns.

Laser technology of therapy has been broadly adopted in medical practice in the recent decades. Medical scientists are working on the rationale for employing biostimulating and regenerative effects of low-energy lasers.

It is known that laser photomodification of autoblood and donor blood reverses endogenous intoxication, enhances oxygen capacity of erythrocytes and eliminates microcirculatory disorders (the sludge syndrome, arteriolar spasm, venular hypotension, etc.).

Being an indirect antioxidant, laser radiation reduces "peroxidation stress".

Evidence reported in the literature indicates that the use of laser energy for biostimulation of the autograft after autodermoplasty has been experimentally validated.

Laser energy has shown a high efficacy in the treatment of adults with burns and unhealing lesions.

The successful use of laser radiation in pediatrics and pediatric surgery is related to the high capability of children's organism for regeneration.

All this has been the reason for the development and adoption of quantum therapeutic methodologies in pediatric combustiology.

Quantum therapy of children with severe burns is pathogenetically relevant, non-invasive, actually does not have contraindications, and is not dangerous for patients and medical personnel.

These guidelines can be used in specialized pediatric burn centers, pediatric surgery units of central, regional and city hospitals, at chairs of research institutes and medical educational centers, as well as by resuscitators and surgeons.
2. DESCRIPTION OF THE METHODOLOGY

These guidelines for physicians are based on the clinical and research experience of the authors and present new quantum methodologies for inclusion in the conservative and operative management of children with severe burns.

Unlike therapeutic modes previously used in health care practice, these methodologies offer the pathogenetic treatment of children with burns and allow the earlier use of active surgical tactics, in particular in the presence of burn surface infection.

Quantum photomodification of blood and blood substitutes is an anti-shock intervention, as it improves rheological properties of blood and microcirculation, and enhances the oxygen capacity of erythrocytes, with beneficial effects on mechanisms of tissue respiration.

Topical quantum treatment improves tissue regeneration by reversing intracellular swelling and increasing the mitotic activity of inflammatory and immune cells and of cambial tissues. Activation of macrophageal elements and changes in crystallic structures of the detritus hasten debridement of infected burn lesions.

Quantum phoromodification of the skin flap improves its engraftment both after delayed autodermoplasty of granulating surfaces and autodermoplasy conducted immediately after necrectomy.
3. LOGISTICS OF THE METHODOLOGY

The two-channel laser therapeutic device Uzor-A-2K with magnetic handpieces has been manufactured by the state-owned enterprise Voskhod in the city of Kaluga with the registration number 94/271-122. The multifunctional device based on gallium arsenide has a semiconductor laser emitter generating near infrared radiation with a 890 nm wavelength. Its output power of radiation is in the range of 0 to 3 mW. The device has a pulsed mode of operation with frequency repetition rates of 80, 150, 300, 500, 1500 and 3000 Hz. Laser radiation exposures in an automatic mode are 4, 8, 16, 32, 128 and 256 seconds.

The quantum therapeutic device RIKTA-04/4 designed by MILTA-PKP GIT Company (Moscow) is a semiconductor laser with a 890 nm wavelength, diode-emitted radiation range of 890 to 950 nm and regulated power of continuous infrared diode radiation of 0 to 50 mW. Pulse repetition frequencies are 5 Hz, 50 Hz, and 1000 Hz. Stationary magnetic field induction at the aperture of the emitter is 30 to 60 mTl.
4. TECHNOLOGY OF USE OF THE METHODOLOGY

4.1. Quantum Photromodification of Autoblood, Autoblood Plasma, Donor Blood and Blood Substitutes

We have developed and introduced in clinical practice a methodology of quantum modification of autoblood, donor blood and blood substitutes.

Extracorporeal quantum photomodification of auto- and donor blood, plasma and blood substitutes is accomplished during transfusion by treatment of droplets with monochromatic red light with wavelengths 632.4 nm (helium-neon lasers) and 650 nm (semiconductor gallium arsenide lasers). Droplets of blood or a blood substitute are formed at the rate of 20-40 a minute in a transparent flask of a disposable system. Light beam power of the emitter or light-conducting fiber connected to the flask of the blood transfusion system is 10 mW.

When semiconductor pulsed lasers with a 650 nm wavelength are used, the pulse repetition rate is 1 kHz (1000 Hz).

Transcutaneous quantum photomodification of blood is performed by attachment of the laser emitter or light fiber using a special device that is fixed at a direct angle to the skin over the cubital, plantar, forearm or wrist vein.

Parameters of the quantum treatment are the same those of extracorporeal photomodification of blood and blood substitutes.

In the process of photomodification of blood and blood substitutes, the oxygen saturation index increases by 3-5 units. The body temperature decreases from 38-39 degrees Celsius to subfebrile figures within 10-20 minutes.

The levels of peripheral blood xanthine oxidase decrease by an average 20 percent and those of venous blood catalase increase 2.2 times. The procedure has been seen to cause a significant regression of symptoms of burn encephalopathy. The quantum treatment of blood induces conformation of erythrocytes: they get a biconvex shape, which appears to increase blood saturation. Less products of cell membrane degradation are found in uri-
nary sediments, while inflammatory and immune cells increase their activity after 2-3 quantum treatments of autoblood or donor blood.
4.2. Quantum Biostimulation during Conservative Treatment of Limited and Extensive Granulating Burn Lesions

In order to calculate quantum radiation doses for treatment of the burn lesion surface, main formulas should be known.

1. Light beam power (P) is measured in watts (W) and milliwats (mW).
2. The surface area of the speckle on the object (S) is measured in square centimeters and calculated using the formula: \( S = \pi R^2 \), where R is the distance from the margin of the speckle to its center. If the speckle is ellipsoid, the formula is:
   \[ S = \pi(R+r)^2/2 \]
3. The surface area is calculated through the distance to the object and the angle of beam divergence:
   \[ \tan \alpha = R/H; \quad R = H \tan \alpha; \quad S = \pi (H \tan \alpha)^2 \] (Fig. 1)
   where \( H \) - distance from the radiation source to the object, \( \alpha \) - angle of divergence of the beam of the radiation source.

![Fig.1](image)

4. Light flux power density (energetic illuminance, \( E_e \)) is calculated using the formula \( E_e = P/S \) and is measured in W/sq.cm.
5. The light flux (dose, W) is calculated using the formula: \( W = P \times T \) (c), where \( T \) - exposure time in seconds, and is measured in joules (J).
6. Energy density (energy exposure, \( H_e \)) is computed by the formula \( H_e = P/S \) and is measured in J/sq.cm.

12
Optic quantum generators radiating energy in red and infrared spectrums are used for the treatment of small burn lesions (1-5 percent of the body surface) or more extensive burns of II - IIIA degrees.

The used wavelength of the helium-neon laser is 632.8 nm, light flux density 10 mW, exposure 120 seconds per 1 percent of the surface area and light flux power density is 5-10 mW/sq.cm.

When semiconductor gallium arsenide lasers with wavelengths ranging from 650 nm (red light) to 650-890 nm (infrared) are employed in therapy, the pulse repletion rate of 100 Hz is used.

Average light flux power is 10 mW. Light flux power per may vary from 2.5 to 4 mW. Exposure durations are the same as for the helium-neon laser.

Quantum biostimulation of the slowly granulation extensive burn surface (more than 20 percent of the body) is used during preoperative preparation of patients for multistage autodermoplasty.

In our opinion, the quantum treatment of torpidly granulating lesions with extensive surfaces may not be used as a single modality for acceleration of repair. It is an adjunct procedure of preparing the lesion for autodermoplasty.

Treatment parameters are the same as presented above.

When the quantum methodology is used for treatment of large granulating lesions, the exposure time may be increased to 15 minutes. The burn surface is treated with a scanning beam from a distance of 5-10 cm at the rate of 0.5-1 cm/s.

Three-five quantum treatments of the burn surface produce early activation of inflammatory and immune cells, epithelialization of lesions of degrees II - IIIA and the formation of succulent granulations on the surface of burn lesions of degrees IIIB - IV. The formation and shedding of the slough occur 3-4 days faster as compared to conventional treatment without the use of laser energy.

Burns of degrees IIIB - IV with relatively small surface areas (9 to 25 sq.cm) heal by marginal epithelialization 5-7 days faster as
compared to those treated by traditional modes. Elongate lesions with length to breadth ratios of 1:5 - 1:10 heal better than round ones.

After the first two treatment sessions (about 5 days), slowly granulating lesions clear of purulent detritus and get a bright color. Prominent marginal epithelialization is seen.

As we examined imprints from slowly granulating lesions, we have not found inflammatory and immune cells in them; the imprints contained cellular elements and showed the dense tissue detritus in phospholipid-calcium, cholesterol and lipoprotein aggregations and in lipid crystals (products of cell membrane degradation). The activity of phagocytes was markedly decreased. Morphologically, this presented as incomplete phagocytosis (cytoplasmic inclusions of cell detritis fragments and microorganisms). The nuclear substance (chromatin) occupied most of the cell, while cytosol made a smaller proportion of the surface. Phagocytes did not show pseudopodia, which retards chemotaxis and does not help the capture of the detritus and microorganisms.

The cell composition in the burn lesions returned to normal during regular quantum treatment, with redressement at a one-day interval.

Electron microscopic examination of lavage samples from lesions at 16000 to 20000 magnification showed fibroblasts and active phagocytes (macrophages) with prominent pseudopodia and abundant phagosomes (intensive vacuolation in cells) with inclusions of the detritus and digested microorganisms.
4.3. Quantum Photostimulation of the Skin Autograft during Autodermoplasty

Quantum stimulation of the split-thickness autograft is used for acceleration of its engraftment. Different quantum methodologies are used, depending on the duration of the burn disease.

If quantum stimulation of the autograft is performed in a longer term after the formation of the granulating surface of the burn lesion, the autograft is treated after placing it on the smooth lesion surface.

If autodermoplasty coincides in time with early necrectomy, this intervention is inappropriate, as photostimulation of the lesion surface immediately after necrectomy can cause an intensive bleeding.

Early ablation of the slough is carried out at 2-5 days after the moment of the trauma after reversal of burn shock, stabilization of hemodynamics and before the beginning of bacterial colonization of the lesion. In cases of patient referrals from other medical centers, the operation is done after clinical stabilization and correction of laboratory findings.

All patients are operated under general analgesia. Depending on the depth of the thermal lesion, the slough can be ablated:
1. within boundaries of deep layers of the derma;
2. to subcutaneous fat;
3. to the superficial fascia.
A thin layer of the normal skin is then removed with a dermatome and perforated. Degrees of perforation vary depending on the surface area of the burn lesion. The perforation degree is 1:4 if the lesion is extensive and 1:2 if it is small. The graft thickness is 0.2 mm.

Parameters of helium-neon laser treatment of the autograft (wavelength, 632.8 nm) are:
- Light flux density - 10 mW; exposure - 60 s, diameter of the speckle - 10-20 cm;
- Power density of the light flux 10 cm in diameter - 0.13 mW/cm;
- When semiconductor gallium arsenide lasers with wave-
lengths 650 nm (red light) and 850-890 nm (infrared) are used, the pulse repetition rate is 1000 Hz.

Average light flux power is 10 mW. Power per pulse may be varied from 2.5 to 10 W.

The time of graft treatment - 60 s.

Distance - 10 cm to the graft. The graft with a large length is treated with a scanning beam at the rate of 0.5 cm/s. The irradiated skin autograft is placed on the lesion surface and ointment tulle dressings and wet-drying dressings with a hydrocortisone suspension are applied.

Redressement is carried out at 1-2 day intervals. During the first redressement, the dressing is removed to the last layer but one and quantum treatment is delivered through one gauze layer.

Quantum generators with a 890 nm wavelength are used.

The pulse repetition rate - 1000 Hz. Exposure - 60 to 600 minutes, depending on the surface area of the burn lesion.

In 83 percent of children treated with lasers, the skin flaps engrafted completely and 3 days earlier than in children whose management did not include this treatment.

To evaluate effects of quantum therapy on graft cells, we obtained glass imprints from the lower surface of autografts before and after laser treatment sessions for following up morphological and histochemical changes.

Imprints obtained immediately after the treatment of the lower surface of the skin graft showed the loose "cloud-like" tissue detritus consisting of finely dispersed components. Inflammatory and immune cells were not found as a rule.

Histologically, an increase in numbers of orthogonal capillaries located in the visual field was seen (3-5 before a treatment session and 15-18 after it). This finding suggested resolution of spasm in small vessels and the formation of collaterals.

In the postoperative period, we treated lesion surfaces during redressement using different versions of gallium arsenide lasers - MAKDEL-00.02, RIKTA and UZOR with 850 to 890 nm wavelengths in combination with magnetic treatment. The pulse repetition rate was 1000 Hz and exposure of the lesion 60 to 600 s-
conds, depending on its surface area.

Quantum therapy begun at an early stage of autograft lysis stopped it. The laser treatment stimulated granulations and induced epithelialization without rough scarring, i.e. the tissue became organ-specific.
5. INDICATIONS AND CONTRAINDICATIONS FOR QUANTUM THERAPY

Severe burns of IIIAB-IV degrees are an indication for the use of this therapeutic modality. No contraindications have been established.

6. EFFICACY OF THE METHODOLOGY

The use of quantum methodologies in the management of granulating, infected and torpidly granulating burn lesions and for biostimulation of isolated donor grafts during autodermoplasty and in the postoperative period significantly improves therapy results and curtails the hospital stay by 3 to 7 days. This intervention prevented the formation of rough scar deformities in 19 percent of children, increased engraftment of skin autologous transplants by 38 percent and accelerated the healing of burn lesions in 80 percent of patients.
7. LITERATURE

2. Guidelines for the use of the quantum therapeutic device RIKTA. Moscow, ZAO MILTA-PKP GIT, 2002