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The investigations of changes of blood microcirculation and temperature during low level laser therapy

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Introduction: The effectiveness of low level laser therapy (LLLT) can be improved by a satisfactory solution of some problems in this field. In particular, the finding of an unequivocal and reproducible response parameters of bioobject during LLLT should be interesting both for justification the therapeutic effect LLLT and for the possible introduction of individualization of treatment.

Materials and Methods: Within the scope of the problem, we researched the dynamics of changes of system parameters of blood microcirculation during LLLT by laser Doppler flowmetry (LDF) with the simultaneous recording of temperature in the area of exposure. It was used in the laser diagnostic complex "LAKK-M" to register the blood perfusion in the exposure area and medical thermograph "IRTIS-2000 ME" for measuring the temperature. In carrying out the procedures we used laser therapy apparatuses "ULAN-BL-20" ($k=0.89\text{Lim}$, 0.30kHz, 5W in impulse) and "ULF-1" ($k=0.632\text{Lim}$, continuous mode, the power of 20 mW). The thermal effect of LLLT was simulated by the use of standard heating element of block "LAKK-TEST" of apparatus "LAKK-M" for the heat provocation (HP) of the bioobject. The backside of the palm and the inside of the forearm were selected as the irradiated areas.

Results: The average recorded indices of the microcirculation, as well as the temperature, have natural physiological fluctuations and drift at 5-7% from the mean value during the observation. There were not observed significant changes in the mean values of the parameters of microcirculation and the temperature when the skin is exposed by low level laser radiation (LLLR). We observed the changes in the parameters of the microcirculation in the case of a lengthy procedure LLLT, when superficial tissues heat was comparable to the HP. This increase was more pronounced compared with control measurements without LLLR and with measurements during HP. This increase appeared to be more obvious comparison with control measurements without LLLR, and with measurements during HP. It was observed the greatest increase in the amplitudes of the oscillations in the frequency range corresponding to the heart rate (0.6-1.6 Hz) and oscillations in the neurogenic band (0.02-0.05 Hz).

Conclusion: New data were obtained by means of digital thermography and LDF method confirming the stimulating effect of LLLR in the matter of the amplitude increase of oscillations of the tissue perfusion with blood. Mean values of other indicators of microcirculation during LLLT were within the level of the natural drift of parameters. At the same time the thermal heating during LLLT is a significant factor in the overall effect of LLLT.

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Photodynamic therapy with nanoparticles

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Introduction: To date nanoparticles are exploited for photodynamic therapy as photosensitizers. Titanium oxide, zinc oxide have been already exploited to generate singlet oxygen. Silicon nanoparticles prepared by laser ablation in liquids are able to act as photosensitizers producing singlet oxygen and resulting in microbe cell killing, opening potential antiseptics or disinfectant therapies.

Materials and Methods: Nanoparticles were produced by ultrashort laser ablation in liquids, which was originally introduced for the fabrication of plasmonics (noble metal) nanoparticles.

Results: We present preliminary results of photodynamic activity and generation of singlet oxygen using silicon nanoparticles in solution. The femtosecond laser ablation regime offers several key advantages over conventional nanosecond or microsecond ablations, enabling a fine control of nanocluster parameters even in the absence of chemical surfactants during the ablation process. However, the main advantage of this approach consists in the possibility of working in a clean, contamination-free environment, which eliminates the toxicity problem and provides complete sterilization of the resulting product.

Conclusions: The future steps of this study will include modification of nanoparticle design to improve photodynamic performance enhancing both either the quantum yield of the singlet oxygen generation and the increase of the desired spectral absorption.

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Acupuncture and laser therapy for prevention and treatment of functional abnormalities in early postoperative period in cancer patients

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Introduction: Functional abnormalities in the lungs, bowel and bladder are not uncommon in early postoperative period, especially after major surgery. Pain occurring as result of insufficient relief by analgesics and narcotics, is usually major cause of such sort of abnormalities. It involves the whole body into the pathologic process, having triggered the reaction of central structures of the brain. In our study we concluded results of acupuncture and laser therapy for the treatment of functional abnormalities in early postoperative period.

Materials and Methods: We managed 73 patients in their early postoperative period after surgical treatment of lung, bladder, and gastrointestinal cancers. Amongst them pain syndrome was treated by acupuncture and low-level laser irradiation in 39 patients (group I). In 34 remaining patients (group II) pain syndrome was treated with narcotic analgesics. In acupuncture analgesia corporal biologically active points (BAP) crossing both the surgical site and ablated tumor's bed were used. BAP with sedative and antispasmodic properties were also exposed. Exposure on auricular points included: 'Locus', Shen Men, Sympathetic, Hypertension, Diaphragm, and Breath-regulating. Laser analgesia and therapy of functional abnormalities were applied to the area of pain locally using semi-conductor laser Uzor (0.89microm), and emission power 3.3W with 10 min -irradiation time.

Results: Two patients (5.8%) of group I developed functional abnormalities during the first 2 days after surgery. Namely, a cough with difficult expectoration of the sputa in a patient (heavy smoker for 35 years) after left-side pneumonectomy; and a spasm of bladder with impossibility of urination in a patient with Hodgkin's lymphoma (stage IV) after splenectomy. In the former patient an obvious bronchial spasmolytic effect with significant reduction of cough intensity was observed after 3 seances of laser irradiation of front and back surfaces of the chest. In the latter patient urination restored after two seances of laser exposure in the area of the bladder and sacrum.

In the control group where pain syndrome was treated by narcotic analgesics, 28 patients (89.3%) developed functional abnormalities. Addition of laser treatment allowed to resolve functional abnormalities in 24 patients (85.7%). In 4 patients (14.3%) with intractable enteroparesis renewal of peristalsis and passage of gases slowly started on the 2nd day. The efficacy of treatment was considered as satisfactory.

Conclusion: Our data revealed that the method of acupuncture-laser-based analgesia demonstrated not only marked pain-relief effects, but spasmolytic and anti-inflammatory ones as well. Thus, the method is highly efficient in both prophylaxis and treating of functional abnormalities in early postoperative period.