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Influence of Light Emitting Diode on Bone Marrow and Healing of Dermatome Wounds

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Abstract

The irradiation of large surfaces or whole body with light emitting diode LED λ-470 nm and λ-940 nm (LED shower) causes structural changes in bone marrow and stimulates healing of experimental dermatome wounds. The increase of migration of the bone marrow cells in derma and epithelial layers of skin indicates that LED-shower intensifies intercellular interactions and cells migration between tissues.

Keywords: Bone marrow; Dermatome wounds; Light emitting diode irradiation; Morphology

Introduction

It is well known that low intensive laser irradiation (LILI) may positively influence on the processes of inflammation, wound healing and cause many other favorable effects [1-9]. It is also known that LILI, and especially He-Ne lasers-HNL stimulate the processes of cells proliferation and differentiation. These biological effects were shown to take place after local and regional irradiation of intact skin and dermatome wounds with HNL and other types of LILI [1,2,6-9].

The irradiation of skin dermatome wounds with Arsenic Gallium (infrared range) lasers with magnet field, which are more commonly used in different fields of clinical medicine cause the same effects and the above mentioned effects in this case are more pronounced than after HNL irradiation, which occur due to stimulation of microcirculation [3,6-9].

Laser irradiation of large surfaces of body or irradiation of whole body - laser shower stimulates physiological and reparative regeneration in skin and other organs. This is also true, concerning bone marrow, where it activates cell proliferation and migration [2,3]. In recent years, light emitting diode – LED were used rather widely along with LILI. By many parameters, the effects of LED are comparable to LILI and its efficiency is not inferior to that of LILI. Simplicity, availability of LED, and possibility to irradiate large surfaces makes this type of phototherapy promising [4,5,8-11]. Influence of LED, used as shower, on the healing of skin wounds and on the bone marrow has not been studied.

Material and Methods

Standard dermatome wounds (area 0.95 cm^2) were made in 42 "Vistar" rats under inhalation of solution of "Narcotan" or after intraperitoneal administration of 2-3 ml of 30% alcohol solution.

34 Vistar rats were exposed to LED shower with the doses of 0.2-0.5 J/cm^2, 3 min/day, during 10 days with the help of the LED set Barva-Flex/BIR (λ-470 and λ-940 nm), which had 12 diodes. The radiation power of each LED was 5 mW. Wounds of control animals [8] were not subjected to any special light exposure. The material of previous studies, concerning the effects of laser shower with comparable doses, in similar animals was used as control and comparison group [2,3]. Wounds and femoral bone marrow were examined after 1, 3, 5, 7 and 10 days after creation of wounds and carrying out shower sessions.

Specimens from wounds, bone marrow were studied with light, electron microscopy and stereomorphometry. Animals were killed by momentary decapitation. Fixation and embedding were performed with standard methods. Semithin sections (STS) from epoxy-embedded specimens were studied under light microscopy prior to be studied with electron microscopy. Planimetric studies were conducted using the computer application "Ploshad", version 1.01 with the following processing of the received results on computer. All micrographs were processed and data stored on computer using applications of Microsoft-"Windows XP-Professional".

Experimental Data and Discussion

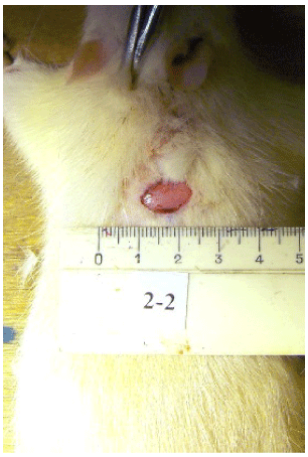

Figure 1: Dermatome wound. 24 hours after dermatomy. Control

The irradiation of the whole body with LED shower 0.2-0.5 J/cm^2 causes significant acceleration of wound healing. In 24 yours after

shower the microvessels of derma are widened, their relative volume significantly increases. This phenomenon is accompanied by the increase of the volume of connective tissues cells, including cells which have bone-marrow derivation: mast cells, neutrophils and lymphocytes (Figures 1 and 2), layers of skin around wounds contained unaltered epidermocytes.

Manifestations of edema and tissue alteration were prevalent in control. LED irradiation reduced the severity of edema in the tissues around wounds and caused an increase in the density of cellular infiltration (Figures 2-6).

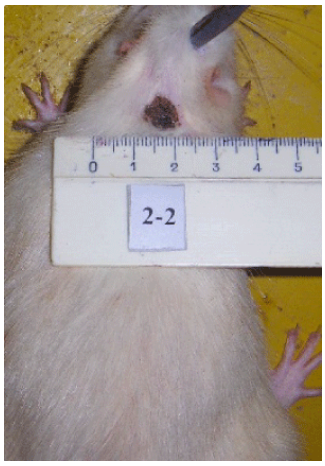

Figure 2: Dermatome wound. LED irradiation. 72 hours after dermatomy. Reduction of wounds surface

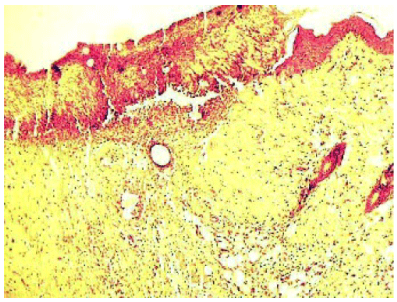

Figure 3: Edema and not numerous connective tissue cells. 24 hours after dermatomy. Control. Hematoxilin and Eosin 10x10

Significant differences, upon the visual assessment of wounds, were detectable on day 3 of study. Wounds in control had greater surface area than in LED irradiation (Figures 1,2,7-11). Granulation tissue with a layer of vertical microvessels starts to form, at this period, on the bottom of wounds, which appears to be more mature and marked in the irradiated group (Figures 5 and 6). Formed granulation tissue serves as the base for "crawling on" of epithelial strands on it and epithelialization of wounds. This process is also more pronounced in irradiated animals.

LED shower causes considerable increase of the amount of some connective tissue cells which have bone marrows origin such as neutrophiles, lymphocytes, and mast cells in lamina propria 24 hours after LED. The changes of the relative volume of connective tissue cell in skin concur with the changes in the volume and ultrastructure of bone marrow.

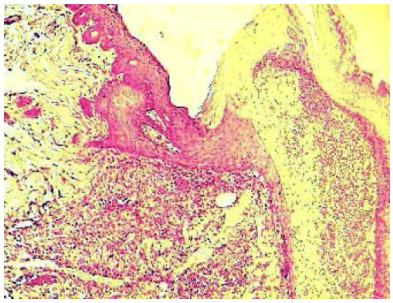

Figure 4: The beginning of epithelialization of wound under the scab.24 h after dermatomy and LED shower irradiation. Hematoxilin and Eosin 10x10

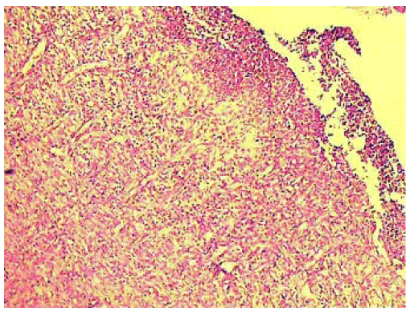

Figure 5: Numerous connective tissue cells and vertical vessels. 72 h after dermatomy. Control. Hematoxilin and Eosin 10x10

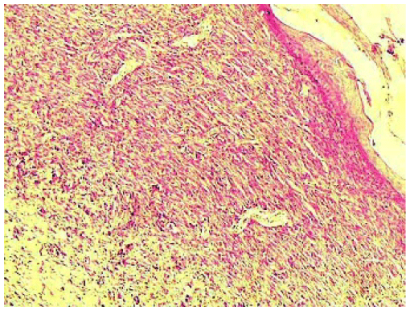

Figure 6: Numerous connective tissue cells and horisontal vessels, epithelialization of the wound. 72 h after dermatomy and LED shower. Hematoxilin & Eosin 10x10

The LED shower causes the widening of sinusoid capillaries. This is accompanied by decrease of these cells in bone marrow, which becomes depleted at 24 hour after LED shower (Figures 7 and 11). It, probably, occurs due to more intensive migration of the bone marrow cells of both erythropoietic and mielopoietic origin into circulation, and later into derma of skin.

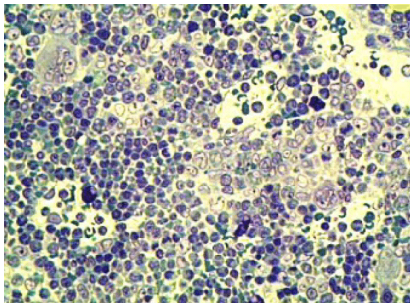

Figure 7: Bone marrow 24 hours after dermatome wound. Control. Reduction of density of cell population. STS 10×40

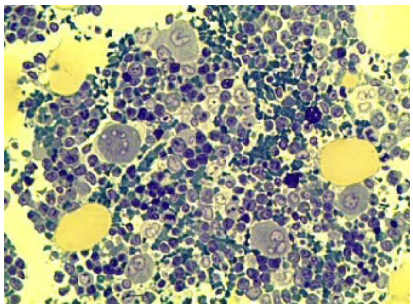

Figure 8: Bone marrow 24 hours after dermatome wound and LED shower. Increase of the density of cell population. STS 10×40

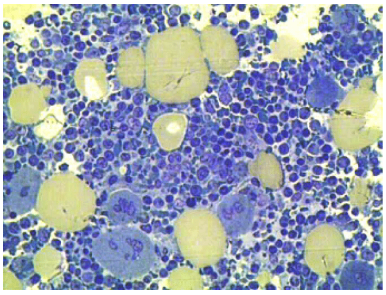

Figure 9: Bone marrow 72 hours after dermatome wound and LED shower. Increase of density of cell population and number of megakaryocytes. STS 10×40

Later (at 72 hours) the intensification of bone marrow cells proliferation compensates for this depletion, with significant increase of their number, which may even exceed the control level. Notably, increases the number of megakaryocytes (Figure 9). This is accompanied by the increase of the number of mitosis in bone marrow and the increase of the volume and amount of intracellular structures in different types of bone marrow cells, and especially, in such differentiated myeloid cells as eosinophiles, neutrophiles and basophiles (Figures 7-11). These phenomena were also described previously [2,3].

The observed increase increased of migration the cells from bone marrow to connective and epithelial tissues testify the intensification of the intercellular and intertissue interactions.

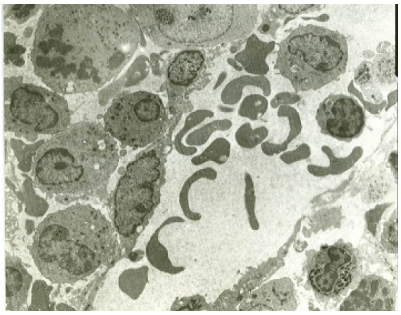

Figure 10: Bone marrow 72 hours after dermatome wound and LED shower. Numerous mitosis, migration of cells into capillary TEM×5000

Conclusion

Some comparative studies of the effects of LILI and LED on the processes of regeneration, proliferation and other processes had shown that within corresponding diapasons of irradiation their influences are comparable. Comparison of the therapeutic effect of a laser (coherent) and a LEDs (noncoherent) source showed no significant difference at the same wavelengths, intensities, and radiation times [4,5,10-12]. In addition to promotion of tissue growth, LED-technology developed for NASA (U.S.A), for experiments on growth of biological objects in space, shows promising results for delivering light deep into tissues to promote wound healing and human tissue growth. The use of light with NASA LEDs in human trials has been approved by U.S. Food and Drug Administration [4,5,11,12]. Although the mechanism of action of LEDs in nonablative light therapy is not fully elucidated, it is believed that specific LED light parameters modulate certain cellular and subcellular photoreceptors, which are numerous in skin. Thus, tissue effects may be achieved through up-regulation or down-regulation of intracellular signaling cascades [4,5,7] (Figures 11-13).

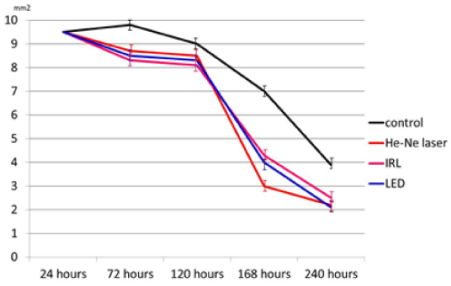

Figure 11: Area of dermatome wounds after laser and LED shower

Our studies have shown that LED shower helps to accelerate the healing of dermatome wounds. Comparison of the results of previous studies with the action of the laser shower on the healing of similar

wounds, performed in comparable doses, showed that the stimulatory effect of LED shower is no less inferior to the action of laser shower.

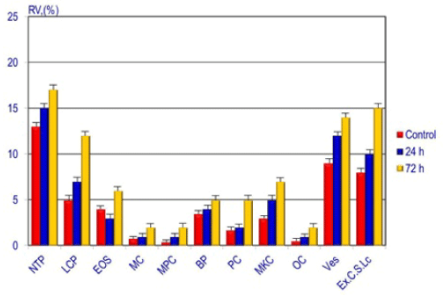

Figure 12: Period after LED shower of bone Relative volume marrow cells and other structure

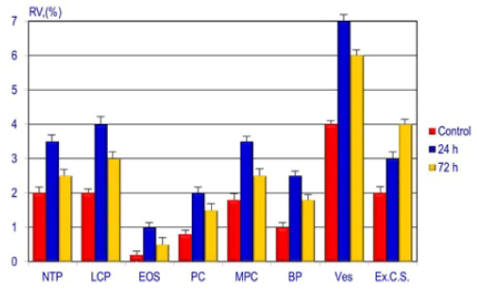

Figure 13: Period after LED shower connective tissue cells in derma (B). Type of cells: NTP-neutrophils, LCP-lymphocytes, EOS-eosinophils, MC-monocytes, MCP-macrophagocytes, MCC-megakaryocytes, PC-plasmocytes, BP-basophils, OC-other cells, Ves-vessels, Ex.C.S.Lc-extracellular structures and lipid cells

LED stimulates proliferation of epithelial cells and the so-called intercalary epidermal growth in epithelial strands, which results in increased numbers of mitotic figures.

LED shower, like laser shower, has a stimulating effect on the bone marrow. That is concluded as in enhanced proliferation of its cells, as well as migration of bone marrow cells with their consecutive settling down in dermal wounds and granulation tissue.

References

1. Baibekov IM, Kasimov AK, Kozlov VI, Musaev E (1991) Morphological Bases of Low Intensive Laserotherapy, Ibn Sino, Tashkent.
2. Baibekov IM, Lishmanova NG, Musaev E, Ibragimov AF (1993) "The Effect of Total Laser Radiation on Migration of Mature Cells from Rat Bone Marrow". Hematology and Transfusiology 8: 22-24.
3. Baibekov IM, Kasimov B, Musaev E, Ibragimov AF (1995) Influence of low intensive laser irradiation on intercellular intertissue interaction. Proc 2323: 520-528.
4. Li WT, Chen HL, Wang CT (2006) Effect of Light Emitting Diode Irradiation on Proliferation of Human Bone Marrow Mesenchymal Stem Cells. Journal of Medical and Biological Engineering 26: 35-42.
5. Li WT, Leu YC, Wu JL (2010) Red-light light-emitting diode irradiation increases the proliferation and osteogenic differentiation of rat bone marrow mesenchymal stem cells. Photomed Laser Surg 1: S157-165.
6. Mester E (1969) Experimentation on interaction between infrared laser in Wound healing. Exp Chirurgie V 2: 94-102.
7. Posten W, Wrone DA, Dover JS, Arndt KA, Silapunt S, et al. (2005) "Low-level laser therapy for wound healing: mechanism and efficacy," Dermatol Surg 31: 334-340.
8. Simunovic Z (2009) Lasers in medicine science and praxis in medicine, surgery dentistry and veterinary Trilogy updates with emphasis on LILT-photobiostimulation-photodynamic therapy and laser acupuncture. Locarno: 772.
9. Tuner J, Hode L (2010) The New Laser Therapy Hand book Prima book. Stockholm.
10. Vinck EM, Cagnie BJ, Cornelissen MJ, Declercq HA, Cambier DC (2003) "Increased fibroblast proliferation induced by light emitting diode and low power laser irradiation," Lasers Med Sci 18: 95-99.
11. Whelan HT, Houle JM, Whelan NT, Donohoe DL, Cwiklinkski J, et al. (2000) "The NASA light-emitting diode medical program- progress in space flight and terrestrial applications". Space Tech & App Znt'l Forum 504: 37-43.
12. Whelan HT, Buchmann EV, Whelan NT, Turner SG, Cevenini V, et al. (2001) "NASA light emitting diode medical applications from deep space to deep sea". Space Tech and App Znt'l Forum 552: 35-45.