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Effects of Nd:YAG laser on wound healing processes: clinical and immunohistochemical findings in rat skin.

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BACKGROUND AND OBJECTIVE: The clinical effects of the Nd:YAG laser in the rat skin as well as alterations of the extracellular matrix during healing were presented in this study. **STUDY DESIGN/MATERIAL AND METHODS:** This study evaluated the clinical effects of the Nd:YAG laser used with different energy parameters (low energy: 1.75 W and 20 pps/high energy: 3.0 W and 30 pps) in a duration 20-40 s in rat skin. Control incisions were performed with a scalpel blade. Rat skin incisions were examined over a period of 28 days by clinical photographs as well as by using immunohistochemical techniques in order to find the distribution and the amount of the extracellular matrix fibrillar components, i.e., collagen types I and III. **RESULTS:** Low energy laser treatment caused a rapid wound healing without scar tissue formation (compared to the high energy laser group) and clinical signs of scar tissue formation (compared to control incisions with the conventional scalpel). During the study period, the laser-induced lesions healed through reparative synthesis of the matrix proteins, which led to filling of the tissue defects. The regenerative processes were similar in the low-energy laser group and in the control incisions. In the high-energy laser treated tissues, we observed a delayed replacement of the defects by newly formed extracellular matrix proteins. **CONCLUSIONS:** This study showed a slower wound healing in the high-energy laser treated tissues. A similar healing in the low-energy laser treated tissues and in the incisions with the conventional scalpel was observed. The differences in the distribution of matrix proteins during healing and the coagulation of the tissues, which were exposed to low-energy laser treatment, might be the explanation for the minimal scarring, contraction, and pigmentation of the laser treated tissues as compared to conventional incisions.

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Increased dermal angiogenesis after low-intensity laser therapy for a chronic radiation ulcer determined by a video measuring system.

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Acute and chronic radiation-induced dermatitis can occur after high doses of ionizing radiation of the skin. We describe a patient with a long-lasting radiotherapy-induced ulcer that healed after low-intensity laser therapy. A video measuring system was used to determine the number of dermal vessels in the ulcer before and after laser treatment. We found a statistically significant increase in the number of dermal vessels after low-intensity laser therapy in both the central and marginal parts of the ulcer compared with its pretreatment status.

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Laser modulation of angiogenic factor production by T-lymphocytes.

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BACKGROUND AND OBJECTIVE: In previous investigations, small variations in the energy densities of low level light therapy (LLLT) were found to produce significant differences in the proliferation of resting T-lymphocytes in vitro. Pulsing these cells with mitogen in addition to laser therapy produced inhibitory effects regardless of the amplitude of the energy density used. In the current study, the effect of LLLT on the production of angiogenic factor(s) by T-lymphocytes was investigated in vitro. **STUDY DESIGN/MATERIALS AND METHODS:** Human T-cells isolated from peripheral blood were prepared in suspension either with or without addition of mitogen. Cell suspensions were irradiated with laser by using the following energy densities: 1.2, 3.6, 6.0, and 8.4 J/cm². Wavelength, pulsing frequency, and power output were kept constant at 820 nm, 5,000 Hz, and 50 mW, respectively. After either 3 or 5 days of incubation, lymphocyte supernatants were collected and added as conditioned media to cultured endothelial cells (ECs). The effect on the proliferation of these ECs was assessed over a 72-hour period by using a methylene blue assay. **RESULTS:** Endothelial cell proliferation increased significantly when incubated with conditioned media collected from resting T-cells exposed to 1.2 and 3.6 J/cm². Day 5 conditioned media produced similar patterns of EC proliferation to that of day 3 but at lower magnitude. Pulsing of T-lymphocytes with mitogen in addition to laser irradiation significantly lessened their angiogenic capability. Conditioned media from 3.6 J/cm² laser-treated T-cells induced the maximal EC proliferation in all groups studied. **CONCLUSION:** It would seem that laser therapy stimulates lymphocytes to produce factor(s) that can modulate EC proliferation in vitro; this effect on the lymphocytes is influenced by (1) the amplitude of energy density used for T-cell irradiation, (2) exposing T-cells to both mitogen and laser, and (3) the duration of T-cell incubation in culture.

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In vitro effects of low-level laser irradiation at 660 nm on peripheral blood lymphocytes.

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Lasers in Surgery
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BACKGROUND AND OBJECTIVE: The effects of low-level laser light irradiation are still highly contested, and the mechanisms of its action still unclear. This study was conducted to test the effects of low-level laser irradiation at 660 nm on human lymphocytes and to investigate the possible mechanisms by which these effects are produced. **STUDY DESIGN/MATERIALS AND METHODS:** Whole blood obtained by phlebotomy was irradiated at 660 nm by using energy fluences between 0 and 5.0 J/cm². The lymphocytes were isolated after irradiation of the whole blood. For the control experiment, the lymphocytes were first isolated and then irradiated at the same wavelength and energy fluence for comparison. The proliferation of lymphocytes and the formation of free radicals and lipid peroxides were monitored. Hemoglobin was also irradiated in a cell-free environment to test for the production of lipid peroxides. **RESULTS:** Lymphocyte proliferation was significantly higher (P<0.05) as expressed by a Stimulation Index in samples

Literature About Lasers Effects

irradiated in the presence of whole blood compared with lymphocytes irradiated after isolation from whole blood. Free radical and lipid peroxide production also increased significantly when samples were irradiated in the presence of red blood cells. CONCLUSION: The present study supports the hypothesis that one mechanism for the photobiostimulation effect after irradiation at 660 nm is the reaction of light with hemoglobin, resulting in oxygen radical production.

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Systemic effects of low-intensity laser irradiation on skin microcirculation in patients with diabetic microangiopathy.

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Low-intensity laser irradiation has been shown to induce wound healing in conditions of reduced microcirculation, which is in part explained by systemic effects. We therefore investigated such a potential systemic effect of low-intensity laser irradiation on skin blood circulation in patients with diabetic microangiopathy. Patients with diabetic microangiopathy were randomized to receive either a single helium-neon (HeNe, 632.8 nm) low-intensity laser irradiation with a dose of 30 J/cm² or a sham irradiation over the forefoot region in a double-blind, placebo-controlled clinical study. Skin blood circulation by means of temperature recordings over forefoot regions was detected by infrared thermography. Following a single transcutaneous low-intensity laser irradiation, a rise in skin temperature in both feet of the subjects in the laser group was noted, whereas in both feet of the subjects in the placebo group a drop in skin temperature occurred. The baseline-adjusted skin temperature 15 min after the end of the irradiation was significantly higher in the laser-treated forefeet compared to the placebo-"treated" forefeet ($p < 0.0001$); the baseline-adjusted difference in the temperature was 1.94 +/- 0.35 degrees C. Simultaneously, the baseline-adjusted skin temperature was significantly higher in the laser-untreated forefeet compared to the placebo-"untreated" forefeet ($P < 0.0001$); the baseline-adjusted difference was 1.70 +/- 0.33 degrees C. Our data show a significant increase in skin circulation due to athermic laser irradiation in patients with diabetic microangiopathy and point to the possibility of inducing systemic effects.

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Effects of near-infrared low-level laser irradiation on microcirculation.

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BACKGROUND AND OBJECTIVE: Recently, there has been an increase in the clinical application of low-level laser irradiation (LLLI) in various fields. The present study was conducted to explore the effects of LLLI on microcirculation. **STUDY DESIGN/MATERIAL AND METHODS:** We investigated the effects of LLLI on rat mesenteric microcirculation in vivo, and on cytosolic calcium concentration ($[Ca^{2+}]_i$) in rat vascular smooth muscle cells (VSMCs) in vitro. **RESULTS:** LLLI caused potent dilation in the laser-irradiated arteriole, which led to marked increases in the arteriolar blood flow. The changes were partly attenuated in the initial phase by the superfusion of 15 microM L-NAME, but they were not affected by local denervation. Furthermore, LLLI caused a power-dependent decrease in $[Ca^{2+}]_i$ in VSMCs. **CONCLUSION:** The circulatory

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changes observed seemed to be mediated largely by LLLI-induced reduction of $[Ca^{2+}]_i$ in VSMCs, in addition to the involvement of NO in the initial phase.

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Experimental study on He-Ne laser irradiation to inhibit scar fibroblast growth in culture.



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OBJECTIVE: To explore the inhibitory effect of He-Ne laser irradiation on fibroblast growth of hypertrophic scars in culture. **METHODS:** He-Ne laser with wavelength of 632.8 nm, power density of 50 mW/cm² and doses of 3 J/cm², 30 J/cm², 90 J/cm² and 180 J/cm² was used to irradiate human scar fibroblasts in culture 1, 3 and 5 times respectively, and then the cell count and cell cycle analysis were done. **RESULTS:** Repeated irradiation with He-Ne laser at dose of 180 J/cm² three and five times led to an evident decrease in total cell number compared with that of the control group and there was a significant difference ($P < 0.05$). The cell cycle analysis showed after three and five times of irradiation with 180 J/cm² He-Ne laser the cell number in S-phase decreased from 51% to 20% and 14% respectively, the cell number in G(0)/G(1) phase increased from 28% to 55% and 60% respectively, and the cell percentage in Sub-G1 phase was 6.7% and 9.8% respectively. **CONCLUSIONS:** Repeated irradiation with 180 J/cm² He-Ne laser can inhibit scar fibroblasts growth in culture. It may be that He-Ne laser irradiation causes cell stagnation in G(0)/G(1) phase and apoptosis.