PBM Laser Therapy-Wound Healing, MRSA Infection

Photobiomodulation, Photomedicine and Laser Surgery, Volume 38, Number 7, 2020 ª Mary Ann Liebert, Inc. Pages 419-424 DOI: 10.1089 / Photob.2019.4754

Effect of photobiomodulation therapy (660 nm) on wound healing of rat skin infected with staphylococci

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short version

Objective: Assessment of the influence of photobiomodulation therapy (PBM) on the healing of infected wounds and documentation of the microscopic findings during the healing process.

Background: Previous studies have shown that PBM accelerates wound healing and reduces inflammation and pain. However, the ideal protocol and ultimate value of PBM treatment for infected wounds are controversial.

Materials and Methods: Eight-month-old male rats were randomly assigned to the control group, the non-irradiation group, or the irradiation group. A skin excision 1 cm in diameter was made. The wounds of the unirradiated and the irradiated rats were inoculated with a suspension of Staphylococcus aureus. We then carried out a 7-day PBM therapy at a wavelength of 660 nm for 35 min / day. On day 8 the rats were sacrificed for histological examination. The sections were stained with hematoxylin and eosin, Masson's trichrome and a kit with proliferating cell nuclear antigen (PCNA). The defect diameter was calculated using the visual acuity image analysis system.

The results: The irradiated group had more epithelial cells and richer granulation tissue than the other groups. The irradiation group had a significantly smaller defect size than the non-irradiation group ($p < 0.01$) and the control group ($p < 0.05$). The amount of collagen was highest in the irradiation group and was classified as 3, 2 and 3+ in the control group, the non-irradiation group and the irradiation group, respectively. The percentage of PCNA in the control group was significantly lower than in the other two groups ($p < 0.05$).

Conclusions: PBM therapy (660 nm) promoted cell proliferation and collagen synthesis, thereby improving the wound healing response to S. aureus infection. Keywords: 660 nm, photobiomodulation therapy, wound healing, infection, staphylococcus

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Journal for Photochemistry & Photobiology, B: Biology

Photobiomodulatory effects of super-pulsed 904 nm laser therapy on the bioenergetic status in wound healing of burns

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Article info Summary Article history: Received April 7th, 2016 Revised receipt received June 16th, 2016 Accepted June 17th, 2016 Available online xxxx

Burn wounds exhibit impaired healing as progression through the normal sequential stages of tissue repair is hampered by disruption of the epidermal barrier, impaired blood circulation, defective defense mechanisms, pathological inflammation and septicemia. Our previous results reported that the super pulsed 904 nm LLLT improved healing and decreased the inflammatory response in burn wounds. The present study examined the effect of the super-pulsed 904 nm LLLT (200 ns pulse width; 100 Hz; 0.7 mW mean output power; 0.4 mW / cm2 mean irradiance) on biochemical and molecular markers of bioenergetics and redox homeostasis on full thickness burn wounds in experimental rats.

The results indicated that super-pulsed laser irradiation for 7 days after the wound drove the cellular milieu towards aerobic energy metabolism, which was demonstrated by significantly increased activities of the most important energy-regulating enzymes HK, PFK, CS and G6PD, while LDH compared to the non-irradiated controls showed reduced activity. The LLLT showed a significantly increased CCO activity and an increased ATP level. In addition, LLLT also regulated redox homeostasis, which was demonstrated by increased NADPH levels and a decreased NADP / NADPH ratio. The Western blot analysis showed that the LLLT caused an upregulation of GLUT1, pAMPKα and a downregulation of glycogen synthase1 (GS1). Our results suggest that super-pulsed 904 nm LLLT improves wound healing in burns by increasing the intracellular energy content by modulating the aerobic metabolism for maximum energy yield. Bioenergetic activation and maintenance of redox homeostasis could be one of the notable mechanisms responsible for the beneficial photobiomodulatory NIR effect mediated by super-pulsed 904 nm LLLT in wound healing of burns.

Photomedicine and laser surgery. April 2010, 28 (2): 281-283. doi: 10.1089 / pho.2009.2489.

The effect of an equal daily dose, achieved by different power densities of low-level laser therapy at 635 and 670 nm, on wound tensile strength in rats: a brief report

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Abstract aim: The aim of our study was to compare the effects of different power densities of LLLT at 635 and 670 nm at a daily dose of 5 J / cm2 on wound tensile strength (TS) in rats. Background data: The optimal parameters of low-level laser therapy (LLLT) are still unknown.

Materials and Methods: Under general anesthesia, a full-thickness skin incision was made on the back of each rat (n = 40) and immediately closed with an intradermal suture. The rats were divided into five groups depending on the treatment parameters: (1) Sham irradiated control group (SIC); (2) 635nm laser treated group at 4mW / cm2 (L-635/4); (3) 635nm laser treated group at 15mW / cm2 (L-635/15); (4) 670nm laser treated group at 4mW / cm2 (L-670/4); and (5) 670nm laser treated

group at 15mW / cm2 (L-670/15). The total daily dose was 5J / cm2. Seven days after surgery, each wound was removed for wound TS measurement.

Results: The lowest wound TS results were measured in the SIC rats (10.5 ± 2.8 g / mm2). Higher wound TS results were measured in the rats of group L-670/15 (11.5 ± 2.5 g / mm2) and group L-635/4 (11.7 ± 4.3 g / mm2), while significantly higher results were found in the rats of group L-670/4 (15.8 ± 4.4 g / mm2) and group L-635/15 (15.9 ± 4.8 g / mm2). The differences were significant between certain groups ($p < 0.01$: SIC vs. L-635/15, SIC vs. L-670/4; $p < 0.05$: L635 / 4 vs. L-635/15, L - 635/4 vs. L-670/4, L-635/15 vs. L-670/15, L-670/4 vs. L-670/15). Conclusion: Both red lasers significantly increased wound TS for selected parameters. While the 635nm laser significantly improved wound healing due to the higher power density,

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Photomedicine and laser surgery, Volume: 28 Issue 2: April 7, 2010

Effects of low-level laser therapy of 780 nm with a pulsed gallium-aluminum-arsenide laser on the healing of a surgically induced open skin wound in rats

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Abstract aim: The aim of the present study is to investigate the effects of a low-level laser with a wavelength of 780 nm on wound healing in open skin.

Background data: Optimal parameters of low-level laser therapy (LLLT) for wound healing are discussed. The Methods: A full thickness skin wound was surgically placed in the dorsal skin of 30 rats. The rats were divided into two groups. The rats in the experimental group were treated daily with a gallium aluminum arsenide (GaAlAs) laser (2J / cm2, λ = 780 nm, pulse frequency 2336 Hz). Rats in the sham-exposed group received the LLLT with the devices turned off. After 4, 7 and 15 days, the wounds were examined using histological and biomechanical methods. The data were analyzed using the Mann-Whitney U test.

The results: fibroblasts, endothelium of the blood vessels, blood vessel sections and maximum load were significantly increased, while the macrophages were significantly reduced in comparison to those of the sham-exposed group.

Conclusion: The pulsed LLLT with a 780 nm GaAlAs laser accelerates the healing process of surgically induced, full-area skin wounds in rats significantly.

Photomedicine and Laser Surgery,: 28 Issue 2: April 7, 2010

Laser photobiomodulation of wound healing in diabetic and non-diabetic mice: implications for splinted and unslit wounds

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short version

Objective: The aim of this study was to compare the healing of laser-irradiated and non-irradiated wounds that were covered with an occlusive dressing in mice. Background data: Many previous studies on the effects of laser irradiation on experimental wounds in mice and rats did not cover the wounds, so healing was mainly through contraction. Covered wounds take longer to heal and more closely mimic wound healing in humans.

Materials and Methods: Forty-seven diabetic and twenty non-diabetic mice were used. A single wound (5 mm diameter) was made on the left flank of each animal and covered with Tegaderm HP bandage (day 1). The wounds were irradiated with a lower power (18 mW) or higher power (80 mW) laser (660 nm) for 20 seconds, starting immediately after the wound had healed, for seven consecutive days (0.36 or 1.6 J / Day); untreated wounds served as controls. The animals were euthanized on the 8th, 10th or 14th day. Wound samples were cut and stained with hematoxylin and eosin as well as Picrosirius red and examined microscopically.

Results: The results confirmed that wound healing was impaired in diabetic mice. Analysis of the data showed that the Tegaderm HP dressing had delayed contraction (splinting of the wounds) in a majority of the diabetic mice and to a lesser extent in non-diabetic mice. The healing of splinted wounds was delayed compared to non-splinted wounds, but the laser irradiation (1.6J / day, 7 days) stimulated healing through re-epithelialization and granulation tissue formation.

Conclusion: These are the first results of the laser-mediated stimulation of healing in splinted wounds. More studies are needed.

The effectiveness of laser therapy in wound healing: a meta-analysis of the literature

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ABSTRACT
Objective: We determined the overall effects of laser therapy on tissue healing by aggregating the literature and studies that meet the inclusion and exclusion criteria to a statistical meta-analysis. Background data: Devices for low-level laser therapy (LLLT) have been in use since the mid-1960s, but their therapeutic value remains in doubt as the literature appears to be full of contradicting results. Materials and Methods: Relevant original research has been compiled from library sources, online databases and secondary sources.
The papers were viewed and coded; those who met all inclusion and exclusion criteria were meta-analyzed using Cohen's d. statistic to determine the size of the treatment effect of each study.

Results: Twenty-four studies with 31 effect sizes met the strict inclusion and exclusion criteria. The mean overall effect of laser therapy on wound healing was highly significant (d = +2.22). Subanalyses of the data showed significant positive effects on wound healing both in animal experiments (d = +1.97) and in clinical studies on humans. (d = +0.54). The analysis also showed significant positive effects on certain healing indices, eg acceleration of inflammation (d = +4.45); Increase in collagen

synthesis (d = +1.80); Increased tensile strength (d = +2.37), shortened healing time (d = +3.24) and decreased wound size (d = +0.55). The failsafe number that was associated with the overall effect of laser therapy was 509; a high number, which the number of additional studies - in which laser therapy had negative or no effects on wound healing - required to achieve the overall large effect size of +2.22. The corresponding fail-safe number for clinical trials was 22.

Conclusion: We conclude that laser therapy is an effective means of promoting wound healing.

Photomedicine and Laser Surgery Volume 22, Number 3, 2004 © Mary Ann Liebert, Inc. Pp. 241-247
