The Effect of Low Level Laser Therapy on Wound Healing

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Abstract

Introduction: Tissue healing is a complex process and comprises vascular and cellular alterations, epithelial and fibroblasts proliferation, synthesis and deposition of collagen, elastin and proteoglycan production, revascularization and wound contraction. Low-level laser therapy (LLLT) has been promoted for its beneficial effects on tissue healing and pain relief. Low doses of laser were found to stimulate the regeneration not only of mechanically induced wounds but also of burns. This study reviews the basic principles of biostimulation of wound healing by low-energy lasers.

Methods: A chemically induced diabetic foot ulcer rat model was used for studying the wound healing effect in vivo. In the in vitro mechanistic studies, human fibroblast cells, human umbilical vein endothelial cells and mouse macrophage cells were assessed for tissue regeneration, angiogenesis and anti-inflammatory activities, respectively.

Discussion : in vivo results demonstrated a significant reduction of wound area in laser group as compared to control. Laser could significantly stimulate proliferation in a dose dependent manner. Besides, low level laser could significantly increase the cell migration and tube formation of HUVEC in the angiogenesis study. Furthermore, significant inhibition of nitric oxide production was found in laser-treated macrophage cells, suggesting its anti-inflammatory activity.

Conclusion Low-level laser can be safely applied to accelerate the resolution of cutaneous wounds, although this fact is closely related to the election of parameters such as dose, time of exposure and wavelength.

Keywords: Low Level Laser, Wound Healing, Regeneration, Angiogenesiss, Anti-inflammatory

Light Amplification by Stimulated Emission of Radiation (LASER)

Low-level laser (or light) therapy (LLLT) also known as cold or soft laser, biostimulation, or photobiomodulation is an emerging therapeutic approach in which cells or tissue are exposed to low-levels of red and near-IR light from lasers or LEDs. It might either stimulate or (less likely) inhibit cellular function, leading to reduction of cell and tissue death, improved wound healing, increasing repair of damage to soft tissue, nerves, bone, and cartilage, and relief for both acute and chronic pain and inflammation.

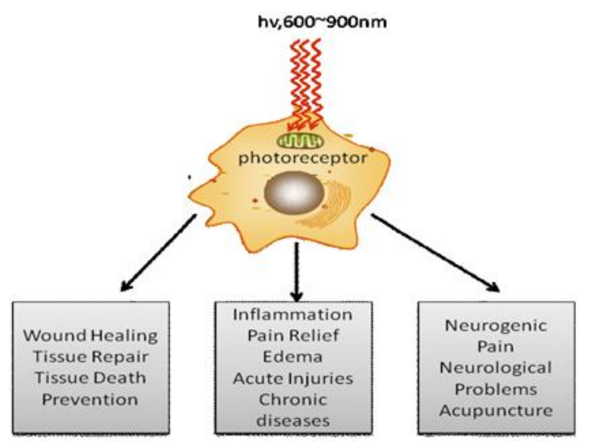


***Figure 1.** Schematic representation of the main applications of low-level laser therapy (LLLT). hν: Laser energy*

Cellular Studies

In examining the effects of LLLT on cell cultures in vitro, some articles report an increase in cell proliferation and collagen production with the HeNe and GaAs lasers using specific and somewhat arbitrary laser settings. Other studies do not report any effect using similar and differing parameters, including laser type, wavelength, and dosage. None of the extant studies convincingly address the mechanism where by LLLT may be exerting its effect. Intuitively, the effect, if it is significant, is unlikely to be photothermal but may be photochemical or photomechanical.

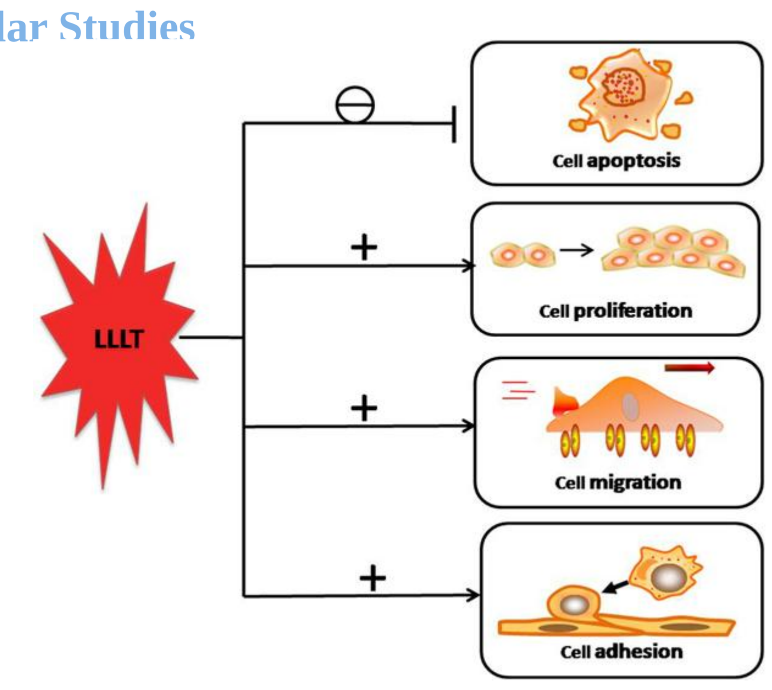


Figure 4. Cellular effects of LLLT.

light absorption and scattering in tissue

Both light absorption and scattering in tissue are wavelength dependent, and the principal tissue chromophores (hemoglobin and melanin) have high absorption bands at wavelengths shorter than 600nm. For these reasons, there is a so-called 'optical window' at red and near-IR wavelengths, where the effective tissue penetration of light is maximal

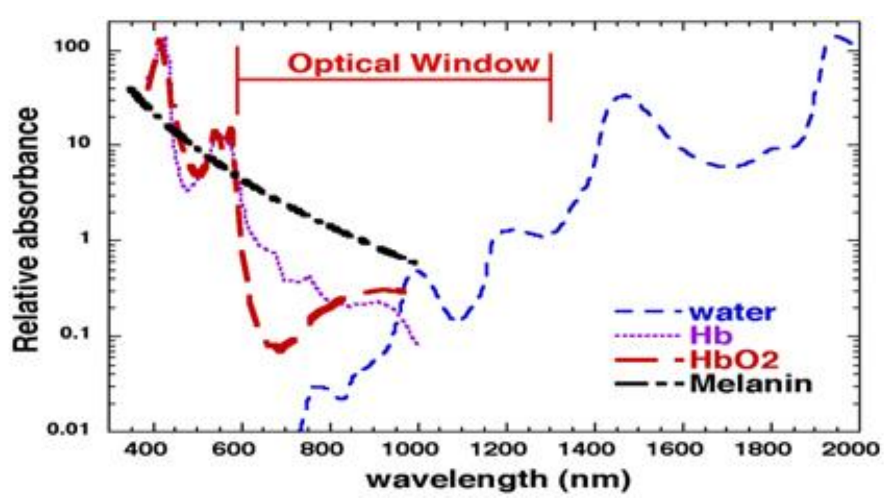


***Figure 2.** Tissue optical window. Hb: Hemoglobin. HbO2: Oxygenated hemoglobin*

Animal Studies

Animal studies have attempted to expand on in vitro research by providing an in vivo model. As with the work in cell culture, some studies report an improvement in surgical wound healing in a rodent model, and this is most commonly reported with HeNe lasers at certain settings. These results have not been duplicated in animals such as pigs, which have skin that more closely resembles that of humans.

Proposed mechanism of LLLT

laser illumination increases both intracellular reactive-oxygen species (ROS) and adenosine triphosphate (ATP) synthesis in mouse embryonic fibroblasts and other cell types in culture. We have also found evidence of nitric oxide (NO) release after exposure to low levels of red and near-IR light. This suggests that ROS might play an important role in the LLLT signaling pathway. It can induce expression of several redox-sensitive transcription factors, such as nuclear-factor kappa B (NF-kB), that can then increase transcription of many gene products.

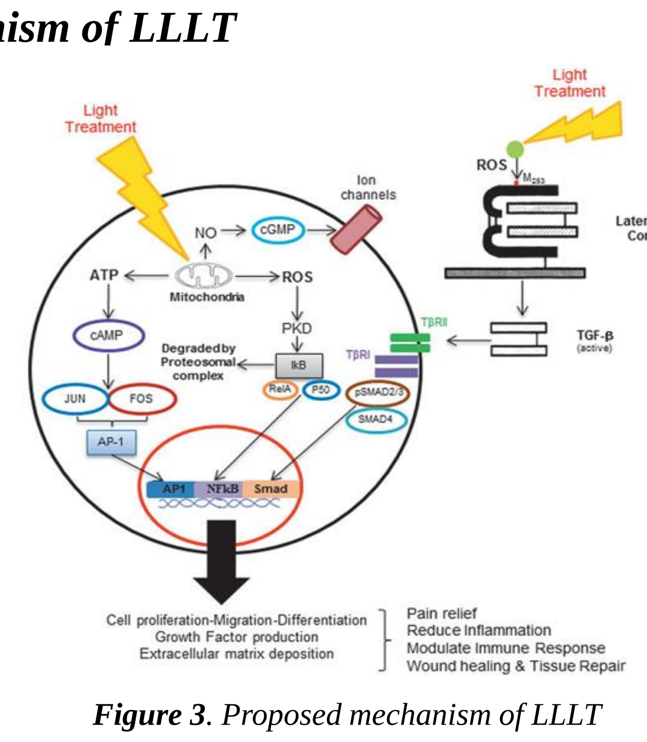
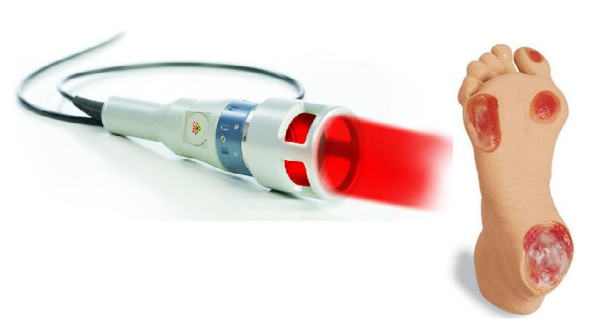


***Figure 3**. Proposed mechanism of LLLT*

Humans Studies

In humans, beneficial effects on wound healing have been found by a few researchers, mostly in small case studies. Other larger studies have failed to yield similar results. Also, although most of the current work has focused on superficial wound healing, future studies may show benefit in neurologic, rheumatologic, and orthopedic applications



Conclusion

- ❑Low-level laser can be safely applied to accelerate the resolution of cutaneous wounds, although this fact is closely related to the election of parameters such as dose, time of exposure and wavelength.
- ❑The LLLT resulted in enhanced healing as measured by wound contraction.This technique also allows for a quick return to baseline firing rates and activity.
- ❑Activation of the direct pathway in basal ganglia can ameliorate motor deficits caused by loss of striatal neurons

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