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Effect of Low-Level Laser Therapy on Bone Repair: Histological Study in Rats

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Background and Objectives: Bone remodeling is characterized as a cyclic and lengthy process. It is currently accepted that not only this dynamics is triggered by a biological process, but also biochemical, electrical, and mechanical stimuli are key factors for the maintenance of bone tissue. The hypothesis that low-level laser therapy (LLLT) may favor bone repair has been suggested. The purpose of this study was to evaluate the bone repair in defects created in rat lower jaws after stimulation with infrared LLLT directly on the injured tissue.
Study Design/Materials and Methods: Bone defects were prepared on the mandibles of 30 Holtzman rats allocated in two groups ($n = 15$), which were divided in three evaluation period (15, 45, and 60 days), with five animals each. control group—no treatment of the defect; laser group—single laser irradiation with a GaAlAs semiconductor diode laser device ($\lambda = 780$ nm; $P = 35$ mW; $t = 40$ s; $\Theta = 1.0$ mm; $D = 178$ J/cm^2; $E = 1.4$ J) directly on the defect area. The rats were sacrificed at the pre-established periods and the mandibles were removed and processed for staining with hematoxylin and eosin, Masson's Trichrome and picrosirius techniques. **Results:** The histological results showed bone formation in both groups. However, the laser group exhibited an advanced tissue response compared to the control group, abbreviating the initial inflammatory reaction and promot-ing rapid new bone matrix formation at 15 and 45 days ($P < 0.05$). On the other hand, there were no significant differences between the groups at 60 days.
Conclusion: The use of infrared LLLT directly to the injured tissue showed a biostimulating effect on bone remodeling by stimulating the modulation of the initial inflammatory response and anticipating the resolution to normal conditions at the earlier periods. However, there were no differences between the groups at 60 days. Lasers Surg. Med. 39:788–796, 2007.

Key words: animals; bone remodeling; LLLT

Currently, bone increment stimulus has been achieved with the application of chemical stimuli, biomaterials, bone morphogenetic proteins (BMPs) as well as the use of physical stimuli, such as ultrasound, electromagnetic fields and more recently low-level laser therapy (LLLT) [2].

Among the chemical stimuli, BMPs are in the forefront of bone repair studies. These proteins are osteoinductive growth factors with potential to act on mesenchymal cells, stimulating a wide array of cell events such as, proliferation, chemotaxis, differentiation, and production of extracellular matrix proteins [3–7].

While the results of physical stimuli associated to bone tissue repair are not yet clearly understood, some knowledge are accepted. Among these, the alterations of ion channel properties and the increase of osteoblast metabolic activity tend to abbreviate the bone repair process [7,8].

One of the hindrances in the bone repair process is the absence of microcirculation at the site of injury, mainly in patients with bone pathologies. The presence of vascularization is a key condition to the occurrence of osteogenesis, which determines the initial events of bone repair [9,10].

Several studies [11–16] have demonstrated that LLLT can biomodulate and accelerate the repair process, stimulating cell proliferation, and vascularization in injured tissues. However, the most important issue is how much energy is necessary to reach a suitable clinical application to yield significant new tissue formation with higher quality of organization within a shorter time. Moreover, the laser light can be delivered either directly on the injured tissue, transcutaneously or postsurgically [17].

LLLT have been indicated for different clinical treatments, encompassing a wide array of applications that range from pain control to tissue healing in general