Recent Advances on the Use of Laser Photobiomodulation on Bone

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Summary

Laser Phototherapy (LPT) is an effective tool to stimulate bone. A series of promising protocols developed by our group are presented. Our results show that the use of IR laser results on increased bone neorformation. LPT effect depends not only on the total dose, but also on both irradiation time and mode. Energy density and intensity are biologically independent and accounts for the success and the failure of the treatment.

Introduction

Bone losses are major problems on many medical specialties and may occur due to physiologic or pathologic conditions. Despite bone tissue have regenerating capacity, defects may be too large for spontaneous and physiologic repair. There are several methods in use to ameliorate bone repair including the use of grafts, guided bone regeneration - GBR and, lately, the use of LPT.

Our experience

We have used several rodent models to study LPT effects on bone tissue. We found significant difference on the areas of mineralized bone between irradiated and non irradiated subjects during early stages of healing, but, not later. In another study, better bone healing around dental implants was observed following LPT. At early stages differences on bone organization and vascularization were detectable. Later we studied, using Raman spectroscopy and SEM, the incorporation of Hydroxyapatite (HA) on the bone around dental implants submitted or not to LPT and found significant differences in the concentration of HA on irradiated and control specimens after 30 days.

We also assessed LPT effects on several biomaterials and on guided bone regeneration. Our results show that LPT does improve bone formation when associated to these protocols. Pioneer works by our team assessed histologically the effect of LPT autologous bone graft and/or BMPs. We found that the use of LPT trans-operatively and or associated to BMPs and Guided Bone Regeneration resulted in a positive biomodulative effect on the healing of bone defects associated to autologous bone grafts. Most recently we also found significant improvement on fracture healing.[1- 8]

Discussion

Our studies indicate that bone irradiated with IR laser shows increased osteoblastic proliferation, collagen deposition and bone neorformation when compared to non irradiated bone. Our experience also indicates that the magnitude of the effect depends on both the physiologic status of the cell and cellular phase at the irradiation time. Our studies reflect the idea that non differentiated mesenchymal cells may be modulated to osteoblasts. On the other hand, LPT seems ineffective when used on normal tissues Improved bone maturation on irradiated subjects is due to increased deposition of HA during early stages of healing as osteoblastic activity is chiefly proliferative and deposition starts later. This later maturation represents the improved ability of more mature osteoblasts to secrete HA in irradiated subjects. The observed differences in the rate of deposition of HA between irradiated and control subjects are probably due to the choice of a wavelength with higher penetration and early osteoblastic differentiation. The reason why the effect of LPT is not much detectable until 30 days after treatment is due to the fact that, during early stages of bone healing, the cellular component is more prominent and more prone to be affected by LPT. Later, bone matrix is the main component of the healing tissue. This is why the timing of application is important. The treatment protocol used on ours studies is in agreement to our experience as no existing parameters are universally accepted. A unique parameter able to produce itself a photo biological response doesn't exist, but the conjugation of different parameters and its variations are in agreement with the experimental models. [1- 8]

Conclusion

It is uncertain if bone stimulation by LPT is a general effect or if the isolate stimulation of osteoblasts; its effect on bone regeneration depends not only on the dose, but also on both irradiation time and mode The threshold parameters energy density and intensity are biologically independent and both influences success or failure of the treatment.

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