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Photoengineering of Bone Repair Processes

ANTONIO LUIZ B. PINHEIRO, D.D.S., Ph.D.,[1,2] and MARLENY ELIZABETH M.M. GERBI, Ph.D.[3]

ABSTRACT

***Objective:* This paper aims to report the state of the art with respect to photoengineering of bone repair using laser therapy. *Background Data:* Laser therapy has been reported as an important tool to positively stimulate bone both *in vivo* and *in vitro.* These results indicate that photophysical and photochemical properties of some wavelengths are primarily responsible for the tissue responses. The use of correct and appropriate parameters has been shown to be effective in the promotion of a positive biomodulative effect in healing bone. *Methods:* A series of papers reporting the effects of laser therapy on bone cells and tissue are presented, and new and promising protocols developed by our group are presented. *Results:* The results of our studies and others indicate that bone irradiated mostly with infrared (IR) wavelengths shows increased osteoblastic proliferation, collagen deposition, and bone neorformation when compared to nonirradiated bone. Further, the effect of laser therapy is more effective if the treatment is carried out at early stages when high cellular proliferation occurs. Vascular responses to laser therapy were also suggested as one of the possible mechanisms responsible for the positive clinical results observed following laser therapy. It still remains uncertain if bone stimulation by laser light is a general effect or if the isolate stimulation of osteoblasts is possible. *Conclusion:* It is possible that the laser therapy effect on bone regeneration depends not only on the total dose of irradiation, but also on the irradiation time and the irradiation mode. The threshold parameter energy density and intensity are biologically independent of one another. This independence accounts for the success and the failure of laser therapy achieved at low-energy density levels.**

INTRODUCTION

Bone losses are major problems in many medical and dental specialties and may occur due to several physiologic and pathologic conditions. Physiologic bone loss occurs mainly due to aging. Bone tissue has an enormous regenerating capacity, and most of the time it is able to restore its usual architecture and mechanical properties. However, there are limits for this capacity, and complete recovery may not occur if there is deficient blood supply, mechanical instability, or competition with highly proliferating tissues. The loss of bone fragments or the removal of necrotic or pathologic bone, or even some surgical procedures may create bone defects. These defects may be too large for spontaneous and physiologic repair. There are several methods that can be used to ameliorate bone repair, and these include the use of grafts and lately the use of laser therapy.

Bone healing differs from the healing of soft tissues due to the morphology and composition being slower than in soft tissues, and bone healing requires consecutive phases, which differ depending upon the type and intensity of the trauma and the extent of the damage to the bone. The trauma to the bone is immediately followed by a sequence of reparative processes in which periostal osteogenic cells begin to proliferate and to differentiate in osteoblasts.

The effects of laser therapy on bone are still controversial, as previous reports show different or conflicting results. It is possible that the effect of laser therapy on bone regeneration depends not only on the total dose of irradiation, but also on the irradiation time and the irradiation mode. Most importantly, recent studies have suggested that the threshold parameters for energy density and intensity are biologically independent of one another. This independence accounts for both the success and failure of laser therapy at low-energy density levels. The

[1]Laser Center, School of Dentistry, Department of Propedêutica and Clínica Integrada, Universidade Federal da Bahia, Canela Salvador, BA, Salvador, Brazil.
[2]Institute for Research and Development, Universidade do Vale do Paraíba, São José dos Campos, SP, Brazil.
[3]Departamento de Prótese e Cirurgia Buco Facial, Centro de Ciências da Saúde, Universidade Federal de Pernambuco, Recife, PE, Brazil.