

The effect of low level laser irradiation on implant-tissue interaction. In vivo and in vitro studies.

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Low-level laser therapy (LLLT) is increasingly used in medicine and dentistry. It has been suggested that LLLT may be beneficial in the management of many different medical conditions, including **pain, wound healing and nerve injury.**

The present thesis is based on a series of in vivo and in vitro experimental studies investigating whether LLLT has the potential to **enhance titanium-implant interaction.** Information about LLLT effect on bone healing is fundamental to understand whether LLLT may improve implant-tissue interaction. Thus in the initial study (I), the effect of LLLT on bone healing and growth in rat calvarial bone defects was investigated. It was found that LLLT may accelerate metabolism and/or mineralization during early bone healing. Based on these findings, study II explored the hypothesis that LLLT can enhance implant integration in the rabbit tibial bone. It was shown that LLLT stimulated the mechanical strength of the interface between the implant and bone after a healing period of 8 weeks.

Histomorphometrical and mineral analyses showed that the irradiated implants had greater bone-to-implant contact than the controls. In the in vitro experiments, cellular responses to LLLT were studied in two cell types: primary cultures of human gingival fibroblasts and human osteoblast-like cells, with special reference to attachment, proliferation, differentiation and production of transforming growth factor beta1 (TGF-beta1). The objectives of studies III & IV were to develop a standardized, reproducible in vitro model for testing a GaAlAs diode laser device and to document the influence of single or multiple doses of LLLT, as a guide to defining the optimal laser dose for enhancing cell activity.

A further objective was to investigate the effect of LLLT on initial attachment and subsequent behaviour of human gingival fibroblasts cultured on titanium. While both multiple doses (**1.5 and 3 J/cm²**) and a single dose (**3 J/cm²**) enhanced cellular attachment, proliferation increased only after multiple doses (1.5 and 3 J/cm²). Study V concerned the response to LLLT of osteoblast-like cells, derived from human alveolar bone cultured on titanium implant material. In this study LLLT significantly enhanced cellular attachment. Greater cell proliferation in the irradiated groups was observed first after 96 h indicating that the cellular response is dose dependent. Osteocalcin synthesis and TGF-beta1 production were significantly stimulated on the samples exposed to **3 J/cm².**

The following conclusions are drawn from the results of these five studies: LLLT can promote bone healing and bone mineralization and thus may be clinically beneficial in promoting bone formation in skeletal defects. It may be also used as additional treatment for accelerating implant healing in bone. LLLT can modulate the primary steps in cellular attachment and growth on titanium surfaces. Multiple doses of LLLT can improve LLLT efficacy, **accelerate the initial attachment** and alter the behaviour of human gingival fibroblasts cultured on titanium surfaces.

The use of LLLT at the range of doses between 1.5 and 3 J/cm² may modulate the activity of cells interacting with an implant, thereby enhancing tissue healing and ultimate implant success.