Bone-Implant Interaction

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The effect of low-intensity laser therapy on bone healing around titanium implants: a histometric study in rabbits.

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PURPOSE: This study aimed to histometrically evaluate the influence of low-intensity laser treatment on bone healing around titanium implants placed in rabbit tibiae. MATERIALS AND METHODS: Each tibia of 12 adult rabbits received a 3.3 x 6-mm titanium implant. The implants placed in the right tibiae were irradiated with a gallium-aluminum-arsenide diode low-intensity laser every 48 hours for 14 days postoperatively, and the left tibiae were not irradiated. After 3 or 6 weeks, the animals were sacrificed (six animals per period), and nondecalcified sections were obtained and analyzed for bone-to-implant contact (BIC) and bone area within the implant threads. Data were subjected to statistical analysis using analysis of variance (ANOVA) and the Tukey test. RESULTS: BIC was significantly increased in the laser-treated group at both 3 weeks and 6 weeks. BIC did not increase significantly with time (3 weeks versus 6 weeks). Conversely, bone area within the threads was significantly increased with time (3 weeks versus 6 weeks), regardless of whether the laser was used. Considering bone area within the threads, no significant difference was found for treatment, eg, with or without laser. CONCLUSION: Low-intensity laser therapy did not affect the area of bone formed within the threads, but it may improve BIC in rabbit tibiae.

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Effect of laser therapy on attachment, proliferation and differentiation of human osteoblast-like cells cultured on titanium implant material.

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The aim of this in vitro study was to investigate the effect of low-level laser therapy (LLLT) on the attachment, proliferation, differentiation and production of transforming

growth factor-ss(1) (TGF-beta(1)) by human osteoblast-like cells (HOB). Cells derived from human mandibular bone were exposed to GaAlAs diode laser at dosages of 1.5 or 3 J/cm(2) and then seeded onto titanium discs. Non-irradiated cultures served as controls. After 1, 3 and 24h, cells were stained and the attached cells were counted under a light microscope. In order to investigate the effect of LLLT on cell proliferation after 48, 72 and 96 h, cells were cultured on titanium specimens for 24h and then exposed to laser irradiation for three consecutive days. Specific alkaline phosphatase activity and the ability of the cells to synthesize osteocalcin after 10 days were investigated using p-nitrophenylphosphate as a substrate and the ELSA-OST-NAT immunoradiometric kit, respectively. Cellular production of TGF-beta(1) was measured by an enzyme-linked immunosorbent assay (ELISA), using commercially available kits. LLLT significantly enhanced cellular attachment ($P<0.05$). Greater cell proliferation in the irradiated groups was observed first after 96 h. Osteocalcin synthesis and TGF-beta(1) production were significantly greater ($P<0.05$) on the samples exposed to 3 J/cm(2). However, alkaline phosphatase activity did not differ significantly among the three groups. These results showed that in response to LLLT, HOB cultured on titanium implant material had a tendency towards increased cellular attachment, proliferation, differentiation and production of TGF-beta(1), indicating that in vitro LLLT can modulate the activity of cells and tissues surrounding implant material.

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Low-level laser therapy stimulates bone-implant interaction: an experimental study in rabbits.

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The aim of the present study was to investigate the effect of low-level laser therapy (LLLT) with a gallium-aluminium-arsenide (GaAlAs) diode laser device on titanium implant healing and attachment in bone. This study was performed as an animal trial of 8 weeks duration with a blinded, placebo-controlled design. Two coin-shaped titanium implants with a diameter of 6.25 mm and a height of 1.95 mm were implanted into cortical bone in each proximal tibia of twelve New Zealand white female rabbits (n=48). The animals were randomly divided into irradiated and control groups. The LLLT was used immediately after surgery and carried out daily for 10 consecutive days. The animals were killed after 8 weeks of healing. The mechanical strength of the attachment between the bone and 44 titanium implants was evaluated using a tensile pullout test. Histomorphometrical analysis of the four implants left in place from four rabbits was then performed. Energy-dispersive X-ray microanalysis was applied for analyses of calcium and phosphorus on the implant test surface after the tensile test. The mean tensile forces, measured in Newton, of the irradiated implants and controls were 14.35 (SD+/-4.98) and 10.27 (SD+/-4.38), respectively, suggesting a gain in functional attachment at 8

weeks following LLLT (P=0.013). The histomorphometrical evaluation suggested that the irradiated group had more bone-to-implant contact than the controls. The weight percentages of calcium and phosphorus were significantly higher in the irradiated group when compared to the controls (P=0.037) and (P=0.034), respectively, suggesting that bone maturation processed faster in irradiated bone. These findings suggest that LLLT might have a favourable effect on healing and attachment of titanium implants.

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Osseointegration of endosseous ceramic implants after postoperative low-power laser stimulation: an in vivo comparative study.

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Stimulation with low-power laser (LPL) can enhance bone repair as reported in experimental studies on bone defects and fracture healing. Little data exist concerning the use of LPL postoperative stimulation to improve osseointegration of endosseous implants in orthopaedic and dental surgery. An in vivo model was used for the present study to evaluate whether Ga-Al-As (780 nm) LPL stimulation can improve biomaterial osseointegration. After drilling holes, cylindrical implants of hydroxyapatite (HA) were placed into both distal femurs of 12 rabbits. From postoperative day 1 and for 5 consecutive days, the left femurs of all rabbits were submitted to LPL treatment (LPL group) with the following parameters: 300 J/cm2, 1 W, 300 Hz, pulsating emission, 10 min. The right femurs were sham-treated (control group). Three and 6 weeks after implantation, histomorphometric and microhardness measurements were taken. A higher

affinity index was observed at the HA-bone interface in the LPL group at 3 ($P<0.0005$) and 6 weeks ($P<0.001$); a significant difference in bone microhardness was seen in the LPL group vs. the control group ($P<0.01$). These results suggest that LPL postoperative treatment enhances the bone-implant interface.

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Effect of low-power laser irradiation on bony implant sites.

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This study was designed to examine the effects of low-energy laser irradiation on osteocytes and bone resorption at bony implant sites. Five male baboons with a mean age of 6.5 years were used in the study. Four holes for accommodating implants were drilled in each iliac crest. Sites on the left side were irradiated with a 100 mW low-energy laser (690 nm) for 1 min (6 Joule) immediately after drilling and insertion of four sandblasted and etched (Frialit-2 Synchro) implants. Five days later, the bone was removed en bloc and was evaluated histomorphometrically. The mean osteocyte count per unit area was 109.8 cells in the irradiated group vs. 94.8 cells in the control group. As intra-individual cell counts varied substantially, osteocyte viability was used for evaluation. In the irradiated group, viable osteocytes were found in 41.7% of the lacuna vs. 34.4% in the non-irradiated group. This difference was statistically significant at $P < 0.027$. The total resorption area, eroded surface, was found to be 24.9% in the control group vs. 24.6% in the irradiated group. This difference was not statistically significant. This study showed that osteocyte viability was significantly higher in the samples that were subjected to laser irradiation immediately after implant site drilling and implant insertion, in comparison to control sites. This may have positive effects on the integration of implants. The bone resorption rate, in contrast, was not affected by laser irradiation.