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Biostimulation of bone marrow cells with a diode soft laser

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In recent years, the use of low-intensity red light in regeneration of soft tissue has been increasingly pursued. As far as hard tissue is concerned, the biostimulating effect of laser has already been demonstrated successfully in more rapid healing of tibial bone fractures in mice at a dosage of 2.4 J. However, the effect of light of a low dose laser directly on osteoblasts has not been investigated yet. The aim of this study was to determine the effect of continuous wave diode laser irradiation on osteoblasts derived mesenchymal cells. Three groups of 10 cultures each were irradiated 3 times (days 3, 5, 7) with a pulsed diode soft laser with a wavelength of 690 nm for 60 s. Another 3 groups of 10 cultures each were used as control groups. A newly developed method employing the fluorescent antibiotic tetracycline was used to compare bone growth on these culture substrates after a period of 8, 12 and 16 days, respectively. It was found that all lased cultures demonstrated significantly more fluorescent bone deposits than the non-lased cultures. The difference was significant, as tested by the Tukey Test ($P<0.0001$) in the cultures examined after 16 days. Hence it is concluded that irradiation with a pulsed diode soft laser has a biostimulating effect on osteoblasts *in vitro*, which might be used in osseointegration of dental implants.

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In recent years, laser light, particularly soft laser, has been increasingly used for the treatment of injuries of soft and hard tissue. Scientific findings indicate good healing of soft tissue (Mester et al. 1971), a faster regeneration of severed nerves (Rochkind et al. 1986) and an increasing formation of new capillaries through the release of growth factors (Kovacs et al. 1974). The stimulation of DNA and RNA synthesis formation in the cell nucleus (Karu et al. 1982) and the transformation of fibroblasts to myofibroblasts (Pourreau-Schneider et al. 1990) are also well documented. Osteoblast proliferation, in particular, is of great clinical interest in the regeneration of lost bone. Favourable results were also achieved in examinations of hard tissue, as bone fractures in mice showed a faster formation of bone tissue with a tighter mesh of trabeculae after 3 weeks of daily irradiation with a Helium-Neon laser (HeNe laser) (Trelles & Mayoyo 1987). Lasing also resulted in an increase in the hard tissue in new bone formation around hydroxyapatite implants in the lower jaw of rabbits (Asanami et al. 1993). Ozawa et al. (1995) achieved a significant increase in the total area of bone nodules with a Gallium-Aluminium-Arsenide laser (GaAlAs) in a dose-dependent manner (10.8–108 J/cm^2/day).

The exact mechanism of action of cell biostimulation by laser or light is still unclear, but is the subject of several studies.

For example, a possible stimulating effect by increasing RNA synthesis (Ribari 1981) and a possible activation of components of the respiratory chain (Karu 1987) or extracellular components (Surinchak et al. 1983) are being discussed as causes of biostimulation. Such an extracellular component might be caused by singlet oxygen, as free radical, following irradiation with laser light (Lubart et al. 1990; Karu et al. 1983).

The formation of adenosine triphosphate (ATP) which is influenced by singlet free oxygen plays an important role in this respect (Kudoh et al. 1989;