

14 studies, November 2005

Khadra M, Kassem N, Haanaes H R, Ellingsen J E, Lyngstadaas S P. **Enhancement of bone formation in rat calvarial bone defects using low-level laser therapy.** Oral Surg Oral Med Oral Pathol Oral Endod. 2004; 97: 693-700.

The aim of the study by Khadra was to investigate the effect of laser therapy with GaAlAs 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 rabbits (n=48). The animals were randomly divided into irradiated and control groups. The laser 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 laser. 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, suggesting that bone maturation processed faster in irradiated bone.

Brugnera A. **LLLT in treating dentinary hypersensibility: A histological study and clinical application.** Proc. 2nd ENSOMA Congress, Houston, Texas, USA. 2001, p. 23-31

Thirty-two upper molars from rats with mechanically exposed dental pulps with standardized abrasion on the occlusal surface were treated with number 2 diamond burs exposing dentinal tissues (~1 cm<sup>2</sup>). The parameters of the laser were continuous HeNe, 632.8 nm, 6 mW output, beam cross section 1.8 mm<sup>2</sup>, and exposure time of 240 s in scanning mode for each tooth, equal to an occlusal area of approximately 1 cm<sup>2</sup>. The animals were divided into 4 groups and were given weekly applications. The results showed that irradiated animals presented an increased production of dentine and shutting of dentinal tubuli. On the other hand, non-irradiated subjects still showed signals of intense inflammatory

reaction and even necrosis at the same experimental times. Irradiated teeth did not show cell degeneration. The laser irradiation was shown to be efficient in the stimulation of odontoblast cells, producing reparative dentin and closing of dentin tubuli.

Taha M F, Valojerdi M R. **Quantitative and qualitative changes of the seminiferous epithelium induced by GaAlAs (830 nm) laser radiation.** *Lasers Surg Med.* 2004; 34 (4): 352-359.

The aim of the study by Taha was to determine the quantitative and qualitative changes of the seminiferous epithelium after GaAlAs (830 nm) laser radiation. The left testes of Sprague-Dawley rats were daily exposed to laser light for 15 days; so the cumulative doses used 28.05 and 46.80 J/cm<sup>2</sup> in two experimental groups. Sampling carried out 24 hours after the last treatment and samples were processed for LM and TEM study. The number of germ cells, specially the pachytene spermatocytes and elongated spermatids increased after 28.05 J/cm<sup>2</sup> laser radiation. Ultrastructural features of germ and Sertoli cells in this group were similar to that of control; while laser irradiation at 46.80 J/cm<sup>2</sup> had a destructive effect on the seminiferous epithelium such as dissociation of immature spermatids and evident ultrastructural changes in them. The findings confirmed the existence of a biostimulatory threshold of applied laser energy and the importance of determining it for clinical applications. Moreover, it was revealed that low doses of laser light have a biostimulatory effect on the spermatogenesis and may provide benefits to the patients with oligospermia and azoospermia.

Ilic S, Leichliter S, Streeter J, DeTaboada L, Oron U. **Effects of Dose, Mode and Frequency of Low Level Laser Therapy on the Rat Brain.** *Photomedicine and Laser Surgery.* 2005. In press.

The aim of the study by Ilic [1590] was to investigate the possible short- and long-term adverse neurological effects of low level laser therapy given at different power densities, frequencies and modalities on the intact rat brain. In a previous study on the effect of laser therapy for stroke in a rat model [1589], an optimal dose had been confirmed and now served as baseline dose 118 rats were used in the study. Diode laser (808 nm, wavelength) was used to deliver doses of 7.5, 75, 750 mW/cm<sup>2</sup> transcranially to the brain cortex of mature rats, in either continuous (CW) or pulse (Pu) modes. Multiple doses of 7.5 mW/cm<sup>2</sup> were also applied. Standard neurological examination of the rats was performed during the follow up periods post laser irradiation. Histology was performed at the light and electron microscopy levels. Both the scores from standard neurological tests and the histopathological examination indicated that there was no long-term difference between laser-treated and control groups up to 70 days post treatment. The only rats showing an adverse neurological effect were those in the

750mW/cm<sup>2</sup> (about 100-fold optimal dose), CW mode group. In Pu mode there was much less, heating and no tissue damage was noted. Long-term safety tests lasting 30 and 70 days at optimal 10x and 100X doses, as well as multiple doses at the same power densities, indicate that the tested laser energy doses are safe under this treatment regime. Neurological deficits and histopathological damage to 750 mW/cm<sup>2</sup> CW laser irradiation are attributed to thermal damage and not due to tissue-photon interactions.

Zereto J L, Sasaki K M, Takeuchi Y, Toda K. **Antinociceptive effect of Er:YAG laser irradiation in the orofacial formalin test.** Brain Res. 2005; 1032 (1-2): 149-153.

In the study by Zereto [1588] the researchers tested the possible antinociceptive effect of laser irradiation when applied to a normal tissue before the onset of a painful stimulus. Male Wistar rats (350-380 g) were used. A 1.5% formalin solution (50 microL s.c., diluted in saline) was injected into the right upper lip of the test animals (n = 9) immediately after 10 min of low-power Er:YAG laser irradiation (energy: 0.1 J/cm<sup>2</sup>/pulse at 10 Hz). Control animals (n = 9) were restrained for 10 min without laser application. The nociceptive response, i.e., the amount of time the rats spent rubbing the formalin injected area, was measured by an investigator blind to whether the animals had been laser irradiated or not. On laser irradiated rats, significantly less nociceptive behavior was observed only during the late phase (12-39 min) of the test. This result is similar to that reported for nonsteroid antiinflammatory drugs (NSAIDs) and other peripherally acting antiinflammatory agents.

Monteforte P, Baratto L, Molfetta L, Rovetta G. **Low-power laser in osteoarthritis of the cervical spine.** Int J Tissue React. 2003; 25 (4): 131-136.

Patients with symptomatic osteoarthritis of the cervical spine were treated with very low-power modulated laser (LPL). Two applications were performed at an interval of 20 days. Changes in pain and ultrasound thickness of the soft connective tissue layer above the right and the left superior trapezium were studied. No worsening of pain was observed. Pain improved after the first application of LPL in 9 out of 14 patients, but the difference was not significant. Pain improvement remained stable between the first assessment and the second assessment, which was performed after 20 days. In comparison with the first application, at the second application the number of patients with improved pain after LPL increased to 12 out of 14 (p < 0.01). An appreciable difference in the thickness of the subcutaneous soft tissue layer overlying the two superior trapezia was demonstrated in all patients at the first examination. Comparison of the measurements before and after the application of LPL showed significant differences.

Mirsky N, Krispel Y, Shoshany Y, Maltz L, Oron U. **Promotion of angiogenesis by low energy laser irradiation.** Antioxid Redox Signal. 2002; 4 (5): 785-790.

The effect of He-Ne irradiation on the process of angiogenesis in the infarcted rat heart and in the chick chorioallantoic membrane (CAM), as well as the proliferation of endothelial cells in tissue culture, was investigated by Mirsky [1591]. Formation of new blood vessels in the infarcted rat heart was monitored by counting proliferating endothelial cells in blood vessels. In the CAM model, defined areas were laser-irradiated or non-irradiated and blood vessel density was recorded in each site in the CAM at various time intervals. Laser irradiation caused a 3.1-fold significant increase in newly formed blood vessels 6 days post infarction, as compared with non-irradiated rats. In the CAM model, a slight inhibition of angiogenesis up to 2 days post irradiation and a significant enhancement of angiogenesis in the laser-irradiated foci as compared with control non-irradiated spots were evident. The laser irradiation caused a 1.8-fold significant increase in the rate of proliferation in endothelial cells in culture over non-irradiated cells.

Moreira LA, Santos MT, Campos VF, Genovese WJ. **Efficiency of laser therapy applied in labial traumatism of patients with spastic cerebral palsy.** Braz Dent J. 2004;15 Spec No:SI29-33.

The aim of this study was to report the effectiveness of laser therapy applied to traumatic labial injury of patients with spastic cerebral palsy. We report two cases of patients with internal mucosa and lower lip traumatism caused by oral reflex automatism with spastic tonic bite and lower lip interposition. One patient presented extensive lower lip ulceration, loss of tissue, crusty and hemorrhagic areas, with increasing pain and spasticity. The other patient presented increased labial volume. Laser therapy was applied to all injured areas, with a low-potency diode InGaAlP laser (685 nm, 190 J/cm<sup>2</sup>) with a 24-h interval between the first and second administration, and a 7-day interval between the two subsequent ones. At first re-evaluation, 24 h later, there was a striking reduction in inflammation, a decrease in vascular congestion, and a reduction of the ulcerated area with spasticity and pain reduction. At the 14-day re-evaluation, significant clinical differences in the advanced healing process were seen. Low-intensity laser showed to be effective in traumatic soft tissue treatment in cerebral palsy patients by accelerating the healing process, reducing secondary contamination, promoting analgesia; thus, it can be an important tool in the treatment of these patients.

**Kubota J. Effects of diode laser therapy on blood flow in axial pattern flaps in the rat model.** *Lasers Med Sci.* 2002;17 (3):146-153.

The study by Kubota was designed to assess the effect of an 830 nm diode laser (power density, 18.5 W/cm<sup>2</sup> energy density 185 J/cm<sup>2</sup>) on the blood flow of axial pattern flaps in the rat model and their survival, compared with unirradiated controls. The flaps were raised in all animals (n=40), and blood flow assessed with laser speckle flowmetry (LSF). In the experimental groups (3 groups, n=10 per group), the flaps were irradiated either directly over the dominant feeder vessel (iliolumbar artery), at the proximal end or at the distal end of the flap itself and blood flow assessed during irradiation. Flowmetry was performed again in all animals at 5 and 10 min post irradiation, and the flaps sutured back in position. The unirradiated controls were handled in exactly the same way, but the laser was not activated. The survival rate of the flaps was assessed on the fifth postoperative day. LSF demonstrated significant increased blood flow in the flaps at 5 and 10 min postirradiation in all experimental groups compared with the control animals. At five days post irradiation, there was significantly better survival of the flaps in all the experimental groups compared with the controls but no significant difference was seen between any of the experimental groups. The author concludes that laser therapy increases the blood flow and perfusion of transferred flaps, and that this has significant effects on the survival of the flaps.

**Kubota J. Defocused diode laser therapy (830 nm) in the treatment of unresponsive skin ulcers: a preliminary trial.** *J Cosmet Laser Ther.* 2004; 6 (2): 96-102.

In a clinical study by Kubota a defocused GaAlAs diode laser (830 nm, continuous wave, 669 mW/cm<sup>2</sup>) was applied once or twice per week in an uncontrolled study of five patients (aged between 5 and 81 years old, average 46.6 years old, doses from 6.3 J/cm<sup>2</sup> to 21 J/cm<sup>2</sup>) with previously unresponsive ulcers of various aetiologies. In all five patients the ulcers healed completely between 3 weeks and 7 months (22.8 +/- 19.3 weeks), without recurrence during a minimum 12-month follow-up. Defocused 830 nm diode laser therapy was well tolerated and was very effective in the treatment of this small number of compromised skin ulcers of different aetiologies and in a large range of patient ages.

**Mok YC, Pang KM, Au CY, Yew DT. Preliminary observations on the effects in vivo and in vitro of low dose laser on the epithelia of the bladder, trachea and tongue of the mouse.** *Scanning Microsc.* 1988; 2 (1): 493-502.

The effects of low dose CW laser were studied by in vivo and in vitro systems by Mok. The experimental tissues that were used included bladders, tracheas and tongues as experimental tissues. Boddings (round surface projections) from

the transitional epithelium of bladder were frequently observed 3 days after laser treatment in both in vivo and in vitro systems. The trachea and tongue were less affected. In both the in vivo and in vitro systems some epithelial cells of the trachea showed decreased microvilli and cilia 3 days after treatment whereas the epithelial cells of the tongue revealed no response to laser treatment in both systems. Low dose laser, however, appeared to promote the rate of healing of experimental tongue ulcer: healing was about 1 day earlier in the laser treated than non-treated animals and vessel infiltration and epithelialisation were detected earlier in the treated tissue.

Brown S A, Rohrich R J, Kenkel J et al. **Effect of low-level laser therapy on abdominal adipocytes before lipoplasty procedures.** *Plast Reconstr Surg.* 2004; 113(6):1796-1804; discussion 1805-1806.

Recently, low-level laser therapy was reported to "liquefy" or release stored fat in adipocytes by the opening of specialized yet not identified cell membrane-associated pores after a brief treatment.. To explore these data further, a series of in vitro studies on human preadipocytes and institutional animal care and use committee-approved protocols in a porcine Yucatan model and an institutional review board-approved clinical study were performed. Using a 635-nm low-level laser of 1.0 J/cm<sup>2</sup>, these studies were designed to determine whether alteration in adipocyte structure or function was modulated after low-level laser therapy. Cultured human preadipocytes after 60 minutes of laser therapy did not change appearance compared with nonirradiated control cells. In the porcine model, low-level laser therapy (30 minutes) was compared with traditional lipoplasty (suction-assisted lipoplasty) and ultrasound-assisted lipoplasty. From histologic and scanning electron microscopic evaluations of the lipoaspirates, no differences were observed between low-level laser therapy-derived and suction-assisted lipoplasty-derived specimens. Using exposure times of 0, 15, 30, and 60 minutes in the presence or absence of superwet wetting solution and in the absence of lipoplasty, total energy values of 0.9 mW were delivered to tissue samples at three increasing depths from each experimental site. No histologic tissue changes or specifically in adipocyte structure were observed at any depth with the longest low-level laser therapy (60 minutes with superwet fluid). Three subjects undergoing large-volume lipoplasty were exposed to superwet wetting fluid infiltration 14 minutes before and 12 minutes after, according to vendor instructions. Tissue samples from infiltrated areas were collected before suction-assisted lipoplasty and lipoaspirates from suction-assisted lipoplasty. No consistent observations of adipocyte disruptions were observed in the histologic or scanning electron microscopy photographs. These data do not support the belief that low-level laser therapy treatment before lipoplasty procedures disrupts tissue adipocyte structure.

Bingöl U, Altan L, Yurtkuran M. **Low-Energy Laser Treatment for Shoulder Pain.** *Photomedicine and Laser Surgery.* 23; (5): 459–464.

In the clinical study by Bingöl, 40 shoulder pain patients were randomly assigned into Group I (n = 20, laser treatment) and Group II (n = 20, control). In Group I, patients were given laser treatment and an exercise protocol for 10 sessions during a period of 2 weeks. Laser was applied over tuberculum majus and minus, bicipital groove, and anterior and posterior faces of the capsule, regardless of the existence of sensitivity, for 1 min at each location at each session with a frequency of 2000 Hz using a GaAs diode laser, 2.98 J/cm<sup>2</sup> per point. In Group II placebo laser and the same exercise protocol was given for the same period. Patients were evaluated according to the parameters of pain, palpation sensitivity, algometric sensitivity, and shoulder joint range of motion before and after treatment. Analysis of measurement results within each group showed a significant post treatment improvement for some active and passive movements in both groups, and also for algometric sensitivity in Group I. Post treatment palpation sensitivity values showed improvement in 17 patients (85%) for Group I and six patients (30%) for Group II. Comparison between two groups showed superior results in Group I for the parameters of passive extension and palpation sensitivity but no significant difference for other parameters.

Salate A C, Barbosa G, Gaspar P et al. **Effect of Ga-Al-As Diode Laser Irradiation on Angiogenesis in Partial Ruptures of Achilles Tendon in Rats.** *Photomedicine and Laser Surgery.* 23; (5): 470-475.

Salate divided ninety-six animals into three groups subject to treatment during 3, 5, and 7 days post-lesion. Thirty-two animals were used in each group. The groups were further divided into four subgroups with eight animals in each, receiving InGaAlP laser, 660 nm, treatment at (1) a mean output of 10 mW or (2) 40 mW during 10 sec, (3) a sham subgroup, and (4) a non-treatment subgroup. Each animal was subjected to a lesion of the Achilles tendon by dropping a 186-g weight from a 20-cm height over the tendon. Treatment was initiated 6 h post-injury for all the groups. Blood vessels were coloured with India ink injection and were examined in a video microscope. Laser exposure promoted an increase in blood vessel count when compared to controls. The 40-mW group showed early neovascularization, with the greatest number of microvessels after three laser applications. The 10-mW subgroup showed angiogenesis activity around the same time as the sham laser group did, but the net number of vessels was significantly higher in the former than in the controls. After seven irradiations, the subgroup receiving 40 mW experienced a drop in microvessel number, but it was still higher than in the control groups. compared to controls.