Selected laser therapy abstracts from Laser Florence 2002.

Laser Florence 2002 had speakers of 38 different countries and five continents. There are usually between 250-300 participants. Information about Laser Florence 2003 can be found at http://www.laserflorence.org/. All the abstracts can be found in Laser in Medical Science 2002; 17 (4), Springer Verlag.

EFFICACY of LOW POWER LASER GaAlAs (630 nm) in THE TREATMENT of VITILIGO PATIENTS

Leila Ataie M.D., Gholamreza Esmaeeli Djavid

Vitiligo patches were treated by using a 630-nm GaAlAs laser (20 mW & 1 J/cm2), twice a week for a maximum of 24 treatments. Patients were followed for 9 months and the effect of treatment was evaluated. Six patients could be evaluated for the purposes of this analysis. Their ages ranged from 11 to 46 years. Decreases in surface area of depigmented lesions were seen ranging between 25% and 75%. Pigmented stippling within depigmented lesions occurred in all patients. In two patients of repigmented of previously depigmented hair were seen. Only one patients experienced arrest of progression of disease after 24 sessions of treatment. LPLT is without side effects and probably effective in repigmentation of vitiligo but has minimal effect of progression of disease.

LOW LEVEL LASER ASSISTED LIPOPLASTY, L.A.L. A NEW TECHNIQUE. NEIRA 4L TECHNIQUE

Rodrigo Neira, C.Ortiz, J.Arroyabe et al.

This study describes the scientific basis for a new lipoplasty technique based on the use of a low-level energy laser diode beam. A multidisciplinary team studied fat samples randomly taken from ten patients that underwent a liposculpture procedure.

Fat samples were processed as follows:

Application of tumescent technique and exposure to laser beam for 4 minutes. Partial disruption of the adipose cell was observed; several cells without disruption of the cellular membrane were preserved. The adipose cells lost their round shape, and fat spread into the intercellular space.

Application of tumescent technique and exposure to laser beam for 6 minutes. Transitory pores were observed in the cell membrane. There was found microscopic evidence that fat was outside the adipose cells, and remained in the interstitial space. Structures such as the capillaries and the remaining interstitial space, were however preserved.

Without the use of tumescent solution, in vitro exposure of adipose tissue to laser beam for 4, and 6 minutes was performed and compared with samples without laser exposure (Zero minutes). Laser penetration through adipose tissue decreased when the tumescent solution was not utilized. The Scanning and Transmission Electron Microscopic findings after six minutes laser exposure without the use of tumescent solution correspond to those observed at 4 min. laser exposure by equal intensity (10 mW) combined with the use of a tumescent solution, suggesting that the application of the tumescent solution is a important enhancement factor. Adypocite cultures confirmed what is happening with the adipose cell after irradiating it with the laser beam. These cells remain alive in spite of the membrane deformation generated by the exposure to the laser beam for 6 minutes

LOW – LEVEL- LASER THERAPY IN MILD AND MODERATE CTS – A DOUBLE BLIND, RANDOMISED STUDY

Th. Rappl, Ch. Laback, St Quasthoff, M. Auer-Grumbach, R. Gumpert, E. Scharnagl

The aim was to evaluate the LLLT in CTS (ENG: < 6,9 ms) monitored by EMG and VAS (Visual Analogous Scale) recordings. 72 hands with CTS treated by LLLT (15 sessions/30 min, over a period of 5 weeks) were evaluated by a double blind – randomised study. ENG and VAS (visual analogous scale) were performed pror to and after LLLT.
LLLT (wavelength 830 nm, 400 mW) with an energy of 3J per point focused on the Carpal – tunnel, on trigger and acupuncture – points was performed in 38 cases, in 38 cases (control – group) we used a red light pen. Follow-up ranged from 8 to 12 months. ENG and VAS improved in 66%, didn't change in 8% and got worse in 26% in the LLLT group after a 12 month period. No improvement was recorded in the control group. The results suggest that LLLT can be recommended in mild or average CTS (ENG < 4,9 ms) especially if a conservative treatment is required.

THE EFFECT OF LOW POWER LASER THERAPY ON OSTEOARTHRITIS OF THE KNEE

Basirnia A., Sadeghipoor G., Esmaeeli Djavid G. et al.
Treatment was performed on 20 patients, aging from 42 to 60 years. All patients had received conservative treatment with poor results. Laser device used for this treatment was pulsed IR diode laser; 810 nm wavelength once per day for 5 consecutive days, followed by a 2-day interval .The total number of applications was 12 sessions. Irradiation was performed on 5 periarticular tender points, each for 2 min. The treatment outcome (pain relief and functional ability) was observed and measured according to the following methods: 1) Numerical rating scales (NRS), 2) Self assessment by the patient, 3) Index of severity for osteoarthritis of the knee (ISK), 4) Analgesic requirements. We achieved significant improvement in pain relief and quality of life in 70% of patients, comparing to their previous status ($p<0.05$). There was no significant change in range of motion of the Knee.

THE USE OF LOW LEVEL LASER THERAPY (LLLT) IN THE TREATMENT OF TRIGGER POINTS THAT ARE ASSOCIATED WITH ROTATOR CUFF TENDONITIS.

Al-Shenqiti, J Oldham
60 patients were randomly allocated to either sham or laser therapy. The active laser parameters included a wavelength 820 nm, power output 100 mW, frequency 5000 Hz (modulated) and energy density 32 J/cm2. 12 treatments were given over four weeks. The blinded outcome measures were pain, range of motion (ROM), functional activities and pressure pain threshold (PPT). Outcome measures were carried out pre and post treatment, then 3 months later. Considerable improvement in pain ($p < 0.001$) was seen for the laser compared to sham group post treatment, and at follow-up (6 points on a 10 VAS compared to 2 points respectively). Similarly, significant differences in favour of laser were seen for ROM ($p < 0.01$), functional activities ($p < 0.001$) and PPT ($p < 0.05$).

THE INFLUENCE OF LOW LEVEL INFRA RED LASER THERAPY ON THE REGENERATION OF CARTILAGE TISSUE

P.Lievens , Ph.van der Veen
This study concerns the influence of Laser treatment on the regeneration process of cartilage tissue. There is no need saying that the regeneration of cartilage tissue is a very big problem in rheumatic diseases for example. The lack of blood supply is one of the most important factors involved. Lots of previous publications give us proof of the regeneration capacities of Laser therapy (in wound healing, bone repair etc.)
In this study we have chosen to experiment on cartilage tissue of the ear of mice. We are aware of the

fact that the elastic cartilage tissue of the ear is not totally comparable with the hyaline cartilage of articulations. For technical reasons however and because of the fact that the chondrocytes are comparable, we decided to use mice ears in our experiment. A 0,4 mm hole was drilled in both ears on 30 mice. The right ears remain untreated, while the left ears were treated daily with IR-Laser (904 nm) for 3 minutes. Macroscopical as well as histological evaluations were performed on the cartilage regeneration of both ears.
Our results show that after one day postsurgery no differences were found between the irradiated and the non-irradiated group. After the second day, only in the irradiated group there is a clear activation of the perichondrium. After four days, there is a significant ingrowth of the perichondrium into the drill hole in the experimental group and there is only an active perichondrium zone in our control group.

THE INFLUENCE OF IR-LASER ON THE PROLIFERATION OF FIBROBLASTS: AN IN-VITRO STUDY

Ph.van der Veen, Y de Rop, P. Lievens

To control the reproductability, the inter-and intra reliability, we cultivated cells coming from the abdomen of two different (NMRI) mice and we divided 4 groups per mouse. Two were irradiated, two were not. Then we did a BrdU-labeling with 4 flasks (2 were irradiated, 2 were control). Differences between the experimental and control groups were examined by means of a t-test and a non-parametric Mann-Whitney test. The results show a significant ($p<0,05$) increase of fibroblasts proliferation after IR-irradiation. The BrdU-labeling showed an increased DNA activity. There is also a perfect match between the increased number of fibroblasts and the DNA activity.

PHOTOBIOMODULATION OF HUMAN T-LYMPHOCYTE PROLIFERATION IN VITRO

M Dyson, A Agaiby, L Ghali

The biomodulatory action of low level laser therapy (LLLT) on human T-lymphocyte proliferation was investigated in vitro at energy densities ranging from 1.2 to 13.2 J/cm2. The wavelength, pulsing frequency and power output were maintained constant at 820 nm, 5000Hz and 50 mW respectively. The T-lymphocytes used in these experiments were separated from human peripheral blood; monocytes obtained from the same blood samples were added to suspensions of the T-lymphocytes to induce proliferation. Cell suspensions of 106 cells/ml were divided into 2 aliquots, one of which was treated with the mitogen phytohaemagglutin (PHA). The mitogen treated and non-mitogen treated cells were either exposed to coherent infrared radiation or were sham-irradiated. The cells were then cultured for 3 days after which their ability to incorporate 3H-thymidine was used as a measure of proliferation. Exposure of non-mitogen treated T-lymphocytes to energy densities of either 1.2 or 3.6 J/cm2 stimulated their proliferation, whereas energy densities of 10.8 and 13.2 J/cm2 were inhibitory. In contrast, the proliferation of the mitogen treated T-lymphocytes was inhibited by all the energy densities tested in the 1.2 to 13.2 J/cm2 range. The results indicate that the sensitivity of these cells to LLLT varies according to their proliferative level, only non-mitogen treated cells being capable of increased proliferation. Although cell proliferation can be increased in non-mitogen treated (i.e. resting) T-lymphocytes by exposure to low energy densities, there appears to be an energy density limit above which inhibition of cell proliferation occurs. Cells whose mitotic activity had been stimulated by PHA had their proliferation inhibited by energy densities, which stimulated

proliferation in resting cells. If the photobiomodulation of T-lymphocyte proliferation observed in vitro also occurs in vivo, then LLLT could be of clinical value in the treatment of various lymphoproliferative disorders.

AN IN VITRO STUDY OF THE EFFECTS OF LOW-LEVEL LASER RADIATION ON HUMAN BLOOD

Dan G. Siposan

In the last time the study of the effects of Low-Level Laser Radiation (LLLR) on the blood is considered to be a subject of great importance in elucidating the mechanisms of action between LLLR and biologic tissues. Different methods of blood phototherapy have been developed and used in clinical purposes with benefic effects. This study investigates some in Vitro effects of LLLR on some selected rheologic indices of human blood. After establishing whether or not damaging effects could appear due to laser irradiation of the blood, we tried to find a new method for rejuvenating the blood preserved in haemonetics-type bags. Blood samples were obtained from adult regular donors (volunteers). HeNe laser and laser diodes were used as radiation source, in a wide range of wavelengths, power densities, doses and other parameters of irradiation protocol. In the first series of experiments we established that LLLR does not alter the fresh blood from healthy donors, for doses between 0 and 10 J/cm3 and power densities between 30 and 180 mW/cm3. In the second series of experiments we established that LLLR does have, in some specific conditions, a revitalizing effect on the erythrocytes in preserved blood. We concluded that laser irradiation of the preserved blood, following a selected protocol of irradiation, could be used as a new method to improve the performances of preservation: prolonging the period of storage and blood rejuvenation before transfusion.

SEM AND AFM STUDIES OF RAT INJURED TIBIAE AFTER HeNe RADIATION.

Cruz-Höfling A, Garavello Freitas Z, Baranauskas I B.

Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM) were used to quantify bone morphology during post-injury ossification in rat tibiae and characterise the differences induced by laser compared with the naturally occurring regenerative process. A 1.5 diameter hole was done surgically in the tibia and two different doses of laser were applied during 7 or 14 consecutive days, starting 24 hrs after lesion. The collagen fibre lamellar organisation in the matrix, typical of mature bone, was promoted by the HeNe laser at doses of either 31.5 J/cm2 or 94.5 J/cm2.

LLLT ON DAMAGED MUSCLE CAUSED BY BOTHROPS MOOJENI SNAKE VENOM.

Dourado DM, Cruz-Höfling MA.

The venom of the bothrops moojeni snake was injected into the gastrocnemius of mice to mimic the effect of a snakebite. Traditional therapies for this snakebite have proven less effective. Three groups were tested: A=saline, B=venom and C=venom+ laser. Two sessions of HeNe laser at 4 J/cm2 during 1 m 32 s were administered and the animals were sacrificed at 24 h, 3 d and 7 d, respectively. The analysis showed myonecrosis with inflammation and an extensive area of degenerated fibres. In the laser group there was, by day 3, an incipient number of regenerating fibres. Laser accelerated the phagocytisis of fibre remnants and recovery of the tissue, decreasing the oedema and increasing regeneration.

21 new studies added June 2003

A systematic review of low level laser therapy with location-specific doses for pain from chronic joint disorders.

Australian J Physiother. 2003; 49: 107-116. Bjordal J M, Couppè, C, Chow R, Tunér J, Ljunggren A E.

The authors investigated if low level laser therapy of the joint capsule can reduce pain in chronic joint disorders (CJD). A literature search identified 88 randomised-controlled trials, of which 20 trials included patients with CJD. Six trials had to be excluded for not irradiating the joint capsule. Three trials used doses lower than a denominated a priori dose range for reducing inflammation in the joint capsule. These trials found no significant difference between active and placebo treatments. The remaining 11 trials, including 565 patients, were of acceptable methodological quality with an average PEDro score of 6.9 (range 5-9). In these trials, LLLT within the suggested dose-range was administered to the knee, temporomandibular and zygapophyseal joints. The results showed a mean weighted difference in change of pain on VAS by 45.6 % (95 % CI 35.0 to 56.2) in favour of LLLT. Global status was improved for 33.4 % (95% CI 20.9 to 45.9) more patients in the LLLT group. LLLT with the suggested dose range significantly reduces pain in CJD, but the heterogeneity in patient samples, treatment procedures and trial design calls for cautious interpretation of the results.

A histopathological study of the effects of low-power laser irradiation on wound healing of exposed dental pulp tissues in dogs, with special reference to lectins and collagens.

J Endod. 1998; (3):187-193. Utsunomiya T

This study investigated the effects of low-power laser irradiation on exposed pulp tissue in dogs. GaAlAs laser (300 mW) irradiation was applied to the exposed surface of the pulp, and histopathological changes were observed at 1, 3, and 7 wk after the operation. In addition, the lectin, binding pattern and distribution of collagens (type I, III, and V) were examined to determine the histochemical and immunohistochemical nature of wound healing. The fibrous matrix formation and the continuing changes in the dentin bridge formation of the irradiation group were observed earlier (1 wk after the operation) than in the nonirradiation control group. Lectin histochemistry and collagen immunohistochemistry showed that concanavalin A, peanut agglutinin, wheat germ agglutinin, and collagens (types I, III, and V) were distributed in the fibrous matrix and dentin bridge. The expression of these lectins and collagens occurred earlier in the laser irradiation group than in the control group. These results suggest that laser irradiation accelerates wound healing of the pulp and the expression of the lectins and collagens. Furthermore, D-glucose-, D-mannose-, N-acetyl-D-galactosamine-, and N-acetyl-neuraminic acid-binding sugars and type I, III, and V collagens play an important role in the healing of pulp wounds.

Low-energy laser irradiation stimulates bone nodule formation at early stages of cell culture in rat calvarial cells.

Bone. 1998; 22 (4): 347-354. Ozawa Y; Shimizu N; Kariya G; Abiko Y

To determine the target cells responsible for the action of laser irradiation and roles of irradiation on these cells during bone formation, we investigated the effects of low-energy laser irradiation at various cell culture stages on cellular proliferation, bone nodule formation, alkaline phosphatase activity, and osteocalcin gene expression, employing rat calvarial cells. Osteoblast-like cells isolated from fetal rat calvariae were irradiated once with a low-energy Ga-Al-As laser (830 nm, 500 mW) at various cell culture stages (days 1-16). Laser irradiation at early stages of culture significantly stimulated cellular proliferation, ALP activity, and osteocalcin gene expression thereafter.

Furthermore, laser irradiation at earlier stages of culture significantly stimulated a greater number (1.7-fold) and larger area (3.4-fold) of bone nodules that had developed in the culture dish on day 21. However, these effects could not be found by irradiation at a later date. These results suggest that laser irradiation may play two principal roles in stimulating bone formation. One is stimulation of cellular proliferation, especially proliferation of nodule-forming cells of osteoblast lineage, and the other is stimulation of cellular differentiation, especially to committed precursors, resulting in an increase in the number of more differentiated osteoblastic cells and an increase in bone formation. Both bone-formation-stimulating roles may be exhibited by laser irradiation to immature cells only.

Rapid healing of gingival incisions by the helium-neon diode laser.
J Mass Dent Soc. 1999; 48 (1):8-13. Neiburger E J
Fifty-eight extraction patients had one of two gingival flap incisions lased with a 1.4 mW helium-neon (670 nm) diode laser for 30 seconds (fluence = 0.34 J/cm2). Healing rates were evaluated clinically and photographically. Sixty-nine percent of the irradiated incisions healed faster than the control incisions. No significant difference in healing was noted when patients were compared by age, gender, race, and anatomic location of the incision. This study concludes that helium-neon diode lasers, at the previously mentioned energy level, increase the rate of gingival wound healing in 69 percent of patients, without any side effects. For the last 30 years, low-power lasers in dentistry have appeared to stimulate healing rates and increase the rate of repair of injured tissue. Helium-neon and similar lasers emit light in the red (600-700 nm) spectrums and produce energy densities (fluences) below 20 Joules/cm2. They have been studied in a variety of animal tissue culture and human evaluations to determine their ability to increase the rates of wound healing by biostimulation. Over the last three decades, researchers have found that ruby and gas helium-neon (low-power laser radiation) have a biostimulatory effect on living tissue. Studies show that under specific conditions, red spectrum laser light speeds the healing of wounds. Photons from the red light lasers, which include ruby lasers (694 nm), helium-neon gas lasers (632 nm), and helium-neon diode lasers (650-670 nm), appear to stimulate rapid epithelialization and fibroblast (collagen) proliferation in animal and human tissue cultures. Low-power lasers have been reported to reduce post-extraction pain and swelling and to increase rates of wound healing (including scar formation, phagocytosis) in cell culture, animal, and human clinical studies. The new, compact, and inexpensive (under $50) helium-neon diode lasers have produced similar effects. These FDA Class IIIa lasers have no hazards associated with them, although one should avoid direct exposure to the eye for a prolonged period of time. In the past, many biostimulation studies using red spectrum lasers produced confusing data and conflicting results. Some studies reported that the biostimulation effect did not occur in all cases of laser irradiation, while other research reported that it did. Results seem to depend on the delivery of appropriate energy fluence levels (between 1 and 20 J/cm2) and the type of laser (wavelength) used. Several of these studies never described the levels of laser energy used to promote the described biostimulatory results. This caused controversy when determining whether or not helium-neon lasers influence wound healing. Studies suggest that low-power laser exposure can significantly increase the healing rate during the first few days of the healing process; however, studies do not show appreciable net benefit as compared to controls toward the end of a two-week wound repair cycle. The increased healing effect appears to be centered around the early, most sensitive stages of the healing process. Several studies showed optimum tissue healing rates at helium-neon laser exposure levels between 1 J/cm2 and 20 J/cm2. Laser-enhanced biostimulation has been reported to produce metabolic changes within the cells. This results in faster cell division, rapid matrix production (increased collagen, myofibroblasts, etc.), and cell movement. There have been few controlled studies using adequate

numbers of human subjects in identifying the beneficial effects of helium-neon laser biostimulation. Ethical concerns, bulky equipment, and problems with biased study designs have frustrated a practical evaluation of laser biostimulation for general dental practice. A recently published "preliminary" study involving 52 patients was designed to reduce these issues. The purpose of this study is to complement the above research and to evaluate whether helium-neon diode laser radiation at average fluences of 0.34 J/cm2.
Editorial comment: There is no such thing as a “helium-neon diode laser” but a diode InPhGaAl laser.

Effect of laser irradiation on the growth and development of fetal mouse limbs in an in vitro model.
Lasers Surg Med. 1999; 24 (4): 285-295. Thawer HA; Houghton PE
The purpose of the present study was to examine the effects of laser irradiation on the growth and development of fetal limb tissue. Day 14 fetal mouse limbs (n=168) were irradiated with gallium arsenide laser (904 nm, spot size=0.002 cm2, pulse duration=200 nanoseconds, peak power=30 mW) for 1 minute each day while being maintained in an organ culture system for 3 or 5 days at the following energy densities [O (control), 0.23, 1.37, 2.75, 3.66, and 4.58 J/cm2]. Computer image analysis of photographic images showed that there was a significant inhibition of new tissue growth after administration of lower energy densities of laser (0.23 and 1.37 J/cm2). These low-energy densities of laser irradiation also produced increased dermal cell number and collagen fibre thickness as assessed with qualitative histologic analysis of limb development by a blinded observer. Quantitative analysis of collagen distribution by colour densitometric analysis of tissue sections stained with sirus red and fast green confirmed that there was a significantly greater amount of collagen present in the dermis of limbs treated with low-energy densities of laser (0.23 and 1.37 J/cm2). Laser irradiation directly affected the growth and development of day 14 fetal mouse limbs in an organ culture system.
Effect of low-power laser irradiation on impulse conduction in anesthetized rabbits.

J Clin Laser Med Surg 1996; 14 (3):107-109. Kasai S; Kono T; Yamamoto Y; Kotani H; Sakamoto T; Mito M
Low-power laser analgesic effect was generally accepted in clinical cases, whereas there was no direct evidence to indicate that low-power laser irradiation suppressed an impulse conduction within a peripheral nerve. The effect of low-power laser irradiation on electrically evoked responses within the sural nerve was electrophysiologically analyzed in anesthetized rabbits. High threshold evoked responses (conduction velocity was about 11 m/sec, unmyelinated A delta), which were induced by an electrical stimulation to the peripheral stump of the nerve, were significantly suppressed (9 to 19% inhibition) during low-power laser irradiation, which applied to the exposed sural nerve between the stimulus site and the recording site. The suppressive effect was reversible and recovered to the control level after the irradiation. Experimental evidence indicated that low-power laser irradiation suppressed the impulse conduction of unmyelinated A delta afferents in peripheral sensory nerve, which caused a pain sensation. These data suggest that low-power laser acts as a reversible direct suppressor of neuronal activity.

Laser modulation of angiogenic factor production by T-lymphocytes.
Lasers Surg Med. 2000; 26 (4): 357-363.Agaiby AD; Ghali LR; Wilson R; Dyson M
In previous investigations, small variations in the energy densities of low level light therapy (LLLT) were found to produce significant differences in the proliferation of resting T-lymphocytes in vitro.

Pulsing these cells with mitogen in addition to laser therapy produced inhibitory effects regardless of the amplitude of the energy density used. In the current study, the effect of LLLT on the production of angiogenic factor(s) by T-lymphocytes was investigated in vitro.: Human T-cells isolated from peripheral blood were prepared in suspension either with or without addition of mitogen. Cell suspensions were irradiated with laser by using the following energy densities: 1.2, 3.6, 6.0, and 8.4 J/cm2 .Wavelength, pulsing frequency, and power output were kept constant at 820 nm, 5,000 Hz, and 50 mW, respectively. After either 3 or 5 days of incubation, lymphocyte supernatants were collected and added as conditioned media to cultured endothelial cells (ECs). The effect on the proliferation of these ECs was assessed over a 72-hour period by using a methylene blue assay.: Endothelial cell proliferation increased significantly when incubated with conditioned media collected from resting T-cells exposed to 1.2 and 3.6 J/cm2 Day 5 conditioned media produced similar patterns of EC proliferation to that of day 3 but at lower magnitude. Pulsing of T-lymphocytes with mitogen in addition to laser irradiation significantly lessened their angiogenic capability. Conditioned media from 3.6 J/cm2 laser-treated T-cells induced the maximal EC proliferation in all groups studied. It would seem that laser therapy stimulates lymphocytes to produce factor(s) that can modulate EC proliferation in vitro; this effect on the lymphocytes is influenced by (1) the amplitude of energy density used for T-cell irradiation, (2) exposing T-cells to both mitogen and laser, and (3) the duration of T-cell incubation in culture

Laser irradiation abates neuronal responses to nociceptive stimulation of rat-paw skin.
Brain Res Bull. 1994; 34 (4): 369-374. Tsuchiya K; Kawatani M; Takeshige C; Matsumoto I
The effects of diode laser irradiation on peripheral nerves was examined by monitoring neuronal discharges elicited by application of various stimuli to the hind-paw skin of rats. Neuronal discharges elicited by brush, pinch, cold, and/or heat stimulation, as well as chemical stimulation by injection of turpentine (0.1 ml, SC) were recorded from L5 dorsal roots in urethane-anaesthetised rats. Diode laser irradiation (830 nm, 40 mW, 3 min, continuous wave) of the saphenous nerve exposed from the muscle of the lower leg significantly inhibited neuronal discharges elicited by pinch (68.4 +/- 6.5%), cold (45.4 +/- 9.2%), and heat stimulation (49.2 +/- 11.3%). Neuronal discharges induced by brush stimulation (104.3 +/- 4.7%) were not affected by laser irradiation. Injection of turpentine, a chemical irritant, into the hind-paw skin (0.1 ml, SC) elicited neuronal discharges in the ipsilateral dorsal root, and these discharges were significantly inhibited or abolished by laser irradiation. In 6- to 7-week-old rats treated neonatally with capsaicin (10 mg/kg, SC), injection of turpentine into the hind-paw skin did not elicit neuronal discharges and laser irradiation did not affect the background discharges. These data suggest that laser irradiation may selectively inhibit nociceptive (pain) neuronal activities.

[The mechanisms of action of extracorporeal helium-neon laser irradiation in acute exogenous poisonings]
Anesteziol Reanimatol. 1997; (4): 33-35. Nemtsev I Z; Luzhnikov E A; Lapshin V P; Gol'dfarb I S; Badalian A V.
Extracorporeal exposure to HeNe laser of 12 mW power was used in 57 patients hospitalised at the intoxication reanimation department with acute poisonings with psychotropic drugs. The clinical result was a decrease of the incidence of pneumonia in the patients with x-ray signs of venous congestion from 52% among those administered to physiochemotherapy to 24% after this treatment modality. Laser hemotherapy brought about a temporary normalization of the erythrocyte membrane permeability, which was changed biophysically by means of a diffractometer. Red cell aggregation was approximating the norm, decreasing by 20%, and platelet aggregation decreased by 17%.

Analysis of the results brought as to a conclusion that He-Ne laser exposure is an effective source of singlet stimulation of molecular O2 evenly dissolved in the blood, which causes resonance oscillations of water difields. This leads to membrane depolarization, which is probably responsible for purification of polarised membranes from toxic agents fixed by them.

Physical and Occupational Therapy in Geriatrics.
2000. 18 (2): 1-19. Verdote Robertson R, Munchua M M, Reddon J R.
The effect of low intensity laser therapy (LILT) biostimulation on wound healing in a largely psychogeriatric population was assessed over a period of 6 years (1991-1996). In total, 84 psychiatric patients were referred for the treatment of open wounds of varying severity and etiology. The wound status, nutritional status, walking status, and psychiatric condition of each patient were assessed prior to the administration of laser therapy treatment. Traditional wound care management was also used in addition to laser therapy. According to laser therapy treatment protocol for open wounds, a single diode laser probe was used for biostimulation of the wound bed and the wound periphery. Pre- and post-treatment measurements of wound size were obtained periodically for a total of 188 open wounds. 84% of these wounds completely healed, 11.2% partially healed, 2.1% did not change, and 2.7% got worse. The number of treatments for the 158 completely healed wounds ranged from 3 to 133 (mean 18.5) and the treatment period ranged from 5 to 383 days (mean 47.7). Wound healing was found to be related to nutritional status but neither walking status nor wound size. Results indicate that LILT is effective in the treatment of open wounds when it is used as a component of a total wound management program. Implications and directions for future research are discussed.

[Efficiency of low-intensity laser radiation in essential hypertension].
{Klin Med(Mosk). 2001; 79 (1): 41-44. Velizhanina I A, Gapon L I, Shabalina M S, Kamalova N N.
In a placebo-controlled study an antihypertensive activity of low- intensive laser radiation (LILR) was evaluated in 52 males with essential hypertension stage I. The placebo group consisted of 14 matched patients. LILR was used as monotherapy of 10 daily procedures. This treatment significantly lowered systolic, diastolic and mean arterial pressure. Moreover, diastolic arterial pressure did not rise high at submaximal bicycle exercise. Total peripheral vascular resistance also decreased. A good hypotensive effect was achieved in 90.4% cases. Thus, LILR is a highly effective treatment in essential hypertension stage I.

Fat liquefaction: effect of low-level laser energy on adipose tissue.
Neira R, Arroyave J, Ramirez H, Ortiz et al. Plast Reconstr Surg 2002 Sep 110:912-922.
Low-level laser energy has been increasingly used in the treatment of a broad range of conditions and has improved wound healing, reduced edema, and relieved pain of various etiologies. This study examined whether 635-nm low-level lasers had an effect on adipose tissue in vivo and the procedural implementation of lipoplasty/liposuction techniques. The experiment investigated the effect of 635-nm, 10-mW diode laser radiation with exclusive energy dispersing optics. Total energy values of 1.2 J/cm(2), 2.4 J/cm(2), and 3.6 J/cm(2) were applied on human adipose tissue taken from lipectomy samples of 12 healthy women. The tissue samples were irradiated for 0, 2, 4, and 6 minutes with and without tumescent solution and were studied using the protocols of transmission electron microscopy and scanning electron microscopy. Nonirradiated tissue samples were taken for reference. More than 180 images were recorded and professionally evaluated. All microscopic results showed that without laser exposure the normal adipose tissue appeared as a grape-shaped node. After 4 minutes of laser

exposure, 80 percent of the fat was released from the adipose cells; at 6 minutes of laser exposure, 99 percent of the fat was released from the adipocyte. The released fat was collected in the interstitial space. Transmission electron microscopic images of the adipose tissue taken at x60,000 showed a transitory pore and complete deflation of the adipocytes. The low-level laser energy affected the adipose cell by causing a transitory pore in the cell membrane to open, which permitted the fat content to go from inside to outside the cell. The cells in the interstitial space and the capillaries remained intact. Low-level laser-assisted lipoplasty has a significant impact on the procedural implementation of lipoplasty techniques.

Double-blind, randomised, placebo controlled low level laser therapy study in patients with primary Raynaud's phenomenon.
Hirschl M, Katzenschlager R, Ammer K et al. Vasa 2002 May 31:91-4
No causal treatment of primary Raynaud's phenomenon is available due to its unclear aetiology. Low level laser therapy (LLLT) is applied in a multitude of medical conditions often without sufficient evidence of efficacy and established mechanisms. To asses the effect of this therapy in patients with primary Raynaud's phenomenon a randomised, double blind, placebo controlled cross over study was designed.: Absolute and relative frequency and intensity of vasospastic attacks during three weeks of either LLLT or placebo therapy and results of infrared thermography before onset and at the end of both therapy sequences were evaluated in 15 patients with primary Raynaud's phenomenon.
RESULTS: Frequency of Raynaud's attacks was not significantly affected by low level laser therapy. Compared to placebo a significantly lower intensity of attacks during laser irradiation was observed, but no transfer effect occurred. Additionally the mean temperature gradient after cold exposure was reduced after laser irradiation, while the number of fingers showing prolonged rewarming was unaffected. Though further studies are necessary to confirm these results we could demonstrate for the first time in a double blind placebo controlled clinical trial that low laser therapy is a potential candidate for an effective therapy of Raynaud's phenomenon, although effects seem to be of short duration.

Low level 809-nm diode laser-induced in vitro stimulation of the proliferation of human gingival fibroblasts.
Kreisler M, Christoffers AB, Al-Haj H, Willershausen B, d'Hoedt B. Lasers Surg Med; 2002 30: 365-369.
The authors investigated the effects of low level laser irradiation on the proliferation rate of human gingival fibroblasts (HGF) in vitro. HGF were obtained from gingival connective tissue explants and cultured under standard conditions. 110 cell cultures in their logarithmic growth phase were spread on 96-well tissue culture plates and were irradiated at energy fluences of 1.96-7.84 J/cm(2). Another 110 cultures served as control. An 809-nm semiconductor laser operated at a power output of 10 mW in the cw-mode was used. The time of exposure varied between 75 and 300 seconds. Laser treatment was performed alternatively once, twice, and three times at a 24-hour interval. After lasing, incubation was continued for 24 hours. The proliferation rate was determined by means of fluorescence activity of a redox indicator added to the cell culture. Proliferation was determined 24, 48, and 72 hours after irradiation and expressed in relative fluorescence units (RFU). The irradiated cells revealed a considerably higher proliferation activity. The differences were highly significant 24 hour after irradiation (Mann-Whitney U-test, $P < 0.05$) but decreased in an energy-dependent manner after 48 and 72 hour after irradiation. A cellular effect of the soft laser irradiation on HGF is evident. Its duration, however, seems to be limited. These findings might be clinically relevant, indicating that

repeated treatments are necessary to achieve a positive laser effect in clinical applications.

Low-level laser effect on neural regeneration in Gore-Tex tubes.
Miloro M, Halkias LE, Mallery S, Travers S, Rashid RG. Oral Radiol Endod 2002 Jan 93:27-34
The purpose of this investigation was to determine the effects of low-level laser (LLL) irradiation on neural regeneration in surgically created defects in the rabbit inferior alveolar nerve. Five adult female New Zealand White rabbits underwent bilateral exposure of the inferior alveolar nerve. A 6-mm segment of nerve was resected, and the nerve gap was repaired via entubulation by using a Gore-Tex conduit. The experimental side received 10 postoperative LLL treatments with a 70-mW gallium-aluminum-arsenide diode at 4 sites per treatment. At 15 weeks after surgery, the nerve segments were harvested bilaterally and prepared for light microscopy. Basic fuchsin and toluidine blue were used to highlight myelinated axons. The segments were examined histomorphometrically by using computer analysis to determine mean axonal diameter, total fascicular surface area, and axonal density along the repair sites. Gross examination of all nerves showed intact neural bundles with variable degrees of osseous remodeling. Light microscopic evaluation revealed organized regenerated neural tissue in both groups with more intrafascicular perineural tissue in the control group. Histomorphometric evaluation revealed increased axonal density in the laser treated group as compared with the control.

Computerized morphometric assessment of the effect of low-level laser therapy on bone repair: an experimental animal study.
Silva Júnior AN, Pinheiro AL, Oliveira MG, Weismann R, Ramalho LM, Nicolau RA. J Clin Laser Med Surg. 2002; 20: 83-87
The aim of this study was to evaluate morphometrically the amount of newly formed bone after GaAlAs laser irradiation of surgical wounds created in the femur of rats. Low-level laser therapy (LLLT) has been used in several medical specialties because of its biomodulatory effects on different biological tissues. However, LLLT is still controversial because of contradictory reports. This is a direct result of the different methodologies used in these works. In this study, 40 Wistar rats were divided into four groups of 10 animals each: group A (12 sessions, 4.8 J/cm2 per session, observation time of 28 days); group C (three sessions, 4.8 J/cm2 per session, observation time of 7 days). Groups B and D acted as nonirradiated controls. The specimens were routinely processed to wax and cut at 6-microm thickness and stained with H&E. For computerized morphometry, Imagelab software was used. RESULTS: Computerized morphometry showed a significant difference between the areas of mineralized bone in groups C and D ($p = 0.017$). There was no difference between groups A and B (28 days; $p = 0.383$).

Effects of near-infrared low-level laser irradiation on microcirculation.
Maegawa Y, Itoh T, Hosokawa T, Yaegashi K, Nishi M. Lasers Surg Med. 2000; 27:427-437.
The present study was conducted to explore the effects of LLLI on microcirculation. We investigated the effects of LLLI on rat mesenteric microcirculation in vivo, and on cytosolic calcium concentration ([Ca2+]i) in rat vascular smooth muscle cells (VSMCs) in vitro. LLLI caused potent dilation in the laser-irradiated arteriole, which led to marked increases in the arteriolar blood flow. The changes were partly attenuated in the initial phase by the superfusion of 15 microM L-NAME, but they were not affected by local denervation. Furthermore, LLLI caused a power-dependent decrease in [Ca2+]i in VSMCs. The circulatory changes observed seemed to be mediated largely by LLLI-induced reduction of [Ca2+]i in VSMCs, in addition to the involvement of NO in the initial phase.

Therapeutic low energy laser improves the mechanical strength of repairing medial collateral ligament.
Fung DT, Ng GY, Leung MC, Tay DK. Lasers Surg Med. 2002; 31:91-96.
Twenty-four rats received surgical transection to their right MCL and eight received sham operation. After surgery, 16 received a single dose of gallium aluminum arsenide laser to their transected MCL for 7.5 minutes (n = 8) or 15 minutes (n = 8) and eight served as control with placebo laser, while the sham group didn't receive any treatment. The MCLs were biomechanically tested at either 3 or 6 weeks post-operation. The normalized ultimate tensile strength (UTS) and stiffness of laser and sham groups were larger than control ($P < 0.001$). The UTS of laser and sham groups were comparable. Laser and sham groups had improved in stiffness from 3 to 6 weeks ($P < 0.001$). A single dose of low energy laser therapy improves the UTS and stiffness of repairing MCL at 3 and 6 weeks after injury.

Impact of low level laser irradiation on infarct size in the rat following myocardial infarction. Ad N, Oron U. Int J Cardiol. 2001; 80:109-116.
The effect of LLLI on the development of acute myocardial infarction (MI) was investigated following chronic ligation of the left anterior descending (LAD) coronary artery in laboratory rats. The hearts of 22 rats were laser irradiated (LI) using a diode laser (804 nm, 38 mW power output) through the intercostal muscles in the chest following MI and on day 3 post MI. In the control non laser irradiated (NLI) group (19 rats) MI was induced experimentally and laser irradiation was not applied. All rats were sacrificed 21 days post MI. Size, thickness and relative circumferential length of the infarct, as well as other parameters, were determined from histological sections stained with Masson's trichrome and hearts stained with triphenyl tetrazolium chloride (TTC) using histomorphometric methods. The infarct size (expressed as percent of total left ventricle area) of the LI rats was 10.1+/-5.8, which was significantly lower (65%; $P<0.01$) than the infarct size of NLI rats which was 28.7+/-9.6. Correlatively, the ratio of circumferential length of the infarcted area was significantly lower (2-fold; $P<0.01$) in the LI rats as compared to the NLI rats. LLLI of the infarcted area in the myocardium of experimentally induced MI rats, at the correct energy, duration and timing, markedly reduces the loss of myocardial tissue. This phenomenon may have an important beneficial effect on patients after acute MI or ischemic heart disease