CONNECTIVE TISSUE / CARTILAGE / LIGAMENT / BONE REPAIR RESEARCH STUDIES

CONNECTIVE TISSUE REPAIR

THE BIOLOGICAL EFFECTS OF LASER THERAPY AND OTHER PHYSICAL MODALITIES ON CONNECTIVE TISSUE REPAIR PROCESSES

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Connective tissue injuries, such as tendon rupture and ligamentous strains, are common. Unlike most soft tissues that require 7-10 days to heal, primary healing of tendons and other dense connective tissues take as much as 6 - 8 weeks during which they are inevitably protected in immobilization casts to avoid re-injury. Such long periods of immobilization impair functional rehabilitation and predispose a multitude of complications that could be minimized if healing is quickened and the duration of cast immobilization reduced.
In separate studies, we tested the hypothesis that early function, ultrasound, 632.8 nm He-Ne laser, and 904 nm Ga-As laser, when used singly or in combination, promote healing of experimentally severed and repaired rabbit Achilles tendons as evidenced by biochemical, biomechanical, and morphological indices of healing. Our results demonstrate that: (1) appropriate doses of each modality, i.e., early functional activities, ultrasound, He-Ne and Ga-As laser therapy augment collagen synthesis, modulate maturation of newly synthesized collagen, and overall, enhance the biomechanical characteristics of the repaired tendons. (2) Combinations of either of the two lasers with early function and either ultrasound or electrical stimulation further promote collagen synthesis when compared to functional activities alone. However, the biomechanical effects measured in tendons receiving the multi-therapy were similar, i.e., not better than the earlier single modality trials.
Although tissue repair processes in humans may differ from that of rabbits, these findings suggest that human cases of connective tissue injuries, e.g., Achilles tendon rupture, may benefit from appropriate doses of He-Ne laser, Ga-As laser, and other therapeutic modalities, when used singly or in combination. Our recent meta-analysis of the laser therapy literature further corroborate these findings.

BONE REPAIR

EFFECT OF LOW-LEVEL LASER ON CALVARIAL BONE DEFECT

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Objective: The purpose of the present study was to evaluate by animal means the effect of laser therapy with GaAlAs diode laser device on bone healing and growth in rat calvarial bone defects.
Methods: The study was performed as an animal trial of 4 weeks duration with blinded, placebocontrolled design. 20 rats had a standardised round osseous defect 2,7 mm in diameter made in each parietal bone (2 defects). The animals were then randomly divided into two equal groups. A GaAlAs diode laser (wavelength 830 nm, output power 75 mw and energy density 23 J/cm2) was used immediately after surgery and carried out daily for 7 consecutive days. The rats were thereafter sacrificed at day 14 and 28 after surgery. Levels of calcium, phosphorous and protein were

determined in 20 bone defects, while the histological analyses were performed in the other 20 defects. Statistical analyses between the test and control were performed using Student's t-test.
Results: The results indicate that calcium, phosphorous and protein contents were significantly higher in the laser-irradiated healing tissues than in the sham group on both time-points. The histological analyses showed that proliferation of fibroblasts, osteoid tissue and bone were more prominent in the irradiated group.
Conclusion: The findings suggest that Laser Therapy may promote metabolism and/or mineralisation in bone forming tissues during the healing of bone defects.

BONE REPAIR OF THE PERIAPICAL LESIONS TREATED OR NOT WITH LOW INTENSITY LASER (WAVELENGHT=904 NM).

Laser Surg Med. Abstract Issue 2002. abstract 303.
Sousa G R, Ribeiro M S, Groth E B.
The effect of bone repair in periapical lesions has been studied by Sousa. 15 patients with atotal of 18 periapical lesions were divided into two groups. One group received endodontic treatment and/or periapical surgery. The patients in the other group were submitted to the same procedure and in addition the lesions were irradiated by GaAs laser, 11 mW, 9 J/cm2. This therapy was performed during 10 sessions with an interval of 72 hours. Bone regeneration was evaluated through X-ray examination. The results showed a significant difference between the laser and the control group in favour of the laser group.

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 post-surgery 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.

LOW-POWER DIODE LASER STIMULATION OF SURGICAL OSTEOCHONDRAL DEFECTS: RESULTS AFTER 24 WEEKS.

Artificial cells, blood substitutes, and immobilization biotechnology. 2001.29 (3): 235-44.
Guzzardella G A, Tigani D, Torricelli P, Fini M, Martini L, Morrone G, Giardino R.
The purpose of this study was to evaluate osteochondral lesions of the knee, treated intraoperatively with low-power laser stimulation, and assess results at 24 weeks. Surgery was performed under general anesthesia on six rabbits; a bilateral osteochondral lesion was created in the femoral medial condyles with a drill. All of the left lesions

underwent immediate stimulation using the diode Ga-Al-As laser (780nm), whereas the right knees were left untreated as control group. After 24 weeks, the explants from the femoral condyles, either treated employing laser energy or left untreated, were examined histomorphometrically. Results obtained on the lased condyles showed good cell morphology and a regular aspect of the repaired osteocartilaginous tissue.

ASSESSMENT OF LASER BIOSTIMULATION ON CHONDRAL LESIONS: AN "IN VIVO": EXPERIMENTAL STUDY.

Artificial cells, blood substitutes, amd immobilization biotechnology.
2000;28 (5): 441-449.
Guzzardella-G-A, Morrone-G, Torricelli-P et al.
The purpose of this study was to evaluate whether intraoperative laser biostimulation can enhance healing of cartilaginous lesions of the knee. Surgery was performed on eighteen rabbits: a bilateral chondral lesion of 1.25 +/- 0.2 mm in length and 0.8 +/- 0.2 mm in width was created in the femoral media l condyle with a scalpel. The lesion in the left knee of each animal was treated intraoperatively using the diode Ga-Al-As 780nm. laser (300 Joules/cm2, 1 Watt, 300 Hertz, 10 minutes), while the right knee was left untreated, as control group. The animals were divided into three groups, A, B and C, according to the survival time after surgery, two, six and twelve weeks, respectively. The explants from the femoral condyles, both treated employing laser energy and left untreated, were examined histologically. Results showed a progressive filling with fibrous tissue of the cartilaginous lesion treated with laser irradiation, while no changes in the original lesion of the untreated group were observed at the end of the study.

LIGAMENT REPAIR

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.