

## Cartilage Regeneration

### **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.

Lasers Surg Med. 2003;32(4):286-93.

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

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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.

Biotechnology. 2000; 28(2):193-201.

### **Biostimulation of human chondrocytes with Ga-Al-As diode laser: 'In vitro' research.**

#### **Artificial Cells, Blood Substitutes, and Immobilization**

Morrone G, Guzzardella G A, Tigani D et al.

The aim of the study was to verify the effects of lllt performed with GaAlAs (780 nm, 2500 mW) on human cartilage cells in vitro. The cartilage sample used for the biostimulation treatment was taken from the fight knee of a 19-year-old patient. After the chondrocytes were isolated and suspended for cultivation, the cultures were incubated for 10 days. The culture were divided into four groups. Groups I, II, III were subject to biostimulation with the following laser parameters: 300J, 1W, 100Hz, 10 min. exposure, pulsating emission; 300J, 1W, 300Hz, 10 min. exposure, pulsating emission; and 300J, 1W, 500Hz, 10 min. exposure, pulsating emission, respectively. Group IV did not receive any treatment. The laser biostimulation was conducted for five consecutive days. The data showed good results in terms of cell viability and levels of Ca and Alkaline Phosphate in the groups treated with laser compared to the untreated group. The results

obtained confirm our previous positive in vitro results that the GaAlAs Laser provides biostimulation without cell damage.

*Lasers Surg Med.* 1997;21(5):480-4.

**Laser's effect on bone and cartilage change induced by joint immobilization: an experiment with animal model.**

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**OBJECTIVE:** Influence of low-level (810 nm, Ga-Al-As semiconductor) laser on bone and cartilage during joint immobilization was examined with rats' knee model. **MATERIALS AND METHODS:** The hind limbs of 42 young Wistar rats were operated on in order to immobilize the knee joint. One week after operation they were assigned to three groups; irradiance 3.9 W/cm<sup>2</sup>, 5.8 W/cm<sup>2</sup>, and sham treatment. After 6 times of treatment for another 2 weeks both hind legs were prepared for 1) indentation of the articular surface of the knee (stiffness and loss tangent), and for 2) dual energy X-ray absorptiometry (bone mineral density) of the focused regions. **RESULTS AND CONCLUSIONS:** The indentation test revealed preservation of articular cartilage stiffness with 3.9 and 5.8 W/cm<sup>2</sup> therapy. Soft laser treatment has a possibility for prevention of biomechanical changes by immobilization.

*Lasers Surg Med.* 2002; 31: 263-267.

**Effect of low-power laser irradiation on cell growth and procollagen synthesis of cultured fibroblasts.**

Pereira A, de Paula Eduardo C, Matson E et al

The cell growth and procollagen synthesis of cultured fibroblasts were studied by irradiation at energy densities ranging from 3-5 J/cm<sup>2</sup> over a period of 6 days. To simulate a situation of stress the cells were grown in a 2.5% FBS solution (10% being optimal). The laser was a 120 mW GaAs laser. Irradiation at 3 to 4 J/cm<sup>2</sup> increased the cell numbers about threefold to sixfold, compared to control cultures. However, the effect was restricted to a small range of densities, since 5 J/cm<sup>2</sup> had no effect on cell growth. The energy density of 3 J/cm<sup>2</sup> remarkably increased cell growth, with no effect on procollagen synthesis, as demonstrated by immunoprecipitation analysis.

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**The therapeutic effect of low-level laser on repair of osteochondral defects in rabbit knee.**

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**INTRODUCTION:** Low level laser therapy (LLLT) has been shown to enhance collagen production and wound healing but its effect on cartilage repair from biomechanical point of view is not known yet. The aim of present study was to evaluate the biomechanical behaviour of repairing osteochondral defect in rabbits which received a pulsed low-level gallium-arsenide (Ga-As) laser irradiation. **MATERIALS AND METHODS:** Osteochondral defects with 5mm diameter and 4mm in depth induced by drilling in right femoral patellar grooves of 41 adolescent male rabbits. They were divided into experimental and control groups. Experimental group received pulsed Ga-As (890nm) laser irradiation with energy density of 4.8J/cm<sup>2</sup>. The rabbits in control group received placebo LLLT with shut-down equipment. The control defects were allowed to heal spontaneously. Each group were divided into three subgroups: A, B and C. Subgroups A, B and C were sacrificed on 4, 8, and 16 weeks after surgery. The knee joint were removed, and the defects were examined biomechanically by in situ-indentation method. The thickness, instantaneous and equilibrium indentation stiffness was measured during the test. Data were analysed using ANOVA and independent sample t-test. **RESULT:** While no difference was observed in the repaired cartilage biomechanical properties among 4th, 8th, 16th weeks in study groups. The equilibrium indentation stiffness of experimental group was significantly higher in 8th week in comparison with control group. **CONCLUSION:** LLLT significantly enhances the stiffness of repairing tissue in the 8th week post injury in osteochondral defects in rabbits.