

Immune-modulating Effects of Therapeutic Laser

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Updated Mar 7, 2011 | ⌚ **6 Min Read** William J. Kneebone, CRNA, DC

Therapeutic laser has been shown to have many interesting effects on immune function. In this article I will present some of the scientific studies that have been published relating to immune modulation.

Immune function within our body is controlled by a system of biological structures and processes that protects against diseases by identifying and destroying pathogens and tumor cells. It can detect many different types of invaders—from viruses to parasitic worms—while distinguishing them from its own healthy cells and tissues. This identification and detection is ever changing as pathogens rapidly change and adapt to the host in a way that circumvents many immune responses. Multiple complex mechanisms and pathways have developed in order for our immune system to react and adapt to the surrounding environment while maintaining life and health (see Figure 1).¹

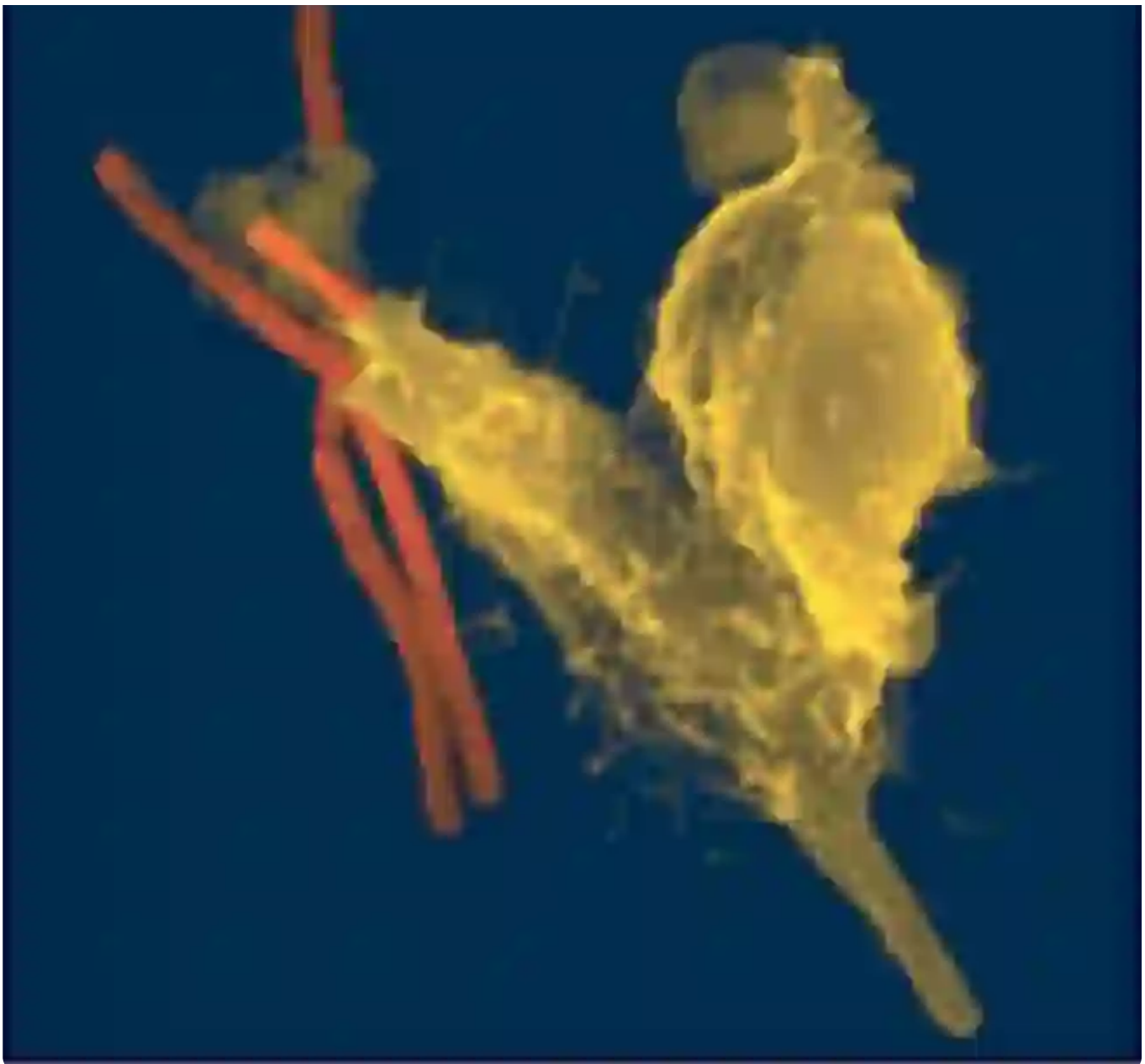


Figure 1. Neutrophil engulfing anthrax bacteria; micrograph was taken by Volker Brinkmann with a Leo 1550 scanning electron microscope; scale bar is 5 micrometers. (source: PLoS Pathogens. Nov 2005. 1(3) from www.wikipedia.org)

Studies of Laser Effects on the Immune System

Kut'ko et al² performed a study that looked at the influence of endovascular laser therapy and of antioxidants on clinical immunological indices and energy metabolism. This was analyzed in 148 schizophrenic patients including 86 patients with shift-like prodromal (first group) and 62 patients with continuous-prodromal (second group) forms of the disease. Positive trends in psychosis course were observed in 57% of cases in the first group and in 41.9% of patients of the second group. Pronounced

improvement of the immunological indices was observed in patients with positive clinical dynamics: decreased peripheral blood immunocytes sensitization to the brain, hepatic, thymus tissue antigens, as well as ATP elevation which was evidence of the improvement of energy metabolism.

Ganju et al³ performed a study that analyzed the effect of laser on immune response in rats. A group of rats were exposed to 0.225 mJ/cm² for 90 min for three days in specially designed fiberglass chambers. The whole body exposure of rats to He-Ne laser modulated both the humoral and cellular responses to tetanus toxoid stimulation. Plain red light used as a control for red laser light showed an appreciable degree of response as compared to the control groups, but not to the extent of the response to laser. Non-responders turned responders after exposure to laser. There was no response in unimmunized groups when exposed to laser and red light alone. The early and heightened immune response and proliferation of lymphocytes after exposure to laser is suggestive of a complex interaction at the cellular immune response level.

Fujiaki et al⁴ conducted a study to examine the effects of low-level laser therapy (LLLT) on production of reactive oxygen (ROS) species by human neutrophils. LLLT is an effective therapeutic modality for inflammatory conditions. An infrared diode laser (GaAlAs), 830-nm continuous wave (150 mW/cm²) was used for treatment. After irradiation, ROS production by neutrophils was measured using luminol-dependent chemiluminescence (LmCL) and expression of CD11b and CD16 on neutrophil surface was measured by flow cytometry. The LmCL response of neutrophils was reduced by laser irradiation at 60 minutes prior to the stimulation with opsonized zymosan and calcium ionophore. The attenuating effect of LLLT was larger in neutrophils of smokers than non-smokers, while the amount of produced ROS was larger in neutrophils of smokers. Expression of CD11b and CD16 on neutrophil surface was not affected by LLLT. The results indicate that attenuation of ROS production by neutrophils may play a role in the effects of LLLT in the treatment of inflammatory tissues. There is a possible utility of LLLT to improve wound healing in smokers.

Takaduma⁵ reports that both visible and infrared light have been shown to act on immune system cells in a number of ways, activating the irradiated cells to a higher level of activity. Infrared laser therapy has been shown to increase both the phagocytic and chemotactic activity of human leukocytes in vitro. This is an example of

photobiological activation. Photobiological cell-specific destruction is possible by using doses of low incident laser energy on cells which have been photosensitized for the wavelength of the laser—such as in photodynamic therapy (PDT) for superficial cancers. Laser therapy has also been shown to act directly and selectively on the autoimmune system, restoring immuno-competence to cells.

Kolarova⁶ reported that doses of 5–10 J/cm² induced a significant increase in phagocytic activity of leukocytes in vitro.

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Duan⁷ has demonstrated a respiratory burst in bovine neutrophils after HeNe irradiation.

Schindal et al⁸ described an experiment on the immune modulating effect of a HeNe laser on e. coli endotoxin pre-immunized rabbits. The influence of transcutaneously-applied low-power laser light on differential blood count and rectal temperature. After three initial immunizations, animals were either given a booster with 5mg/kg of endotoxin or with pyrogen-free saline solution. Both groups underwent laser irradiation with two different wavelengths of red laser and a sham application. The lymphocyte values were considerably higher and the neutrophils were significantly lower in the laser treated group 23 to 24 hours post treatment. The differential blood counts returned to normal levels in the boosted rabbits and continued to rise in the non-boosted rabbits post laser irradiation. Rectal temperature increased after laser treatment, especially in the non-boosted animals. The results indicate that a single dose of low power laser irradiation can modulate immune responses depending on the immunological status of the organism.

Inoue et al⁹ studied the effect of 830 nm laser on tuberculin reactions in vivo. Laser was shown to suppress this well-known immunological test for the evaluation of cellular immunity.

Funk et al¹⁰ performed a study demonstrating that He Ne laser increases cytokine production in human peripheral blood mononuclear cells in vitro.

Katsuyama et al¹¹ performed a study that demonstrated a suppressive effect of diode laser irradiation on picryl contact sensitivity in a rat model. The thickness of the right ear was used as an indicator to various doses of 830 nm laser irradiation. Laser therapy suppressed the cutaneous inflammation due to picryl contact sensitivity in an exposure–time dependant manner. This suppressive effect was restricted to within the radiation site. Remote irradiation to the proximal portion of the tail had no effect.

Yu et al¹² performed a study in which they used an argon pumped dye laser at a wavelength of 630 nm to determine the effects of laser therapy on the immune system. Rats with experimentally-induced sepsis via cecal ligation received laser therapy at 5 J/cm². At sixty days, the survival rate was 79% for the laser group and 42% for the control group. Ex vivo lymphocyte proliferation was 180 in the laser group and 130 in the control group. Enhanced ATP synthesis was observed in the laser group.

Mikhailov et al¹³ performed a study on patients with Hashimoto's thyroiditis. Forty two patients were treated with 10 applications of 2.4 J/cm² via an 890nm laser and targeted the thymus projection zone, vascular junction, and the thyroid gland. A control group of similar size was given L-thyroxin, 100 mg/day. All laser-treated patients experienced a decrease in the feeling of squeezing in the area around the thyroid and a decrease in facial edema. The thyroid gland became softer on palpation and smaller on ultrasound examination. There was also a decreased number of patients that caught winter colds in the laser group. The immunoregulatory index (Th/Ts) normalized from 7.5 to 4.2%. The laser effects were still noticeable in 78% of the laser patients four months after treatment. This index was only slightly changed in the control group.

Summary

We can see from the above studies that many significant immune modulating effects have been observed in response to therapeutic laser. Figure 2 illustrates that immune activation is one of many biochemical responses observed with therapeutic laser.

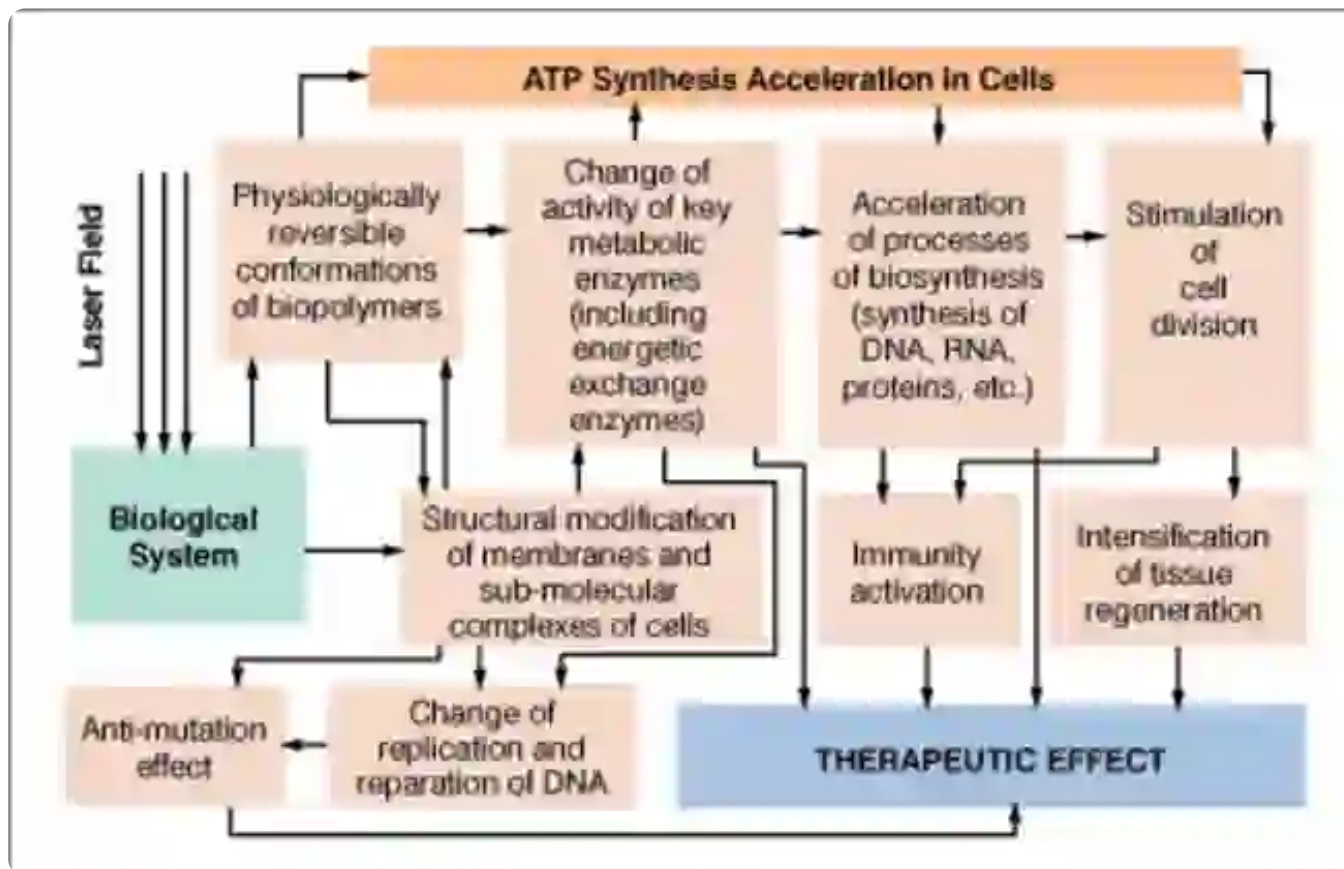


Figure 2. Flowchart of some of the most commonly observed biochemical effects of therapeutic lasers (courtesy MedicalQuant).

Laser therapy can provide a boost to aid in immunological adaptation and stimulate immune responses. A secondary benefit of treating various ailments with therapeutic laser is that each patient's immune system is also being stimulated due to the global effects that occur coincidentally with laser therapy. We can further target our treatment protocols toward the immune system by stimulating the lymph nodes or spleen, for example, to amplify the effect on the immune system. Therapeutic laser can be a safe, effective immunomodulator that can be applied to patients of all ages with a wide variety of clinical conditions.

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