

Laser Biostimulation with Image Guidance for Patients with Arthritis, Rheumatoid Arthritis and Other Related Diseases

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Laser Biostimulation

Laser biostimulation has been found effective in treatment of wound healing and inflammatory conditions. The nature and characteristics of laser light is different from natural light and of conventional light sources. Specifics of the laser include spectral coherence, temporal coherence and spatial coherence [1,2]. In addition, some lasers emit polarized photons and parallel beam. Laser with the power over 5 W has cutting and coagulating effects. Low Level Laser with the power of 5-50 mW may have photochemical as oppose to burning effects: biostimulation [3-5].

Wound Healing

Wound-healing and anti-inflammatory effects observed on superficial skin areas can be reproduced in deeper structures, e.g., musculoskeletal structures. The biological effect of the emitted laser photon is decreasing as the light penetrates to the deeper level of muscles, tendons and synovial structures. Photons reaching the deeper tissue have a direct effect. Those photons absorbed in superficial structures before reaching the deeper tissue may produce stimulatory effects on the overlaying tissue [6,7].

Laser absorption in the tissue depends primarily on the wavelength of the light. The near infrared lasers (780-1500 nm) have optimal absorption characteristics. These lasers have a 4 mm distance for a 50% loss of light intensity as opposed to 2 mm distance using lasers in the visible red light wavelength. In order to have an effective light intensity in deeper tissue levels higher photon density has to be exposed on the skin surface. For example, in order the expose deeper tissue at level of 2-3 cm the laser power on the skin surface has to be 500 mW [8,9].

Imaging

MRI and ultrasonographic imaging help to identify the area and depth of maximal inflammation. This way the appropriate power and direction of the laser treatment can be identified.

If required photon density is not enough to reach a deeper structure either slight compression of soft tissues can decrease the tissue thickness or multiple laser diodes have to be used. In case of multiple diode clusters light scattering results deeper penetration. Another method to increase the penetration depth is a second level (kHz) of pulsed laser, while so called continuous wave laser itself has inherent THz pulsation by temporal coherence.

Third solution of higher light intensity in the target volume is the multi-gate technique: from different angles the same joint can be reached based on imaging findings [10-12].

Irradiation Doses

Power density is the first requirement to reach anti-inflammatory effect in the musculoskeletal system. Absorbed energy is the second requirement: 1-4 Joule/cm² are the effective doses at level of target volume. Higher photon density results of course faster treatment time. Doses in many papers are not used properly unfortunately; they don't use any planning, any calculation of penetration depth. Pseudo-negative results of such application failures have unfortunately disavowed misleading information. If imaging based therapy-planning would have been used in scientific papers; all studies could prove positive results.

Imaging helps more, than simple depth measurement and inflammation localization. Pain often doesn't correspond to real disease localization. If laser treatment was only based on painful locations often the target volume is not reached or not optimally reached. Imaging helps to find subclinical inflammations, where additional treatment is required as well [12,13].

Inflammation Reduction

Inflammation reduction resulted by direct laser beam is not the only effect. Indirect effects on immune system have experimental and clinical evidences as well. Polypeptides secreted by macrophages and lymphocytes result additional systemic effects, which are only measured in patients who don't get steroid therapy. Laser has evidence based positive effects on both microcirculation and on lymphatic vessels. These are important effects if decreased drainage occurs in arthritis and in Sudeck syndrome [14,15].

Other indirect effect is the direct pain reduction by different sensitivity of pain responsible C-fibers versus nociceptor A-fibers (see spinal gate control). Furthermore experimental data show increased levels of anti-inflammatory prostaglandins.

Additional observations show local muscle relaxant effects in the irradiated area, which promotes functional mobility.

Advantages of laser arthritis treatment are: neither side effects nor complications occur-as with drug therapies and with biological therapies unfortunately these can happen. Laser treatment has no negative influence on any other drug therapy of physical therapy forms, but excellent synergistic effects with all conventional modalities. Laser light can be used in combination: prior, after or during other physical therapy and rehabilitation activity forms. Numerous publications show positive correlation of combined laser and exercise in combination [16,17].

Conclusion

FDA approved laser biostimulation promotes wound and arthritis repair, regenerative biological functions and increases anti-inflammatory cellular and cell-mediated activities, if proper doses and proper techniques are used. Imaging helps more effective laser applications [18].

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