Laser Therapy for Pain – When, Why, and How to Do it Safely

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The expanding emphasis on pain control in animals is embracing non-drug therapies. Popular approaches span the spectrum of physics, imparting analgesia through various means, be they the nerve stimulation of electrical impulses, the jiggling of cells through ultrasound[1], the stretching of tissue through massage, or the gentle caresses of the neuromatrix through acupuncture. Alternatively, low level laser therapy (LLLT) works through mechanisms which for decades remained mysterious, coming to light only recently.[2]

LLLT devices typically emit either infrared gallium-arsenide-aluminum (GaAsAl) or red-beamed helium-neon (HeNe) light.[3] The radiation dose delivered arises as a product of the device's power (P) multiplied by exposure time (T), divided by treatment area (A), or D=(PT)/A. Hair and skin pigmentation affect absorption, but the clinical impact remains unclear.

Evidence supports LLLT for patients suffering from back pain, myofascial pain syndrome, osteoarthritis, rheumatoid arthritis, and even radiation-induced mucositis in patients with cancer of the head and neck.[4] [5] [6] [7] [8] [9] [10] [11] [12] Its anti-inflammatory attrributes relate at least in part to reductions in PGE_2 concentrations. PGE_2, generated through the arachidonic acid pathway, increases the sensitivity of nociceptors during inflammation; the counteracting effects of LLLT therefore inhibit this sensitization.[13] Furthermore, LLLT produces dose-dependent reduction in tumor necrosis factor (TNFα) in acute inflammatory states.[14]

Not all evidence supports LLLT, but contradictory findings may be due to insufficient laser power, time exposure, or improper selection of sham controls.[15] [16] A 2007 study on LLLT for zymosan-induced arthritis in rats found length of illumination time a more critical factor than the power density or milliwattage.[17] As with acupuncture controls, when "sham" laser locations overlap in a spinal segmental fashion with "real" locations, the neuromodulatory outcomes may similarly overlap. Fortunately, the World Association of Laser Therapy published a consensus agreement aimed to improve the consistency of methodology and better evaluate outcomes.[18]

After decades of searching, studies are now exposing the mechanisms of LLLT at new depths. An intriguing report, hot off the press from Chow et al in the *Journal of the Peripheral Nervous System*, illuminates novel means by which LLLT blocks pain. In short, as with acupuncture, LLLT invokes neuromodulation.[19] Previous studies indicated that laser suppressed nerve conduction in nociceptive fibers and caused a variety of neurotransmitter effects such as increased serotonin, beta-endorphin, and acetylcholinesterase activity. The difference is that this paper links laser's effects on mitochondria to nerve transmission. They irradiated cultured dorsal root ganglia neurons with an 830 nm laser, dosed at levels previously recognized as clinically beneficial in humans. They focused their attention on neural

elements most critically dependent on mitochondrial function and ATP generation in order to evaluate whether a connection existed between mitochondria and nerve inhibition. Their search led to three functionally interdependent facets of nerve function and action potential propagation: microtubule arrays, fast axonal flow (FAF), and mitochondrial membrane potential (MMP). Previous work done elsewhere showed that photoacceptors in mitochondrial membranes absorbed laser light and transduced laser energy into electrochemical changes. Cytochrome c oxidase and possibly other photoacceptors within neuronal mitrochondrial membranes constitute the primary acceptor sites for 830 nm laser energy absorption. Chow et al asked whether 830 nm laser affected mitochondrial activities and nerve function particularly in nociceptors and if so, how.

They found that laser blocked both FAF and mitochondrial migration along the axon. The most notable architectural change appeared as varicosity formations, indicating microtubule disruption. Microtubules ferry high-energy mitochondria by FAF and thereby provide ATP for the generation, maintenance, and restoration of axon potential capability. Disrupting microtubules interrupts ATP supply and impairs delivery of contents held within synaptic vesicles. In other words, laser irradiation selectively blocks the stuff of neurotransmission in nociceptor fibers. Analogously, the anti-gout drug colchicine reversibly destabilizes microtubules, as do the local anesthetics lidocaine and procaine, based on ultrastructural investigations. In short, this study showed, for the first time, a direct mechanism by which LLLT produces analgesia, involving nociceptor-specific inhibition in the peripheral nervous system. In contrast to drugs, however, LLLT appears to produce few known adverse effects, as long as practitioners follow standard safety precautions when treating patients.

Safety with Low Level Laser Therapy (LLLT)

Paying attention to LLLT precautions and contraindications keeps practitioners and patients safe. First and foremost, LLLT providers and, if possible, patients, should wear laser-protective glasses or goggles. Practically everyone knows that looking directly at the sun can be dangerous. Laser beams, even those from an LLLT device, can similarly cause ocular damage when reaching the retina.[20] As stated by G. David Baxter, author of *Therapeutic Lasers – Theory and Practice* [1994; Churchill Livingstone, p. 57], "The use of laser-protective goggles by therapist and patient is so widely recommended and well established that most manufacturers now include two pairs of goggles in the cost of their unit." Baxter continues, "[Goggles for use with a given system…must be designed to filter the wavelength(s) emitted by that particular apparatus. If not, unwitting but inappropriate use of the goggles by operators and patients may be more dangerous than their non-use, as they may provide a false sense of security." In addition, LLLT should take place in a controlled area with minimal access to avoid inadvertent exposure to passersby. One should remain vigilant about avoiding laser reflection from mirrored surfaces.

Baxter lists as absolute contraindications to LLLT the following three conditions: direct treatment of the eye, cancer, hemorrhage, and a pregnant uterus. Relative contraindications include treatment over open epiphyses, autonomic ganglia, the heart, reproductive organs, infected tissue, photosensitive skin or tissue, and in patients with impaired sensation or responsiveness.

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