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Laser Therapy: Understanding a New Chiropractic Modality, Part I

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By Daniel Knapp, DC, ACRB II

The use of lasers for stimulating living tissues has a history of more than 40 years. Yet, this modality is underutilized in chiropractic largely because of a lack of exposure or inadequate understanding of the physics and physiology of photon-tissue interaction. This article will help improve the knowledge base of the field practitioner in laser use in the healing process and address conditions commonly encountered by DCs.

Doctors of chiropractic are not alone in the rising interest in laser. At the recent North American Association for Laser Therapy 10th annual conference, presenters included DCs, MDs, PhDs, DPTs, LACs and DMVs—from those in private practice to representatives of the Mayo Clinic. Papers ranged from "Response of Neurons to Light Irradiation in an In Vitro Diabetic Model" to "Can Low-Level Laser Therapy Aid in Acute Spinal Cord Injury in the Dog?" The peer-reviewed journal *Photomedicine and Laser Surgery* alone has published 2,170 papers to date, with a majority on laser therapy. All health care fields are looking for new safe and effective modalities to combat rising costs and comply with outcome-based care guidelines.

What Is Laser?
LASER is an acronym for "light amplification by stimulated emission of radiation." This theory was introduced by Einstein in 1917. Theodore Maiman of the Hughs Research Laboratory announced the first working laser in the 1960 publication *Physical Review Letters*. For medical purposes, laser was first used in 1963 to coagulate retinal lesions.[1] The first use of low-power laser to stimulate healing is credited to Dr. Endre Mester of Semmelweis University in Budapest, Hungary, for his wound-healing studies on mice in 1967.

Just like the sun, conventional light or X-ray, laser is another source of electromagnetic radiation—a wide range of wave particles. These particles or energy packets, known as photons, have defined wavelengths. These characteristics determine the strength and application of the radiation, or the transfer of energy. Photons can then be absorbed, reflected or refracted, depending on the property of the medium the incident beam is striking. There will also be a scattering once inside the body, based on tissue optical properties and fiber orientation such as fat plane lines, muscle fibers and fascial bundles.

The monochromatic photon effect on tissues is described in terms of photobiomodulation or photobiostimulation, which can apply to non-coherent light-emitting diodes (LEDs) or to coherent laser. The Grotthus-Draper law states that light must be absorbed to stimulate a chemical reaction. The Stark-Einstein law states that each molecule will absorb one photon and become activated with the equivalent amount of energy to drive a chemical reaction.

The reaction most commonly found in laser literature is the production of adenosine triphosphate (ATP).[2,3] We remember from Guyton's *Textbook of Medical Physiology* the importance of ATP as the primary energy source to drive cell processes for homeostasis—such as improving cell division and migration, improving intracellular and extracellular active transport of regulatory proteins, or driving ion pumps to facilitate concentration gradients.[4] An exciting and new understanding of ATP stretches beyond intracellular properties to include endocrine cellular signaling, which emphasizes the importance of how increasing mitochondrial production of ATP can have beneficial effects on pain and healing.[5]

Clinical Use of Laser
Adding laser can allow the practitioner to enhance the patient's altered physiology in multiple ways:

> Pain reduction or even potential nerve regeneration can occur through altering nerve membrane potentials and reducing inflammatory cytokines, which can be influential in pain management by reducing the heightened nociceptive load.[6-8]
>
> Muscle soreness can be decreased, potentially allowing more comfortable adjustments and a faster return to activity.[9]
>
> Edema reduction may also be achieved by a variety of mechanisms.[10]

The list of conditions with indications for laser therapy, supported by peer-reviewed literature, is quite extensive. Low-back pain; acute, chronic and multi-factorial cervical pain; peripheral nerve injuries and radiculopathies; myofascial pain; TMJ syndrome; shoulder tendinopathy; frozen shoulder; knee degenerative arthritis; rheumatoid arthritis; carpal tunnel syndrome; Achilles tendinitis and plantar fasciitis are common examples. Patients often see immediate range of motion increases and pain reductions. Spinal corrections can be achieved with greater ease. Rehabilitation goals can usually be met more quickly, allowing patients the potential of less work-time loss and a faster return to activities of daily living.[11-21]

Laser therapy has also been shown ineffective or unsupported in some of the same conditions.[22, 23] Care must be taken in placing credibility on a single study. Doses are often not reported or incorrectly calculated, leading to inaccurate conclusions. A recent paper reported that up to 30 percent of published laser phototherapy papers lack relevant information to determine dosage or the doses have been calculated incorrectly.[24]

Laser Characteristics
Wavelength
The wavelength will be a fixed property of the laser. Most therapeutic lasers are in the 630 nm to 980 nm ranges of the electromagnetic spectrum. This is commonly known as the therapeutic window, where the least energy is absorbed by surface tissue. This range encompasses the red visual and near infrared non-visible wavelengths.

It is generally accepted that the 750 nm to 1000 nm infrared wavelengths are more effective for the deeper lying structures, while the lasers in the 530 nm to 650 nm visual ranges can be a better choice for wound healing. Clinical improvements have been shown in a multitude of conditions with either of these ranges, but the physics of lasers suggest which are optimal.

Remember that wavelength and pulse frequency are not the same. The wavelength is made up of a crest and a trough. It is defined by the distance from peak to peak and is inversely proportional to frequency. Radio waves have wavelengths greater than 1 meter, microwaves between 1 mm and 1 meter and infrared light is between 700 nm and 1 mm. Therapeutic lasers are measured in the nanometer ranges, 800 nm for example. Visual light is between 400 nm and 700 nm.

Pulse frequency
Frequency is a time unit of wavelength separation. The higher the frequency, the closer the waves and the greater the energy. When wavelengths shorten energy increases. This is why X-rays can be damaging and light healing. Laser therapy wavelengths are longer, with less energy than the shorter UV, X-ray and gamma wavelengths, where ionization becomes more hazardous.

Wattage
The minimum and maximum watts (W) generated are important considerations. The device will also be continuous wave (CW), pulsed, variable pulsed or superpulsed, or will allow combinations of all. Continuous wave is self-explanatory. Pulse frequencies are measured in Hz. An example would be a frequency modulation of 10 Hz means the beam is turned on/off 10 times a second. Superpulsing is the building up of higher energy bursts by the laser with short consistent spacing which can be pulse per second to billionths of a second.

Choosing a Laser
When choosing a laser to purchase, it is advisable to choose three or four manufacturers of variable powers, wavelengths and prices, and then ask for in-office demonstrations. This will allow the doctor to experience the ease of operation and get a feel for the clinical impact of each laser. I recommend scheduling four to eight cases of varying body regions and duration of complaints. Obtain informed consent from the patients, and offer treatments at no charge. A different laser company can be scheduled each week. This is an important decision, not to be rushed. Clinical results and budget will guide you.

Inadequate or inappropriate settings will be met with no impact or even a worsening of the symptoms. These can only be given to you by the training representative—preferably, another physician—or another doctor familiar with the laser you have purchased.

Next month: Classes of laser and how laser therapy works

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USEFUL DEFINITIONS:
LASER: light amplification by stimulated emission of radiation
PHOTOBIOMODULATION: use of LASER or LEDs to stimulate or inhibit cell function
WAVELENTH: distance from peak to peak, measured in nm, inherent to laser medium, e.g., GaAlAs
MONOCHROMATIC: narrow wavelength emission, based on lasing medium, e.g., 800 nm
COHERENT: identical waves traveling in common phase and direction, unique to laser
GROTTHUS-DRAPER LAW: light must be absorbed to create a chemical reaction
STARK-EINSTEIN LAW: each molecule will absorb one photon and become activated with the equivalent amount of energy to drive a chemical reaction
CW: continuous wave
PULSED WAVE: on/off timing of a laser beam, measured in Hz, e.g., 2 Hz
POWER = rate of flow in watts, or energy/time, or W/sec.
POWER DENSITY = amount of power delivered per unit area in cm2, W/cm2
JOULE =1 W per second (when in CW mode)
ENERGY DENSITY = DOSE (FLUENCE) = J/cm2 per spot or point treated; multiple points may be treated in a single session
TOTAL JOULES = amount of energy utilized for the entire treatment time
AVERAGE J/cm2 = total J/total treatment area

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