TREATMENT PLAN
Laser therapy is an emerging technique that can potentially be incorporated into treatment plans for wound healing, pain management, and rehabilitation for various conditions.

INTEGRATIVE MEDICINE

Laser Therapy: Fact or Fancy?

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THE SCIENCE OF LASER THERAPY: PHOTOBIOMODULATION

Laser therapy is the result of electromagnetic energy interacting chemically and biologically with tissue, causing "photobiomodulation." Electromagnetic energy affecting biologic processes is not a novel concept—it fills our environment as photosynthesis occurs in plants and literally surrounds us as vitamin D is formed in our skin cells.

Lasers produce a single wavelength (monochromatic) beam of light, which is collimated as it is generated. Laser light has the property of being coherent, or in phase, which in simple terms means it is uniform and very orderly light. Laser therapy uses a simple beam of light—monochromatic, coherent, collimated light—to penetrate deeply into tissues and produce positive tissue changes.

Laser therapy has had many contradictory and confusing names. The terms cold laser therapy, low-level laser therapy, class III laser therapy, and class IV laser therapy have all been used. Unfortunately, these terms describe the devices being used rather than the effect they have on tissue. Terminology based on the tissue effect is more descriptive and accurate.

The term most descriptive of the complex mechanisms and the cascade of physiologic events that follow laser therapy is *photobiomodulation*. Photobiomodulation describes the way photons interact with target tissues. It accurately describes a nonthermal interaction within the tissue, dependent on endogenous chromophores that absorb the energy in photons and elicit photophysical and photochemical events.

THE RESULTS OF PHOTOBIOMODULATION

The effects of photobiomodulation are a result of photons—packets of electromagnetic energy—interacting with cells.

In the clinical setting, therapy lasers that emit near infrared light are most often used. Different from LEDs (light-emitting diodes), therapeutic diode lasers emit invisible light in the 800- to 1000-nanometer (nm) range. These therapeutic wavelengths are less absorbed by water and other nontarget chromophores within the tissue and therefore achieve greater depth of penetration. They also interact with target chromophores to produce photochemical changes within the tissue.

Key to photobiomodulation is the absorption of photonic energy by chromophores within cells. The chromophore cytochrome oxidase is concentrated within mitochondria; it absorbs the energy in photons and delivers it into metabolic processes, including the Krebs cycle. This results in increased ATP production, as well as increased levels of nitric oxide and reactive oxygen species, important in cellular signaling. Metabolic activity increases, and cell growth and reproduction are accelerated.

Other complex mechanisms occur at the same time. There is an increased release of endogenous opioids; beta-endorphin levels rise. There is a direct effect on nerve tissue producing suppression of nociceptors and an increase in stimulation threshold. Neuron impulses are reduced, reducing pain. Researchers describe a "neural blockade" that results from the slowing of mitochondrial transport along axonal fibers.

A marked and rapid effect on inflammation is due to modulation of chemical mediators, with a decreased release of proinflammatory substances such as prostaglandins. A transient vasodilation results in increased circulation and oxygenation of the tissue. In addition, there is a similar effect on lymph vessels, activating the lymph drainage system and reducing edema.

Significant stimulatory effects on the healing process are induced. As with the anti-inflammatory effect, chemical mediators are involved, with an increased release of pro-healing cytokines such as transforming growth factor and platelet-derived growth factor. Angiogenesis is stimulated, fibroblast replication and migration increase, collagen production increases, and wound contraction is accelerated by the conversion of fibroblasts into myofibroblasts.

There is a similar stimulatory effect on bone healing. Angiogenesis is stimulated at the fracture site, accompanied by an elevation of osteogenic factors in the damaged tissue, resulting in accelerated development of new bone and faster fracture healing.

LASERS FOR PHOTOBIOMODULATION

Regulatory agencies classify lasers based on their ability to do harm if used improperly. Different agencies use somewhat different systems, but in general, lasers are classed into 1 of 4 broad hazard classes (I, II, III, IV) depending on their potential for causing biologic damage. Classification is based on wavelength, power, and exposure time.

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Therapy lasers, like most medical lasers, are usually class III or class IV. Class III therapy lasers have a maximum power of 500 mW (0.5 W). Class IV therapy lasers are those over 500 mW in power.

Class III therapy lasers are applicable for treatment of superficial lesions and wounds. These lasers can be used for treatment of deeper tissue and musculoskeletal conditions, but due to their lower power level, longer treatment times are needed to achieve effective target doses.

Class IV therapy lasers are usually diode lasers emitting light in the 800- to 1000-nm wavelength range. The longer wavelengths in this spectrum have the deepest tissue penetration and produce excellent photobiomodulation. With these devices, effective treatments can be delivered in an acceptable amount of time, even when treating deep tissue conditions in large patients.

TREATING ANIMALS WITH LASER THERAPY

Incorporation of laser therapy into routine pain control protocols is appropriate. As an adjunct to medical protocols, laser therapy is helpful after surgery and dental procedures. Most postprocedure patients require a single treatment immediately after the procedure. Examples are patients undergoing elective surgeries, minor dental procedures, and closure of minor wounds. Postprocedure patients with more extensive tissue disruption should receive additional treatments (2 to 6) daily or every other day.

Patients with a wide variety of acute problems benefit from laser therapy. Acute conditions are treated once or multiple times, until resolution of the condition. Patients with acute conditions that include pain, inflammation, a healing process, or a combination of any of these are candidates for laser therapy.

Chronic conditions involving pain, inflammation, and healing may also be helped, although the treatments have to extend over a longer time and are frequently followed by ongoing treatments to maintain effect. Patients with chronic conditions that include pain, inflammation, a healing process, or a combination of any of these are candidates for laser therapy.

Successful treatment design for chronic conditions follows accurate diagnosis and assessment of chronicity. Practitioners must avoid having a "one-size-fits-all" treatment design for chronic condition patients. Patients with chronic conditions are treated in 3 phases: induction, transition, and maintenance. Evaluation of an acceptable response to treatment depends on the patient signalment, the condition, and the expectations of the clinician and the owner.

Eye protection is critical when using class IIIB or class IV therapeutic lasers. All persons in the treatment area should wear appropriate safety glasses and pay strict attention to avoiding direct exposure of their eyes.

EVIDENCE-BASED DATA

When first introduced to laser therapy, most veterinarians ask for evidence-based data. Initially, much of the knowledge practitioners had about laser therapy was experience-based information shared within the profession. Now veterinarians can find supporting evidence-based data in peer-reviewed publications and scientific literature. The results of in vitro and in vivo studies and clinical trials are readily available in publications like *Lasers in Surgery and Medicine*; *Photobiomodulation, Photomedicine*, and *Laser Surgery; Journal of Photochemistry and Photobiology B: Biology; Journal of Clinical Laser Medicine & Surgery*; and *Lasers in Medical Science*.

HEALING WITHOUT HARM

Virtually any medical laser has potential to do damage if used improperly. Proper training about a device, and how to use it safely, gives practitioners and staff the confidence that patients can be treated without harm.

In 2011, the American National Standards Institute revised guidelines for the safe use of lasers in healthcare. *ANSI Z136.3 – 2011 Safe Use of Lasers in Health Care* is the foundation of laser safety in veterinary medicine. Practices are encouraged to be familiar with ANSI Z136.3 and to have a designated, trained, and certified laser safety officer responsible for their laser safety program.

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The eyes of patients should also be protected with safety glasses (clients love this) or goggles made specifically for animals, or by covering their eyes with a dark cloth, a hand, or any material that the patient will tolerate. Some patients will not tolerate any covering of the eyes. For these patients, sedation is recommended, or if the patient is still and not moving, treatment can be administered with the therapist instantly ready to divert the laser beam in a safe direction if the patient moves.

CONTRAINDICATIONS

For over 40 years, a list of contraindications has accumulated and been passed down, often repeated in publications and in device manuals, without consideration of whether it is valid. Currently, the one absolute contraindication is exposure of the retina by a direct or reflected beam transmitted through the pupil. Scattered photons reaching the retina through adjacent tissue treatment are not the concern; penetration through the pupil is.

Since there is no knowledge about how different wavelengths of light interact chemically with medications, and one does not want to alter the rate of absorption of medications, do not treat over areas into

which medication or vaccines have been injected. Apply laser therapy to tissue before injecting; then, do not treat the area again until the injection has been absorbed.

It is contraindicated to treat over a malignancy, or the surgical site from which a malignancy has been removed. There is contradictory data from the laboratory indicating that some malignant cell lines are stimulated, some are inhibited, and photobiomodulation has no effect on others. There is no contraindication for treating a site distant to a malignancy, and it is valid to treat areas of malignancy, with informed owner consent, for pain management in hospice care.

Historically, treating over a gravid uterus has been contraindicated. This was based on studies done decades ago in which chicken embryos showed cellular changes when exposed to high doses of visible red light through an eggshell window. This has no practical application to the clinical treatment of patients. Near infrared light is neither mutagenic nor teratogenic, and an embryo or fetus within a gravid uterus is well protected from photons that are readily absorbed by multiple layers of chromophores in the surrounding tissues.

Do not treat areas of active hemorrhage since a transient vasodilation is induced. Once hemorrhage has stopped, laser therapy will not reactivate the hemorrhage.

Treatment over active epiphyses, the testicles, or the thyroid glands all require similar consideration. Treatment with high doses for a prolonged time has been demonstrated to produce change in these tissues. However, negative effects are not reported with lower dose treatment over shorter periods.

Several historical contraindications are false. Treatment over areas of hyperpigmentation and over tattoos is safe with appropriate monitoring of skin temperature and delivery technique.

Treatment over implants is safe and indicated. Near infrared photons have no effect on metal implants. Photobiomodulation improves the health of the soft tissue around implants, contributing to implant success. Do exercise care when treating over very superficial metal implants because of the very small amount of overlying soft tissue.

Finally, the historical contraindication of treating patients on photosensitizing medications is invalid. In

Do not treat areas of active hemorrhage since a transient vasodilation is induced.

2014, a review of publications over the last 40 years found photosensitization and laser therapy linked only 4 times and no adverse effects ever reported. TVP

Suggested Readings

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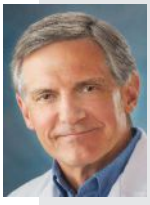

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Dr. Godbold graduated from Auburn University School of Veterinary Medicine in 1978. In 1980, he established Stonehaven Park Veterinary Hospital in Jackson, Tennessee, where he practiced full time for 33 years while developing a special interest in laser surgery and laser therapy. Dr. Godbold now works with Stonehaven Veterinary Consulting, generating and delivering educational content for colleagues and assisting equipment manufacturers with the development of new laser and light-based technologies. He is co-editor and a chapter contributor of the 2017 textbook *Laser Therapy in Veterinary Medicine: Photobiomodulation*.