Mark Silverman DVM, MS

Sporthorse Veterinary Services

Light has long been recognized as being crucial to normal human function and health. Our ability to remain alert and active, along with some of the biochemical processes essential to health, are tied to receiving adequate amounts of light throughout our day. Only recently have we been able to manipulate light in such a fashion as to maximize the beneficial effects of this powerful energy source while avoiding potentially harmful side effects.

LASER, **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation, is the optical amplification of electromagnetic radiation. The light produced by a LASER has several special qualities separating it from the more mundane stuff produced by your common flashlight. Laser light is collimated (photons or waves are traveling in parallel) narrow spectrum, coherent and polarized light. Basically this means that LASER light is highly organized with each photon of light traveling parallel to its fellow photons, and these photons can be produced at a single wavelength or 'color'. These monochromatic photons can be manipulated to produce a beam that travels in a tightly packed linear fashion. Complicated as it sounds, the ability to produce LASER light allows us to produce devices with the ability to optimize the therapeutic ability of light, allowing for targeting of specific tissue effects quickly, while avoiding potential side effects.

We encounter lasers regularly in our daily life. These LASERs are arranged in a series of classifications separating them based on their function and potential harmful biological risk factors. The lowest category of LASERs, class 1 and 1M, has no risk of biological hazard, though they are not intended for direct viewing. The laser scanner that you might notice at your grocery store falls into this category. Class 2 and 2M LASERs have a maximum power output of 1.0 milliwatt of visible light and while not intended for direct viewing, their brightness would

make direct viewing uncomfortable and therefore self-protective. It is assumed that we are intelligent enough to not stare directly at the Sun for example. (No, the Sun is not a LASER). The 3A and 3R, are a bit more powerful, though usually no more than 5 milliwatts, and would be dangerous for intra-beam viewing. This class would include the LASER pointer as one example, so please don't stare into the beam of someone's LASER pointer. Another LASER device that falls into the class 3b category is the popular cold laser often seen around barns. The cold or LLLT (low level laser therapy), LASER has some limited ability to penetrate tissue and offers some level of therapeutic benefit.

The next, and final category of LASERs is the class 4. This class of LASERs is of the highest power levels. Industrial, military, scientific and medical LASERs fall into this category. The use of these LASERs requires special care and training, and they are generally not available to the public. Surgical and therapeutic LASERs fall into class 4 and this is the type of LASER that has the greatest potential for therapeutic benefit due to its ability to penetrate deeply into tissue.

Even among the class 4 LASERs there is a hierarchy. While most class 4 therapeutic LASERs still fall into the LLLT category, there is a special category within this class that provides a much higher power output to gain even greater ability to penetrate deeply into tissues. To achieve this greater depth of penetration the delivery of the electromagnetic radiation must be manipulated to avoid damaging tissues superficial to the target tissue. These LASERs are categorized as HILT or **H**igh **I**ntensity **L**ASER **T**herapy devices. HILT LASERs use special methods of energy delivery to achieve their goals and can deliver peak power output of up to 20 kilowatts. In addition, if you recall the special characteristic of LASERs to deliver monochromatic or single wavelength light, the HILT LASER operates with a wavelength of 1064 nanometers (a nanometer is one billionth of a meter). The 1064 nm wavelength becomes important when we understand that different materials absorb different wavelengths of light. The water in the cells and tissues readily absorbs shorter wavelengths used by many therapeutic LASERs. The use of 1064 nm light, which requires a more sophisticated generation technology, allows for deep tissue penetration to achieve the desired tissue effects.

Other special features of the HILT LASER are designed to optimize tissue penetration and delivery of the optimum amount of energy to the target tissue. The pulsing of the power delivery has on and off periods that allow for high intensity energy to be delivered without thermal damage to the tissue. Cooling occurs between bursts of energy. A large focal spot that is well collimated again enables the device to deliver its energy effectively. Imagine the burst of LASER light arriving as a well-defined cylinder of light, energizing the target tissue evenly. A smaller focal spot

will have more scatter of the photons and therefore a less well-defined energy delivery.

If you are not a techno-geek it would be appropriate to skip the first portion of the paper. Perhaps I should have made that point earlier? Suffice it to say that HILT LASERs are able to deliver a higher level of energy deeper into the target tissues than other forms of therapeutic LASERs.

Now that we have all of this capability, what can LASERs do for us? There are three general functions of therapeutic LASERs. These fall into the categories of pain management, reduction of inflammation and increase in healing rates and function.

LASER has a direct ability to affect nerve cells, decreasing nerve conduction of pain. An additional benefit of LASER therapy is increased production of endorphins, a naturally occurring opioid, (a drug similar to morphine), that fights pain reception in the body. Pain is also part of the inflammatory process, making it difficult to isolate the discussion of pain from that of inflammation. When a tissue has been damaged there is local increase in swelling which causes pain. LASER, through management of this swelling, decreases local pain.

Inflammation, the combination of pain, heat, redness, swelling and loss of normal function, is a biochemical process initiated by either injury or infection. LASER therapy has photochemical effects that decrease the inflammatory regulators released during injury. The LASER, increasing their function, stimulates macrophages, cells that help to clean up damaged tissue. In addition, lymphatic drainage is improved through the dilation of the lymphatic channels, carrying extravascular fluid back into the main circulation.

The final, and most interesting, category of the LASERs therapeutic function is in regard to the improvement of healing. This is an area where the HILT LASER excels. Photochemical and photo thermal effects can be achieved by both class 3 and class 4 LASERs, but the photo acoustic (photomechanical) effect is reserved for LASERs that can safely deliver high levels of energy to the tissue. The photo acoustic effect can best be appreciated as a messaging of tissue through the rapid heating and cooling of neighboring tissues due to the pulsed delivery of the LASER energy. The combination of these effects lead to dilation of the local blood vessels and the creation of new blood vessels. Improvement in local circulation allows for increased availability of growth factors, oxygen and other components required for healing that are carried by the blood. An additional effect of LASER therapy is an increase in the production of ATP, the power source for the cells. This increase in energy leads to

increased metabolic function and a more rapid return of the cells to normal function.

Fibrocytes, inactive cells that normally travel with the blood, enter into the tissue and convert to fibroblasts during injury. These fibroblasts help orchestrate the repair during acute injury, calling in needed growth factors and important repair components from the blood. HILT LASER therapy recruits greater numbers of these critical cells into action. Of particular interest is the HILT's ability to recruit fibrocytes during chronic injury. By activating fibroblast activity in a chronic injury, the HILT returns the relatively inactive sight back to an acute phase where active repair can occur, yielding improved tissue function in the process.

Let's take a tendon injury as an example. There are two main categories of tendon injury. The first, tendonitis, is an acute injury due to over stretching of a tendon and subsequent fiber damage, tearing or rupture. Tendonitis can be either from a singular event or from additive events. As a fresh injury our first step is to use the LASER, along with other supportive therapy, to minimize inflammation. Controlling the activity of inflammatory mediators and improving lymphatic function will decrease local edema and minimize the damaging effects to collagen peripheral to that which was involved in the initial injury. In addition to minimizing the progression of the injury, pain will be decreased, making the patient more comfortable. Fibrocytes in circulation will be recruited to enter the damaged tissue and morph into fibroblasts, increasing production of extracellular matrix along with stimulating production of collagen and elastin for repair of the tendon. ATP production in the cells around the injury will be stepped up by the LASER, increasing metabolic activity of these cells, helping to provide energy needed for healing. Local small vessels will dilate and new vessels will be formed to improve the flow of blood that brings the components needed to repair the damaged tendon. Heat shock proteins will become activated by the LASER and will help to manage the formation of new proteins used in the repair of the tendon, limiting formation of unwanted aggregations of proteins (scars). All of these benefits with the simple addition of some very special light.

What becomes extremely interesting is when the injury is not addressed immediately and the biochemical processes proceed unchecked. This injury, known as tendinosis, becomes more extensive, more collagen damage occurs and healing proceeds along a more haphazard course. Scar tissue, uncoordinated formation of collagen with poor alignment, is formed and the tendon enters a state of chronic injury. The repair will occur, but the end result is weaker and lass elastic than a proper repair. Long-term function is compromised and performance of the horse is negatively affected. Once the tendon has reached this chronic state, some of the mechanisms for proper repair are no longer effective.

Through the use of the HILT LASER, fibrocytes can once again become activated and recruited to enter the damaged tissue as fibroblasts. This fibroblast activity brings the injury back to a state similar to that of an acute stage of injury, allowing for proper healing to take place and for elimination of some or all of the scar tissue that had been formed. The end result can be a tendon that regains its original elasticity and function. All of this takes time and effort, but in the end a properly healed tendon will stand a better chance of coping with the rigors of competition.

HILT on its own, along with good management, can provide for excellent healing of damaged tissues by minimizing the negative effects of the injury and optimizing the bodies repair mechanisms. In addition, the HILT LASER can be used in concert with other regenerative technologies. HILT can, by controlling the inflammatory process, prepare damaged tissue allowing PRP, stem cells or even IRAP to do their work. In addition, once the regenerative therapy is applied the HILT will help with improving circulation and activating the bodies natural repair mechanisms. In the case of a chronic injury, use of HILT can bring the injury back to a stage where other regenerative therapies can be functional.

Treatment with HILT is safe and fairly simple. The system can either be used in a clinic or at your barn and is painless to the patient. Most patients don't require sedation or any form of restraint other than a good handler. In most cases the effected area will need to be clipped and a water-based gel applied prior to treatment. In an acute injury we may elect to treat for a week or more with only the anti-inflammatory settings in a non-contact mode. Once the initial inflammation has settled, we will proceed with the full three phases of therapy. The first phase is a non-contact phase and is considered a rebalancing or cleaning phase, providing a good environment for healing. The second phase is a contact phase and is considered the regeneration or seeding phase. Phase two is where the photo-acoustic action is in play. The third and final phase is again non-contact and is considered the rehabilitative or feeding phase. Once past the initial anti-inflammatory stage of treatment, all three phases are applied each day. The patient is treated 3 days a week for approximately 10 weeks. HILT has been used in the treatment of injuries to tendons, ligaments, bone and even cartilage. The ultimate goal for HILT, as for all is to return tissue to normal function through the use of a safe and non-invasive therapy.

Sporthorse Veterinary Services 1288 Calle Maria San Marcos, CA 92069

760/798-4850 hoofdoc@mac.com