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Laser Therapy in Equine Rehabilitation

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Introduction

LASER is an acronym for light amplification by stimulated emission of radiation (Wikipedia, 2024a). A laser is a device that produces light that is coherent, collimated (parallel), and monochromatic (Wikipedia, 2024a). Lasers may be used in a wide range of applications, from bar code scanners to surgical lasers. Lasers use this light to stimulate various body processes such as waste removal, reduction of swelling, increased tissue repair processes, biostimulating effects, and stimulation of wound healing (Hamblin *et al.*, 2017). Currently, the most common term used to describe the use of lasers in tissue healing and regeneration is photobiomodulation (PBM) (Wikipedia, 2024b). Other terms that may be used colloquially are low-level laser therapy (LLLT) and high-intensity laser therapy (HILT). This chapter discusses the use of lasers in equine rehabilitation.

Lasers used in equine rehabilitation are classified based on their ability to cause ocular damage (Wikipedia, 2024a). The following are the most common classes of lasers used in equine rehabilitation:

- Class 1M – safe under all conditions of normal use (Figure 33.1).
- Class 3B – can cause immediate eye damage upon exposure (Figure 33.2).
- Class 4 – can burn skin; in some cases, even scattered light from these lasers can cause eye and/or skin damage (Figure 33.3).

The wavelengths of light used for laser therapy fall between 600 and 1070 nm (Chung *et al.*, 2012). Wavelengths in the range of 600–700 nm are used to treat superficial tissue, and longer wavelengths in the range of 780–950 nm, which penetrate further, are used to treat deeper-seated tissues (Chung *et al.*, 2012). As a general rule, the

higher the wavelength, the deeper the penetration of laser photons. However, it should be noted that there is a decrease in penetration depth in the range of 970–990 nm due to increased chromophore and water absorption (Hamblin and Demidova, 2006; Hamblin *et al.*, 2017). Duesterdieck-Zellmer *et al.* evaluated penetration of laser light using a Class 4 laser (800 & 970 nm wavelength) in an ex-vivo model (Duesterdieck-Zellmer *et al.*, 2016). They found that most of the laser energy was absorbed or scattered by the skin. Only 1–20% and 0.1–4% of energy were absorbed by SDFTs (superficial digital flexor tendons) and DDFTs (deep digital flexor tendons), respectively, depending on skin color, skin thickness, and applied wavelength. Ryan and Smith, using an 810 nm laser, found that when applying laser to a subcutaneous structure in the horse, the area should be clipped and cleaned beforehand (Ryan & Smith, 2007). They also found that laser light transmission was not affected by individual horse, coat color, or leg. However, it was associated with the condition of the leg (clipped). Limbs clipped dry and cleaned with alcohol were associated with greater transmission of light than the unprepared limbs. They recommended that the area to be treated should be clipped and cleaned beforehand. Luna *et al.* evaluated the penetration of a Class 1 and Class 4 laser in equine skin (Luna *et al.*, 2020). They found that the Class 1 device provided a greater penetration than a Class 4 laser in unclipped light and dark skin, suggesting that the former may produce a better therapeutic clinical effect (Luna *et al.*, 2020).

Laser therapy has also been subjectively divided into LLLT and HILT primarily based on the energy output (Ahmad *et al.*, 2022). Lasers with an energy output of <500 mW (Class 1, 2, 3) are considered low-level lasers while lasers with an energy output of >500 mW (Class 4) are considered high-intensity lasers. Both LLLT and HILT can use many of the same wavelengths, though HILT lasers



Figure 33.1 Class 1M laser (Steve Adair (Chapter Contributor)).



Figure 33.2 Class 3B laser (Steve Adair (Chapter Contributor)).



Figure 33.3 Class 4 laser (Steve Adair (Chapter Contributor)).

usually will have longer wavelengths. LLLT lasers generally do not have a thermal effect, while HILT does, meaning extra care must be taken not to damage tissue due to the photothermal effect. Most of the recent research on horses uses HILT.

PBM in Equine Literature

Much of the literature on laser usage in the horse pertains to surgical conditions. The literature pertaining to the use of therapeutic lasers in the horse is sparser and often has conflicting results. The efficacy of laser therapy in treating different conditions is unclear. Zielinska *et al.* using HILT found that an efficient photothermal effect can be achieved in skin with a nonclipped coat, but that clipping the treatment area increases photobiostimulation of the tissue, while reducing the photothermal effect (Zielińska *et al.*, 2020). These authors also found that while it reduces joint pain and lameness grade, it poorly limits joint discomfort after a flexion test is performed (Zielińska *et al.*, 2023b). Pluim *et al.* evaluated healing of experimentally induced suspensory branch lesions following HILT and showed improved healing compared to conservative therapy (Pluim *et al.*, 2020, 2022). However, Rushing reviewed the literature looking at the effects of HILT on suspensory ligaments and concluded that the two studies they evaluated provided only weak evidence to show that horses treated with both HILT and conservative management return to primary function sooner than horses treated with conservative management alone (Rushing, 2023). Pluim *et al.* using HILT reported a decrease in lameness and improvement in ultrasound scores within 2 weeks of starting therapy in 150 sports horses with either a tendinopathy or desmopathy (Pluim *et al.*, 2018). They also reported a decrease in re-injury rate. Ahmed *et al.* evaluated the effects of a Class 1M laser on equine longissimus and gluteal muscles and found that LLLT has a positive effect on horse muscles that showed a change in their firing frequency that is equal with changes seen with analgesia in subjects experiencing pain (Ahmed *et al.*, 2021). Zielinska *et al.* evaluated the effect of HILT on equine longissimus muscle and skin temperature and found it increased skin temperature and decreased longissimus muscle pain, as shown by decreased withdrawal from digital palpation (Zielińska *et al.*, 2023a). Haussler *et al.* found that LLLT produced significant reductions in back pain, epaxial muscle hypertonicity, and trunk stiffness (Haussler *et al.*, 2020). The effect of high-intensity lasers on tendon and ligaments injuries has shown that it promoted analgesic and anti-edema effects, with visual lameness reduction in horses with tendon and ligament injuries, and reduced lesion percentage, but did not

influence change in lesion echogenicity (Zielińska *et al.*, 2020). Kidtiwong *et al.* found that HILT in superficial flexor tendonitis had the ability to reduce inflammation but had no effect on reducing the cross-sectional area of the treated tendon (Kidtiwong *et al.*, 2022). Michanek *et al.* found no effect of LLLT on experimentally created equine wounds (Michanek *et al.*, 2021). Freeman *et al.* conducted a literature review on factors that influenced equine wound healing and found there is currently insufficient evidence to figure out whether laser therapy provides benefits in wound healing in the horse (Freeman *et al.*, 2021). Peat *et al.* evaluated the effect of irradiating mesenchymal stem cells (MSC) with a 1064 nm laser; they found that 1064 nm irradiation shows promise in the photobiomodulation of MSCs to enhance their therapeutic properties (Peat *et al.*, 2018). In a 2023 review on laser therapy, Millis and Berg found conflicting results and unclear application for clinical use (Millis & Bergh, 2023). They concluded that although some beneficial effects were reported for light therapy, the studies also had limited scientific quality regarding these therapies, with a high or moderate risk of bias. Many of the aforementioned studies provide potential evidence that both LLLT and HILT may be beneficial in treating various conditions found in the equine. However, it is important to recognize the limitations of these studies and that well-designed clinical trials are necessary with correctly and consistently reported parameters. Many of the studies in current literature either fail to report the laser parameters adequately or do so incorrectly, making it difficult to evaluate the quality of the study.

Dosimetry

Laser therapy dosage is described as energy density at the tissue surface. This measurement is also known as the fluence and is expressed in Joules/cm² (J/cm²). When determining dose, an area wider than the injured tissue should be treated. We treat 1–2 cm outside of the boundary of the affected structure. One should measure the area to be treated and then decide the fluence you will use. As an example, if you want to deliver 10 J/cm² to a 100 cm² area you would multiply 100 by 10 to arrive at a total dose of 1000 J that must be delivered. You should treat in a grid pattern and keep the laser perpendicular to the skin surface. Ideally, you should treat in on-contact fashion, as this will improve the depth of penetration. However, for some conditions (i.e., wounds), noncontact may be preferred. The dose needed for a particular condition is dependent on several factors, including the anatomical area, the laser used, and the wavelength.

We do not use set protocols based on specific clinical conditions. Instead, we base our dose and treatment frequency

on depth of lesion, size of lesion, and whether the condition is acute or chronic. The more superficial a tissue, the less energy is needed. In our practice, we use 4–8 J/cm² for superficial lesions (i.e., wounds); 8–15 J/cm² for tendons and ligaments; and 15–35 J/cm² for deep muscles (Riegel, 2018). The frequency of treatment is case dependent. For postsurgical applications, we typically treat daily for 2–4 days. For acute conditions, we typically treat daily until a response is noted. Then we decrease to every-other-day treatment until resolution of signs. For chronic conditions, we follow a similar treatment frequency as for an acute condition, and then decrease to the minimum needed to maintain a positive clinical response. In our practice, the most common use of laser therapy is to decrease pain and inflammation associated with musculoskeletal injuries both before and during the rehabilitation process and for wound healing. We also use lasers in conjunction with injection of orthobiologics because of its biostimulatory effect. In this case, we follow a similar frequency to postsurgical applications.

When selecting proper dosages some guidance can be obtained from the literature. Chen *et al.*, using a GaAs laser (820 nm) and InGaAs, P laser (635 nm) with a power output of 40 mW and a pulsed frequency rate of 50 Hz found the best dose to stimulate porcine tenocytes in culture was 2 J/cm² (Chen *et al.*, 2009). Dueterdieck-Zellmer *et al.* found that 1–20% and 0.1–4% of energy was absorbed by SDFTs and DDFTs, respectively, depending on skin color, skin thickness, and applied wavelength (Dueterdieck-Zellmer *et al.*, 2016). By extrapolating these figures to clinical use we use 8–15 J/cm² for treating tendonitis of the SDFTs and DDFTs, using a multi-wavelength (810–980 nm) high-intensity laser. This dose is also used for treating desmitis. For tendonitis of the SDFT or suspensory branch lesion we would use 10 J/cm² and for a DDFT or mid-body suspensory ligament lesion we would go with 15 J/cm² (Figure 33.4). We would typically treat once daily until a response is noted and then every other day until resolution of signs. Following the injection of an orthobiologics we would use similar dosages but would treat immediately following the injection and then daily for an additional 3–4 days.

We typically use 20–30 J/cm² for treatment of muscle pain (Figure 33.5). This is supported by work from Zielińska *et al.*, who showed a reduction in longissimus muscle pain using 20 J/cm² (Zielińska *et al.*, 2023a). The thicker the muscle, the higher the total energy that is delivered (total joules). For acute pain we typically treat daily until a response is seen, then every other day until pain is gone.

The application of laser light to equine wounds is controversial. Michanek *et al.* found no effect on experimentally induced wounds when using 637 and 956 nm wavelength



Figure 33.4 Class 4 laser being used to treat superficial digital flexor tendonitis (Steve Adair (Chapter Contributor)).

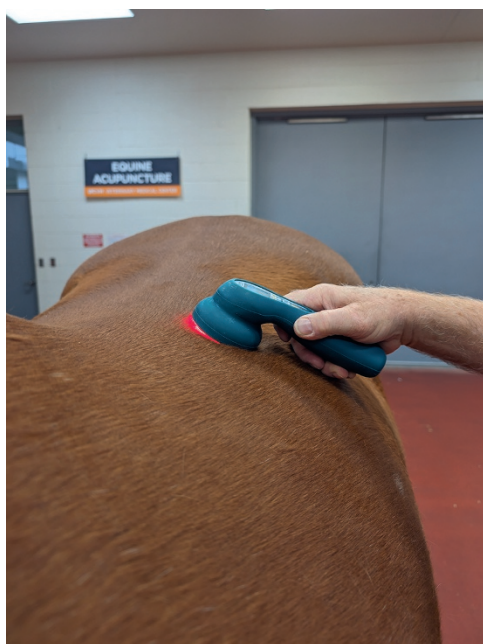


Figure 33.5 Class 1M laser being used to treat longissimus muscle pain (Steve Adair (Chapter Contributor)).

light emitting diodes (delivering 0.2 and 1.2 J/cm² for each wavelength, respectively) (Michanek *et al.*, 2021). However, Hoisang *et al.* showed a significant effect in treating chronic wounds in dogs using an 830 nm laser with a fluence of 4 J/cm² (Hoisang *et al.*, 2021). Lopez and Brundage reviewed the literature dealing with wound photobiomodulation and



Figure 33.6 Class 3B laser being used to treat wound over flexor tendons. Note the sterile plastic wrap covering laser head for protection (Steve Adair (Chapter Contributor)).

also found conflicting results in the equine – one study that showed benefit used a fluence of 5.1 J/cm² and a wavelength of 635 nm, while another study that showed no effect used 2 J/cm² and a wavelength of 830 nm (Lopez & Brundage, 2019). Based on these studies, we typically use a higher fluence of 6 J/cm² and a multi-wavelength laser. We treat daily until we note evidence of epithelization, and then every other day until most of the wound is epithelized. We treat the entire surface of the wound, using sterile plastic wrap over the laser head to protect both the wound and the laser (Figure 33.6). Once the wound is epithelized, we stop treatment.

When performing laser therapy, adequate safety precautions must be observed. Proper signage and eye protection should be used, based on the class of the laser and its wavelength. Individuals using the laser should have appropriate laser safety training. This is mandatory at our facility, and if a person has not been trained, they are not allowed into the room where laser therapy is being performed. While signage and eye protection are unnecessary for Class 1M lasers, we have a blanket policy that they must be used regardless of the class of laser. Further information on safety is included in Chapter 5.

Conclusion

The use of photobiomodulation therapy in equine rehabilitation is becoming more common place. Alongside the application of cold, PBM is also valuable to treat

inflammation that occurs not only in the acute condition but also any inflammation that may occur during the rehabilitation process. Additionally, because of its ability to stimulate growth factors and regenerative cells, it is beneficial during the healing process of different tissues and especially following the administration of biological products. The one thing that is lacking is appropriate dosage protocols. At this time, dosages are arbitrary or have been adapted from other animal models or human medicine. This approach often leads to dosage regimes that are often inadequate or in some cases excessive. There is a need to

have well-designed clinical trials in the horse that establish a set dosage protocol based on the condition being treated, the laser wavelength and its fluence. Standard protocols must be instituted and all researchers need to report the protocols used in parameters accepted by the laser community. Researchers should also utilize quantifiable measurements when evaluating response. It is very important that the studies be designed such that they can be repeated by other researchers. Only by doing the aforementioned can we be assured that appropriate dosimetry is being used regardless of the laser.

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