PRACTICAL EQUINE REHABILITATION
Review of Available Modalities

Andris J. Kaneps, DVM, PhD, DACVS, DACVSMR
Kaneps Equine Sports Medicine and Surgery
Beverly, MA USA

With contributions by Melissa King, DVM, PhD, DACVSMR,
Colorado State University

Physical treatment and rehabilitation of horses is often a major adjunct to surgical or medical therapy. It may also be the primary therapy under which circumstances a horse may be competing under Federation Equestre Internationale (FEI) or other competition regulations that prohibit the use of medications.

The modalities discussed below are applicable in most practice situations. Some techniques lend themselves to ambulatory work on farm or at a competition, while some techniques are better suited to a hospital environment. Application of these techniques requires knowledge of indications, methods of treatment and end points. Proper rehabilitation therapy is greatly facilitated by utilizing the skills of a physical therapist trained in equine techniques or a technician trained and certified by an equine rehabilitation therapy program. There will gradually be more veterinarians trained in equine rehabilitation via residency programs associated with the American College of Veterinary Sports Medicine and Rehabilitation (ACVSMR) and the European College of Veterinary Sports Medicine and Rehabilitation (ECVSMR). Continuing education opportunities for gaining understanding of select techniques continue to become more prevalent.

For perspective, the results of a recent a study that tallied use of various therapeutic modalities in horses is of interest. According to the results of 305 respondents, the most commonly used modalities are: controlled hand walking (97%), corrective shoeing (96%), ice (95%), compression bandaging (90%), PRP (87%), therapeutic exercise (84%), IRAP/ACP/ACS therapy (81%), stretching (83%), cold water (83%), heat (78%), massage (70%), and acupuncture (68%) (Wilson JM, McKenzie E, Duesterdieck-Zellmer K. International Survey Regarding the Use of Rehabilitation Modalities in Horses. Front Vet Sci 2018;5:120.).

THERMAL THERAPY

Therapy type	Indications	Methods of application	Responses to treatment
Cold	• Acute injury (first 24-48 hours) • Pain reduction	• Ice water immersion • Ice surface application • Cold packs	• Restricts blood flow • Reduces metabolism • Reduces activity of inflammatory enzymes • Reduces pain
Heat	• Chronic injury (after 72 hours) • Enhance tissue stretching • Enhance healing response	• Warm water from hose • Hot packs • Leg sweat • Therapeutic ultrasound	• Increases blood flow • Increases metabolism • Increases activity of tissue enzymes • Relaxes muscle spasm • Reduces pain • Increased tissue extensibility

One of the most accessible and time-tested methods of physical treatment is thermal therapy. Heat or cold may be administered to horses using many modalities and can range from simply applying water from a garden hose to deep-heating ultrasound therapy.

Cold Therapy- The major physiologic benefits of cold therapy are decreased local circulation, decreased pain, and reduced tissue swelling.[1,2] These benefits are most effective very early in the period following injury or surgery. The primary effect of local cold application is to constrict blood vessels and reduce tissue temperature. Reduced blood flow will reduce edema, hemorrhage, and extravasation of inflammatory cells. Cold reduces tissue metabolism and may inhibit the effect of inflammatory mediators and slow enzyme systems. Cyclical rebound vasodilatation is another response to cold therapy. Following a minimum of 15 minutes of cold therapy that results in tissue temperatures that range from 10° to 15° C, cycles of vasoconstriction and vasodilatation occur. Vasodilatation associated with cold therapy may help further resolve tissue edema. Analgesia follows cold therapy. Cold therapy is indicated in acute musculoskeletal injuries and following surgical procedures to reduce edema, slow the inflammatory response and reduce pain. It is particularly effective during the first 24 to 48 hours after injury or surgery. Cold immersion of the distal limbs is also effective in reducing severity of laminitis by decreasing the activity of laminar matrix metalloproteinase (MMP) and causing laminar vasoconstriction when applied during the developmental phase.

Cold may be applied by ice water immersion, application of ice packs or cold packs, and ice water-charged circulating bandages or boots. The most beneficial therapeutic effects of cold occur at tissue temperatures between 15° and 19° C (59° to 66° F).[1] Average time of cold application is 20 to 30 minutes. Treatments are best repeated every 2 to 4 hours during the first 24 to 48 hours of injury or surgery if the goal is to reduce tissue inflammation. Direct contact of ice water with the skin is the most effective method of cold therapy. Buckets or turbulator boots may be used depending on the site. If immersion therapy is used immediately following surgery, the wound must be protected with a water impervious barrier. Ice may be placed in a plastic bag or water may be frozen in a paper cup and applied to the site. To prevent laminitis, continuous cold therapy is applied to the distal limbs using plastic bags filled with ice, ice water immersion or commercial cold therapy boots. A recent study identified a simple way to effectively cool the distal limb using a bag-within-a bag technique. Empty 5L fluid bags are secured on the limbs and filled with ice. This technique effectively reduces tissue temperatures for a prolonged period of time and is very easy to apply. Ice water immersion of the equine digit for 30 minutes resulted in significant decreases in laminar temperatures. Vascular perfusion decreased, but not significantly.[3] When comparison of laminar and venous temperatures was made between ice water immersion in vinyl boots, ice water slurry in plastic bags and application of malleable cold packs, ice water immersion and the slurry in bags were comparable in reducing measured temperatures while cold packs did not substantially reduce temperatures.[3]

A new system of cold packs and boots has been recognized to reduce hoof surface temperatures sufficiently to prevent and treat laminitis.[4] Reusable cold packs were attached to the foot and pastern for eight hours with changes to freshly frozen packs every 2 hours (Cold Capsule Technology; Ice Horse, MacKinnon Products, Sonoma, CA, USA). These packs use new technology to maintain colder temperatures for longer periods of time compared to packs previously used by this company. Hoof wall surface temperatures were significantly decreased to a median 11° C. The minimum temperature reached with this system was 6.8° C at 68 minutes after initial cold pack application.[4]

Boots connected to a cold source that circulate fluid through them are also very effective at cooling tissue. Systems are available with a variety of boot configurations for different portions of the limb, making effective cold therapy logistically very simple. Some of the systems also provide compression and may be used for cold and heat therapy.

Cold Salt Water Emersion- Exercising in water with higher solute concentrations has been reported to have anti-inflammatory, osmotic and analgesic effects.[5] Horses diagnosed with distal limb injuries stood in hypertonic (20g/l sodium chloride, 30g/l magnesium sulfate) cold water baths for 10 minutes, 3 days

a week for 4 weeks.[6] These horses demonstrated both clinical and ultrasonographic healing of digital flexor tendon and suspensory ligament lesions.[6] Visual improvements in the degree of soft tissue swelling were also demonstrated within 8 days of the initiation of hypertonic cold water therapy.[6] In horses, tendonitis and desmitis monitored ultrasonographically demonstrated reduced peritendinous and periligamentous edema, decreased inflammatory infiltration, and improved collagen fiber alignment after the four weeks of hypertonic cold water therapy.[6] The added mineral components in water provide an increased osmotic effect, which reduces soft tissue inflammation and swelling, decreases pain, and ultimately improves joint range of motion. These osmotic effects and the cold water can help manage soft tissue changes associated with musculoskeletal injury, wounds, lymphangitis, and cellulitis in horses.

Heat Therapy- The major physiologic benefits of heat therapy are increased local circulation, muscle relaxation (and therefore, reduction of muscle spasms and associated pain), and increased tissue extensibility.[1,2] Increasing local blood flow mobilizes tissue metabolites, increases tissue oxygenation and the metabolic rate of cells and enzyme systems. In general, metabolic rate increases 2 to 3 times for a tissue temperature increase of 10° C.[1] These responses to heat therapy are especially beneficial for wound healing. Increased blood flow and vascular permeability may promote resorption of edema, which is a common reason for heat application in horses. Heat application also decreases pain. Soft tissues may be stretched more effectively when they are warm. Heat decreases tissue viscosity and increases tissue elasticity. Low-load, prolonged stretching of tissues heated between 40° to 45° C (104° to 113° F) results in increased extensibility of tendons, joint capsules, and muscles.[1,2] For example, heating the flexor structures of foals with contracted limbs will result in more elongation of the affected tendons.

Heat is best applied after acute inflammation has subsided. It is useful for reducing muscle spasms and pain that is often a result of musculoskeletal injuries. Heat therapy can be used to increase joint and tendon mobility, particularly by their application before active stretching. Heat may benefit recovery of localized soft tissue injuries by accelerating the healing response.

Superficial heat is most commonly applied using hot packs and hydrotherapy. These modalities provide heat penetration to approximately 1 cm below the level of the skin. The most profound physiologic effects of heat occur when tissue temperatures are raised to 40° to 45° C (104° to 113° F).[1,2] Tissue temperatures above 45° C may result in pain and tissue damage. For deeper tissues, such as tendon or muscle, 15 to 30 minutes is required to elevate tissue temperature to the therapeutic range. When using heat sources warmer than 45° C, the source must be wrapped in several layers of moist towels before application. Heat from these sources is usually applied for 20 to 30 minutes. Warm water is probably the most accessible method of heat therapy. Methods of application include the use of a hose, wet towels, water immersion in a bucket, turbulator boot, and circulating treatment system. A rule-of-thumb is that water as hot as your hand can comfortably stand has a temperature of 38° to 41° C (101° to 105° F). However, tissue heated by water at this temperature may only reach the lowest tissue therapeutic range. Therefore, the target temperature should be above this level, but as mentioned earlier, horses will commonly experience discomfort with water 45° C and warmer.

Heat may be used to relax tight muscles in the back before exercise. Simply using a thick fleece blanket or exercise rug can be used to relax muscle spasm and prepare the back for stretching exercises or riding.

Contrast Heat/Cold- Efforts have been made to use thermal contrast modalities to improve tissue oxygenation and local circulation to improve healing of injuries and speed recovery from exercise. A study in humans, where lower lower legs had contrast baths where 4 minutes of hot immersion followed by 1 minute of cold immersion was continued for a total of 30 minutes (6 hot/cold cycles). Compared to controls, tissue hemodynamics and oxygenation in the lower leg muscles increased following contrast therapy (Shadgan, et al. J Athl Train 2018; 53(8):782-787).

The use of magnetic blankets to increase blood flow has been another treatment method used to treat muscle stiffness and soreness. However, a study of a static magnetic field blanket on back muscle blood flow, skin temperature, mechanical nociceptive threshold or behavior in normal horses failed to find any changes following a 60 minute treatment.[7]

RADIOFREQUENCY THERAPY

Radiofrequency waves are applied to regions of the body for tissue heating and non-thermal stimulation of deep structures. The therapy is known by several terms such as shortwave diathermy, pulsed shortwave, radiofrequency therapy or pulsed electromagnetic energy. Indications for RF include pain relief, muscle spasm, joint contractures or stiffness, edema reduction and chronic inflammation. RF therapy is effective at heating deeper tissues and not heating superficial structures. The non-thermal effects are due to ion stimulation, repolarization of cells, increasing microvascular circulation. Among other functions.

Equine studies have shown that RF can improve tendon injuries and back discomfort. (Becero, et al. Capacitive resistive electric transfer modifies gait pattern in horses exercised on a treadmill. BMC Veterinary Research 2020;16:1-10.)

THERAPEUTIC ULTRASOUND

Therapeutic ultrasound (US) may be used for superficial and/or deep heating of tissues. Ultrasound selectively heats tissue with high protein/collagen content. The most intense heating occurs at tissue interfaces, much like a diagnostic US image has sharp delineations between tissue interfaces such as skin, tendon, and fluid. In dog thigh muscles, US treatment with a 3.3-MHz transducer at 1.5 W/cm^2 resulted in temperature increases of 4.6° C, 3.6° C, and 2.4° C at 1 cm, 2 cm, and 3 cm depths, respectively.[8] Soft tissue temperature in man has been shown to increase 0.2° C per minute with a 1-mHz transducer set at 1.5 W/cm^2.[9]

This deeper heating effect of ultrasound has not been identified in equine studies. In equine epaxial muscles mean temperature rise after 20 minutes of treatment at 3.3 MHz at 1.5 W/cm^2 was 1.3°C at a depth of 1.0 cm, 0.7°C at 4.0 cm, and 0.7°C at 8 cm.[9] However, temperatures in tendons were significantly elevated following 10 minutes of treatment at 3.3 mHz: mean temperature rise was 3.5°C in the SDFT and 2.5°C in the DDFT at the end of the 1.0 W/cm treatment and 5.2°C in the SDFT and 3.0°C in the DDFT at the end of the 1.5-W/cm treatment.[10]

An additional benefit of therapeutic US is the deep massage of tissues caused by the sound waves referred to as cavitation and streaming. These non-thermal effects result in compression and expansion of tissues and tissue fluids that may improve tissue healing. Fibrous connective tissue scars may be more effectively stretched following heating with therapeutic ultrasound.

Treatment protocols:

The hair must be clipped and coupling gel must be used to provide good contact between the transducer and the skin. In horses, standard therapeutic ultrasound treatment is usually conducted with a 1-MHz transducer for deepest penetration (2.5-5 cm depth) and 3-MHz transducer for superficial penetration (1-2.5 cm depth). Energy levels administered are 1-2 W/cm^2, with a continuous wave for 10 minutes.[11] The transducer should be slowly moved throughout the treatment area. Pulsed wave may be used over a boney prominence to reduce discomfort. The ability to manipulate the transducer and adjustment of treatment output for specific circumstances makes traditional therapeutic ultrasound the most versatile means for applying this modality.

Low-intensity ultrasound may be applied for 2-3 hours of treatment for acute injuries and 3-4 hours once daily for chronic injuries. The device does not have adjustable settings with output set at 2.75 MHz at 0.85 W/cm^2. For accessible anatomic locations the device is placed on the limb for the appropriate treatment time (UltrOZ; ZetrOZ LLC: Trumbull, CT US).

EXTRACORPOREAL SHOCK WAVE THERAPY

Extracorporeal shock wave therapy (ESWT) is very useful for treatment of soft tissue and bone injuries. Focused and non-focused ESWT devices are available for application in horses. Shockwave devices make use of several different methods to generate the energy wave. The wave is a very short duration, high intensity sound wave that physically induces a biological response in the tissue (mechanotransduction). The energy imparted on the tissue releases ATP, increases local growth factor production, recruits and stimulates stem cells and activates PRP.[12-15] Each treatment usually consists of 2000 pulses. Intensity of shock wave therapy is set in a range of 0.2 to 0.45 mJ/mm^2, or according to the atmospheric pressure at the output probe (2.5 to 4 bar), depending on the manufacturer's recommendations.[16,17] Treatment protocols require three to five separate treatments spaced at 1 to 3 week intervals. Tissue compression and shear loads occur as the shock wave passes tissue interfaces resulting in stimulation of bone and soft tissue healing. ESWT treatment of arthritis of equine distal tarsal joints (bone spavin) resulted in improvement of lameness grade in 59 of 74 horses treated.[18]

Treatment protocols:

Impulses:
Small lesions, such as a collateral ligament of the distal interphalangeal joint, requires 1000 impulses per treatment. The average suspensory desmitis site requires 2000 impulses per treatment. Large areas of the back may require a total of 3000 impulses for each treatment.

Energy levels:

- Soft tissue injuries less than 4cm deep to the skin: 0.2-0.35 mJ/mm^2.
- Soft tissue and bone in the heel region: 0.35-0.45 mJ/mm^2. These are higher levels than the previous example because the penetration of energy is not as efficient.
- Backs disorders: 0.45-0.55 mJ/mm^2. Higher levels because of the deep muscle mass overlying the target tissues.
- Bucked shins and incomplete fractures: 0.35-0.55 mJ/mm^2.
- Osteoarthritis: 0.15-0.3 mJ/mm^2.
- Wounds: 0.1-0.15 mJ/mm^2 (See: Link LA, Koenig JB, Silveira A, et al. Effect of unfocused extracorporeal shock wave therapy on growth factor expression in wounds and intact skin of horses. Am J Vet Res 2013; 2:324-332).

Focus depth:
The focus point for ESWT should be the average depth of the lesion from the skin. Some ESWT devices use gel standoffs to focus the energy depth and other devices use hand pieces with different focus depths. The machine I use has a wide effective treatment zone around the focus point. The 30mm standoff on my device has a focal area of 15-45mm with therapeutic effect between 0 and 105mm.

Aftercare and treatment intervals: For horses in exercise, I ask for grazing only or stall rest for two days following treatment. The horse then returns to the recommended rehabilitation exercise protocol. Some individuals recommend administering NSAIDS and cold therapy for three days following each ESWT. I do not use these ancillary treatments because I believe that the mild tissue inflammation associated with ESWT is a beneficial effect. ESWT treatment is conducted at 2–3 week intervals for 3 sessions. The horse undergoes a full recheck examination two weeks following the third ESWT. At that examination, the decision is made to continue further ESWTs, stop treatment or to change treatment modalities.

Shockwave therapy cannot be used within 5 days of FEI competition or 3 days of USEF competition. USEF has an exception for shockwave therapy of the back and dorsal pelvis, where treatment may be conducted up to 12 hours before competition.

LASER THERAPY

Low level-laser therapy is beneficial for wound therapy, pain reduction and healing of soft tissue injuries. The biological effects of laser include: release of endorphins, blocking of pain sensation through reduced nerve depolarization, enhanced ATP production, and reduced IL-1 levels. Laser light energy is optimally absorbed through the skin at wavelengths from 805-980 nm.

There are a wide variety of laser devices available to the veterinarian. Wavelength and laser energy output are important considerations when choosing a device. Laser wavelengths for wound treatment should be in the 650 nm range, while treatment of deeper tissues requires wavelengths from 805-980 nm.[15] Lasers are available with energy outputs less than 500 mW and up to 15 W. Higher energy outputs reduce treatment time, but may cause undesired tissue effects if used incorrectly. Newly developed multi-wavelength super pulse lasers have been reported to provide deeper penetration and enhanced photobiomodulation at lower energy outputs than conventional lasers (White Paper: Multi Radiance Medical, Solon, OH USA)). Recommended laser dosage for soft tissue injuries is 4-12 J/cm^2.[19]

A recent study by Haussler found that laser combined with chiropractic therapy resulted in more measurable pain relief for equine back pain than laser or chiropractic alone.[16]

TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (King)

Transcutaneous electrical nerve stimulation (TENS) uses electrical current applied via surface electrodes to preferentially stimulate peripheral nerves and is used primarily for pain modulation. The mechanism of pain relief is thought to be through the stimulation of inhibitory interneurons at the spinal cord level or the release of endogenous endorphins within the central nervous system. The "conventional mode" TENS setting is frequently used for more acute pain with a higher frequency (>100Hz) and lower pulse duration (50 µs), which is thought to modulate pain through the gate control theory. The pain modulation with the conventional TENS mode will be relatively short once the electrodes have been removed. The "acupuncture like mode" TENS setting is used for more chronic pain with a lower frequency (<20Hz) but a longer pulse duration (200 µs), this relieves pain through the release of endorphins. The duration of pain modulation following removal of the electrodes using the "acupuncture like mode" may persist for 1-2 hours. In humans, there is moderate evidence to support TENS as an effective treatment for managing pain.[21] While there is no evidence of the effectiveness of TENS use in horses, there may be some overlap in the mechanisms of action, clinical indications and effects reported for electroacupuncture.[22]

NEUROMUSCULAR ELECTRICAL STIMULATION (King)

Neuromuscular electrical stimulation (NMES) uses a low-level electrical current that through stimulation of the alpha motor neurons, allows recruitment and muscle contraction after orthopedic or neurological injury. NMES assists neuromuscular function by enhancing the force capacity, or the ability of the muscle to contract, as compared with a true strengthening of the muscle. It is unclear if the role of electrical stimulation in improving muscle function is actually related to increased muscle strength, improved voluntary contractions, restoring motor control, or possibly due to proprioceptive activation within injured or atrophied myofascial tissues.[23] The combination of electrical stimulation and exercise has been reported to be effective in alleviating pain and improving voluntary activation in human osteoarthritis patients, but it did not enhance muscle strength or functional performance.[24] The use of

NMES can also aid in the reduction of edema and swelling as the direct current drives the charged plasma protein ions within the interstitial spaces to move in the direction of the oppositely charged electrode, facilitating movement into the lymphatic channels.

NMES is helpful in my practice to relieve muscle spasm and stiffness, particularly in the neck and back.

In an equine study NMES was conducted at 21-39 mA, 50 Hz, for 45-60 minutes 5 days per week for 4 weeks. Measurements of fiber area, glycogen content, enzyme activity and distribution of fiber types were made. No changes in treated versus control muscle samples were identified.[25]

WHOLE BODY VIBRATION

Whole body vibration (WBV) therapy uses a plate to transfer vibration energy to the horse. There are several manufacturers that supply plates that are useful for horses. The plates may be relatively small and portable or an entire stall floor can be fitted for therapy. The effects of vibration therapy include: increased circulation, maintenance of bone density, maintenance of muscle mass, improvement of core stability and reduced stress.[26-28] Indications for WBV therapy are: pre- and post-exercise warm-up/cool down and support of the horse during rehabilitation or stall confinement. Protocols used to prevent bone loss during confinement include plate therapy for 20 minutes twice daily (University of Tennessee) or 45 minutes daily, 5 days per week[26]. Protocols for warm-up and cool down involve 15-20 minutes of plate vibration time.

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