

ANIMAL REHABILITATION

SPECIAL INTEREST GROUP

THE USE OF THERAPEUTIC ULTRASOUND FOR EQUINE INJURIES

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The field of equine rehabilitation is in its early stages of potential in the United States. In contrast equine physical therapy is a well-established profession in Belgium, Sweden, England, Australia, and Canada. These equine practitioners are well aware of the positive effects that a variety of manual treatment approaches and modalities, such as therapeutic ultrasound (tUS), can offer and how tUS can benefit the horse in terms of healing, tissue extensibility, and pain relief. This therapeutic intervention is available in the USA to improve healing not only in humans, but also our 4-footed friends (dogs and horses).

Therapeutic ultrasound is a modality that many people have heard of and used regularly in human physical therapy. It is a comforting, mild heating, noninvasive modality used for promotion of healing tissues or prior to stretching of tight or adhered structures. Inaudible sound waves are absorbed primarily by collagen rich connective tissues such as ligaments, tendons, fascia, and scar tissue. Ailments such as tendon or ligament injuries, muscle spasm or tearing, joint swelling, open wounds, and even mild arthritis can benefit from application of tUS. Recent studies show tUS has beneficial effects on delayed bone healing.¹ Many of these ailments described above occur in horses. Now tUS is an available option for horse owners to consider when faced with an equine injury, and when they are searching for a method to promote healing of structures for faster recovery.

Therapeutic ultrasound results from a conversion of electrical energy traveling through a crystal mounted within the transducer head. The piezoelectric ability of the crystal causes it to contract and expand, generating a high frequency of sound waves of greater than 20,000 cycles per second, known as Hertz (Hz). Humans can hear sounds with frequencies between 16 – 20,000 Hz. Sounds with a frequencies greater than this are categorized as ultrasound.² Sound waves transmit energy by alternate compression and expansion of material. Ultrasound has a variety of physical effects described as thermal or non-thermal.² Thermal mode (continuous setting) has the ability to increase tissue temperatures, and is ideal for pre-stretching preparation of tight tissues. Nonthermal (pulsed setting) effects are ideal for the promotion of the healing of tissues and decreasing inflammation. Both methods of ultrasound (US) work due to the sound waves causing vibration of the tissues and cells, stimulating tissue metabolism. Increasing cell metabolism accelerates the healing process, increases circulation, and relieves pain. In a method called phonophoresis, medications are pushed transdermally into targeted tissues below the skin.

Horse owners have often been confused by the term “ultrasound” due to two different kinds of ultrasound used by equine practitioners. Therapeutic ultrasound described above, is ideally used to assist healing or heating of tissues, usually applied by physical therapists. Diagnostic ultrasound (dUS) customarily used by veterinarians is used to view internal tissue integrity. The method of dUS works in the same manner as tUS, with settings at higher frequencies of 3-7 MHz most commonly used for equine diagnostics.³ Echoes are generated whenever the sound beam crosses a boundary between structures of differing acoustical impedance. Returning echoes generate electrical pulses that are electronically manipulated and displayed on a monitor for veterinarian and client viewing of involved structures.³

Applications of tUS are usually at 1 MHz or 3 MHz frequencies. Selection of the frequency will be dependent on the depth of the target tissue to be addressed (ie, a superficial structure of a flexor tendon vs. a deeper thicker structure such as a muscle tear). It is thought to affect target tissues as deep as 5 cm-6 cm.^{2,4} For proper transmission of tUS into the horses' tissues, hair must be clipped and shaved down to the skin, followed by application of a gel medium to allow sound waves to penetrate through skin and underlying tissues. Determination of frequency, duration, and choice of pulsed or continuous applications depends on the nature of the injury, collagen composition of target tissue, point in time within the healing continuum, and the depth of the target tissue.⁵ These are important elements for the equine physical therapist to consider when treating the horse. Tissue damage can occur with improper use and technique of tUS application such as periosteal pain.⁶ There are many contraindications to consider, such as poor circulation, reduced sensation, and prolonged use over epiphyseal areas.⁶ Therefore, horse owners should consider only qualified, credentialed, and licensed professionals when hiring practitioners to treat their horses with any modality or treatment. Benefits of tUS abound in terms of tissue physiology.

Used correctly, tUS can benefit the horse through:

- increased elasticity of collagen in tendons, joint capsules, and scar tissue;⁵⁻⁷
- increased motor and sensory nerve conduction velocities that assist in reducing pain;⁵
- altered contractive activity to skeletal muscle that reduces muscle spasm;⁵
- diminished muscle spindle activity, another factor in muscle spasm reduction; and⁵
- increased blood flow that can bring healing factors to site of injury and speeds up local metabolism.^{5,6}

There is an abundance of research demonstrating the efficacy of tUS in the treatment of humans. A great deal of research has been performed on research animals (ie, mice, rats, and dogs) along with humans. Unfortunately, there are not abundant studies on equine subjects to draw from, due to the size and cost of maintaining these large animals for research purposes. Therefore, we can extrapolate the physiology of the

horse to be similar to these other mammalian species in hopes that tissue response in the horse's tendons, ligament, bones, muscle, wounds, along with pain responses would be similar to research findings of these study specimens. However for validity purposes, it is best to look at the specific equine research to draw the best conclusions. The following are a few examples of specific tUS research conducted on equines.

Wound Healing: Therapeutic ultrasound works in several ways to accelerate the healing of injured tissue. Therapeutic ultrasound modulates the inflammatory response, increasing the healing process and the epithelization of the wound. A study done by Moreas et al⁷ suggests that tUS properties can diminish the time required for equine wound healing. After 7 sessions of tUS, surgically induced lesions treated with tUS had approximately a 35% decrease in initial measurements indicating an increase of wound contraction as compared to controls.⁷ Therefore, tUS is recommended in treatment of equine wounds.⁷

Tissue Extensibility: Tissue extensibility increases at higher settings, 1.2-2.0w/cm², of continuous tUS.⁶ Moreas et al⁷ suggest that tUS used in studies on horses with resultant tissue restrictions (scar) secondary to the wound healing process, increases cell permeability of the tissue's membranes, changes the cells' volume, and releases adhesions due to the detachment of the collagen fibers. Draper⁶ suggests that scar tissue can be softened if treated early with tUS.

Arthritis: Singh et al⁸ studied a group of 8 donkeys induced with acute septic arthritis of their carpal joints. Four were treated with tUS for 10 minutes daily for 7 days and the other 4 were used as the control group with no treatment. Later, dissection of the carpal joint capsule and cartilage showed decreased alterations of smooth cartilage and decreased synovial membrane inflammation in comparison with the control group. The gross changes in the fibrous joint capsule and synovial membrane were much milder in the US treated animals. No calcium deposits were noted in the treated donkeys reflecting normalization of the joint capsule. From this study, they concluded that treatment with tUS in early onset of septic arthritis resulted in promotion of healing of joint tissue and articular cartilage, therefore preventing the development of degenerative joint disease.⁸

Pain, Muscle Spasm, and Scar: Mitchell and Richard⁹ propose that tUS is helpful for pain and spasm reduction when used over the adjacent musculature of spinal dysfunction in horses.⁹ Therapeutic ultrasound is the deepest source of heat available, penetrating 5 cm-6 cm deep into tissues.^{6,10} This therapy can be very useful for back pain, especially for large muscle spasms and deeper scar tissue causing pain in the horse.¹⁰

A study done by Moraes et al¹¹ states that, tUS energy is capable of producing cellular changes by mechanical effects. Therapeutic ultrasound mechanism of action correlates with activation of fibroblasts and collagen, and stimulates blood flow. This in turn promotes anti-inflammatory properties for tissue relaxation and a decrease of local pain. "The treatment of tUS was crucial for local analgesia in these horses, as no other analgesic therapy was used. The use of tUS should be included in the treatment of acute pain in horses, since it is noninvasive and effective."¹¹

Tendon Injuries: Tendonitis is a common problem that

affects a substantial proportion of racing and performance horses. Superficial digital flexor tendonitis is a significant cause of lameness in horses, and tUS has been widely used to treat this injury. Guiomar et al¹² have conducted several studies looking at the efficacy of using tUS in healing tendons. One study evaluated the effects of tUS throughout the healing process in equine-induced tendonitis. One forelimb from each horse from the two different groups were randomly treated with tUS 3 times a week, until completing 15 days for the first group, and 60 days for the second group. Results suggest that tUS treatment time (3x/week for 5 weeks) was insufficient to improve the process of tendon repair. However, a protocol (3x/week for 60 days) was beneficial and supports the hypothesis that tUS enhances tendon healing over a longer period of time.¹² In conclusion they stated, "tUS accelerates tissue healing rate and promotes tendon regeneration."¹²

Guiomar et al¹³ conducted another study to evaluate the effects of tUS on the healing process in equine-induced tendonitis with the purpose of detecting and measuring the organization of collagen fibers. Findings suggest that tUS is beneficial in equine tendons healing improving the arrangement, aggregation state, and molecular order of the collagen fibril.¹³

Bunchner and Schildboeck¹⁴ looked at 3 experimental studies evaluating the effect of ultrasound therapy on equine tendon healing in tendon lesions employing contralateral tendons as untreated controls for clinical, sonographic, or histological investigation. They found improved clinical results of less degeneration and inflammation in the tendons treated with tUS as compared to controls.¹⁴

Magnetic therapy vs tUS: Many horse owners are curious if magnetic therapy could be beneficial to their injured horses. Chuit et al¹⁵ conducted a study in 2003 on 4 clinically healthy adult horses. The study evaluated ultrasound and low and high intensity magnetic field therapeutic effects on repair of experimentally induced injury in the superficial digital flexor tendon of all 4 limbs of each animal. One limb served as the control, the second limb was treated with tUS, the third limb was treated with low intensity magnetics (LIM), and the fourth limb was treated with high intensity magnetics (HIM). On day 60, histomorphological biopsy results indicated no sign of intrinsic and extrinsic adhesions with regular and parallel collagen fiber bundles formation in ultrasonically treated limbs in all 4 animals. There was adhesion formation and inflammatory cells in both HIM and LIM. The high intensity static magnetic field regimen had higher occurrence of adhesion formation when compared with low intensity static magnet field. In comparison, US therapy is significantly more effective in the repair rate and better collagen arrangement when compared with low and high static magnetic field therapeutic regimens in SDFT injury.¹⁵

Contraindications and Dangers of Ultrasound: Although tUS is a relatively safe treatment modality, the dangers associated with tUS treatment are unacceptable temperature rise within the target area and/or collapse of cells leading to deep tissue necrosis and damage.¹⁶ Therefore, it must be applied by licensed practitioners with care to avoid harming the patient in terms of hot spots or tissue damage. In the human, we have the luxury of patients verbally telling the practitioner if they feel any discomfort or are overheating. With the horse, prac-

tioners must be attuned to pain behaviors that may indicate discomfort and therefore use the modality judiciously, in terms of lower intensities and correct application. Contraindications of tUS are to avoid use over malignancies, eyes, and reproductive organs. Do not use on patients who are pregnant, or have joint cement, a pacemaker, or thrombophlebitis.

Therapeutic ultrasound has much to offer equine clientele in terms of acceleration of tissue healing, disruption of adhesion formations, and heating tissues in preparation for stretching. Low intensity pulsed ultrasound (LIPUS) is showing promise in the area of bone healing.⁶ More research has yet to be performed for possible efficacious treatment of diagnosis of bucked shins, splints, and fracture healing acceleration.

Mary Bromiley, PT,¹⁶ world-renowned author, lecturer, equine enthusiast, and practitioner states the following in regards to the use of tUS in equine rehabilitation, "Machine therapy, such as tUS, on its own is far from satisfactory. If it is possible to incorporate a rehabilitation program at the same time as the use of machines, the result will be far superior to the "tUS machine only" cases. Unfortunately, irreversible changes can occur in the recipient, should an inappropriate therapy be selected or used by an untrained nonprofessional. Following a diagnosis made by a veterinary surgeon, physical therapy ought to become a useful adjunct to veterinary medicine, but this can only occur if the varied therapies are administered by a qualified person, correctly trained in the use of therapy apparatus, who also possesses an in-depth knowledge of the equine and of the demands of the individual equine disciplines."¹⁶

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