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FES General Information FAQs

Treatment of Deep Digital Flexor Tendon & Superficial Tendons and Ligaments

Tendon and ligament rehabilitation has been studied extensively in humans. The evidence is strong that during both tendon and ligament rehabilitation, tension due to muscle movement will assist in the repair of the injury, leading to a return of more normal function (Mass et. al, 1993). Synder-Mackler L, et al (1995) found that using electrical stimulation early in the rehabilitation process of anterior cruciate ligament reconstruction improved the functional ability of the knee, when compared to the controls that received no electrical stimulation. In addition, the maintenance of muscle strength during the rehabilitation process was significantly better with the electrical stimulation, than with the control. In the horse the suspensory ligament (SL) is the modified third interosseous muscle and contains striated muscle fibers, which comprise 10-14% of its cross-section area (Wilson et al. 1991). Therefore, stimulus of motor neurons in this tissue by FES to obtain functional movement is possible. In addition, due to the depth of penetration, FES can be used for rehabilitation of the deep digital flexor tendon. A case study on the website outlines the success of a deep digital tendon rehabilitation.

FES Will Help Improve Muscle Strength and Reduce Atrophy

Several decades ago FES was first used in the rehabilitation of spinal cord injury patients to generate muscle movement to prevent atrophy. Today, FES has been shown to be effective for multiple purposes including the treatment of both spastic and flaccid muscle and to restore grasping and reaching functions (Kawashima, et al. 2008; Thrasher, et al., 2008). Studies in rats that evaluated the neuroplasticity of reinnervation has shown that FES can delay muscle atrophy by producing better nerve conduction and higher muscle weights (Lim and Han, 2010) and can restore muscle size, and functional and histochemical properties when compared to no stimulation (Marqueste et al., 2006). Additional human studies have shown the ability of FES to reverse muscle atrophy for denervated muscle tissue to obtain standing and walking in spinal cord injury patients (Gallien, et al., 1995; Graupe and Kohn, 1998; Graupe, et al., 2008; Mushahwar, et al., 2007; Yarkony, et al., 1990). Other research on humans has shown that FES can prevent and even reverse atrophy of chronically denervated muscles when evaluated by muscle biopsies and knee extension torque (Kern, et al., 2002, 2005, 2008).

Health muscle function is basically a cyclic response with equal moments of contraction and relaxation. When a muscle is not functioning properly, one of these responses is typically absent or shortened. After an injury, muscle tissue will "splinter". In this condition, the muscle fibers are held in a firm, contracted state to protect the muscle from being over used and causing further injury. This condition is the "knot" that is felt when an injured muscle is palpated. The goal of FES is to replicate the body's own natural functions. FES will restart the cyclic activity of the contraction and relaxation phases to return the muscle to a more normal functioning pattern.

Recruitment of Muscle Fiber Types

During electrical stimulation, the recruitment order of muscle fibers has been researched. Earlier studies indicated that with electrotherapy recruitment occurred in the opposite order of normal recruitment. The reasoning was, that with electrotherapy, the large diameter fibers were being activated before the

smaller diameter fibers. This was thought to be because large diameter fibers are stimulated with lower voltage due to the wider spacing between nodes. In addition, it was felt that the fibers closest to the electrodes would fire first. Recruitment was thought to continue to a point where no more increase in force can be obtained and at this point the muscle is considered "saturated".

Current research is indicating that during electrical stimulation the recruitment pattern is nonselective and therefore all motor units are activated simultaneously (Gregory and Bickel, 2005). This is an important consideration when viewing the use of electrotherapy in rehabilitation. The activation of all muscle fiber types can be beneficial due to the limited use of normal exercise in the early stages of rehabilitation. The benefits of muscle movement during rehabilitation, with out the negative effects of trauma or full range of motion activities, are possible with the use of electrotherapy.

FES Will Reduce Inflammation Through Production of Muscle Contractions

The prolonged contraction of a splinted muscle is initially useful, but this immobilization of the muscle quickly leads to a reduction in circulation and an increase in inflammation. Inflammation is a natural response of the body to injury. However, if the swelling associated with the inflammation lingers, there can be many detrimental results. The inflammation reduces the ability of the body to remove the disease tissue from the injury. In addition, inflammation does not allow the cellular components for regeneration to reach the injury site. Without the components needed for repair, the tissue cannot regenerate to its functionally equivalent pre-injury state.

FES Will Produce Muscle Movement to Reduce Adhesions During Healing

Adhesions will form at the site of an injury to immobilize the tissue, therefore protection it from further injury. However, immobilization for an extended period of time is one of the factors leading to a preponderance of non-functional adhesions. Movement of the injured tissue results in the condition necessary for the production of more organized functional tissue, therefore the possibility of a full recovery is greatly increased.

Treatment of Deep Muscle Problems Including Spinal And Pelvic Issues

One of the specific reasons that FES is beneficial to the equine practitioner is due to the depth of penetration of the signal. The FES signal can reach 6 to 8 inches below the surface of the skin so that the deep muscle, tendon and ligament tissues of the horse can be stimulated. Videos taken during ultrasound imaging has shown that FES results in the contractions down to the psoas muscle. This is of great value when dealing with spinal and pelvic problems. In addition, the FES signal feels comfortable, so the horse remains compliant to the treatments without the need of a tranquilizer.

Prevention of Tendon and Ligament Problems

Stiffness or injury to the tendon at the insertion or attachment point can cause discomfort and poor quality movement. Tightness in the ligaments is also a common problem leading to injury and pain. FES can mobilize the tendons and associated ligaments during rehabilitation to improve range of motion and help improve the quality of movement. FES has been successfully used as a prophylactic, reducing muscle, tendon and ligament strain therefore avoiding potential injury.

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Fatigue is the precursor to injury and reduction in fatigue can lead to fewer injuries. Svantesson et al (1998, 2000) found that fatigue develops earlier in subjects that had increased stiffness in the tendons. Therefore, the use of FES to loosen tight tendons can appreciably decrease fatigue, leading to less chance of failure of the tendon.

Improved Performance Due to Improved Muscle Function

Pain after an injury or surgery causes the patient to have difficulty in contracting and relaxing the effected muscles. As a result of this limited use, there can be a lack of sensory input from the muscle. The lack of input makes movement more difficult, and any movement that is performed is uncoordinated. When the muscle is stimulated by FES to encourage the contraction/relaxation cycle to return to normal, there is an associated increase in the sensory input from the muscle. This input is necessary for muscle coordination and performance.

Reeducation of muscle memory has been shown to be a result of FES. Studies of FES spinal cord injury patients found improved muscle movement even when FES was not being applied (Popovic, et al., 2009). An evaluation of the use of FES for gait rehabilitation after stroke, showed that retraining strategies, which included FES, were more effective than retraining with FES (Belda, et al., 2001). In addition, FES was used to show improved motor functional recovery in improved range of motion in hemiplegic patients when compared to controls (Wang, et al., 2002). Another interesting study of 10 patients with chronic facial nerve paralysis showed improvement in facial muscle movement with electrotherapy after other forms of treatment were non-effective (Hyvarinen, et al., 2008).

Faster Recovery After Injury or Surgery

In rehabilitation, the typical exercise program used after injury or surgery involves low stress to the muscles and joints, and therefore the fast-twitch type fibers would rarely be recruited. With electrical stimulation, these fast-twitch fibers can be recruited at higher intensities. Therefore, faster and greater strength gains can be made with the use of electrical stimulation during rehabilitation (Andrews et al., 1998).

Reduced Discomfort From Arthritic Conditions

Arthritic pain from joint problems produces poor quality asymmetrical muscle movement. Therefore, arthritis results in not only joint pain, but also secondary muscular pain. In addition, many arthritic conditions may originate due to the uneven pressures on the joint because of asymmetrical muscle development and use. In both of these situations, FES can assist in reducing the muscular discomfort or the pressure on the joint due to asymmetrical muscle use.

Research has found that children with juvenile chronic arthritis have reduced muscle strength and thickness in the muscles near the inflamed joint (Lindehammar and Backman, 1995). Therefore, depending on the severity of the cause, the use of FES to improve muscle integrity could help reducing the discomfort associated with arthritic conditions.