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FUNCTIONAL ELECTRICAL STIMULATION (FES)

Also known as FNS (Functional Neuromuscular Stimulation) NMES (Neuromuscular Electrical Stimulation) or Computerized Functional Electrical Stimulation (CFES). This system controls the stimulation parameters by a computer.

FES is a rehabilitation technique where electrical current is applied by surface electrodes to produce controlled movement of the muscle, tendon and associated ligaments. FES is a microprocessor-controlled system that replicates the body's electrical impulse from the brain to the muscle producing a functional response. The ability to produce functional movement is what defines the FES systems from all other electrical stimulation modalities. For example, the application of FES to the appropriate muscles of the hand can produce a precise gripping action.

The mobilization of a wide range of injured tissues can be controlled by FES, therefore the rehabilitation process can begin earlier and even acute injuries can be treated.

FES WILL HELP RESTORE NORMAL CYCLIC CONTRACTION/ RELAXATION OF HEALTHY MUSCLE

Healthy 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 restart the cyclic activity so that both the contraction and relaxation phases of healthy muscle are present.

FES WILL REPLICATE THE BODY'S OWN NATURAL FUNCTIONS

FES muscle stimulation, which results in a contraction, is physiologically identical to the one produced by the functional nerve. In addition, FES can provide restoration of lost motor function through the stimulation of the intact motor neurons. This is why FES has been used extensively in the rehabilitation of spinal cord injury patients.

FES WILL REDUCE INFLAMMATION THROUGH PRODUCTION OF MUSCLE CONTRACTIONS

The prolonged contraction of a splintered 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 diseased tissue from the injury site. In addition, inflammation does not allow the cellular components for regeneration to reach the injury. 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 protecting 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 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 3 to 4 inches below the surface of the skin so that the deep muscle, tendon and associated ligament tissues of the horse can be stimulated. 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.

TREATMENT OF DEEP DIGITAL FLEXOR TENDON
TREATMENT OF SUPERFICIAL TENDONS AND LIGAMENTS

FES produces contractions in muscles and tendons as well as in the ligaments associated with the joints being stimulated. With the use of FES some movement to the ligament is possible as a secondary result of the muscle and tendon movement. Due to the lack of an action potential in most ligaments, FES results in movement of the ligament due to the joint movement caused by the stimulation of the muscle and tendons. The suspensory ligament of the horse is unusual in that it contains myoblasts, therefore FES can be effectively used to stimulate this ligament.

Due to the depth of penetration, FES can be used for rehabilitation of the deep digital flexor tendon. A case study listed on the website outlines the successful progress of a deep digital tendon rehabilitation.

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.

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 to help in rehabilitation or improve the quality of movement.

Fatigue is the precursor to injury and reduction in fatigue can lead to fewer injuries. FES has been successfully used as a prophylactic, reducing muscle, tendon and ligament strain therefore avoiding potential injury.

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.

REDUCED PAIN AND 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 the limited use, there can be a lack of sensory input from the muscle. This 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.

Evidence supports the use of strong muscle contractions to produce better relief from pain (Picker, 1988) (Picker, 1989)

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 case, the use of FES to improve muscle integrity could help in reducing the discomfort associated with arthritic conditions.

ACTIVATION OF BOTH MOTOR AND SENSORY FUNCTION

FES can be used to improve both sensory (nerve) and motor (muscular) function. For FES to be effective, the lower neurons must be intact from the anterior horns of the spinal cord to the neuromuscular junction of the muscle.

The stimulation of motor nerves cannot occur by a steady flow of direct stimulation, therefore a pulsed current must be used.

In humans, FES is used extensively where lower motor neurons are intact and muscle tissue is healthy, such as in: spinal cord injury, stroke, head injuries, cerebral palsy, multiple sclerosis

FES is used with caution when there is lower motor neuron damage, such as in:
Polio, amyotrophic lateral sclerosis (ALS), peripheral nerve injuries, muscular dystrophies due to unhealthy muscle

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, if 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.