

## Functional Electrical Stimulation (FES)

### The Use of Functional Electrical Stimulation (FES) in Therapeutic Rehabilitation

Function Electrical Stimulation (FES) is the application of computer-regulated electrical impulses to the surface of the skin through electrodes. The waveform produced mimics the motor neuron signal the brain sends to the muscle to cause a contraction.

The ability of FES to replicate the functions of the body is why this modality is called Functional Electrical Stimulation.

FES has been used successfully for several decades in the human medical field to restore normal function to injured tissue, therefore the chances of a complete recovery are increased.

Decades of rehabilitation work, combined with research results and practical experience, has proven that the body does not rehabilitate itself in an effective way. Currently, modalities and techniques to assist the repair process of the body are available so that a return to normal functioning of injured tissue is possible.

The International Olympic Committee's Rehabilitation of Sports Injuries (Frontera, 2003) documents many research studies that show the importance of early movement in the rehabilitation of muscle, tendon, ligament and bone.

FES is used in rehabilitation to exercise injured tissue with specific movement parameters, therefore reducing the chances of further injury due to incorrect and/or uncontrolled exercise.

Because the mobilization of injured tissues is easily controlled by FES, the rehabilitation process can begin earlier and even acute injuries can be treated.

With horses, rehabilitation techniques are similar to those used for humans. However, the body of the horse presents specific characteristics that must be taken into consideration when developing a rehabilitation plan.

First, the tissue masses of horses are much larger, when compared to humans. Due to this characteristic, it can be difficult to access some of the deeper structures from the surface of the skin.

FES treatments are extremely effective for use on horses due to the ability of the signal to reach up to 4 inches below the surface of the skin, therefore access to the deep muscles, tendons and ligaments is possible.

Second, some rehabilitation modalities designed for humans are too uncomfortable for use on horses.

During treatment, FES feels like a deep muscle massage because the sophisticated software mimics the electrical signals produced naturally between the brain and the body. FES treatments can be given to the horse without the use of a tranquilizer.

The benefits of FES treatments include (with selected references):

1. Pain relief due to decreased spasticity of muscle (Loeser et al., 1975), (Moore and Shurman, 1997), (Repperger et al., 1997), (Billian et al., 1992), (Schecker et al., 1999).
2. Improved range of motion due to reduced muscle tension (Pease, 1998), (Bremner et al., 1992).
3. Reduction in swelling due to injury (Mendel FC and Fish, 1993).
4. Reduction of scar tissue during healing (Hainaut, 1992), (Kloth LC, 1995).
5. Re-education of muscle function to prevent further injury (Synder-Mackler, 1990), (Bremner et al., 1992), (Snyder-Mackler, 1994), (Glanz et al., 1996).
6. Strengthening of muscles and tendons (Delitto and Snyder-Mackler, 1990), (Bremner et al., 1992), (Snyder-Mackler, 1994), (Glanz et al., 1996).
7. Reversal of muscle wasting (Eriksson and Haggmark, 1979), (Scremin AM, 1999), (Bélanger et al., 2000)
8. Decreased rehabilitation time after injury and surgery (Hainaut, 1992), (Delitto et al., 1988), (Snyder-Mackler et al., 1995).

One of the most familiar forms of FES is the cardiac pacemaker, which is used to stimulate the heart to beat by releasing a specific series of electrical discharges. FES electrical stimulation is also used as a substitute for lost neurological function for spinal cord injury patients. This modality can replicate muscle movement so accurately that patients who have no control over their lower bodies can pedal a stationary bicycle. Currently, prosthetics are being designed that will utilize FES technology to obtain more normal limb movements for their users.

Movement of soft and hard tissues (other than fractures) is an essential part of early rehabilitation. FES provides an excellent means to mobilize muscle, tendon and the associated ligaments through the generation of controlled muscular contractions. Numerous research studies have shown that the quality of the injury or surgery repair is linked to early mobilization of the injured site. However, these manipulations must be done with a thorough understanding of the specific biomechanical parameters of the body.

We once thought the body can rehabilitate itself, but that is not true. To obtain the best quality of healing, intervention through an appropriate rehabilitation program is essential. FES treatments have been successfully used for:

- Acute or chronic injuries
- Relaxation of spastic muscles
- Reduction of myofascial pain syndrome
- Treatment of tendon and ligament injuries
- Reduction of edema
- Improved circulation

There are many different types of electrical stimulation and FES is only one of these types. Electrical stimulation devices must be evaluated carefully to correctly choose an effective and comfortable treatment. Different systems exist for different purposes, and some confusion concerning the benefits of electrical stimulation has been due to the lack of understanding of which type of system to use for a particular issue. In addition, animals will not necessarily accept a system that may be well tolerated by humans. Therefore, it is even more important for the veterinary practitioner to select the appropriate modality.

An understanding of the different types of systems and how they work will assist the practitioner in finding the best modality to use. A discussion of the variety of electrical stimulation modalities can be found in the "Types of Muscle and Nerve Stimulators" section within our website.

In general, a FES signal is produced by an electrical current, which moves electrons by a voltage through the resistances within the body. These resistors are skin and muscle, tendons, ligaments or bone, and the current must be strong enough to move through these tissues. Due to the massiveness of the equine muscular system, when compared to the human, the intensity of the signal is of utmost importance or the deeper muscles of the horse will not be affected. However, at a high intensity the signal must closely replicate the electrical charges of the body so that the treatment is as comfortable as it is effective.

When the intensity of the voltage reaches a sufficient level, an action potential is produced in the muscle or nerve. The intensity level required for an action potential is referred to as the "threshold" level. The membranes of sensory and motor neurons can produce action potentials.

Action potentials perform two major functions:

1. Rapid transmission of information over long distances in nerve and muscle fibers.
2. Control of effector responses such as muscle contraction, and the release of neurotransmitters and hormones.

To determine if electrical stimulation is an option for treatment, a veterinarian should perform a thorough diagnostic exam. The type of injury (sprain, fracture, tear, hematoma, etc) and the stage of the injury (acute, repair phase, chronic, etc) must first be determined. Then, an evaluation of the treatment protocol that will correctly address the injury, can be selected.

For rehabilitation use in the horse, FES electrical stimulation is generally used for three basic purposes:

1. To stimulate muscles, tendons and ligaments so that normal movement is returned to injured tissue.
2. To promote edema reduction and tissue healing through increased circulation of blood and lymph due to the movement of muscles.
3. To stimulate muscle movement and sensory nerves for the treatment of pain.



Other uses for FES electrical stimulation have included:

1. Reversal of the wasting of muscle (used in EPM rehabilitation)
2. Increasing range of motion
3. Wound healing

One of the most common confusions is that electrical stimulation is the same as magnetic therapy. It is not. Magnetic therapy utilizes negative and positive magnetic fields, which passively affect blood flow. Magnetic therapy cannot elicit a muscle contraction and does not penetrate deeply into the tissues of the body. There are two basic categories of magnets, static magnets that have no electricity connected to them and electromagnetic systems that require an electrical connection. These systems can be continuous or pulsed and are specifically used only to influence blood flow, not to initiate muscle contraction.