Electronic Muscle Stimulation for Strength, Athletic Performance and Recovery

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This article will be one of many on the topic of Electronic Muscle Stimulation (EMS) and related topics on electrotherapy and electrophysiology. It provides a general overview on the applications and benefits of electrotherapy devices. Future articles will delve further into the specific protocols for performance enhancement, injury management and recovery.

I’ve spent the better part of the last 12 years experimenting with EMS on myself and various speed athletes I’ve coached. My very first personal experience with EMS technology was back in 1986, when I severely sprained my ankle during a basketball game and the physiotherapist was trying to aid muscle re-education by stimulating my soleus muscles just above the ankle. Needless to say, it was an electrifying experience, with the muscle contracting to a point where it felt like an extraordinary cramp. And, the fact that you knew it was going to happen every 30 seconds for 6 seconds of contraction time was a little nerve racking. A small set of LED’s would either
glow green for “ON” or red for “OFF” – much more intense than waiting for a traffic signal to turn green. I still vividly remember that first experience. My own electronic muscle stimulation experimentation started with a small EMS unit that only allowed 1-10 seconds of contraction, with a fixed three second recovery. It also had a TENS (transcutaneous electrical nerve stimulation) function that permitted pulsing and tapping sensations in the muscle. The unit was promoted with a 1981 article by Charlie Francis, and a photo of Bruce Lee with the EMS pads strapped to his shoulders, biceps and pectoral muscles. Seeing that both of these individuals were inspirations to me, it was an easy sell and I purchased the unit for my own home-lab experiments.

**Benefits of EMS Technology**

When I had that first EMS treatment back in 1986, it was clear to me that something profound was happening. As a kid, I had the periodic “finger in the light socket experience” where you would get zapped and classical conditioning finally kicks in. However, once you experience direct stimulation on a large muscle group, you will feel a magnitude of contraction that you normally could not experience through voluntary means. From the standpoint of lifting a weight, a larger load typically means greater recruitment, leading to greater adaptation (i.e. greater maximal strength). Accordingly, one should expect a greater contraction through EMS to result in greater maximal strength abilities as well. Although this benefit of EMS is not readily known by the sporting and fitness public, it is well supported by research and practice.

**Strengthening**
Electronic muscle stimulation can strategically target specific muscles for isolated strengthening. Careful placement of adhesive electrodes can determine not only which muscle or muscles are to be recruited, but also how well these muscles are recruited. EMS used on glutes, hamstrings and calves can help with stride extension and power for running, while work on the quadriceps can assist with eccentric strength and reduce ground contact times. EMS has also been used for strengthening the bottom of the feet. While EMS targets specific muscles isometrically, it must be combined with regular sprinting and running to allow for the gains in raw strength to be converted to coordinated strength and power. Studies have also show that there is a lag in adaptive response – with full gains in strength not realized until four to six weeks after an EMS training block has been concluded. It is important to note that the best results are realized under conditions of significant contraction – which can be quite uncomfortable, bordering on excruciating. It may take several sessions for an individual to get to a point where they can tolerate the higher levels of stimulation required for significant strength adaptation.

**Muscle Re-Education and Atrophy Reduction**

In cases where an injury has been incurred and an athlete must accelerate strengthening or off-set muscle atrophy, EMS can play an important role. This is very common when a joint injury occurs, the limb cannot be used and muscles are not being worked normally. A foot or ankle injury is a perfect example of this application. The EMS unit can be used to work quads, hamstrings, glutes and calves when the athlete cannot properly walk or run for the initial stages of rehabilitation. For the athlete that sprains their ankle or knee in the latter stages of their training cycle, EMS can help to maintain muscle strength until you are ready to resume conventional training.
Pain Management

Through the use of transcutaneous electrical nerve stimulation (TENS) and similar methods of electrotherapy, athletes can benefit from an analgesic effect to manage pain and discomfort. TENS selectively activates large diameter Type A nerve fibers without activating smaller diameter A and C (pain-related) nerve fibers or nerves that innervate muscle. It is often referred to as sensory-level stimulation – where stimulation occurs at or above the sensory threshold, but below the motor threshold. The level of current is determined by the perception of the patient, where current is increased until the patient feels a tingling sensation or “pins and needles” feeling. The mechanism of pain control is most likely either a block of pain transmission or activation of central inhibition of pain transmission by large-diameter nerve fiber stimulation.

Interferential current (IC) was developed by Dr. Hans Nemec in Vienna in the 1950s and became a popular method of electrotherapy in the 1970s. IC involves alternating medium frequency currents at approximately 4000 Hz in an effort to reduce skin resistance and discomfort. The theoretical mechanisms of pain control through IC is similar to that of conventional TENS therapy, including sensory-level stimulation and physiological block of nerve conduction. Others have also claimed that IC improves circulation and reduces swelling.

Circulation Enhancement and Massage

Use of low frequency electric currents have been used to induce a gentle pulsing of the muscle to physically increase circulation, thereby enhancing
blood flow to the treatment area and remove waste products and fluid (venous and lymphatic systems). If you examine the treatment area, you would be able to see the muscle pulsing – unlike EMS for muscle strengthening, where you would see the muscle hold a contraction for anywhere from 3 to 10 seconds. For athletes who cannot access regular massage, EMS can be a useful means to achieve a flushing massage for specific areas of the body. It also can be very useful in cases where athletes have to travel regularly and are sitting for long periods of time in a car, on a bus or during a flight. This form of stimulation can also be used for warm-up routines (in cases where conventional warm-up cannot be implemented) and combined with harder contractions to create a potentiation program enhancing muscle readiness for high intensity work.

**Reduction of Muscle Spasm**

In 1997, I sustained a whiplash injury in a motor vehicle accident which has created problems for me ever since. Numerous times throughout the year I will experience a massive spasm in the muscles around the upper thoracic and cervical areas of my back. Historically, it has taken four to five days for the muscles to settle down, with normal range of motion in my neck returning in 5-6 days. In the last few years, I have been using my Compex muscle stim unit to help reduce recovery times from spasm. The Compex unit has a pre-programmed selection called “Cramp Prevention” that lasts 30-40 minutes in duration. This program helps to settle down the spasm in 1-3 days and restore range of motion in my neck in 2-3 days. The program consists of a series of low frequency pulsing cycles that work the muscles to bring down muscle tone. In essence, the program sequentially fatigues the spastic muscles – bringing down muscle tone – in a comfortable manner using a range of frequencies and pulse widths. When used alone or in
combination with conventional massage, you can effect much quicker recoveries from cases of spasticity using strategically programmed electronic muscle stimulation.

**Soft-Tissue Regeneration, Wound Recovery and Bone Healing**

The use of direct current (DC) stimulation for the healing of tissue is based on the concept that it can enhance the naturally occurring DC potentials associated with natural repair, thereby stimulating the healing process. It has been postulated that living tissue possesses DC electro-potentials that regulate the healing process. When tissue damage occurs, the injury creates a current that triggers the body to biologically repair itself. Studies in both humans and animals have shown that electrical stimulation can actually enhance wound healing. In cases where wounds have shown to be chronic and/or have not healed within the expected time frame, it has been suggested that normal electro-biological healing processes have been arrested. The use of external electro-stimulation of such wounds theoretically produces a series of events which ‘jump-start’ the normal healing process.

Work by Robert Becker suggests that bioelectrical activity occurs throughout the body in a complex field that is closely related to the distribution of the central and peripheral nervous systems. Localized injuries, as well as disease, are thought to lead to a disturbance of this whole-body bioelectrical system, acting as a stimulus for the regeneration and repair process. It has also been long reported that electrical stimulation can be used to enhance bone healing. When external forces are placed on bone, an electrical potential is generated. Negative electrical potentials have been recorded at fracture sites, which is in line with the “current of injury” theory
proposed by Becker. Fukada and Yasuda suggested that the induced electrical potentials at the cathode (negative electrode) triggered the body’s piezoelectrical potentials, which enhance bone repair and growth. Although regarded with skepticism by many in the medical field, there is abundant evidence from clinical studies of the effectiveness of electrical stimulation for bone healing.

**Conclusions and Implications**

The exact mechanisms by which electrical stimulation enhances strength, circulation, muscle tone reduction, regeneration and recovery are still not clearly understood. It is obvious to me – through my personal experiences and discussions with peers – that there is significant value in working with EMS in coordination with other methods of training and recovery. And, I will continue to work with EMS in an effort to determine a coordinated approach to training and rehabilitating athletes. There is amazing “potential” for this technology that I look forward to discovering.

There are several choices in the marketplace for consumers who would like to purchase their own EMS device. In a future article on EMS, I will review a specific EMS device to give my personal opinion on its suitability for both athletes and coaches. I will also devote some time to looking at specific cases where EMS is appropriate, and the protocols required to maximize the effectiveness of this tool.

**References**


**The SpeedCoach Electrical Muscle Stimulation for Sport Training**