Electrical Muscle Stimulation as an Effective Recovery Modality

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ABSTRACT

Electrical muscle stimulation (EMS) has been used to enhance sport performance and rehabilitation from injury for over 50 years and there is a substantial body of scientific research to support the practice. In addition, some coaches and performance professionals have taken advantage of advances in available technology to use EMS to support recovery from training and competition. Research in this area is less complete but sport scientists are now taking a closer look at the concept. The author, an experienced strength and conditioning coach, shares his experience with the use of EMS in the following areas: 1) enhancing blood circulation and the delivery of oxygen and nutrients to muscles and other soft-tissues, 2) enhancing muscle activation to assist with preparation for training or competition, 3) increasing the muscle lengthening effect of Proprioceptive Neuromuscular Facilitation stretching, 4) managing muscle soreness and pain after training sessions. In each case he provides an overview of the use of EMS and the expected benefits. In his conclusion, he cautions that while EMS is an important practical tool for bolstering already established recovery methods, it should be used in combination with them and not as a substitute.

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Introduction

Electrical muscle stimulation (EMS) has been used as both a strength building alternative and a rehabilitation tool for more than 50 years. Numerous studies have demonstrated its efficacy for the development of strength and power particularly when combined with conventional training. Studies using isometric EMS have shown significant strength gains in trained subjects (+32.6% +/- 17.6)[1-6] as well as in elite athletes (+32% +/- 15.6%)[7,8] and that these gains translate into improvements in power and speed[9-12].

More recently, EMS has been used with high-performance athletes for the purpose of hastening recovery from training and competition. Although there has not been as much research into the recovery benefits compared to the strength improvements, sport scientists are now taking a closer look at the advantages of incorporating EMS along with other recov-

ery and regeneration methods into the regimes of athletes. In our practice with numerous top-level performers from a number of sports we have used EMS for more than 20 years and found it to be a useful aid to recovery in the following four ways:

- enhancing blood circulation and the delivery of oxygen and nutrients to muscles and other soft-tissues;
- enhancing muscle activation to assist with preparation for training or competition;
- increasing the muscle lengthening effect of Proprioceptive Neuromuscular Facilitation stretching;
- managing muscle soreness and pain after training sessions.

Written for the benefit of coaches of high-level athletes, this article will explore the use and benefits of EMS technology as it relates to recovery enhancement.

Circulatory Enhancement

It is common practice for athletes to use low intensity exercise as an active recovery method in between more intense training sessions. The concept of active recovery is to increase the body's natural circulatory mechanisms through movement at an intensity level that is high enough to moderately elevate the heart rate without creating excessive fatigue, which would be counterproductive.

Figure 1: Abdominals

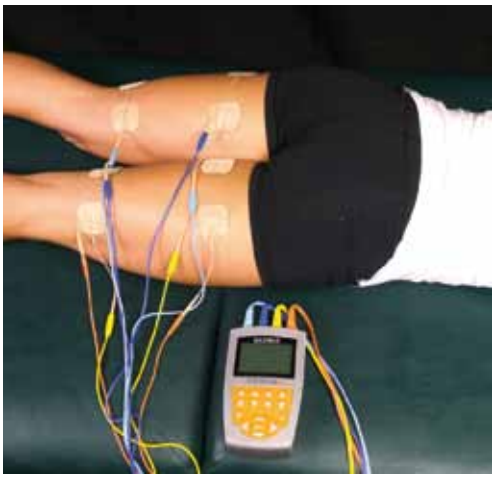

Figure 2: Hamstrings

As such, athletes have also incorporated aerobic exercise into their post-training and competition regimes to facilitate circulatory processes that remove waste products (i.e., lactic acid) and, more importantly, to improve the delivery of oxygen and nutrients to muscles and other soft-tissues.

EMS technology can increase the effects of active recovery and play a significant role in the recovery process with low-intensity pulses through larger muscle groups immediately following or between training and competition sessions. The placement of electrode pads on larger muscles groups, including the quadriceps, hamstrings and gluteals, can produce a larger circulatory effect due to the mechanical contribution of the larger muscles. While a pulsing EMS protocol on a specific muscle group will have a greater impact locally with regard to circulation and muscle loosening, there are also general circulatory effects that are felt throughout the body. The rhythmic contraction of the muscles by EMS can produce dilation of the blood vessels, allowing for greater transport of nutrients to tissues and overall increases in blood flow from about 20 to 200 %, both during and after stimulation[14,15]. A study of competitive swimmers demonstrated that EMS was useful for the removal of lactate following a 200m front crawl sprint when compared to passive recovery[16].

It is important for coaches and athletes to understand that the circulatory benefits of pulsing EMS should be used as a supplement to conventional methods of cooling down, and not as a short-cut permitting athletes to avoid the work required for proper active recovery methods. Although, research has shown that EMS can improve the removal of waste products following intense exercise significantly better than passive rest it is not as effective as whole body low-intensity aerobic work[17]. Only in cases where time or circumstances do not permit the implementation of conventional active recovery methods should EMS be used on its own. This includes cases where an athlete may need to avoid using a certain muscle group or joint due to injury or overuse. For example, an athlete with a sore ankle may be unable to undertake a running or cycling workout for circulatory enhancement for fear of exacerbating the injury. In this case EMS would be an appropriate alternative for creating a suitable circulatory response.

Another case would be for those athletes who have rigorous travelling schedules and often forgo their cool-down session post training, thereby missing out on the benefits of the low intensity activity. While it is not advisable to consistently substitute a voluntary cool-down protocol with EMS, a portable battery powered EMS unit can be a very handy alternative when athletes need to leave training or competition early to attend to other commitments. In many cases, athletes will be seated for long periods of time on a bus or an airplane. Using a portable EMS unit on long rides and flights can be very effective in enhancing circulation in a seated position. Some very simple EMS units have been designed for this purpose increasing circulation in the lower legs while preventing blood pooling in the lower extremities and feet.

Figure 3: Calves

Maximal Muscle Recruitment

As already mentioned, EMS is an effective means of building strength and power when compared to conventional training methods[18-20]. An interesting benefit of EMS in the context of maximal recruitment is that EMS can provide a significantly more intense muscular contraction than a voluntary effort, thereby inducing profoundly greater adaptive responses[21]. In many cases, EMS has the ability to invoke neural adaptations through cortical plasticity[22]. Many athletes who use EMS as part of their training report a feeling of enhanced readiness prior to training or even a greater state of relaxation following training. Although they may have only used maximal EMS on a specific muscle group, they report a general feeling of readiness and relaxation throughout their bodies.

Given these benefits, the application of EMS for maximal contractions can be a valuable tool for speeding the recovery process by promoting a general feeling of muscle relaxation and mobility, and by facilitating a sense of readiness both centrally and peripherally. Prior to exercise or competition, small volumes of intense EMS contractions can create neural activation and greater neuromuscular efficiency in sports and events requiring strength, power and/or speed. The volume of work can be as low as four to five contractions of five to 10

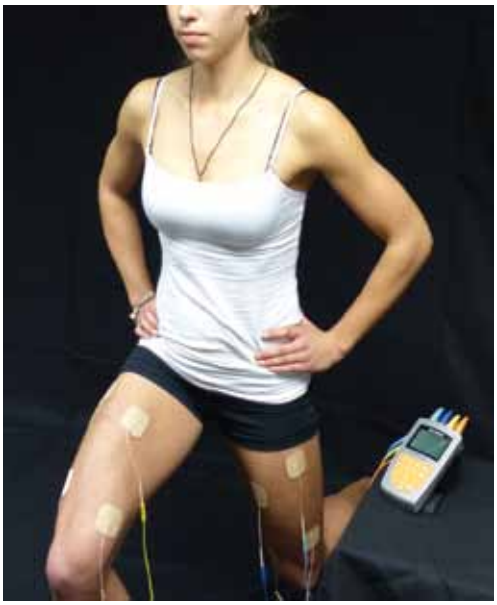

Figure 4: Lunge-Oblique

seconds in duration, with no less than 45 to 60 seconds between contractions to ensure fatigue is not a byproduct. A similar protocol can be followed within rehabilitation progressions where athletes are trying to recruit muscles that have been experiencing disuse following an injury. The high intensity of an EMS invoked muscular contraction can facilitate a more effective voluntary training session in preparation for returning to competition[23, 24, 25].

Conversely, following an intense voluntary workout where muscles have adopted a contracted state, a short series of EMS contractions can help to de-contract and lengthen muscle. While many athletes may gravitate towards a more gentle pulsing protocol for a post-workout session, short duration, high-intensity contractions can have a more profound positive effect in terms of creating a general relaxation response both locally and generally. Similarly to a pre-workout protocol of maximal contractions, four to five contractions of three to five seconds with 30 to 45 seconds between contractions is adequate to promote relaxation while not causing excessive fatigue. While this type of work (i.e. forceful muscle contractions) may appear to be counter-intuitive as a post-exercise recovery method, athletes who have experienced this method of muscle loosening have anecdotally reported significant sensations of relaxation and muscle lengthening.

Muscle Lengthening and Stretching Facilitation

Conventional stretching methods such as Proprioceptive Neuromuscular Facilitation (PNF) have been used for increasing the range of motion (ROM) and elongating muscle before and after a training session. One PNF method is that of reciprocal inhibition. With this method, when the athlete contracts a muscle on one side of a joint, this causes the relaxation and elongation of a muscle on the other side[26]. This method has been typically implemented with partner facilitated stretching protocols, where manual resistance is applied to a limb to promote active contraction of one muscle group in an effort to relax and elongate an opposing muscle group. Use of EMS in combination with PNF stretching

Figure 5: Back

have produced greater improvements in ROM than EMS or PNF alone, particularly in the initial stages of a stretching programme[27].

Implementation of EMS in combination with PNF stretching can be done with many currently available portable EMS devices, in particular those offered by Globus and Compex. These units provide "stretch-relax" programmes that stimulate one muscle group (e.g. quadriceps) in an effort to allow the user to elongate the opposing muscle group (in this case the hamstrings). Ratios of contraction to relaxation durations are typically pre-programmed but can also be customised. Often, it is advisable to stay within the same work to rest ratios as applied to maximum strength protocols, with one second of contraction being paired with five seconds of relaxation. A typical protocol may involve a 10 second contraction on the quadriceps with a 50 second elongation on the hamstrings. In the case of hamstring lengthening, an athlete can easily implement this protocol while standing for the quadriceps contraction phase of the duty cycle. During the relaxation phase, the athlete would focus on lengthen the hamstrings with a toe touching exercise, draping the body forward for 50 seconds. This could be performed for three to five repetitions to effect significant hamstring lengthening. Similar protocols can be carried out quite easily with opposite muscle group combinations such as; anterior tibialis: calves, glutes: hip flexors, triceps: biceps, and adductors: abductors.

Use of EMS with stretching protocols may yield best results when used as a training session implemented away from regular workouts or competitions to increase mobility[28]. Presumably the intent would be to attain new ROM goals in isolation that would transfer to training in subsequent sessions. Athletes should be careful not to over-stretch prior to a training session, as coordination can be compromised and the risks associated with proprioceptive changes can be disruptive.

In addition, athletes can also use low-intensity pulsing protocols on the targeted muscle to improve circulation prior to the stretching session. This can be performed pre- or post-workout depending on the needs of the athlete, as the intensity of contractions are minimal and the changes in ROM are considerably less than with PNF-EMS interventions.

Figure 6: Shoulder

Muscle Soreness and Pain Management

The literature provides mixed results regarding the use of EMS for the management of sore muscles and pain following intense exercise. While some studies have observed no significant difference in muscle soreness following intense exercise 24 hours post training session[29], others have noted a transient attenuation of muscle soreness, particularly when used frequently and consistently[30]. Some studies have looked into the quantification of exercise induced muscle damage using the evaluation of serum creatine kinase (CK) levels. In one, researchers identified significantly lower CK activity following intense exercise using EMS technology as compared to passive recovery[31]. This reduced CK activity was attributed to the EMS's earlier mentioned ability to induce an increase in muscle blood flow.

In cases where athletes are attempting to reduce muscle and joint soreness following intense training sessions, a combination of protocols may be used, provided their EMS unit has the capability to carry out all of the possible programmes. For general muscle soreness, use of a pulsing protocol that enhances circulation mechanism can be used at a light to moderate intensity at and around the site of the muscle group or body part in question. This pulsing programme may also alleviate muscle tightness reducing overall muscle tone. As some muscle and joint soreness may be related to high muscle tone due to a shortened contracted state of the muscle, a light pulsing programme can provide some degree of relief. A higher frequency programme, similar to that used in Transcutaneous Electrical Nerve Stimulation (TENS) devices, can often provide general pain relief and a reduction in muscle soreness over a number of sessions[32]. In some situations, a reduction in pain sensation will allow an athlete to relax mentally, thereby breaking the chain of pain and discomfort through the facilitation of movement, circulation and muscle lengthening[33].

Conclusion

While many athletes are searching for the single "magic bullet" for recovery, they would be best served by establishing a well-rounded approach to recovery and regeneration in their training programmes. Electrical muscle stimulation (EMS) is a tool available to athletes to bolster already established recovery methods. When combined with other methods, such as massage, contrast baths, stretching and active recovery activities, EMS can hasten recovery and give the athlete a tangible feeling of wellness and, ultimately, readiness preparing them for their next training session. In cases where athletes do not have the time or luxury of implementing a well-rounded battery of recovery methods, such as in scenarios where frequent travel is required, EMS can serve as a alternative to conventional recovery protocols. The portability and convenience of the current generation of EMS devices makes it much easier for athletes to take advantage of the technology in these situations. Additionally, the preprogrammed protocols that accompany many of the higher quality machines make it easy for athletes to guide themselves through recovery sessions, without an advanced knowledge of electrophysiology being a prerequisite.

For athletes and coaches considering the use of EMS for recovery purposes, it is imperative that their training programmes incorporate well-planned training loads, appropriate rest intervals and a supportive array of recovery methods. EMS can be a very valuable piece of the recovery puzzle, but must be integrated with a sound approach to training and recovery. Before deciding to purchase an EMS device for performance and recovery purposes, coaches and athletes should take the necessary steps to identify where and how the technology can be used consistently and effectively. Once EMS is properly integrated into an overall training and recovery approach, athletes will notice the daily contribution of EMS in terms of their readiness and performance. As more coaches, athletes, and sporting organisations incorporate EMS for performance and recovery purposes, it is anticipated that a greater amount of research will be undertaken to further determine optimal protocols for athletes in between their training sessions and competitions.

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