ELECTRO-MUSCLE STIMULATION - THE APPLICATION IN PRACTICE

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Review paper

Abstract
The need to get 'fit' has resulted in a planetary fitness centre expansion, which has by the principle of cause and effect brought out a massive number of different fitness exercising programmes, methods, equipment and props, with an aim to achieve better and faster training results, i.e. the wanted transformational anthropological status. The new fitness programs are emerging almost every day, which in spite of a vast marketing support and a current publicity are forgotten very fast. Within those conditions, in order to achieve satisfaction and trust of your clients, the offered programmes need to produce wanted effects in regards to the transformation of targeted abilities or characteristics of those who perform exercises. This presents constant challenges to the fitness industry, along with the obligation to seek for optimum, scientifically accepted and proven exercising methods. It is because of those reasons that the professional fitness centres are interested in introducing and applying only proven training methods, using highly sophisticated and technologically advanced equipment. This paper deals with analysis of Electro muscular stimulation (EMS) as one of the three methods which have been developed through a research designed for the astronauts. It was released into public after the fall of the "Berlin Wall 1989" and opening the secret USSR and USA documents. The current research defines the related units starting from epistemology of the electro muscle stimulation (EMS), its application as an alternative to developing conditional capacities, clinical use in physiotherapy and EMS and EMS as one of the means to athlete recovery (body's regeneration processes) so as to prevent negative training effects (the development of overtraining and chronic fatigue). Each of the units will contain information which is relevant to the theory and practice in sport, recreation and convalescence of athletes and patients.

Key words: *electro-muscle stimulation (EMS), fitness and sport, the application in practice, contraindications, convalescence.*

Introduction

In the last few decades with the right one can speak of fitness as a serious, first of all, very profitable industry. The need to be "fit" resulted in the planetary expansion of the fitness, which causally caused the emergence of a large number of different fitness programs, exercise method, devices, and equipment, with the aim of better and faster training results, i.e. the desired transformation of anthropological status. In such circumstances, in order to achieve satisfaction and customer trust, programs that are offered must lead to the desired effects on the transformation of targeted skills or characteristics of trainees. Thus, almost every day, new fitness programs appear, which despite massive marketing support, as well as the current publicity, quickly fall into oblivion. The most common reasons for this lie in the lack of desired results, and termination of client interest for this type of exercise. This continuously sets new challenges to the fitness industry and imposes a duty to seek optimal, therefore scientifically accepted and proven method of exercise. It should not be overlooked that such programs and methods must follow the trends of modern understanding of fitness. For these reasons, serious fitness centers have the interest to introduce and practice only the proven training methods, using at the same time highly sophisticated, technologically advanced equipment. In this study will be presented in detail one of three methods that have arisen in research intended for astronauts, i.e. the space program of major world powers (Vrcić, Kovačević, &Abazović, 2015). These findings later found their place in the military industry, and finally at the top sports, i.e. the Olympic programs of the USSR and the USA. Only by the cessation of the "cold war" and the opening of secret documents, vibration training, isokinetic training and electrical muscle stimulation saw the daylight. This research will try to elucidate knowledge in the field of electrical muscle stimulation (EMS) and on objective and professional way present scientific research findings of mentioned training methods. The research aims to answer key questions, give serious and proven recommendations for safe application of EMS methods in fitness and make explicitly the expected benefits and possible contraindications.

Epistemology of electro-muscle stimulation (EMS)

The EMS stands for electric muscle stimulation, a method widely used for years in rehab medicine and sport. This method successfully restores and improves muscle tonus, but it is also used in the treatment of medical conditions which involve the loss of muscle mass. In sports and fitness, the EMS is used as an additional part of the conventional training in order to stimulate specific muscle groups

to increase their strength and efficiency or aesthetic appearance. Different level of muscle contraction is achieved by sending electric pulses of different types depending on the selected program. These contractions reactivate muscles, increase their efficiency and stamina and are very important for muscles which, for whatever reason, were not regularly used (muscle atrophy). In sport, it represents benefit because it increases the effect of training and improves performance. By typing the term "electro-muscle stimulation" - EMS, the browser opens a vast number of websites that offer this type of training or services. By a more detailed analysis of the offered content we can easily come up with a few striking and for kinesiology practice a bit worrying facts. Firstly, most of the conclusions presented are at the level of scientific and professional speculations, which means that they are scientifically untested or, at worst, completely untrue.

It's a bit like this: "Muscle electro-stimulation is electrotherapy treatment with a highly sophisticated machine, which through a low-frequency current breaks down fat and cellulite, accelerates weight loss, stimulates peripheral microcirculation, improves muscle tonus, shapes the body and restores its thinness." (Vrcić, et al., 2015). This is just one of a myriad of definitions that can be found on mentioned sites, and even at first glance, it shows that marketing is a very cleverly written, and that it provides consumer a quick and easy path to perfect figure without excess fat. Another extremely important fact refers to the type and use of facilities that provide these treatments. Deliberately is used the term treatment, not training, because it is evident that in addition to fitness centers and physical medicine, beauty salons or some wellness centers dominate (Vrcić, et al. 2015). It is clear that electrical muscle stimulation, as a service, is offered in a very large number of facilities that have a completely different purpose and essence of its work. This in itself carries a third possibly decisive factor of "failures", with the exception of the first marketing impression on consumers, and that is actually a person "coach" who realizes this type of treatment. It is clear that we are talking about a very small number of medical (physical medicine doctors and physiotherapists) personnel, and occupations such as beauticians, makeup artists and people of similar professional profile dominate. It is almost unbelievable that kinesiologists or people with education in the field of physical training participate the least in the provision and control of the implementation of this type of training.

The situation is even worse if we take into account that there are people with an adequate kinesiology education, who because of marketing and quick profits, through their facebook profiles and web portals, promote unverified information, and consciously or unconsciously confuse the public. This leads to the appearance that this method is discussed at the level of "hearsay" and there are contradictory customer experiences, from complete disappointment to rebirth in training, but also life in general. The truth, as usual, is somewhere in between, that is halfway between a disappointed customer experience who is really overweight and in chronically bad health condition, which, after several EMS treatment has not improved at all, and aggressive marketing campaigns to promote this method as a breakthrough in the fight with all the problems of the modern fitness centre users. In a serious expert literature this training method is generally defined as follows: "Electrical stimulation is a type of training that is carried out through passive movements of body segments, caused by the application of electric current. The apparatus used is called an electric muscle stimulator. It is mainly used for the purpose of treatment of injuries and muscle atrophy, during and after the immobilization. It is believed that electrical stimulation accelerates the renewal of muscle tissue and shortens the duration of rehabilitation. Improper use can result in burns to the skin and deeper tissues." (Ostojic, 2006). EMS is primarily a method of physical therapy and has been used for many years as a method of rehabilitation of muscles after injury or surgery. In the early 1960s, it was often used in an attempt to prevent the atrophy of skeletal muscle that occurred as a result of weakened or interrupted innervations (Davis, Hamzaid, & Fornusek, 2008). With the development of stimulation devices the EMS has become a popular method for the treatment of patients who have suffered damage to the central nervous system, most often due to stroke or spinal cord injury (Scremin, Kurta, Gentili, et al., 1999; Wheeler, Andrews, Lederer, et al. 2002). Over the past 20 years, manufacturers have developed high-quality devices, capable of modulating various forms of pulses of electrical current, which can be used to stimulate muscle contraction. For these reasons, the EMS is being increasingly applied in order to improve the strength of the lower extremities (Laughman, Youdas, Garrett, et al. 1983) in the process of rehabilitation of patients who have had orthopedic surgery, especially the reconstruction of the anterior cruciate ligament (Porcari, Mclean, Foster, et al., 2002; Avramidis, Strike, Taylor, &Swain, 2003). To understand better the idea of the use of electrical muscle stimulation in rehabilitation, but also sport, it is necessary to know the basic physiological mechanisms of muscle contraction and its nervous regulation, because it is the one that inspired the researchers, using external excitation of muscles, to try to cause its contraction and generate greater force than during maximal voluntary contraction.

Physiological mechanisms of electro-muscle stimulation (EMS) and functioning

EMS is achieved by an electric impulse which, via electrodes on the skin stimulates nerves that innervate specific muscle group (Figure 1). The muscles work differently depending on the severity, frequency and pulse width of electric impulse. Muscle is made up of two types of muscle fibers: red - which slowly contract and work under aerobic

conditions, and white - which react faster and are capable of anaerobic work. The ratio of white and red muscle fibers depends on the way the muscles are used. Muscle fibers can be converted from one form to another, depending on the signals they receive. This is known as a trophic effect (Pavlović, 2014). Contraction (lat. contraho-contract) or muscle spasm is a process of muscle shortening whereby there is a manifestation of the forces at its ends (tendons). All skeletal muscles are composed of a large number of muscle fibers; each muscle fiber contains several hundred to several thousand muscle fibers or myofibrils. Each myofibril consists of about 1500myosin and 3000 actin filaments or microfilaments. The main commander and controller of motor activity is the central nervous system (CNS), which generates and transmits nerve impulses necessary for muscle contraction. Every nerve ending is tied with muscle fibers in the neuromuscular junction, located approximately in the middle of the muscle fiber. The nerve fiber branches at its end, making web branched nerve endings, which make the structure called the motor plate. The electric impulse in the form of an action potential travels along the motor nerve to its end on the muscle fibers. Each impulse that arrives at the neuromuscular junction typically creates the potential motor plate, which is about three times higher than the potential required to incite the muscle fiber. When a nerve impulse reaches the neuromuscular junction, from the nerve endings in the synaptic cleft is emptied one part of the neurotransmitter acetylcholine bubbles (10,000 molecules).

Acetylcholine acts locally on the membrane of muscle fibers and allows the entry of sodium ions into the interior of the muscle fibers membrane. This reaction promotes the formation of the action potential in the muscle fiber, which along the muscle fiber membrane travels in the same way as along the nervous fiber membrane, leading to depolarization of muscle membrane (2-4ms).The membrane suddenly becomes very permeable to sodium ions, which immediately neutralize the impact of the normal polarized state of -90 mV and the potential increases rapidly in the positive direction (5mV). In this way, a large part of the electric current of the action potential goes deep within the muscle fiber, releasing from the sarcoplasmic reticulum large amount of calcium ions. Calcium ions induce forces of attraction between the actin and myosin filaments, causing their mutual sliding necessary to create muscle contraction. Immediately thereafter (milliseconds) calcium pump membrane returns the calcium ions to sarcoplasmic reticulum where they remain stored until a new action potential (Guyton, & Hall, 2003). Spots of contact of muscular and nervous fibers make the motor unit (muons). The motor unit consists of a single α (alpha) -motor neurons (with associated nerve fibers) and all the muscle cells that irritate these individual neurons. During the voluntary activity, CNS first activates the smallest alpha motoneuron, while, with the increase of the force, higher motoneurons are progressively triggered. This principle is called the "recruitment in size", and refers to the engagement of motor units and depends on the size of the alpha motor neurons. Among motor units, there are differences in the frequency of nerve impulses, and these differences depend on the type of muscle cells in motor units (Mišigoj-Duraković, et al., 1999). The male motor unit usually contains slow (red) oxidative fibers of low threshold stimulation. Nerve fibers, which sensitize them, have relatively low impulse frequencies (10-20 Hz).Opposite of them are the motor units with a fast (white) glycolytic fibers, with the nerve fibers of high-frequency impulses (40-60 Hz). Between these two types, there are transitional fast oxidative-glycolytic fibers (Type IIa), with the nerve fibers of medium impulse frequency (20-40 Hz). Lower relative forces of contraction (relative force is the strength percentage) trigger the slow fibers. Between 40-60% of relative forces are activated type IIa fibers, and most of the high-speed fibers are activated only above 90% of relative force (Pavlović, 2014; Vrcić,et al., 2015). Increasing the force of contraction leads to the increase of impulse frequency of all types of motor units, up to a maximum contraction, when the nerve fibers of all activated motor units achieve the highest frequency impulses, in terms characteristic for individual fibers (so fibers of slow units will again have the lowest and high-speed fiber units the highest frequency). The order of muscle fibers activation is reversed when the muscle is electro-stimulated therefore activated by external stimuli through electro-stimulator. In this case, first are recruited fast contractile muscle fibers and with the highest engagement, and after that, slow contractile muscle fibers with low engagement (Porcari, Mclean, Foster, et al., 2002). This phenomenon significantly affects the size of the forces generated during electro-stimulated contraction, i.e. the difference between the force in this type of contraction and the force generated during maximal voluntary contraction.

The principle of electrical stimulation consists of stimulating the nerve fibers by electrical impulses that are transmitted through the electrodes. In active training muscular work comes from the brain, which sends the command in the form of electrical signals to nerve fibers that contract. The principle of electrical stimulation corresponds exactly to the process that takes place at the desired contraction. The stimulator sends an electrical current impulse to the nerve fibers, which causes their irritation. This irritation is submitted further to the muscle fibers that perform elementary mechanical response (muscle twitch) as an essential element of muscle contraction. The reaction of the muscle is fully synchronized with the work of the muscles from the brain. In other words, the muscle cannot distinguish the command from the stimulator from those from the brain. Various parameters (number of impulses per second, the duration of contractions, the duration of resting stages) allow different types of muscles to start working, depending on the muscle fibers.

Fast fibers will be more prevalent among sprinters while marathon runners will have more slow fibers. Knowledge of human physiology and a perfect mastering of stimulation parameters of the program allow very precisely the work of muscles to be directed to the desired objective (to strengthen muscles, increase blood flow, mounting). To achieve the pain relief effects the electrical impulses can also arouse sensitive nerve fibers. The stimulation of nerve fibers blocks the transfer of the pain through the nervous system, in contrast to the stimulation of some other types of sensible fibers which causes an increase in the production of endorphins alleviating pain. (Baker, McNeal, Benton, et al. 1993).

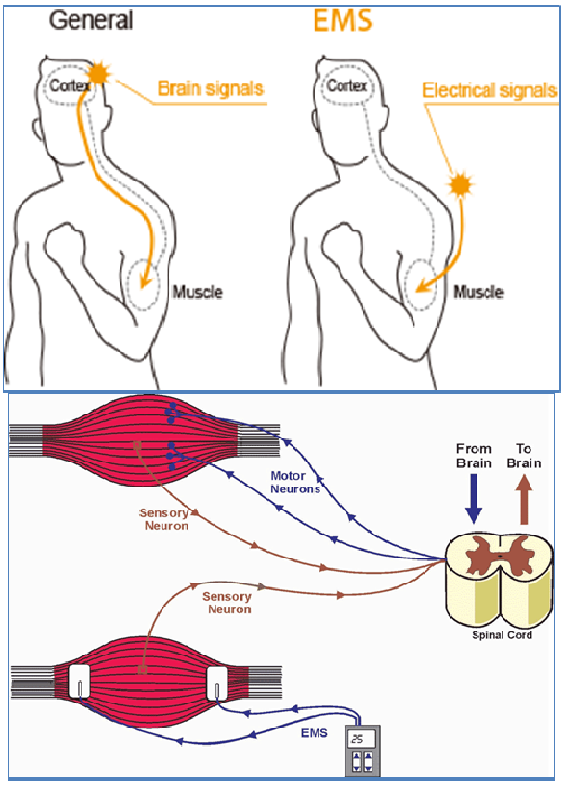

Figure 1. *Stimulation of motor neuron (EMS)- afferent and efferent impulse*

The use of EMS in sports and fitness

Electrical stimulation in recent years has begun to be applied in sports, especially with athletes who need strength. It is implemented by using special appliances, and the length of stimulation lasts for 10-15 seconds with breaks of 45-50 seconds, usually with 10 repetitions. It can be particularly useful when properlydosed; otherwise, its use can cause harmful effects, especially if used for longer than the scheduled time. By applying electrical stimulation blood circulation and metabolism of nutrients in muscle cells are improved, thereby contributing to the increase of muscle mass, and thus strength.Most often it is used for the purpose of recovery, but after three weeks of its effect lowers. The application of EMS in the sport and fitness helps strengthen specific muscles or muscle groups in order to achieve the desired proportions of the body, the development of muscular endurance, warming, strengthening and increasing strength, improves muscle recovery and rehabilitation of sports injuries (Vrcić, et al., 2015). It is important to note that the effect of the EMS functioning can be expected only in regular use, it does not replace regular exercise but it is good as a complementary part. There are only a few studies in the scientific literature in the field of electrical stimulation of muscles. There are even fewer allegations that document the effects of applying this method to healthy people, and the physically active population, or recreational athletes (Banerjee, Caulfield, Crowe, & Clark, 2005; Davis, Hamzaid, & Fornusek, 2008). Previous research in the field of the EMS identified the significant effects on strength and power, but in isolated muscle groups (*m. quadriceps femoris or m.bicepsfemoris*).There are top sportsmen (canoe or kayak) with a very positive attitude towards electrical stimulation, but even they apply it locally (on several muscles), before major competitions, including the Olympics. Some allegations indicate that if the EMS is applied regularly (twice a day) on the small muscles of the foot arch, improvements are probable, or on higher muscle groups the EMS treatment can vary from 15-60 minutes, twice a week to several times (Malacko & Rađo, 2004). In addition, the EMS has been successfully applied to the extensor muscles of the spine with the rowers and kayakers, who tend to the occurrence of pain in the lower back (Wheeler, Andrews, & Lederer, R., 2002 Zaciorski, & Kremer, 2009). Advantages of using the EMS to the whole body in order to achieve better physical form or shape have never been tested. However, it is evident that the EMS has an important place in the field of recreational exercise, and a growing number of fitness centers that follow the modern trends offer this type of training.

The first allegations and the first documented research in the Soviet Union state that the EMS is a more effective method of developing strength and power of skeletal muscles in athletes than exercise without the use of electrical stimulation (Kots, 1977).This method was used in the Soviet Union on the athletes at the end of the sixties of the twentieth century, but contrary to some beliefs it was not regularly used as a substitute for traditional strength training. Often the authors state that the advantage of using the EMS lies in a different mode of motor unit recruitment in relation to the exercise with maximum voluntary contraction. The EMS method found its application in the field of sports and fitness mainly through a technique called tetanic stimulation. It represents a series of repeated stimulus-electrical impulses, which are determined by two key factors: the duration of each impulse and the time between consecutive impulses.Tetanic stimulation makes it possible to manipulate the impulse duration and breaks between two consecutive impulses, which determines the total load on the stimulated muscle. If the time between two consecutive impulses is short, the muscle will not be ready for the next contraction. This period is called the absolute non-irritability refraction period lasting from 1-3ms. (Pavlović, 2014).

This method theoretically should cause the maximum possible power development as a series of consecutive impulses causes the maximum contractions of the stimulated muscle. It is recommended to use with athletes or recreational athletes with a higher level of quality. Electrical muscle stimulation in sport and fitness is applied mainly through external electrodes, i.e. through the skin. Bipolar electrodes are commonly used (which means that the electrode has two different poles).

The electrodes are typically attached to the skin above the stimulated muscle. For proper and comfortable work it is very important to use the appropriate size electrodes and properly position them in the muscle (Knez, 2000). For the successful implementation of the EMS method, it is necessary to take into account the quality of the stimulation device. In fact, studies have shown that the actual frequency of electrical impulses (modulation), provided by stimulator, can significantly (for several times) be different from those declared on the device.Specifically, the muscle fatigue is increased with the increase in the stimulation frequency (DeVahl, 1992). Most of the previously used protocols, intended for the development of strengths and the power, indicate that the frequency must be sufficiently high to achieve a tetanic contraction, but at the same time sufficiently low to minimize the muscle fatigue (Baker, et al., 1993). Usually, this is achieved by using frequencies of between 50 and 75 Hz.

Excessive stimulation frequency in combination with short breaks between contractions leads to extreme fatigue at stimulated muscle fibers, which can result in an insignificant increase in muscle strength after the EMS. Another factor that can affect muscle fatigue, and thus the size of the effects, is the order of engaged muscle fibers during the EMS (considerably changed in relation to the voluntary contraction).So, first are engaged the fast contractile muscle fibers (Van Swearingen, 1993). In addition, there is a synchronous activation of all of the same sized axons, at equal distance from the electrode (Baker, et al., 1993).

Thus, in relation to the voluntary contraction, electrically caused contraction leads to a much greater fatigue of the muscle fibers, due to selective engagement of fast contractile muscle fibers in combination with synchronous activation of the same muscle fibers repeatedly. Accordingly, protocols used to develop strength and muscle strength using the EMS, usually are designed to reduce fatigue. The first manner of reducing fatigue is to allow plenty of time to recover muscle fibers after each contraction. This is often accomplished by the ratio of contraction and relaxation of 1: 5 (Baker et al., 1993). However, a large number of stimulators used in research allows a relatively short recovery time. This ratio is ranged from 1: 3 to 1: 5. Although in the offer can be found different types of electro-stimulation treatments or training, in professional sports literature is mainly mentioned the so-called "Russian protocol".

Russian Protocol (Zaciorski and Kremer. 2009):
- Carrying signal - sinusoidal or triangular
- Frequency - greater than 2500 Hz
- Modulation - 50 Hz
- Amplitude of stimulus - adapted to the individual to induce a force greater than 100% of maximal isometric force or up to the limit of athlete's endurance; the amplitude of the stimuli depends on the output of the impedance of the stimulator, and is often greater than 90 V
- Duration of contraction -10 s
- Pause between contractions - 50 s
- The number of contractions – 10 daily
- The number of training days - 5 times a week

Extremely important factor for the development of strength and power is the intensity of the training, which is carried out regardless of whether combined with external irritation or not. The EMS in previous studies was mostly combined with a generally isometric type of muscle contraction. The results of the studies which combined the EMS and strength training, thefirst state that to achieve an increase in strength of contractions the muscle should be stimulated above the critical threshold. This threshold can be very low 30% of the maximal voluntary contraction (MVC) in untrained individuals, but must strictly be in the range of 60-80% MVC in athletes (Mueller, 1959).After a series of studies to determine the minimum threshold required to achieve improvements in strength (Currier, Lehman, & Lightfoot, 1979) it was concluded that electrically induced contraction must be at least 60% of MVC (Currier, et al., 1979; Currier, & Mann 1983; Soo, Currier, &Threlkeld, 1988). Studies have established that if the power of electrically induced contraction was less than 20% of MVC, the stimulus is below the critical threshold needed to increase muscle strength and changes in the appearance of a healthy person.

In fact, in a study on healthy people was administered a battery of tests that included: body weight, percentage of subcutaneous adipose tissue - skin folds, circumferences, isometric and isokinetic strength (biceps, triceps, quadriceps and hamstring) and appearance (photos - forward, backward) in order to determine the actual effects of the EMS on physical strength, reduction of body fat and general appearance of trainees (Porcari, Mclean, Foster, & et al. 2002). Treatment of 8 weeks long EMS stimulation did not result in statistically significant effects on these variables. The findings of this study do not support the manufacturers' claims that the EMS is important for the development of strength and power, and that it lowers the proportion of subcutaneous fat as well as the general appearance of healthy people. Electrical stimulation could serve as a useful addition to traditional training methods. It can stimulate not only the creation of maximum force but also the speed of movement and muscle endurance. Time of accommodation is usually twenty to twenty-five days of training, the training for the development of maximum power, and ten to twelve days for speed training.

If electro-stimulation is applied to increase muscular endurance, stabilization cannot be achieved even after thirty-five units of training. However, although the EMS has the potential to increase the strength, many experienced athletes do not accept this method. In addition to the usual resistance to everything that is new, there are two very strong reasons for this. First, athletes can take advantage of advances in an isometric mode in real competitive activities. Second, some athletes during the electro-stimulation had an unpleasant feeling that they lose the muscle control or coordination, and therefore refused to continue further treatment. This confirms the theory that the electro-stimulation trains only the muscles (but not the neurological factor). The ability to increase activation of a muscle cell is not increased by this type of training (Zaciorski and Kremer, 2009). In the end, it is necessary to indicate the possible contraindications and precautions to be followed during each non-medical application of electrical stimulation, regardless of the objective and purpose.

Contraindications of the EMS

- ✓ It is not applied to the thoracic area in patients with arrhythmia, congestive heart failure, recent myocardial infarction and other heart diseases;
- ✓ Not applied anywhere on the body in a patient with a built-heart stimulator, defibrillator or other medical electrical stimulators;
- ✓ Not applied to the area of the carotid arteries as it can cause a rise in blood pressure, cause reflex vasodilatation and slow down the heart rate;
- ✓ Not applied to the head area (electrical impulse travels "through the head");
- ✓ not applied at malignant (cancer) tissues; not applied to the area of damaged or irritated skin because it can cause pain and discomfort, exception is medical electrical stimulation for wound healing;
- ✓ Not applied to the territory or close contact with metals, such as external pins, orthopedic fixations, etc. (metals are excellent conductors of electricity);
- ✓ Not applied to any patient who has a negative feeling of stimulation;
- ✓ Not applied to a patient with undiagnosed pain, without conclusions on the cause of the disease;
- ✓ Not applied to a patient who cannot provide adequate feedback on the level of stimulation (children, people with mental disorders).

Precautions during the EMS

- ✓ Pay special attention when using the EMS with high amplitudes directly over the area where the bone is positioned on surface (it can lead to periosteal pain);
- ✓ Pay special attention when applying in areas of excessive body fat, because they require high stimulation to activate the desired muscles which may cause pain;
- ✓ Pay particular attention to the application near the womb during pregnancy and childbirth (possible effects on the fetus have not been established); pay special attention when applying in the region of the bladder, because it can interfere its normal function;
- ✓ Pay particular attention to the implementation to patients with a history of metastatic diseases.

Conclusion

Based on the above it can be concluded that EMS is now commonly used as an additional method in the development of the strength at experienced athletes or top recreational sportsmen. Electrical stimulation provides the highly effective ability of muscular work with the development of different quality muscles without the fatigue of cardiovascular system and psyche, by the low workload of joints and tendons, allowing muscles a greater working task than working with the willful actions.

To be effective this work must be carried out preferably with the activation of a large number of muscle fibers, and the number of fibers depends on the stimulation energy. The user himself/herself is responsible for this aspect of the simulation. The higher the stimulation energy, there is a greater number of working muscle fibers, so the progress follows.

In order to the extract greater benefit from the achieved results during the application of the EMS we need to pay attention to all information obtained during previous research and practical application, in order to achieve the desired effects and improve training practice of top athletes, and recreational athletes in fitness centers.

However, the existing knowledge of the EMS is still not fully explored scientifically and not practically confirmed, it requires further experimental research in the field of professional sport and fitness so that this method could take its place in everyday use.

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ELEKTROMIŠIĆNA STIMULACIJA - PRIMJENA U PRAKSI

Sažetak

Potreba za "uklapanjem" dovela je do planetarnog ekspanzije fitnes centara. Novi fitnes programi se pojavljuju skoro svaki dan, no uprkos velikoj marketinškoj podršci i trenutne javnosti vrlo brzo budu zaboravljeni. U okviru tih uslova, a u cilju postizanja zadovoljstva i povjerenja svojih klijenata, ponuđeni program treba proizvesti željene efekte u vezi sa transformacijom ciljanih sposobnosti ili karakteristika onih koji obavljaju vježbe. Ovo predstavlja stalne izazove za fitnes industriju, uz obavezu da se traže optimalne, znanstveno prihvaćene i dokazane metode koje se obavljaju. Ovaj rad se bavi analizom elektromišićne stimulacije (EMS), kao jednim od tri načina koji su razvijeni kroz istraživanja dizajnirana za astronaute. Pušten je u javnost nakon pada Berlinskog zida 1989.godine i otvaranja tajnih SSSR i SAD dokumenata. Sadašnja istraživanja definiraju odgovarajuće jedinice, počevši od epistemologije na elektromišićastimulacije (EMS), njegove primjene kao alternative razvoja uslovnog kapaciteta, kliničke primjene u fizikalnoj terapiji i EMS kao jedan od načina za oporavak sportaša (regeneracije tijela) kako bi se spriječili negativni efekti treninga (razvoj pretreniranosti i kroničnog umora). Svaka jedinica će sadržiti informacije koje su relevantne za teoriju i praksu u sportu, rekreaciju i oporavku sportista i pacijenata.

Ključne riječi: *elektromišićna stimulacija (EMS), fitnes i sport, primjena u praksi, kontraindikacija, izliječenja*

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