# ELECTROSTIMULATION AND FORCE PRODUCTION

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## INTRODUCTION

Setting the body in motion requires coordination of many muscular contractions. These are governed by the nervous system. In fact electrical stimulation (ES) is a way of substitute for this system provoking confined stimuli. In sport ES presents several types of applications:

- fight against muscular atrophy,
- a mean of reducing pain,
- improvement of muscular strength.

For muscular and sport exercise,the force production is one of the first important parameter to control. If the goal is toincrease muscle strength, it may thus be important to maximize tlie muscle tension achieved during training period. Before more detailed study is carried out. it is necessary to understand how the induction of current brings out the activation of nerve or muscle.

An action potential may be conducted by the nervous system. Ionic movements produce this potential. Ions in the region will migrate toward or from electrodes according to their charge. Some of the ionic movement occurs in the extra cellular fluid, some of tlie current passes through the nerve membrane. The net effect of tlie current is a depolarisation of the nerve membrane. If the current is large enough, an action potential will be evoked. Excitability of muscle and nerve fibers is different. We know that peripheral nerve fibers are inherently more excitable by ES than muscle fibers. Firstly ES activate nerve fibers. Secondly, in a mixed peripheral nerve, fibers with the largest diameter are the most easily excited. It is generally thought that with ES, the pattern of recruitment tends to be from largest to smallest diameter fibers, so first fast fibers are activated followed by slow fibers. A relationship between stimulus intensity and magnitude of the response can be described. This relation affects the motor unit recruitment and muscular strength production. So, it is always possible to regulate force production via the intensity, but in order to minimize fatigue phenomenon it may be interesting to have a better control of parameters of stimulation. In fact ES is defined by several parameters such as intensity, pulse duration, wave form or frequency. To achieve optimal activation, the distance between tlie electrodes and their localization on the muscle is also an important factor.

The aim of this work is to determine the advantage of a multi - electrodes technique, in order to induce a maximal isometric force on the quadriceps femoris muscle.

## METHOD

The experiment was conducted on 8 healthy male volunteer subjects (P.E. students, 1.72 m ,75 kg, 29 years old). The subjects were seated with the knee flexed at 60°. Trunk and thigh angle was fixed at 11O°. A force transducer linked to a computer was fixed on the ankle. A large common proximal electrode was secured over the femoral nerve and three distal electrodes were put in regards of the motor point of VL,VM, and VI muscle. Left and right legs were stimulated alternately.

A symmetrical square wave signal with a 2 ms rest between positive and negative phase (150 μs) was applied at 80 Hz frequency. The maximal intensity of each stimulation was determined according to the maximal tolerance of the subjects.

The training procedure consists in 6 sets of 6 contractions with 4s on and 2 s off during 18 sessions.

The following parameters were measured before and after training, on the right and left legs:

- Maximal voluntary isometric force
- Maximal force induce by ES.

## RESULTS

After an initial ramp a nearly flat curve corresponding to tetanus was reached. The stimulation procedure allows to reach 88% and 90% of MVC on the left and right leg respectively. After training session we got a similar result and forces induced reached 91% and 99% of the force considered as MVC. The training group improve force of about 16% on the right leg and of 14% on the left leg.

## DISCUSSION

For beginners as well as after electrical training sessions, inducing performance increases, the new muscular stimulation procedures proposed allow to get maximal contraction with a relative comfort. Most of the studies report that ES can induce nearly 70 to 80% of MVC. But, in the literature, most of the authors used only two electrodes. One is located on the proximal part, and one on the distal part of the thigh( Grimby, 1989; Snider-Mackler. 1989; Delitto, 1989; Portmann, 1991; Liber 1993). It is quite surprising to notice that recent studies use this placement whereas Guilbert and Carnot in 1909 already proposed an electrode localization above the motor points. With the proposed technique we can reach quite easily 100% of MVC. This will he a powerful tool to improve maximal force. One of the potential advantage of ES is to allow muscle strength improvement even if the subjects can't perform weight training exercise. If we consider that we can override the fatigue sensation, we must be very careful with the introduction of ES in the training session. Furthermore, ethic problems are associated with the introduction of ES in training programm.

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