ELECTROSTIMULATION AND FATIGUE

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INTRODUCTION

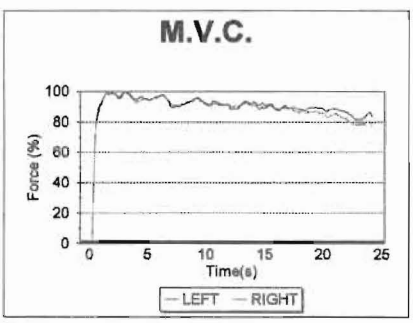
Electrostimulation (ES) appears to be a complement to voluntary training because it specifically induces the activity of large motor units which are more difficult to activate during voluntary contractions (Hainaut and Duchateau, 1992). To achieve a strong contraction over 80% of maximal voluntary contraction (MVC) several parameters should be considered : adequate positioning of electrodes and adequate electrical stimuli parameters (Ferry et al 1994). Prolonged electrical stimulation of a healthy muscle will lead to muscular fatigue (Jones et al., 1979; Currier and Man, 1983; Duchateau and Hainaut, 1985).During ES training sessions, in order to avoid overstimulation and fatigue, adequate rest periods should be provided between consecutive stimuli. The aim of this paper is to describe the force production evolution during prolonged or briefly interrupted ES.

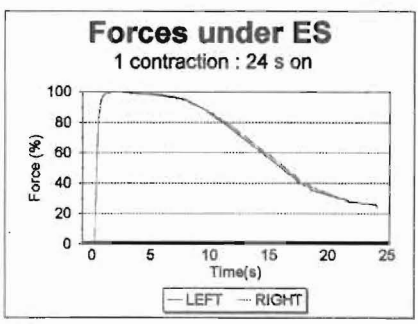
METHODS

The experiment was conducted on 5 healthy, male volunteer subjects (PE students, used to practising weight-training).Removable electrodes were secured over the quadriceps femoris muscle after skin cleaning. The centre of the proximal electrode (12*4 cm) was secured over the crural nerve, while the distal electrodes (4*4cm) were placed over the vastus medialis, the vastus lateralis and the rectus femoris muscles. A bi-phasic, symetrical square wave signal (frequency=80 Hz) was applied with a SG3 apparatus. The pulse duration was constant throughout the experiment with a rest of 2ms between positive and negative hemiphases (150µs each).Isometric force of the knee extensor was measured using a special seat including two force transducers(200 daN). Both legs were studied for all subjects. Four experimental conditions were used : 1- MVC during 24s, 2- ES during 24s, 3- 6 contractions under ES with 4s on, 2 s off, 4- 4 contractions under ES with 6 s on and 2s off.

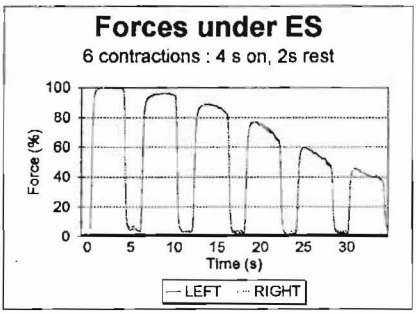
RESULTS

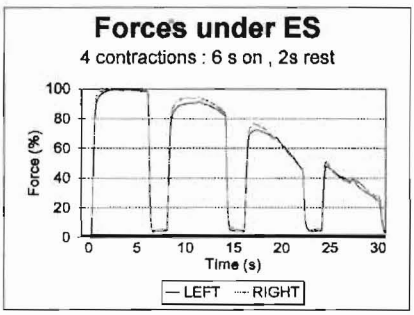
ES allows to reach between 90 to 100% of MVC. During a 24s contraction, the loss of force is about 20% for voluntary contraction and about 70% under ES.





The use of different periods of contraction and rest always induces the same loss of force after completing the 24 s of exercise under ES.





CONCLUSION

Muscle fatigue may be defined as a transient decrease in the capacity to perform work due to prior activity or as a failure to maintain the required force. Our results agree with Hosking et al. (1978) who found a 60 % force decrement during a prolonged ES (18s) with a 100Hz current. During voluntary force stengthening exercises as squats, generally trained subjects can performed about 5 repetitions with a 90% of their maximal load. Under ES, even during the experimental condition 3 (4 s on, 2 s off), the subjects can only perform 2 repetitions above 80% of their maximum force.
This finding suggest that we can't directly apply the training rules used in weight training to ES training. If we consider that fatigue can occur at various sites in the chain from brain to force generation, with ES we generally consider that impairment is located in the peripheral nerve or contractile muscle. More precisely we can make the hypothesis that during ES all motors units are fully excited but not during voluntary contractions. The force loos may also be due partly to a reduced excitability of the muscle fibre membrane, especially for type IIb fibres. Specific researches must be conducted in order to optimise the training procedures under ES when they are applied to healthy and trained subjects. We also have to appreciate muscle potential damages induced by such training procedures.

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