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 practicing 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*4 cm) were placed over the vastus medialis, the vastus lateralis and the rectus femoris muscles. A bi-phasic, symmetrical 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 (150 μs 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, 2s off, 4- 4 contractions under ES with 6s 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.

CONCLUSION
Muscle fatigue may be due to prior activity or with Hosking et al. (1981) with a 100Hz current, generally trained subjects can only perform a maximal load. Under ES the subjects can only propagate the ES training to ES training. This finding suggest that fatigue during ES training is located in the peripheral chain from brain to force generating structures due to prior activity or voluntary contractions. Excitability of the muscle potential damage when they are applied. The hypothesis that delay in the hypolhesis that delays excitability of the muscle when they are applied.

REFERENCES
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 (18 s) with a 100 Hz current. During voluntary force strengthening exercises as squats, generally trained subjects can perform about 5 repetitions with a 90% of their maximal load. Under ES, even during the experimental condition (4 s on, 2 s off), the subjects can only perform 2 repetitions above 80% of their maximum force. This finding suggests 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 motor units are fully excited but not during voluntary contractions. The force loss may also be due partly to a reduced excitability of the muscle fibre membrane, especially for type IIb fibres. Specific research 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.

REFERENCES