INFLUENCE OF REST PERIOD ON ELECTRICAL STIMULATION EFFICIENCY

Georges Poumarat, Robert Chandezon,
Université Blaise Pascal Clermont-Ferrand II, Aubière, France,
G. Vanneville, S. Terver, Université d'Auvergne, Aubière, France

KEY WORDS: electrical stimulation, training, muscle

INTRODUCTION: Electrical stimulation (ES) is now widely used as a modality of strengthening in healthy subjects and highly trained athletes. Most of the previous studies have reported that training by ES induces strength gains (Portmann, 1991; Fredon & Poumarat, 1995). Pulse parameters and stimulus regimens are well documented, especially for frequency of stimulation and electrode localization (Ferry & Poumarat, 1994; Ferry et al., 1994). There is a lack of information on training protocols. These should include periodic rest periods to minimize muscle fatigue and maintain an adequate level of contraction during the training session. The aim of this paper is to clarify the effect of rest periods on muscular performance.

METHODS: Ten male subjects gave their informed consent to participate in the experimentation. ES was applied on the biceps brachii via a RELAX* electostimulator. A symmetrical square wave signal with a 400µs rest between positive and negative phases (300µs) was applied at 60 Hz frequency. A displacement transducer linked to a computer was fixed on the wrist. The subjects were sitting, with the arm lying on a horizontal plane; ES induced a flexion of the forearm. We used ES for 5 seconds with different rest periods (5, 10 and 15 seconds) between contractions. The voltage was fixed in order to obtain a complete flexion at the beginning of the session. The regimen of stimulation was applied as long as we observed forearm movement.

RESULTS: Only displacement of forearm was obtained. The force developed was not controlled. For all the subjects we observed a decrease in flexion along with the repetitions.
According to the great variety of the behaviors observed, a large number of subjects should be tested in order to try to precisely describe the muscular response under ES. In this initial study we are going to point out the main typical behaviors observed.
- The maximal movement amplitude was reached for all subjects during the first three repetitions.
- Some subjects could maintain a movement amplitude superior to 50% of the maximum displacement during more than 30 to 60 repetitions independently of the work/rest ratio. (Figure 1)

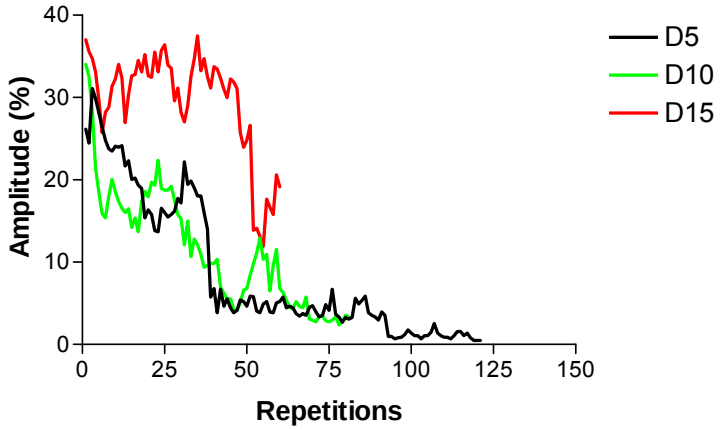

Figure 1 Amplitude of displacement for one subject with 5s, 10s, 15s rest periods.

- Other subjects showed an immediate important decrease in movement amplitude. After that they could maintain a low movement amplitude (25%) for quite a long time. (Figure 2)

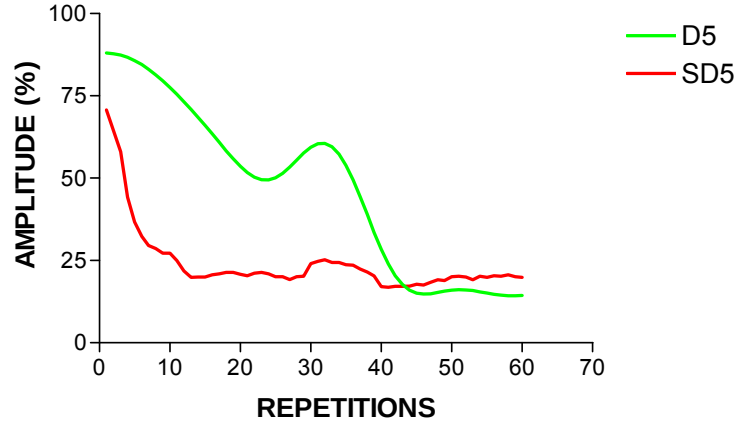

Figure 2 Different responses for 2 subjects during the same training session.

- Sometimes we could observe a linear decrease of movement amplitude ($P < .001$), especially for short rest periods. (Figure 1)
- Response depends on initial status of muscle. (Figure 3)

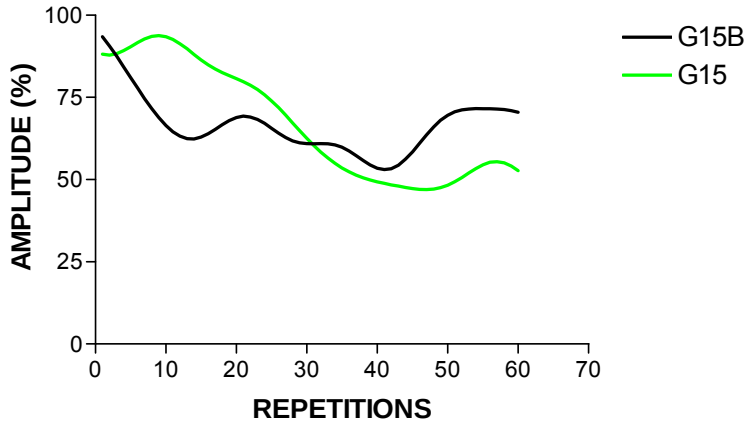

Figure 3 Effect of initial status of muscle.

- For one subject, the results may differ between the two arms. (Figure 4)

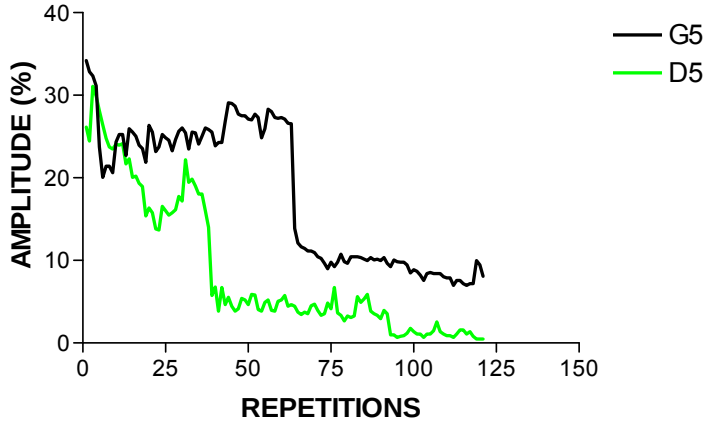

Figure 4 Differences between two arms of same subject

- For short rest periods (5s on, 5s off) we generally observed a sudden decrease of movement amplitude after 30 to 60 repetitions (depending on the subjects).

The mechanical resistance of the displacement transducer represents 70 N, which is only 10% to 20% of maximal voluntary contraction. As we used the minimal intensity allowing a complete initial flexion, the fatigue effect shown in this experiment was dependent on the solicitation of a few muscular fibers only. At the end of the training session subjects were able to perform a maximal voluntary flexion, which tends to prove that the whole muscle was not fully activated, despite the muscular contraction sensation.

CONCLUSION: The number of optimal contractions depends on the subjects: training status, muscular typology, previous fatigue status.

Using ES for strength training or more simply for muscular activation is common, especially with portable individual stimulators. Most of these devices produce a continuous stimulus regimen with a rest time equivalent to contraction time. The present study confirms our previous results pointing to the fatigue effect of ES on muscles (Ferry et al.,1995). In order to expect a positive effect such stimulators must take into account the necessary relaxation time between muscle stimulations. Generally, the increase in rest time allows maintaining higher amplitude.
Because of the low number of subjects, this initial study does not allow us to generalize muscular response to ES. In order to increase efficiency, more individual parameters should be taken into account.

* Acknowledgments: The authors are greatly indebted to RELAX SAS, Via Pasubio, 17-21040 Venegono Superiore (VA)Italia, for material and financial support.

REFERENCES:

Ferry, B., Fredon, J. P., Vanneuville. G., Poumarat G. (1994). Electrostimulation and Force Production. In *XII International Symposium on Biomechanics in Sports*. Budapest.
Ferry, B., Fredon, J. P., Favre-Juvin, A., Poumarat, G., Vanneuville, G. (1995b). Force musculaire et fatigabilité: approche électromyographique. In *XX Congrès Société de Biomécanique*. Lausanne.
Fredon, J. P., Ferry, B., Favre-Juvin, A., Poumarat, G., Vanneuville, G. (1995). Evolution temporelle de la force musculaire sous électrostimulation. In *XX Congrès Société de Biomécanique*. Lausanne.
Portmann, M., Monpetit, R. (1991). Effets de l'entraînement par l'électrostimulation isométrique et dynamique sur la force de contraction musculaire. *Science & Sports* **6**, 193-203.
Poumarat, G, Ferry, B., Fredon, J. P., Vanneuville, G. (1996). Electrostimulation and Fatigue. In J. Abrantes (Ed.), *Proceedings of the XIV International Symposium on Biomechanics in Sports*. Lisboa: Edições FMH.