Investigations Showing Muscular Stress Effects when Using Electric Stimulation – Short- and Long-term- Effects – Prerequisite for Maximum Therapeutic Use

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Abstract

Our results show that electric muscle stimulation (EMS) has an intensive effect on contractile structures. This affects acute as well as long-lasting changes in different functional systems. Therefore electric muscle stimulation is a necessary procedure in therapy.

But there is still a great need for more knowledge of EMS-application, especially choosing the right stimulating parameters, application length and duration and above all in combination with other physiotherapeutic facilities.

Keywords

Electric muscle stimulation (EMS), creatine-kinase (CK), strength, fatigue, metabolism, adaptation

1. Introduction

Electric muscle stimulation (EMS) can not be resigned as a supportive technique for muscle strengthening. The used stimulus parameters determine the advantage of using EMS.

When repeating this application further knowledge of fatigue and restitution courses has to be considered.

Further experiments will be described. On the one hand acute EMS-effects and on the other hand training-experiments have been investigated.

2. Methods and results

2.1 Experiment 1

12 men and 12 women aged 25 to 52 years took part in this investigation.

Blood lactate concentration was measured before, immediately, as well as 3 and 15 minutes after stimulation. Creatine-kinase was determined before stimulation took place and 1, 6 and 24 hours after EMS. 6 pairs of muscles (M. quadriceps femoris, M. glutaeus maximus, M. gastrocnemius on both sides) were stimulated simultaneously. Parameters for stimulation: Frequency of impulse 50kHz, beat-frequency 50Hz, duration 10 minutes.

Table 1 shows the measured lactate-concentration before and after stimulation. The creatine-kinase activity (CK) before and up to 24 hours after EMS is shown in table 2. After 6 hours an increase of about 96% was recorded for CK. The increase reached 121% after 24 hours.

Initial value	*Immediate value*	*3-minute-value*	*15-minute-value*
x 1,69	2,33	2,42	1,88
s 0,25	0,37	0,38	0,44

Comparing initial value with immediate value and 15-minute-value: $p<0,05$

Table 1: Lactate-concentration (µmol/l) before and after 10 minutes of EMS

Initial value	*after 1 hour*	*after 6 hours*	*after 24 hours*
x 1,96	2,28	3,85	4,33
s 0,89	1,18	2,30	3,47

Comparing initial value with 1 hour after EMS: $p>0,05$

Comparing initial value with values after 6 and 24 hours: $p<0,05$

Table 2: Creatine-kinase (µmol/s.l) behaviour before and after 10 minutes of EMS

2.2 Experiment 2

This experiment shows a self-attempt. The male testperson was 48 years old, had a weight of 84kg and was 182cm tall. As biochemical parameters we used ATP, creatine-phosphate, glycogen and lactate.

Testing the strength with stimulation frequency of 25, 75 and 200Hz before and up to 24 hours after EMS was chosen as stimulation-mechanographical parameters. Stimulation occurred on the right and left quadriceps femoris with a permanent stimulation for 10 minutes (frequency of impulse 50kHz, beat-frequency 50Hz, max. tolerable intensity).

For Bergström biopsy-examination samples were taken from M. rectus femoris reciprocal before, immediately and 1, 6 and 24 hours after EMS. The initial biopsy was taken from both femurs. Following biopsies were taken alternating from right and left femur.

Strength-measurements were carried out before, immediately and again 1, 6 and 24 hours after EMS on the right and left side.

A glucogen-decrease to 36% of initial value was observed after 6 hours. Immediately after EMS lactate rised to 15,4mmol/kg fresh substance. Creatine-phosphate decreased to 72,8% immediately after EMS. A decline of strength was measured according to different frequencies as shown in the following table (table 3).

	after 1 hour	*after 6 hours*	*after 24hours*
25Hz	55%	50%	80%
75Hz	44%	45%	71%
200Hz	69%	62%	90%

Table 3: Decline of strength after 1, 6 and 24 hours and different frequencies

2.3 Experiment 3

This experiment was modified to enhance muscle-strength by using EMS. 73 male probands aged 18 to 19 underwent electric muscle stimulation. The probands did not take part in any sportive activities.

Quadriceps femoris strength was measures before, during and 4 weeks after EMS. EMS was carried out an both sides of the M. quadriceps femoris for four weeks.

During 10 minutes stimulation the frequency changed every minute between 75Hz and 200Hz.

Additionally M. quadriceps femoris willpower was measured.

Muscle-strength increased to 129% compared to initial value. Maximum value was reached the first week after stimulation ended. The initial value was re-established after four weeks without stimulation.

The control group showed no relevant increase in strength.

2.4 Experiment 4

Experiment 4 investigated the training effect of electric muscle stimulation on lipid metabolism.

We examined 44 male patients (average age 57,8 ± 4,3 years) with ischemic heart-disease and Hypertonie stage I concerning WHO.

23 patients completed an endurance-training with different exercises. EMS was accomplished by 13 men. 8 patients were held as control-group without any endurance-training. For four weeks EMS was applied on both sides of femur muscle tissue. EMS was carried out one hour twice a day or respectively two hours once a day (sequence-frequency 50kHZ, beat-frequency 10 Hz and max. tolerable intensity).

As lipid metabolism parameters total Cholesterol, Triglycerides and ApoB were measured. We examined this parameters before and after the four weeks lasting medical treatment.

Triglycerides decreased about 25,7%, total Cholesterol about 5,1% and ApoB about 8,9%.

The examined endurance-group showed a Triglyceride reduction between 13 and 31% and a total Cholesterol reduction between 3 and 13%. ApoB showed a 8 to 25% reduction.