STUDY ON FREQUENCIES AND TIME-EXPOSURE IN THE GLOBAL BODY ELECTROSTIMULATION AND THEIR PHYSIO-METABOLIC IMPACT

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INTRODUCTION

Electrotherapy and electro-stimulation is a system widely used in the field of sport, physiotherapy-medicine and aesthetics. It is about the use of devices that cause an involuntary muscle contraction through electrical impulses of different frequencies and; as a result, its effect is similar to that obtained exercising the muscles.

The appearance of the EMS or Electrical Muscle Stimulation has opened a debate that is broadly focused on the overproduction of high levels of CK. Although this fact has not been sufficiently contrasted by detailed studies, it has caused some alarm in the social network.

OBJECTIVE

Apart from the effects at a nervous level regarding the neuromotor system, the current study aims to determine the frequencies and time-exposure to different frequencies of electro-stimulation in order to determine the impact and consequences on the metabolic and physiological system of different individuals, especially in the production of creatine kinase (CK) enzyme. We have also studied the physio-metabolic adaptation of the organism to such exposure.

SUBJECTS AND METHOD

The sample was composed of 7 subjects, 2 men and 5 women aged 24-59 to whom a full blood-count test was conducted prior to the EMS session. It included: mean platelet volume (MPV), platelet distribution width (PDW), complete Biochemistry (glucose, urea, sodium, potassium, venous gasometry, lactic acid, progesterone and testosterone and Creatin-kinase repeated at 24 h and 72h in order to observe the Peak of increase. These tests are repeated after 8 sessions to observe adaptations and those that have undergone obvious changes susceptible of explanation are listed.

The 20-minute sessions are alternating the capillarization-cardio program with the strength program to equal times of 2+2 minutes at specified levels, such as MILD, MEDIUM and STRONG, and at an interval of 3-4 days. These values are detailed in the PROTOCOL section. The use of the continuous strenght program (20 minutes) is discarded since the levels of CK increased enormously, with values above 7000 U/L.
In all cases, water or electrolyte drink consumption remained stable during the sessions.

RESULTS

After the first session, a clear increase in CK values in almost all of the participants is clearly observed. 24 h values are significant, but the really important ones are the values at 72 h coinciding with the medical literature that places the maximum peak within this period. However, these values adjust to the condition of athletes of some participants; so based on the results obtained, it is important to point out that the recovery period between 1 and 2 sessions should be bigger at the 5th. day, since CK levels go down about 40% every 24 h.

We also observe that the adaptation to exercise is correct in almost all cases placing the values in what we would consider as normal, after a certain strong physical exercise. Also, the Urea/Serum levels remained stable without significant changes.

On the other hand, what has been significant with the data obtained is that in order to safeguard the health of the user of the continuous strength programs in 20-minute-sessions, these would only remain for very trained individuals; and always alternating the continuous strength training sessions with those called 2+2 (2 capillarization minutes + 2 strength minutes).

No significant changes in the rest of analytical parameters, such as urea, sodium, potassium etc., have been observed.

CONCLUSION

Results support the idea of safety in the use of EMS based on progression and active breaks during workouts. Even so, CK values after the first session are in some cases very high and similar to those measured after tests of high-intensity, (*Priscilla Clarkson (1990). Demasiado y muy Rápido: Las Consecuencias del Ejercicio Excesivo. PubliCE Standard.), (Galbo H. Hormonal and metabolic adaptation to exercise. Thieme-Stratton. New York. 1983);* therefore, it is especially important to have longer intervals between the first and the second sessions, a minimum of 5 days in order to normalize values.

However, we have not observed any significant increase in lactic acid, so we cannot establish as a reference the muscle pain with a recovery factor, since pain is a subjective value and the threshold for each individual is different.

It is observed that after the completion of 8 training sessions with EMS, blood concentrations of creatine kinase (CK) decrease, which suggests a proper adaptation to exercise and clearly reflects that training with EMS is safe, as long as:

A. Frequency and exposure times are equal or similar to what is detailed in the PROTOCOL section.

B. You rest a minimum of 5 days from session 1 to session 2.

C. You rest a minimum of 48 hours between sessions at least until the first 8-10 sessions.

D. The hydration levels remain stable.

E. Do not be in a fasting period.

EQUIPMENT

Model: XBody - New Wave
Frequency: 47 - 63 Hz
Programs: 6 Automatics and manual*

**All the study was carried out in a manual mode.*

INTRODUCTION

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The appearance of the EMS or Electrical Muscle Stimulation has opened a debate that is broadly focused on the overproduction of high levels of CK. Although this fact has not been sufficiently contrasted by detailed studies, it has caused some alarm in the social network. In this study we have measured these values with the aim of determining at different intensities and equal exposure period, not only the resulting values in the maximum peak but the adaptations at the production level of CK after 8 sessions of training over several weeks.

There are different authors who have pointed at the training by electrostimulation or EMS as a complementary system to the usual training *(Zatsiorsky, Kraemer - 2006. Science and Practice of Strength Training - EMS*, page 132-133; *Human Kinetics*.), although conclusive studies are still needed to clearly define the benefit obtained. In the

EMS there are still missing conclusive studies, since obtaining clarifying data (in the case of muscle tone - for example) is not only complex but also subjective and depends on multiple factors that include the neuromotor system of the subject to be studied, his sports experience etc. However, there are multiple studies and/or articles that show the benefits of the EMS in terms of improving muscle tone and even in its application to different sports. For example, the *Journal of Strength and Conditioning Research* lists the following articles:

- Effects of Electrostimulation Training on Muscle Strength and Power of Elite Rugby Players; *(Babault, Nicolas; Cometti, Gilles; Bernardin, Michel; Pousson, Michel; Chatard, Jean-Claude)*
- Effects of Electromyostimulation Training and Volleyball Practice on Jumping Ability. *(Malatesta, Davide; Cattaneo, Fabio; Dugnani, Sergio; Maffiuletti, Nicola A.)*
- Supplemental EMS and Dynamic Weight Training: Effects on Knee Extensor Strength and Vertical Jump of Female College Track & Field Athletes. *(Willoughby, Darryn S.; Simpson, Steve)*
- The Effects of Combined Electromyostimulation and Dynamic Muscular Contractions on the Strength of College Basketball Players. *(Willoughby, Darryn S.; Simpson, Steve)*

1. RHABDOMYOLYSIS AND CK

There are also various reports on the use of EMS and rhabdomyolysis graphs; nevertheless, in an exercise of scientific rigor, it would be necessary to determine which dose and with what subject have been determined such reports, since in some cases described, such as *the International Journal of Cardiology*: "*Severe rhabdomyolysis after MIHA - bodytec ® electrostimulation with previous mild hyper-CK-emia and noncompaction*", it has been used in the social network as information that has created a certain unjustified alarmism, given that the article emphasizes a metabolic myopathy as a probable cause of the rhabdomyolysis:
http://www.researchgate.net/publication/269114674_Severe_rhabdomyolysis_after_MIHA-bodytec_electrostimulation_with_previous_mild_hyper-CK-emia_and_noncompaction

Other articles also point out to myopathy (*Journal of Cardiology (J. Finsterer, C. Stöllberger / Int J Cardiology 180 (2015) 100-102*), as a more than probable cause of the described rhabdomyolysis cases.

Rhabdomyolysis by effort includes the following symptoms: muscle pain, weakness, and/or inflammation; myoglobinuria; and high levels of sarcoplasmic proteins and other muscle cellular constituents in blood.

The results obtained in the present study leave no doubts about the risk <u>after the first session</u> of triggering rhabdomyolysis, which in some cases can be severe and lead to acute kidney failure by the breakdown of muscle fibres and the release of the contents of these fibres (mainly myoglobin) in the bloodstream. Since myoglobin is a muscular haemoprotein and brakes down into potentially harmful compounds, it may block the structures of the kidney, causing damage such as acute tubular necrosis or kidney failure. That is the reason why we set up as a main rule the progressive increase of the frequencies that are determined in the PROTOCOL section of this study, and through this progression to achieve the safety values obtained in session number 8.

It is also important to point out that in Clinica Planas Barcelona there is a history record of almost 3.000 sessions of EMS carried out with a zero level of incidences. This makes relevant again the importance of progression and the correct adaptation to training.

1.1 LEVELS OF CK OBTAINED

As detailed in the graphs, the resulting values of the tests carried out prior to the first session reflect a slight increase at 24 h of the first training and a very high increase at 72 h; values that are kept in subjects 4 and 7, to whom the workload was significantly increased. This shows that even beyond than session 8, frequencies and, therefore, workload should not increase.

It is observed that after 8 training sessions with EMS, elevations in the creatine kinase (CK) decrease in blood concentration, which suggests a proper adaptation to exercise and clearly reflects that training with the EMS system is safe provided that:

A. Frequencies and time-exposure are equal or similar to what is detailed in the PROTOCOL section.

B. You rest a minimum of 5 days from session 1 to session 2.

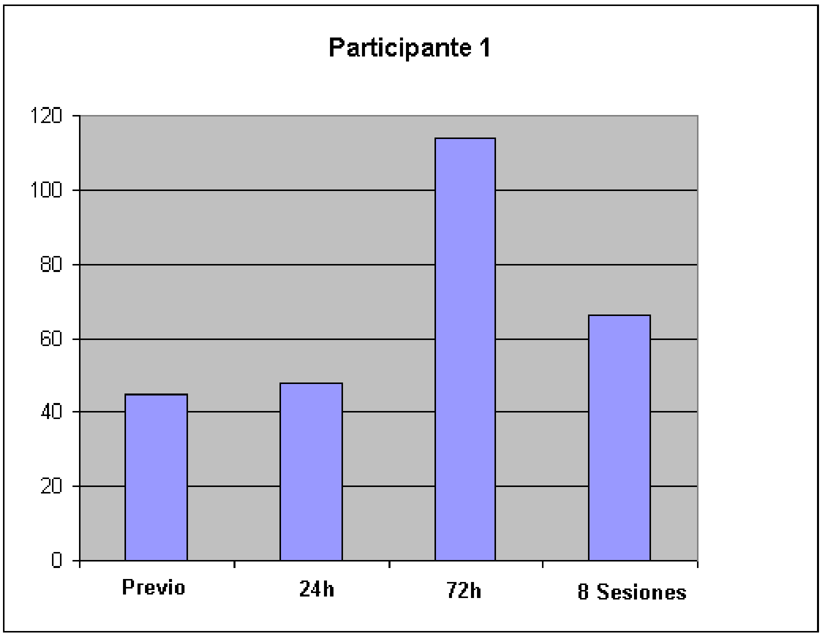
C. You rest a minimum of 48 hours between sessions, at least until the first 8-10 sessions.

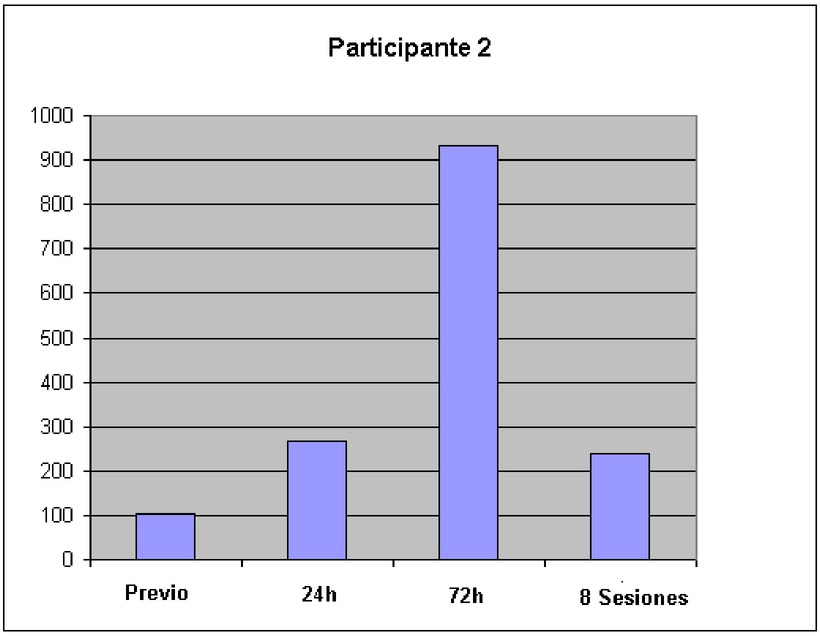
D. Your hydration levels remain stable.

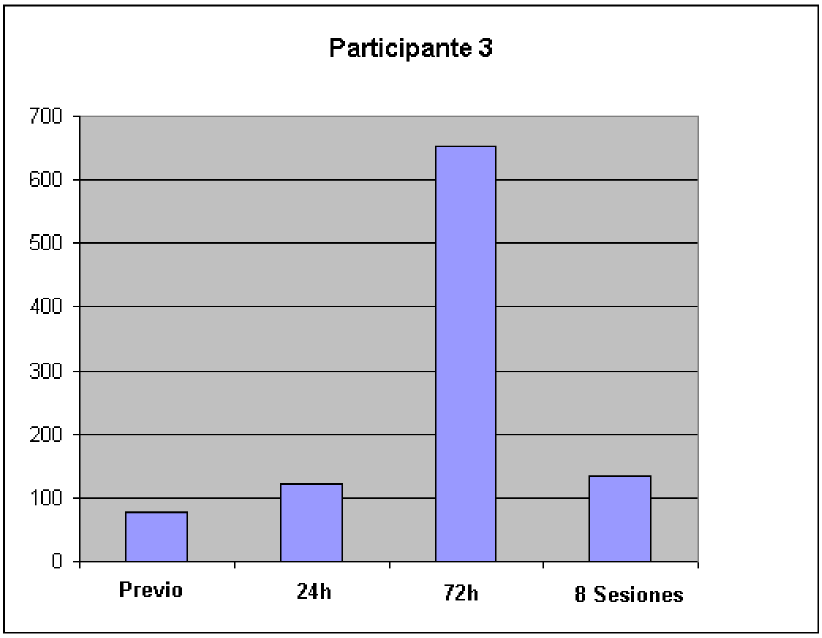
E. Do not be in a fasting period.

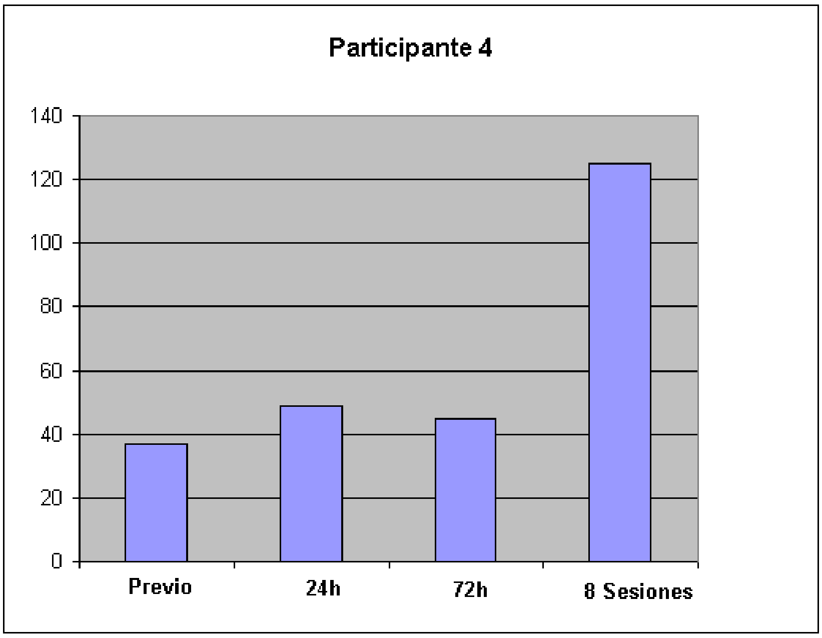
CK Tables and Graphs:

	PREVIO A SESIÓN	24 HORAS	72 HORAS	8 SESIONES
PARTICIPANTE 1	45 U/L (30-135)	48 U/L (30-135)	114 U/L (30-135)	66 U/L (30-135)
PARTICIPANTE 2	103 U/L (30-135)	266 U/L (30-135)	931 U/L (30-135)	239 U/L (30-135)
PARTICIPANTE 3	78 U/L (30-135)	123 U/L (30-135)	653 U/L (30-135)	134 U/L (30-135)
PARTICIPANTE 4	37 U/L (30-135)	49 U/L (30-135)	45 U/L (30-135)	125 U/L (30-135)
PARTICIPANTE 5	156 U/L (30-135)	156 U/L (30-135)	767 U/L (30-135)	120 U/L (30-135)
PARTICIPANTE 6	192 U/L (30-135)	180 U/L (30-135)	857 U/L (30-135)	160 U/L (30-135)
PARTICIPANTE 7	83 U/L (30-135)	93 U/L (30-135)	157 U/L (30-135)	182 U/L (30-135)






Participante 3
700
600
500
400
300
200
100
0
Previo
24h
72h
8 Sesiones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100
80
60
40
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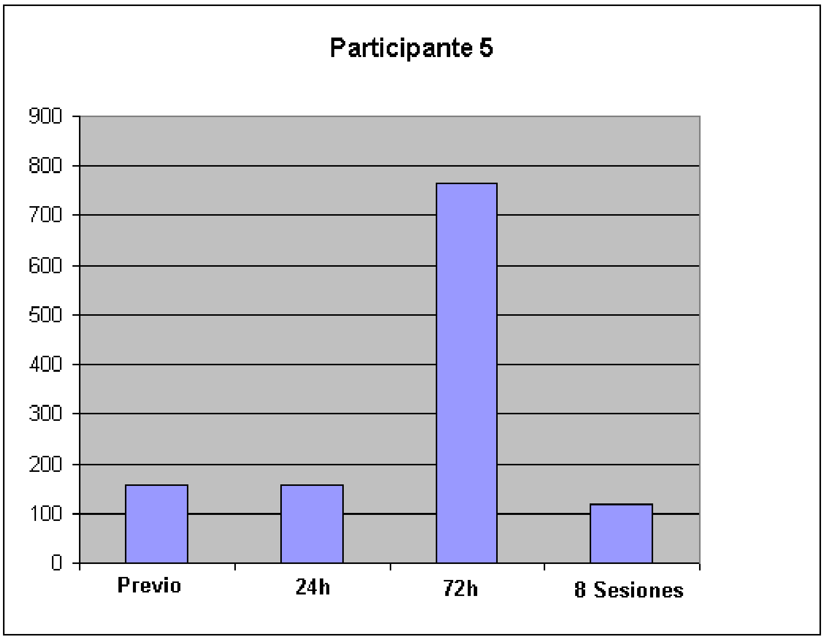
Previo
24h
72h
8 Sesiones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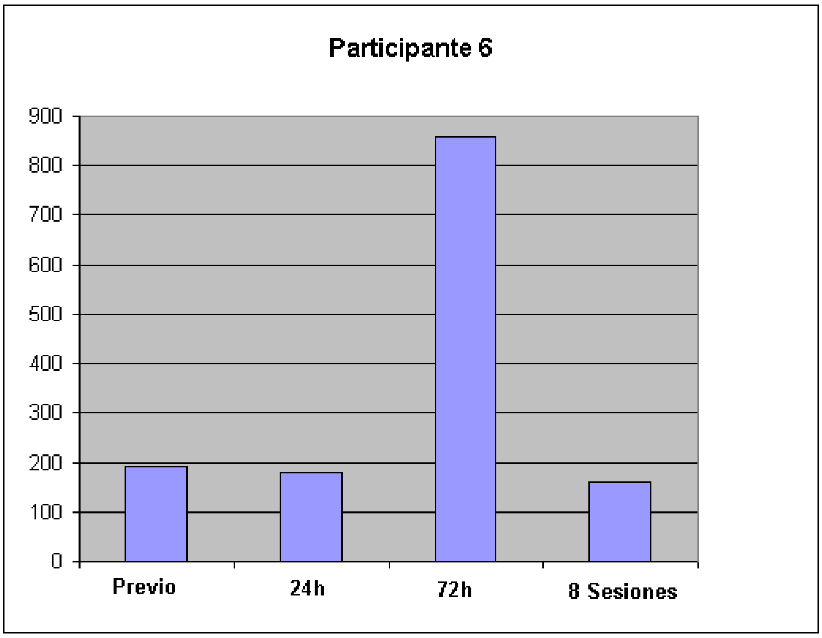
300
200
100
0
Previo
24h
72h
8 Sesiones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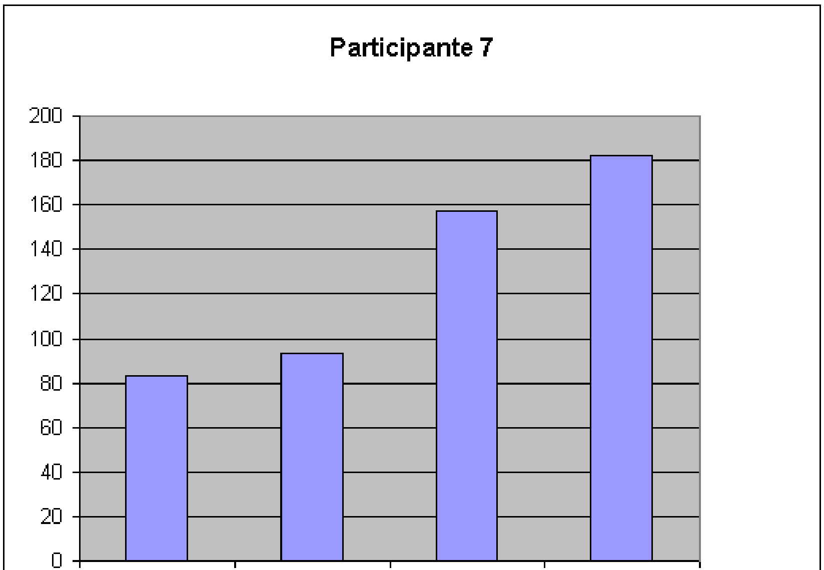
Previo
24h
72h
8 Sesiones


Participante 7
200
180
160
140
120
100
80
60
40
20
0

2. CK, UREA AND PHYSICAL EXERCISE

Increased levels of uric acid in blood (hyperuricemia) are very common in cases of rhabdomyolysis (Knöchel, 1982). Hyperuricemia is probably triggered by the hepatic metabolism of the Adenine Nucleotides, which come from the damaged muscle (Milne, 1988) and that in many cases present elevations in the blood concentration of creatine kinase (CK). However, the results of the tests performed do not show any significant changes, even in subjects that reflected higher levels of CK, keeping them in stable levels.

With respect to the CK levels, it is very important to highlight that there are extensive bibliography showing that when a well-trained individual starts doing a 'new' high-intensity exercise, there are a lot of probabilities of increasing the CK levels and this will cause muscle damage (Clarkson, 1990). Thus, the parameter of the initial physical state is not a good indicator regarding the frequencies or time-exposure to be used.

2.1 HYPO AND HYPER-HYDRATION

Another important aspect is the need to maintain optimal and stable hydration levels, since kidney failure has proved to be most common with dehydration (Milne, 1986). The presence of heat stress is also a common contributor in cases of acute renal failure.

In this sense, it is elementary to point out that overhydration is also harmful because when sodium goes down in the organism by dilution due to an excessive increase of fluids intake, the adrenal cortex will rise the levels of aldosterone; and it can lead to muscle weakness, fatigue, cramps or headache, and even in some cases, postural hypotension and acute hypertension.

In the case of subjects in a state of fasting or poor diet in nutrients (e.g. low-calorie or high-protein diets), it is noted that the Rhabdomyolysis by effort appears on a more regular basis in subjects with nutritional deficits that perform high intensity exercise (Knöchel, 1982). An alteration in the normal muscle power reserves, can possibly affect the muscle function in susceptible subject who exercise intensively, so it must be taken into account during workouts with EMS.

Urea tables:

	PREVIO A SESIÓN	24 HORAS	72 HORAS	8 SESIONES
PARTICIPANTE 1	37 mg/dL (15-36)	38 mg/dL (15-36)		38 mg/dL (15-36)
PARTICIPANTE 2	27 mg/dL (15-36)	28 mg/dL (15-36)		31 mg/dL (15-36)
PARTICIPANTE 3	29 mg/dL (15-36)	36 mg/dL (15-36)		36 mg/dL (15-36)
PARTICIPANTE 4	39 mg/dL (15-36)	28 mg/dL (15-36)		28 mg/dL (15-36)
PARTICIPANTE 5	37 mg/dL (15-36)	33 mg/dL (15-36)		33 mg/dL (15-36)
PARTICIPANTE 6	36 mg/dL (15-36)	38 mg/dL (15-36)		36 mg/dL (15-36)
PARTICIPANTE 7	31 mg/dL (15-36)	26 mg/dL (15-36)		42 mg/dL (15-36)

3. SODIUM, POTASSIUM AND KIDNEY FAILURE

The optimal concentration of sodium and potassium in the body is essential for an appropriate response of the osmotic balance at a metabolic level. During the EMS training, although you do not swear profusely there is the possibility of generating problems with respect to the plasma concentrations of these ions.

They are also essential points for a proper recovery and for the assimilation of different post-training nutrients. In this sense, it is important that the levels are balanced both in excess and defect, since one of the most common electrolyte abnormalities associated with rhabdomyolysis is hyperkalaemia, an increase of potassium in blood (Honda & Kurokawa, 1983) and it is not directly related to an excess in its intake, it is just that it can be released into blood from the damaged muscle cells (Honda & Kurokawa, 1983). So, it is a significant value in this study since hyperkalemia can also cause as a result a renal failure when the kidneys cannot excrete enough amount of potassium (Marieb, 1992; Milne, 1988).

Therefore, it is especially significant to mention the excessive high levels of potassium in blood since they can interfere with the mechanisms of depolarization in the muscle by reducing the membrane potential at rest (Marieb, 1992).

When sodium is not compensated during training through fluids intake, it may impact on the decrease of the sodium concentration that surrounds the nerve endings of the muscles, and to result in muscle cramps. Although the EMS workouts are short and sweating is not usually excessive, intensity is also crucial in terms of sodium values due to metabolic stress, which in combination with the environmental heat and/or the thermal stress produced by the own costume can alter the values in certain subjects.

There is also an abnormality in the gene CFTR (Cystic fibrosis transmembrane conductance), regulator of the transmembrane conductance of the cystic fibrosis, which is located in the 7q31 chromosome. This gene encodes a protein which forms a chloride channel and normalizes chlorine transport mainly in the apical membrane of the exocrine epithelial cells, including the sweat glands.

It is considered that one in 20 people of the whites has an abnormal CFTR gene therefore; we consider that this is an aspect to take into account when using the EMS in the future.

During the present study, the levels of hydration and fluid intake were regular, not observing remarkable changes in the values of sodium and potassium in any of the samples tested.

Sodium tables:

	PREVIO A SESIÓN	24 HORAS	72 HORAS	8 SESIONES
PARTICIPANTE 1	139 mEq/L (137,0-145,0)	138 mEq/L (137,0-145,0)		137 mEq/L (137,0-145,0)
PARTICIPANTE 2	139 mEq/L (137,0-145,0)	140 mEq/L (137,0-145,0)		140 mEq/L (137,0-145,0)
PARTICIPANTE 3	141 mEq/L (137,0-145,0)	142 mEq/L (137,0-145,0)		141 mEq/L (137,0-145,0)
PARTICIPANTE 4	142 mEq/L (137,0-145,0)	141 mEq/L (137,0-145,0)		141 mEq/L (137,0-145,0)
PARTICIPANTE 5	143 mEq/L (137,0-145,0)	143 mEq/L (137,0-145,0)		143 mEq/L (137,0-145,0)
PARTICIPANTE 6	141 mEq/L (137,0-145,0)	140 mEq/L (137,0-145,0)		140 mEq/L (137,0-145,0)
PARTICIPANTE 7	142 mEq/L (137,0-145,0)	141 mEq/L (137,0-145,0)		138 mEq/L (137,0-145,0)

Potassium tables:

	PREVIO A SESIÓN	24 HORAS	72 HORAS	8 SESIONES
PARTICIPANTE 1	3,90 mEq/L (3,60-5,00)	4,50 mEq/L (3,60-5,00)		4,30 mEq/L (3,60-5,00)
PARTICIPANTE 2	3,80 mEq/L (3,60-5,00)	4,00 mEq/L (3,60-5,00)		4,20 mEq/L (3,60-5,00)
PARTICIPANTE 3	4,00 mEq/L (3,60-5,00)	4,30 mEq/L (3,60-5,00)		4,00 mEq/L (3,60-5,00)
PARTICIPANTE 4	3,90 mEq/L (3,60-5,00)	4,10 mEq/L (3,60-5,00)		4,20 mEq/L (3,60-5,00)
PARTICIPANTE 5	4,10 mEq/L (3,60-5,00)	4,40 mEq/L (3,60-5,00)		4,30 mEq/L (3,60-5,00)
PARTICIPANTE 6	4,20 mEq/L (3,60-5,00)	4,20 mEq/L (3,60-5,00)		4,30 mEq/L (3,60-5,00)
PARTICIPANTE 7	3,80 mEq/L (3,60-5,00)	3,90 mEq/L (3,60-5,00)		3,90 mEq/L (3,60-5,00)

4. GLUCOSE

During this study, the glucose levels of the participants remained stable in all the samples tested. However, it is important to note a predictable high consumption of glucose in athletes and/or muscular subjects. This is important, since that ATP (adenosine triphosphate) reserve, can only provide energy in the first two to five seconds after the beginning of the muscle contraction; therefore, in lower intervals, the muscle must resort to the ATP resynthesis through two mechanisms: one of quick action, that is, the use of phosphocreatine and subsequently, the oxidation of glucose when muscle ATP and phosphocreatine reserves run out and the anaerobic metabolism of glucose starts, with the appearance of lactic acid.

Either way, taking into account that the energy demand during the EMS training is not proportional to the capacity of oxygen supplied, it will be necessary to resort to anaerobic ways; with the resulting elevation of lactic acid than in muscled subject can be dramatic.

5. PROTOCOL

1. Sessions were divided according to intensities and time-exposure into SOFT, MEDIUM and STRONG levels in order to assess mainly patterns of excess.

2. Intensity-exposure values in each session remained unchanging in groups of two sessions, increasing slightly every two sessions in order to obtain a reliable indicator and allow a good level of adaptation.

3. By muscle groups, in every program there have been used fixed “average” values for the same reason, changing only the “master” intensity.

4. Intensities were determined taking tolerance to pain and comfort in performing the exercises as a parameter, although this is not a reliable factor since tolerance is different in each subject.

5. Configuration parameters remained fixed in all sessions and with all programs.

MASTER	
Program Time	20'
Impulse Length	5
Impulse Break	2
Impulse Frequency	80
Impulse Depth	350
Impulse Gain	1.1

*Otherwise, it would not have been possible to establish a pattern of correlation between the results obtained and the values used.

On the other hand, the *Impulse Gain*, was determined in 1.1, in order to adapt to each subject.

It is significant that in the soft program, participants did not increase the CK values in excess, not even 72 hours after.

Training was performed using the 2+2 system, that is: alternating 2 minutes of strength, according to the graphs, with 2 minutes of the cardiovascular program at an intensity of between 45% and 55 %m, and ending the training with 5 added minutes from the massage program (out of the training time).

The reason for using the "cardio" program is pursuing the increase of blood flow and promoting the development of capillaries as well as the dilation of the existing ones especially around the fast fibres, improving the contribution of glucose, the diffusion of oxygen and the elimination of lactic acid and other components.

PROGRAM - SOFT / 2' Strenght + 2' Cardio

PROGRAM - SOFT

Sessions 1-2

Leg Extensor	59	Back	55
Leg Flexor	59	Trapezius	50
Bottom	77	Chest	50
Abdomen	70	Arm	40
Waist	65	Option	0

MASTER	MAX 60%

- Maximum levels of CK at 72h after the session 1:
  Subject A. 114 U/L (30-135)
  Subject B. 45 U/L (30-135)

Sessions 3-4

Leg Extensor	59	Back	55
Leg Flexor	59	Trapezius	50
Bottom	77	Chest	50
Abdomen	70	Arm	40
Waist	65	Option	0

MASTER	MAX 65%

Sessions 5-6

Leg Extensor	65	Back	60
Leg Flexor	65	Trapezius	55
Bottom	85	Chest	55
Abdomen	80	Arm	45
Waist	70	Option	0

MASTER	MAX 70%

Sessions 7-8

Leg Extensor	65	Back	60
Leg Flexor	65	Trapezius	55
Bottom	85	Chest	55
Abdomen	80	Arm	45
Waist	70	Option	0

MASTER	MAX 75%

- Maximum levels of CK at 72h after session 8:
  Subject A. 66 U/L (30-135)
  Subject B. 125 U/L (30-135)
- 15% increase in the Master intensity between session 1 and session 8.

PROGRAM - MEDIUM 2' Strenght + 2' Cardio

PROGRAM - MEDIUM

Sessions 1-2

Leg Extensor	65	Back	60
Leg Flexor	65	Trapezius	55
Bottom	80	Chest	55
Abdomen	75	Arm	45
Waist	70	Option	0

MASTER	MAX 62%

- Maximum levels of CK at 72h after session 1:
  Subject A. 653 U/L (30-135)
  Subject B. 157 U/L (30-135

1. Note that the values of CK in the subject A (female, 37 years old, moderate usual physical activity, with no known pathologies), have increased dramatically from 123 U/L

in the record of 24 h to 653 U/L in the one of 72 h, which shows a high muscle damage. Not the same in patient B, even following the same program.

2. Although data are difficult to interpret since they come from the first training session, they suggest that the EMS is likely to lead into moderate-to-severe muscle damage with the consequent risk of rhabdomyolysis. Given the used values and as a precautionary measure, we would propose to bring values the first 3 sessions below the ones exposed during in the first week of the soft program.

Sessions 3-4

Leg Extensor	**68**	**Back**	**63**
Leg Flexor	**68**	**Trapezius**	**59**
Bottom	**83**	**Chest**	**55**
Abdomen	**77**	**Arm**	**47**
Waist	**73**	**Option**	**0**

MASTER	**MAX 67%**

Sessions 5-6

Leg Extensor	**70**	**Back**	**66**
Leg Flexor	**70**	**Trapezius**	**63**
Bottom	**85**	**Chest**	**55**
Abdomen	**80**	**Arm**	**50**
Waist	**76**	**Option**	**0**

MASTER	**MAX 73%**

Sessions 7-8

Leg Extensor	**75**	**Back**	**69**
Leg Flexor	**75**	**Trapezius**	**65**
Bottom	**87**	**Chest**	**55**
Abdomen	**83**	**Arm**	**53**
Waist	**79**	**Option**	**0**

MASTER	**MAX 78%**

- Maximum levels of CK at 72h after session 8:
  Subject A. 134 U/L (30-135)
  Subject B. 182 U/L (30-135
- 16% increase in the Master intensity between session 1 and session 8.

3. The adaptation of both subjects after 8 workout sessions with EMS has been complete since the results obtained are consistent with an exercise of moderated intensity.

PROGRAM - STRONG 2’ Strenght + 2’ Cardio

PROGRAM - STRONG

Leg Extensor	67	Back	62
Leg Flexor	67	Trapezius	57
Bottom	82	Chest	55
Abdomen	76	Arm	47
Waist	72	Option	0

MASTER	MAX 65%

- Maximum levels of CK at 72h after session 1:
  Subject A. 931 U/L (30-135)
  Subject B. 767 U/L (30-135)
  Subject C. 857 U/L (30-135)

Sessions 3-4

Leg Extensor	70	Back	65
Leg Flexor	70	Trapezius	59
Bottom	85	Chest	55
Abdomen	79	Arm	49
Waist	75	Option	0

MASTER	MAX 69%

Sessions 5-6

Leg Extensor	74	Back	67
Leg Flexor	74	Trapezius	62
Bottom	87	Chest	55
Abdomen	82	Arm	52
Waist	76	Option	0

MASTER	MAX 75%

Sessions 7-8

Leg Extensor	77	Back	70
Leg Flexor	77	Trapezius	62
Bottom	90	Chest	55
Abdomen	87	Arm	55
Waist	76	Option	0

MASTER	MAX 80%

- Maximum levels of CK at 72h after session 8:
  Subject A. 239 U/L (30-135)
  Subject B. 120 U/L (30-135)
  Subject C. 160 U/L (30-135)
- 15% increase of Master intensity between session 1 and session 8.

1. Once again, very high values are reflected at 72h of the first session, which stabilize almost completely after 8 sessions of training.

2. The analysis of these data and those obtained from all subjects point out to maximise precautions during the execution of the first training session.

6. CONCLUSIONS

A detailed review of the analytical records requires an exercise of common sense that sometimes will not be compatible with business interests.

As a positive aspect, it should be pointed out the really fast adaptation of most of the subject to exercise with EMS, regardless of their sex, age or sports experience. Likewise, according to the data obtained, metabolic stress seems to revolve exclusively around the CK levels, since in other values detailed before, no significant changes have been observed.

As a negative aspect we should focus on potential damage to human health and integrity of clients and patients in the first training session, reaching alarming and potentially harmful CK values.

However, we would keep acceptable safety levels -as a precautionary measure- with the guideline of being under slightly lower frequencies than those exposed to during the first and second sessions; and even increasing "break" times around 4'' or raising the recovery period with cardio about 3'.

Nevertheless, a thorough analysis, which applies scientific rigour, requires being very cautious not only in sessions 1 and 2 but also spacing both sessions out a minimum of 5-6 days.

Based on the aforementioned and after the data evaluation, we consider that training with EMS is safe provided that the detailed caution guidelines of the present study are contemplated.

It is noted that after the completion of 8 training sessions with EMS, elevations in the blood concentration of the creatine kinase (CK) decrease, which suggests a proper adaptation to exercise and clearly reflects that training with the EMS system is safe provided that:

A. Frequencies and time-exposures are equal or similar to what is detailed in the Protocol section.

B. There is a rest of a minimum of 5 days between session 1 and session 2.

C. There is a minimum rest of 48 hours between sessions, at least until the first 8-10 sessions.

D. Hydration levels should be kept stable.

E. Do not be in a fasting period.

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