BIOMARKERS EVALUATION IN DELAYED ONSET MUSCLE SORENESS (DOMS): NEW ELECTRICAL STIMULATION STRATEGY

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INTRODUCTION

Regular exercise is beneficial to our health. However, unaccustomed or exhaustive exercise can result in detrimental health effects such as muscle damage, inflammation and oxidative stress. Specifically, repetitive muscle contraction involves accumulation of reactive oxygen species (ROS).The overproduction of ROS induced by exhaustive exercise training or other stresses, along with compromised antioxidant defenses can lead to oxidative stress and related tissue damage.
Eccentric exercise is a case in point. Eccentric contractions may lead to: cellular-muscle enzymatic increase in blood circulation, protoplasmic injury, inflammatory cell response to acute muscle injury, muscle soreness. Exercise-induced muscle soreness is classified into acute and delayed onset muscle soreness (DOMS). Acute muscle soreness occurs during the exercise and may continue for about 4 to 6h. DOMS occurs 8 to 24h after strenuous exercise and peak occurs 24 to 48h after the exercise. DOMS is a kind of muscle strain injury that includes increased pain sensitivity to palpation and/or stiffness during movement [1].
Electrical stimulation is frequently used in the treatment of pain, swelling and spasm, which are commonly associated with musculoskeletal trauma [2]. We.C.0102 is a new electrical stimulator, that may be able to restore the physiological cellular homeostasis, decreasing the perceived pain after a few minutes of treatment (frequency range 1-100 Hz).

The purpose of the study is to assess the effect of applying We.C.0102 micro-current device on perceived pain and muscle strength, following an intense eccentric exercise.

METHODS AND EXPERIMENTAL PROTOCOL

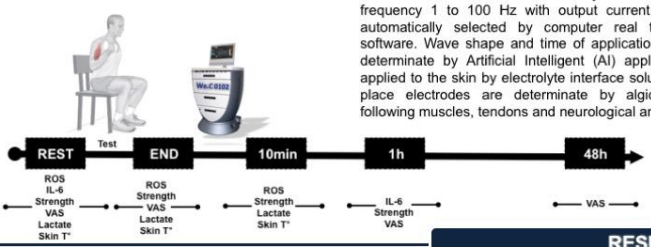
Subjects and Exercise

Thirteen healthy sedentary volunteers (6 F/7 M; 56,45 ± 4,87 yr; 24,55 ± 3,88 BMI) with no current or previous upper arm injuries, who were not suffering from any arm pain were recruited. DOMS was induced in the elbow flexors through repeated eccentric muscle contractions. All subjects performed, in a sitting position, repetitive flexion/extension movements of elbow with a handheld load of 3 kg, with non-dominant arm. Subjects were asked to use a smooth controlled movement at a speed of 3s to move from full flexion to full extension. This pattern was repeated until exhaustion. Voluntary exhaustion was defined as the inability to continue the exercise, despite vigorous encouragement by the operators, as well as by maximal levels of self-perceived exertion using the validated Borg scale [3]. Subjects were assigned to complete two experimental conditions in cross-over: a) physical exercise, followed by a rest period of 10 min (CTR); b) physical exercise, followed by We.C.0102 treatment, for a time not to exceed 10 min (We.C.). The investigated variables consisted in muscle soreness assessed through the visual analogue scale (VAS), isometric strength assessed using a hydraulic hand dynamometer, ROS, lactate, hematocrit, plasma IL-6 concentration and skin temperature assessed by thermographic camera. Changes in these variables before, immediately after, 10 minutes post exercise, and 1h after exercise were compared between the We.C.0102 treatment and CTR conditions. Muscle soreness was also assessed at 48h (**FIG.1**). Each experimental condition was followed by a wash-out period of 7 days.

Blood Sampling and EPR

A bench top continuous wave instrument (Bruker) operating in the X-Band region (~ 9 GHz) dealing with very low ROS levels in 50µl samples was used. For each subject, in every time, capillary blood was taken from the fingertip and immediately treated with CMH (1-hydroxy-3-methoxycarbonyl-2,2,5,5-tetramethylpyrrolidine,1:1) spin probe. 50ul of the obtained solution was put in the glass EPR capillary tube at 37° C. CP• (3- carboxy-2,2,5,5-tetramethyl-1-pyrrolidinyloxy) was used as external reference to calculate absolute concentration levels (µmol·min^{-1}) . The adopted experimental protocol is shown in **FIG 2** [4].
Plasma samples, for IL-6 assay, were obtained by centrifugation of heparinized capillary blood[5]: plasma was aspirated by using micro-loader tips 0,5–20 µL (Eppendorf, U.S.A.) All samples were stored at -80° C until assayed. Samples were thawed only once before analysis, performed within two weeks from collection.

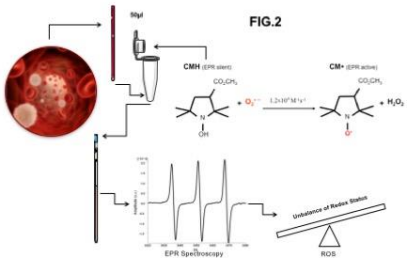
FIG.1



We.C.0102 treatment

We.C.0102 is a new low intensity electro-stimulator, ranging in frequency 1 to 100 Hz with output current ranging 1 to 500 µA automatically selected by computer real time analysis resident software. Wave shape and time of application to the skin was auto determinate by Artificial Intelligent (AI) application. Electrodes are applied to the skin by electrolyte interface solution. Anatomical site to place electrodes are determinate by algic symptoms generally following muscles, tendons and neurological anatomical course.

FIG.2



Statistical Analysis

Numerical values are reported as mean ± standard deviation (SD). Data were analyzed by ANOVA variance analysis followed by Bonferroni's multiple comparison test to further check the among groups significance (GraphPad Prism 6, Software Inc. San Diego, CA). P<0.05 statistical significance level was accepted.

RESULTS

FIG.3

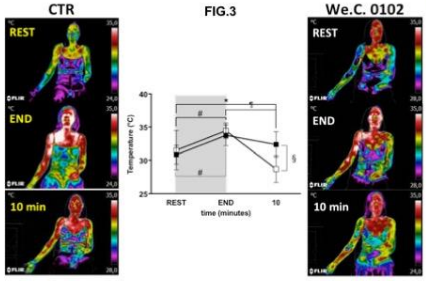


FIG.4

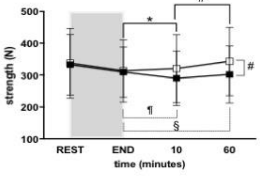
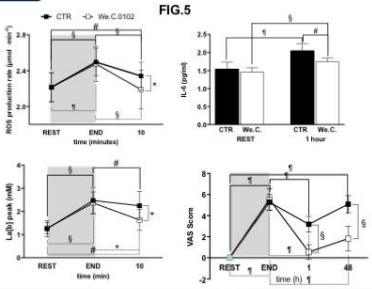


FIG.5



There was no difference in temperature index of infrared thermogram between the two groups before exercise (example and graphic **FIG 3**).
After exercise, the temperature index of the infrared thermogram significantly increased in both groups ($P < 0.01$), and after 10 min, the increase in the temperature index of arm muscle in the CTR was significantly higher than in We.C group. Immediately at the end of exercise a decrease of strength (**FIG.4**; CTR -7,01%,We.C -7,14%) and an increase of ROS production (CTR 12,73%,We.C 11,68%), lactate (CTR +97,68%,We.C +86,12%) and skin temperature (CTR +9,44%,We,C +9,23%) were present in both study conditions (**FIG.5**).
Treatment with the We.C.0102 post-exercise device favored muscle recovery both in terms of strength and metabolic parameters. IL-6, among the major players in the muscular soreness process and subsequently DOMS, is significantly (P<0,01) reduced following We.C.0102 treatment, compared to the control condition. Concerning VAS, the treatment led the value of perceived pain from 5,55 at 1h post exercise to 0,82 evaluated at 48 h post-exercise, with a significant difference of P<0,001 compared to the control condition.
Mean values (±SD) of the parameters collected from the volunteers. Significant differences compared to Pre-exercise: P<0.05 (*),P<0,01(#), P<0.001 (§), P<0.0001 (¶).

CONCLUSIONS

Temperature, ROS and plasma IL-6 concentration can reflects metabolic changes of local tissue. The post-exercise treatment with We.C.0102 device reduces the skin temperature of arm exercised, inflammatory parameters and the severity of painful symptoms. In summary, this study demonstrated that We.C.0120 device can decrease the muscle soreness and promote the restore to muscular physiological homeostasis. Future research into the relationship between the muscle state and biological parameters, will help us to better understand the therapeutic mechanism of We.C.0102 device.

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