The Influence of Extremely Weak Pulsed Electromagnetic Field Typed BEMER 3000 on Ratings of Perceived Exertion at Ventilatory Threshold

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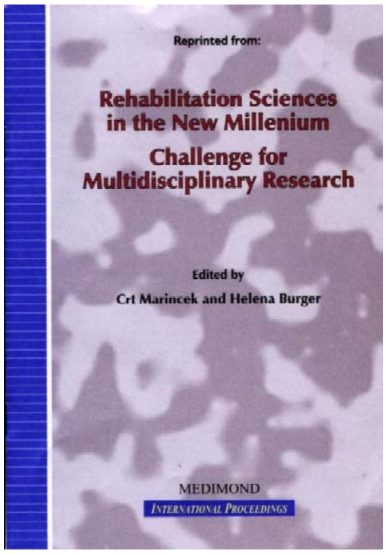

Summary

The purpose of this study was to examine overall, leg, and chest ratings of perceived exertion (RPE) at ventilatory threshold (Th_{vent}) and at maximum oxygen consumption (VO_2 max) after one-month 'exposition to extremely weak pulsed electromagnetic field typed BEMER 3000 (35 µT induction) in 14 male volunteers (mean age 21.4 years). The control (sham-treated) group consisted of 14 age-matched volunteers. Th_{vent} and VO_2 max were measured during a graded exercise test on a cycle ergo meter. The overall, leg, and chest RPE were determined during the last 15s of every exercise stage by placing the 6-20 Borg scale. Results obtained in (his study suggest that subjects exposed to extremely weak pulsed electromagnetic field typed BEMER 3000 rate an intensity corresponding to Th_{vent} to require a lower overall, leg, and chest effort than not exposed ones exercising at a similar intensity.

Introduction

Assessment of during exercise testing is widespread and an important tool in evaluating a subject's level of perceived stress in both a clinical and non-clinical setting. Various physiologic measures such as heart rate. oxygen uptake, blood lactate, and ventilatory threshold have been suggested as appropriate parameters for quantifying exercise training intensity. In preventive or rehabilitative exercise programs, training intensity has been most commonly identified and monitored using measures of heart rate and/or ratings of perceived exertion. The scale most commonly used to measure perception of effort is the 15-point Borg rating of perceived exertion (RPE) scale (Borg, 1971). Ekblom and Goldbarg () proposed that RPE was based on both local (peripheral) and central (respiratory-metabolic) perceptual signals. Hill et al. (1987) have shown that RPE at ventilatory threshold was not affected by training, although after training the ventilatory threshold occurred at a higher power output and was associated with higher absolute and relative metabolic and cardio-respiratory demands. Following Good Clinical Practice, the present study was focused to determine some of the characteristic factors such as: 1) overall, 2) leg, and 3) chest exertion ratings at ventilatory threshold (Th_{vent}) and at maximum oxygen consumption (VO_2 max) under well defined low energetic, extremely low frequently pulsed, broad banded electromagnetic stimulation conditions.

Materials and Methods

The study involved 28 healthy, non-smoking, male volunteers from the student and staff population of the University (mean age 21,4 years). They were randomly sorted into 2 groups 10 subjects each under blind conditions: S-T (control as sham-treated subjects without electromagnetic stimulation), and E35 (exposed to 35 µT electromagnetic field). All subjects were screened for current injury or pain, suffering from diabetes, asthma or any hematological disease, weight training, consumption of drugs, and participation in similar experiments within the past year. All tested persons were requested not to perform hard physical exercise, or to restrict on diets or other limitations during the test period of 30 days. For electromagnetic stimulation the subjects (S-T with switch-off apparatus) had to rest once a day (17 pm) for 12 min in supine position on mattresses (80x170cm) with six inbuilt equidistantly arranged flat applicator coils. Depending on the intensity of well defined 30 Hz pulsed DC-currents - each pulse being characterized by a spectral wide banded time course y(x) following the formula $y=k(x)*x^{a}*e^{\sin(x^{\wedge}b)}c+d$ (BEMER 3000 ® typed stimulation signal), these coils rendered mean electromagnetic flux-densities of 35 µT for group E35. Overall, leg, and chest rates of perceived exertion were determined during a standardized exercise test on a cycle ergo meter within the last 15 seconds of each exercise level load by a 6-20 Borg scale to be pointed by the subjects, corresponding to the individual and respective level of exertion at Th_{vent} and VO_2 rnax. Thus, the schedule of the study consisted of 4 steps: pilot study, first physical exercise and evaluation, 30 days of repeated electromagnetic stimulation and second exercise and evaluation. Oxygen consumption (VO_2) and heart rate (HR) were measured continuously, and overall, leg, and chest RPE were obtained at the end of each stage of the exercise bout. The protocol of graded exercise test began at 60 W for 2 min and increased by 20 W*min^{-1} until maximal voluntary effort was attained. The subjects were instructed to maintain a pedal rate of between 60 and 70 rpm. Overall, leg, and chest RPE were determined during (he last 15 s of every exercise test stage by placing the Borg scale within reach of the subject and asking the subject to point to the number that corresponded to his effort. Th_{vent} was determined from graphs of the ventilatory equivalent for oxygen (VE/VO_2,) and carbon dioxide (VE/VO_2) plotted against time in minutes, and was defined as the point when (VE/ VO_2) began to increase without a corresponding change in the (VE/VO_2). All Th_{vent} plots were examined by the same investigator who was familiar with identifying this parameter. The VO_2, corresponding to Th_{vent} was determined so that Th_{venr} could be expressed as a percentage of VO_2max. The overall leg, and chest RPE obtained in the exercise test stage corresponding to Th were used as the RPE at Th_{vent},. A one-way ANOVA was used to examine within group differences in the overall, leg, and chest RPE at Th_{vent}, and VO_2max. A Tukey post-hoc lest was utilized when a significant ANOVA result occurred. Pearson product-moment correlations were determined to evaluate the relationship between overall, leg, and chest RPE at Th_{vent} within each group.

Results and Discussion

The cardio respiratory responses at Th_{vent} are presented in Table 1. There were no differences between investigated groups in cardio respiratory parameters. When Th_{vent} was expressed as a percentage of VO_2 max there were no evident group differences (data no showed). The RPE responses at maximal exercise are presented in Table 2. Overall, leg, and chest RPE values at maximal exercise for the group E35 were 18.5 (1.2), 18.7 (1.6) and 18.1 (1.0), while the values for the group S-T were 18.6 (1.2). 18.4 (1.2) and 18.6 (1.6). There were no significant differences between groups with respect to any of the RPE values at this level of exercise. When a one-way ANOVA was applied to examine differences among overall, leg, and chest RPE within each group, no differences were detected.

Table 1. *Cardio respiratory responses at ventilatory threshold. Values are given as the mean (±SD). (VO_2 - oxygen consumption, $VO_{2\ max}$ - maximal VO_2 R – respiratory exchange ratio, HR - heart rate. HR_{max} - maximal HR)*

Variable	Group E35	Group S-T
VO_2 (l· min^{-1})	2,12 (0.18)	2.24 (0.47)
VO_2 (ml · kg^{-1}· min^{-1})	30.4 (4.4)	30.8 (5.9)
R	62.4 (5.2)	61.7 (5.3)
HR (beats · min^{-1})	146.9 (10.5)	147.5 (11.2)
% HR_{max}	81.4 (3.9)	79.9 (4.6)

Table 2. *Overall, leg and chest ratings of perceived exertion (RPE) in exposed on electromagnetic field and sham-treated subjects at maximal exercise. Values are given as the mean (±SD), no significant differences*

RPE	Group E35	Group S-T
Overall	18.5 ±1.2	18.6 ±1.2
Leg	18.7 ±1.6	18.4 ±1.2
Chest	18.1 ±1.0	18.6 ±1.6

Table 3. *Overall, leg and chest ratings of perceived exertion (RPE) in exposed on electromagnetic field and sham-treated subjects at ventilatory threshold. Values are given as the mean (±SD). * $p<0.05$ E35 vs S-T*

RPE	Group E35	Group S-T
Overall	12.3* ±2.3	13.8 ±2.6
Leg	12.1* ±2.5	14.7 ±2.8
Chest	10.4* ±2.1	11.7 ±2.0

The RPE responses at Th_{vent} are showed in Table 3. Overall, leg, and chest RPE responses at Th_{vent} in the E35 group was 12.3 (2.3), 12.1 (2.5) and 10.4 (2.1), while for the S-T these values were 13.8 (2.6). 14.7

(2.8), and 11.7 (2.0), respectively. All RPE values were lower ($P < 0.05$) for the subjects exposed to the electromagnetic field when compared to the sham-treated ones. These results indicate that subjects exposed for one month to the magnetic field perceived considerably lower level of exertion when they reached ventilatory threshold during exercise. It is very interesting that in both groups the signals arising from the legs appeared to dominate the RPE response, while signals arising from the chest appeared to have less influence.

The purpose of this study was to examine overall, leg, and chest ratings of perceived exertion (RPE) at ventilatory threshold (Th_{vent}) and at maximum oxygen consumption (VO_2 max) after one month exposition to extremely weak pulsed electromagnetic field typed BEMER 3000 (35 μT induction). Both chest and leg RPE at Th_{vent} were higher for the sham-treated group, suggesting that the sensations arising from these regions were perceived more intensely by those subjects, and most likely contributed to the difference in the overall RPE. In both groups, the signals arising from the legs appeared to dominate the RPE response, while those arising from the chest appeared to have less influence. Within each group, the overall and the leg RPE measures obtained at Th_{vent} were higher than the chest RPE. The leg RPE was lower in subjects exposed to extremely weak pulsed electromagnetic field typed BEMER 3000 and factors not associated with metabolic acidosis may have contributed to the difference between investigated groups. This indicates that sensory mechanisms associated with the mechanical aspects of muscle activation are primarily responsible for the perceived exertion differences noted in this study. Although cause and effect are difficult to establish, it may be of interest to speculate on the physiological factors that mediate the perception of effort in subjects exposed to the electromagnetic field. A variety of metabolic (sensitivity to a variety of stimuli such as catecholamine, potassium, partial pressures of oxygen and carbon dioxide and pH) and mechanical (frequency of muscle contraction and force production) factors have been proposed as primary determinants of the RPE. Robertson (1982) in a review of the central factors thought to influence RPE suggested a theory in which peripheral factors were relatively more important and the contribution of central ones (Th_{vent} and relative VO_2) was moderated by the intensity of exercise. He proposed three levels of intensity I <50%; II 50-70%; III >70% VO_2 max. These increases coincided with changes from exercise hyperpnoea to isocapnic buffering and ended with respiratory compensation for metabolic acidosis. The ventilatory response to exercise is under multiple levels of control involving both central command and peripheral feedback arising from exercising muscle and arterial chemoreceptors. A number of factors beyond the level of pulmonary ventilation are likely to affect the perception of effort. The extremely weak pulsed electromagnetic field typed BEMER may be considered as possible mediator of the perception rating by its influence on chemo reflex sensitivity.

Conclusion

In summary, results of this study suggest that subjects exposed to extremely weak pulsed electromagnetic field typed BEMER 3000 rate the intensity corresponding to Th_{vent} to require a lower overall, leg, and chest effort than not exposed ones exercising at a similar intensity.

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