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Effects of whole-body electromyostimulation with and without voluntary muscular contractions on total and regional fat mass of women

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ABSTRACT

The effects of whole-body electromyostimulation training with voluntary muscular contractions (WB-EMS),and whole-body electromyostimulation without voluntary muscular contractions (EMS) on total and regional fat mass were examined in sedentary female subjects. The subjects (N = 40) were divided two equal groups as the experimental group (EX),and the control group (CON). The EX group underwent WB-EMS training program during 8 weeks via the WB-EMS training device, while the CON group participated in the EMS program. The electrodes placed on 16 regions of whole body, and than80Hz stimulation frequency was used for all training sequences. The regional body composition analyzer was used for determination of total/regional fat percentage, fat mass, and lean mass of subjects. Differences between variables were assessed using paired samples t test. There were no significant changes between the pre-, and post-test in the total, and regional parameters of the CON (p > 0.05). After the WB-EMS training program, significant decreases were found in the body weight, body mass index, total fat percentage, total fat mass, and fat percentage/fat mass of all regions of the EX (p<0.05). Significance was not found in the total/regional lean mass parameters of the EX(p>0.05).According to the results, the WB-EMS training, which a technologic method in exercise science,improved the total, and regional fat mass of women.

Key words: Exercise, Body composition, Electromyostimulation, WB-EMS

INTRODUCTION

The muscle contraction by electric current was used for the treatment of variable diseases. Then, it was determined strength achieves by 40% with the electromyostimulation (EMS) method that used in the sport science [1].The EMS method provides stimulation to nerves, and muscles via electrodes on skin surface. Some changes in the neuromuscular transmission speed occurred related to these stimulations [2].

The whole body EMS system (WB-EMS) is a new exercise technology, and is different than the EMS which is used for the therapeutic aims. This new exercise technology gives stimulation on whole muscle groups (relatively 2800 cm^3 area) at the same time, and successfully used in the physical fitness field. In this technology, the EMS current affects lots of muscle groups, and allows increase the energy expenditure with simultaneously various exercises [3].

Positive effects of the WB-EMS on the body composition have been mentioned in several studies [4,5]. It has defined that the WB-EMS shows fast and significant effect on destruction of the abdominal fat that is pointer of the coronary heart disease [6]. While the classical EMS does not present positive effect on the muscle coordination [7],the WB-EMS exercises positively affect the muscle coordination because of active and dynamic protocol of the WB-EMS

[8]. Several studies have presented that the classic EMS method which is not include voluntary contraction is less effective than the exercise method included voluntary contraction in terms of the strength development[9-11].

The WB-EMS is an EMS technology combined with voluntary exercises. The motor units can activate with this combination at high threshold [12,13]. But, the number of activated motor unit is lesser compared to the classic exercise method included voluntary contraction. Therefore, it is specified that the WB-EMS exercise method more efficient than the classic EMS[14]. Nevertheless, it is advised that the WB-EMS technology is complementary to the classic exercises have voluntary contraction[15].It could be hypothesized that the whole-body electromyostimulation training with voluntary muscle contractions may positively affect the fat mass of women, while whole-body electromyostimulation without voluntary muscle contractions may not. The aim of this study is determination of the effects of 8-weekthe WB-EMS training program with voluntary muscular contractions and the EMS program without the contractions on the total and regional fat mass of women.

MATERIALS AND METHODS

Experimental Design

The present study was including 8-week training program, and test-retest design with control group was used in order to identify effect of the WB-EMS. The all subjects have visited three times laboratory. During first visit, the subjects were familiarized regional body composition analysis method and WB-EMS training device. During second (pre-test) and third visit (post-test), regional body composition analysis test was applied to the subjects. Between second and third visit, the experimental group completed 8-week WB-EMS exercise protocol, while the control group was done 8-week participated in EMS sessions.

Subjects

Forty sedentary women participated in the study as subject. The subjects were randomly divided two equal groups as the experimental (EX; n = 20, age = 33.00 ± 8.83 years), and the control (CON; n = 20, age = 31.20 ± 8.39 years).Separation of the groups was applied before first measurement of the study for the subjects who had same baseline characteristic were not gathered same group. We received written consent from the subjects, and also received ethical approval from Gaziantep Clinical Researches Ethical Committee.

Nutrition advices were not given to the subjects. The pregnant, the persons who was in first 12 months after giving birth, and the persons who attached platinum anywhere on body were not accepted of participation in the study. In addition, WB-EMS practice was not applied on the subjects during first two days of the menstruation period.

Exercise Protocol

WB-EMS exercise program was implemented on the EX group during 8 weeks (3 days/week, 25 min/day) with Miha Bodytec WB-EMS device (Augsburg, Germany) as following four steps;

1. 10 minutes general warm-up,
2. First 10 minutes of the WB-EMS training, worked out with the dumbbell lifting in intensity of 4 seconds stimulation and 4 seconds rest,
3. Second 10 minutes of the WB-EMS training, worked out with the step-aerobic moves in intensity of constant stimulation.
4. Last 5 minutes of the WB-EMS training, applied active cooling moves, in intensity of 1 second stimulation and 1 second rest [3,8,16,17].

The EMS electrodes were placed on 16 regions (Figure 1) of body [3,5,8,16]. Electric current (current range 35-99 Hz) in 80 Hz frequency was used each training unit [16,17]. According to intensity of the subjects can tolerate, current intensity was adjusted separately for the each region of the body. The conductive gel was used toimprove electrical current transmission. The WB-EMS vests, that were to ease transmission of the electric current and were washable, were supplied for each subject [3,5,8,16,17].

The CON participated in EMS program that was only the electric current without voluntary muscular contractions. The EMS program of the CON was applied with same device, area, and vest type, and was same duration per day with same current scheme.

Figure 1.WB-EMS vest and electrode placement

1. Anterior side of worn vest, 2. Inner side of vest, 3. Posterior side of worn vest

Data Collection Procedures

Height was measured in the anatomic position, and without shoes. Furthermore weight, body mass index (BMI), total fat percentage, total fat mass, total lean mass, and regional fat percentage, regional fat mass, regional lean mass parameters recorded with Tanita BC418MAregional body composition analyzer (Tanita Corp., Tokyo, Japan). During the measurement, the subjects put their foot on the metal surface of the analyzer as barefoot, and they held the hand electrodes with their hands. At this position, they wait one minute, and after data were recorded[18,19].The regional body composition analyzer measure was taken two times as one day before and after 8-week exercise period.

Statistical Analyses:

All statistical calculations were performed using SPSS version 22.0. Data were presented as mean, and standard deviation. Shapiro-Wilk test was used for normality. Paired Samples T test was applied for analysis of difference between the pre- and post-test. Statistical results were evaluated on $p \leq 0.05$as significance level.

RESULTS AND DISCUSSION

The pre- and post-test results of the CON and EX were presented in Table 1. In the EX, significant decreasing $(p < 0.05)$was obtained in the weight, BMI, total fat percentage, total fat mass, and fat percentage, and fat mass of whole regions (trunk, right / left leg, right / left arm). There is no significant difference in the total / regional lean mass of the EX, and in all parameters of the CON $(p > 0.05)$.

Effects of the WB-EMS exercise method with voluntary muscular contractions and the EMS method without the contractions on total and regional fat mass of women were examined in the present study.

Significant decreases were found in the total and regional fat mass of the EX after the WB-EMS training period in the present study $(p < 0.05)$. Researchers showed that exercises with the EMS can positively affect the jumping[20-22], the strength[21,23],and the skill development[24,25].In several studies related with the body composition, same results were recorded comparing with results of the EX[5,16,17].

On the other hand, it has been presented that there were no differences in results of the body composition parameters when using the EMS without voluntary muscular contractions[26,27].These findings are same with our results of the CON who participated in the EMS program without voluntary muscular contractions. In the present study, there was no significant difference in the total / regional body composition parameters of the CON $(p > 0.05)$. For these results, it can be considered that the EMS without voluntary muscular contractions does not create positive differences on the body composition because of no affect to the energy metabolism without voluntary contraction [3] that gives increasing to the number of motor units participating to contraction and to the contraction synchronization level [8,28].

Table 1. Comparison of pre and post test results of the CON and EX

Variable	Test	CON (n = 20)			EX (n = 20)		
		Mean ± SD	**% Difference**	**p**	**Mean ± SD**	**% Difference**	**p**
Weight (kg)	Pre-test	66.29 ± 7.68	+0.91%	0.107	**65.79 ± 9.91**	**-4.56%**	**0.013***
	Post-test	66.89 ± 7.94			**62.92 ± 9.50**		
BMI (kg/m^2)	Pre-test	24.32 ± 2.71	+0.90%	0.109	**24.72 ± 2.91**	**-5.10%**	**0.006***
	Post-test	24.54 ± 2.78			**23.52 ± 2.89**		
Total Fat Percentage (%)	Pre-test	31.06 ± 6.35	-0.16%	0.898	**30.72 ± 6.30**	**-10.11%**	**0.001***
	Post-test	31.01 ± 6.76			**27.90 ± 6.17**		
Total Fat Mass(kg)	Pre-test	22.36 ± 4.32	-1.04%	0.805	**20.25 ± 5.50**	**-15.12%**	**0.001***
	Post-test	22.13 ± 4.34			**17.59 ± 5.21**		
Total Lean Mass(kg)	Pre-test	42.72 ± 2.01	+0.16%	0.782	45.56 ± 8.60	-0.51%	0.680
	Post-test	42.79 ± 1.82			45.33 ± 8.20		
Right Leg Fat Percentage (%)	Pre-test	35.91 ± 5.39	0.00%	1.000	**34.59 ± 7.87**	**-4.72%**	**0.034***
	Post-test	35.91 ± 5.53			**33.03 ± 6.50**		
Right Leg Fat Mass (kg)	Pre-test	4.26 ± 1.04	+1.64%	0.285	**4.07 ± 1.06**	**-8.24%**	**0.039***
	Post-test	4.33 ± 1.05			**3.76 ± 0.94**		
Right Leg Lean Mass (kg)	Pre-test	8.04 ± 1.10	-0.12%	0.823	7.76 ± 1.67	-2.78%	0.071
	Post-test	8.03 ± 1.06			7.55 ± 1.44		
Left Leg Fat Percentage (%)	Pre-test	35.74 ± 5.59	+0.53%	0.375	**34.81 ± 7.72**	**-4.69%**	**0.012***
	Post-test	35.93 ± 5.83			**33.25 ± 6.92**		
Left Leg Fat Mass (kg)	Pre-test	4.45 ± 0.79	+0.90%	0.599	**4.01 ± 1.03**	**-8.67%**	**0.022***
	Post-test	4.49 ± 0.77			**3.69 ± 0.92**		
Left Leg Lean Mass (kg)	Pre-test	7.38 ± 0.61	+0.14%	0.893	7.59 ± 1.58	-1.88%	0.116
	Post-test	7.39 ± 0.44			7.45 ± 1.44		
Right Arm Fat Percentage (%)	Pre-test	32.54 ± 5.46	+0.03%	0.798	**30.62 ± 7.17**	**-13.45%**	**0.001***
	Post-test	32.55 ± 5.46			**26.99 ± 7.76**		
Right Arm Fat Mass (kg)	Pre-test	1.15 ± 0.32	+0.87%	0.780	**0.99 ± 0.31**	**-16.47%**	**0.001***
	Post-test	1.16 ± 0.29			**0.85 ± 0.33**		
Right Arm Lean Mass (kg)	Pre-test	2.22 ± 0.25	-0.91%	0.693	2.31 ± 0.61	-0.87%	0.678
	Post-test	2.20 ± 0.18			2.29 ± 0.62		
Left Arm Fat Percentage (%)	Pre-fat	32.80 ± 6.30	0.00%	1.000	**31.27 ± 7.15**	**-13.17%**	**0.001***
	Post-test	32.80 ± 6.43			**27.63 ± 7.85**		
Left Arm Fat Mass (kg)	Pre-test	1.17 ± 0.29	-4.46%	0.381	**1.04 ± 0.38**	**-18.18%**	**0.002***
	Post-test	1.12 ± 0.32			**0.88 ± 0.36**		
Left Arm Lean Mass (kg)	Pre-test	2.20 ± 0.18	0.00%	1.000	2.31 ± 0.62	-0.43%	0.840
	Post-test	2.20 ± 0.14			2.30 ± 0.62		
Trunk Fat Percentage (%)	Pre-test	27.65 ± 6.28	+0.04%	0.879	**28.02 ± 6.33**	**-15.07%**	**0.001***
	Post-test	27.66 ± 6.29			**24.35 ± 6.43**		
Trunk Fat Mass (kg)	Pre-test	10.12 ± 2.50	+0.30%	0.279	**10.13 ± 3.21**	**-20.31%**	**0.001***
	Post-test	10.15 ± 2.54			**8.42 ± 3.00**		
Trunk Lean Mass (kg)	Pre-test	24.31 ± 2.35	+0.41%	0.096	25.61 ± 4.21	+0.59%	0.644
	Post-test	24.41 ± 2.36			25.76 ± 4.15		

**: $p < 0.05$, CON: Control Group, EX: Experimental Group, SD: Standard Deviation, % Difference: Percent difference between the pre- and post-test*

In the EX, we determined higher reducing in the fat percentage and mass parameters on the arm, and trunk regions than legregion. About of reason of this result, we considered that the number of the electrodes on the trunk, and arms are more than the leg electrodes.

Significant differences have not been observed between the pre- and post-testin total and regional lean mass parameters of the EX in the present study*($p > 0.05$)*. The literature showed increase in the muscle contraction strength with the WB-EMS training method, but not showed hypertrophy on muscles. Reason of this result, they asserted occurred neural adaptation without muscle mass increment[8].This finding in above study can explain to the results of the present study.

CONCLUSION

As a result, it could be said that the WB-EMS exercises can improve the total and regional fat mass of women because of contains voluntary muscular contractions, but cannot affect lean mass. Also, the EMS method without voluntary muscular contractions cannot affect total and regional fat mass of women due to without physical exercises.We suggest that the WB-EMS exercise method is not adequate, and the method should use as a support to the physical training methods with voluntary contractions.

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