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Effect of Microcurrent stimulation and Combined exercise on Body composition and Blood lipid profile in Young obese women

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미세전류자극과 복합운동이 비만 여대생의 체성분과 혈중지질성분 변화에 미치는 효과

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요 약 : 본 연구는 미세전류자극이 비만인의 체성분과 혈중지질성분의 변화에 미치는 효과를 규명하고, 복합운동의 효과와 비교함으로써 효과적인 체형 관리 방안으로서 미세전류자극의 유용성을 밝히고자 하였다. 체지방율 30% 이상인 여대생 30명을 통제집단, 복합운동집단, 미세전류자극집단으로 분류하였으며, 각 집단 별 4주간의 처치 전후 체중, 체지방율, 허리 둘레 등의 체성분 요인과 TG, TC, apolipoprotein 등의 혈중지질성분을 측정한 자료를 분석하여 다음과 같은 결과를 얻었다. 통제집단에서는 모든 측정 항목에서 통계적으로 유의한 차이가 나타나지 않은 반면 복합운동 집단에서는 허리둘레와 TC가 유의하게 감소한 것으로 나타났고, 미세전류자극 집단에서는 체중, 체지방율, 허리둘레, apolipoprotein 등이 유의하게 감소한 것으로 나타났다. 이러한 연구결과를 고려할 때 미세전류 자극은 비만인의 체성분과 혈중지질성분을 개선시켜 건강한 신체를 갖도록 하는데 효과적인 중재 방안으로 제안할 수 있다.

주제어 : 미세전류, 복합운동, 체성분, 혈중지질, 비만

Abstract : The present study aims to verify the usefulness of microcurrent stimulation as an effective intervention for managing body shape. Thirty female college students with a percentage body fat of 30% or more participated as subjects and belonged to the one of three groups; control group, combined exercise group, microcurrent stimulation group. Based on the results of analyzing the measurement data from pre- and post-intervention for four weeks for each group, the following conclusions were obtained. There was no statistically significant difference in all measured variables in the control group. However, waist circumference and TC were significantly reduced in the combined

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exercise group, and also weight, percentage body fat, waist circumference, and apolipoprotein were significantly reduced in microcurrent stimulation group. Considering the above conclusions, it can be suggested that microcurrent stimulation could be an effective intervention to improve body composition and blood lipid profile to have a healthy body.

Keywords : Microcurrent, Combined exercise, Body composition, Lipid profile, Obese

1. Introduction

In modern society, people try to improve their appearance because beautiful and attractive looks can not only serve as an important factor in interpersonal relationships but also as individual competitiveness [1]. Women, in particular, are more evaluated for their physically healthy appearance according to the beauty standards required by society than men, and women, especially young women, are lavishly investing time and money in managing their body shapes to maintain health and improve competitiveness [2]. In order to create a healthy body shape, calorie intake and energy expenditure must be controlled through proper diet and regular exercise [3]. However, it is not easy to exercise regularly in the daily life of busy and irregular modern people, and moreover, it is very difficult for people who do not usually exercise to start and keep them going. Therefore, many women tend to control their weight and body shape through diet control rather than exercise. However, diet control using the wrong method, such as fasting or excessively limiting the amount of meals, is not easy to achieve its purpose and can have a bad effect on health. In addition, even if they temporarily lose weight or adjust their body shape, they are likely to return to their original state due to the yo-yo phenomenon [4].

As seen above, young women in modern society have a great desire to have a beautiful and healthy body for various reasons, and they are trying various ways for that, but the effect is not so great compared to the difficulty. A variety of new interventions have recently been proposed to achieve greater effects with less effort to meet this situation of the times, which replace traditional forms of exercise or help maximize its effectiveness. Such new therapies include whole body vibration, cryotherapy and microcurrent stimulation [3,5-10].

Microcurrent is a low-level electrical stimulation technique characterized by a sub-sensory, extremely low-amplitude current, typically ranging from 1 to 1000 microamperes, which is applied to the body for therapeutic, diagnostic, or physiological purposes [11]. In the context of bioelectric medicine, microcurrent is also described as a gentle and non-invasive electrical modality that harnesses currents at sub-sensory levels to stimulate cellular repair, modulate inflammation, and promote tissue regeneration, aligning with the concept of restoring natural electrical gradients in biological systems [12]. Microcurrent exhibits several key characteristics, including its sub-sensory nature, minimal discomfort or sensation during application, biophysical similarity to endogenous electrical currents in living tissues, and its capacity to influence cellular signaling, ion transport, and tissue healing processes, making it a versatile modality in healthcare and therapeutic interventions [13]. Several researchers have emphasized that microcurrent therapy is distinguished by its biophysical resemblance to the natural electrical currents found in living tissues, which enables its non-invasive and biocompatible nature, making it an ideal choice for promoting cellular healing and homeostasis [14].

As the safety and effectiveness of microcurrent stimulation are verified, the scope of application is expanding beyond the existing medical field to the beauty field [15]. In addition, research is being conducted to utilize microcurrent to modify body shape and improve health by reducing body fat [9,16-19]. Previous studies have reported that microcurrent stimulation can increase fat metabolism by activating lipolysis in adipocytes, and thus reduce body fat [3,10,18-22]. Therefore, it can be suggested that microcurrent stimulation for the purpose of decreasing body fat or losing weight could be a safe and effective intervention. However, most of the previous studies predict the effect on the human body through in-vitro or animal research [10, 20], so there are few pieces of evidence on whether fat metabolism is actually activated in the human body by microcurrent stimulation. In addition, clinical studies on microcurrent stimulation and fat metabolism are combined with the effects of exercise [9,16-17,23], making it difficult to clearly explain whether microcurrent stimulation itself, except exercise, works and how much the effect is.

Thus, the purpose of present study is to verify the effect of microcurrent stimulation on the human body on changes in body composition and blood lipid profile and to compare them with the effect of aerobic exercise in young obese women.

2. Research Method

2.1. Subjects

Thirty young obese women who are attending N University in Cheonan city volunteered to participate in the present study and were admitted to the study after meeting the following criteria; (1) Their percentage body fat was more than 30%, (2) They had not been involved in any diet or regular exercise program for reducing weight or body fat for at least recent 3 months, (3) They were not on any meditation at the time of their participation in the study. After hearing notice about the purpose, significance and procedure of the study from the researcher, they fully understood the contents and signed a voluntary consent to participate in the study. All subjects were informed and consented that they could be randomly allocated to one of the three groups (control group; CG, combined exercise group; CEG, microcurrent stimulation group; MCSG). The physical characteristics of the subjects for each group are shown in Table 1 below.

2.2. Experimental procedures and measurement

All subjects were tested to measure body composition factors and blood lipid profile before and after 4 weeks of intervention according to the group they belonged to. Body composition factors were weight, percentage body fat, waist circumference, and blood lipid profile factors were triglyceride (TG), total cholesterol (TC), and apolipoprotein.

Weight and percentage body fat were analyzed using Inbody720 (Biospace Co., Ltd., Seoul, Korea), an automatic body composition

Table 1. Physical characteristics of subjects

group \ item	age(yrs)	height(㎝)	weight(㎏)	%bodyfat(%)
CG	21.2±1.23	161.4±5.52	62.8±7.67	35.1±3.72
CEG	20.6±1.00	161.2±5.61	64.6±10.44	36.5±4.28
MCSG	22.8±2.04	162.2±4.37	62.5±8.13	35.6±4.15

Values are M±SD

CG: control group, CEG: combined exercise group, MCSG: microcurrent stimulation group

analyzer using bioelectrical impedance analysis (BIAs). Inbody720 was performed while the subjects were standing upright: hands hold the electrodes and feet on the electrodes, with 8-point tactile electrode method. It also provides 6 different frequency impedance measurements (1, 5, 50, 250, 500 and 1000 KHz) and 3 different frequencies of phase angle messurement (5, 50 and 250 KHz) at each 5 segments (right arm, left arm, trunk, right leg and left leg). Waist circumference was measured with the subjects in a standing position at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest [24]. The measurement was performed twice in mm by an expert, and re-measurement was performed when the error between measurements was 7 mm or more. Blood sampling for measuring blood lipid profile was conducted by a professional clinical pathologist using a disposable syringe to collect 5 ml of blood from the forearm main vein while the study subject remained fasting for more than 12 hours. The blood sample was requested to Seegen Medical Co., Ltd.,(Seoul, Korea) a blood analysis agency, to analyze the concentrations of triglyceride(TG), total cholesterol(TC) and apolipoprotein.

2.3. Intervention

2.3.1. Microcurrent stimulation

Microcurrent stimulation was applied using a newly developed microcurrent generator and leggings-typed clothing made of conductive fabric. The microcurrent generator was developed as small, light, and rechargeable, and was attached to leggings to deliver microcurrent stimulation to the skin(Cellogin Co., Ltd., Wonju, Korea). The leggings are easy to wear and have a similar wearability to general leggings, so they do not cause any inconvenience in daily life or exercise. In addition, it was developed so that the microcurrent stimulation function is not lost even after washing. The subjects belonged to microcurrent stimulation intervention group were provided with the leggings suitable for their own body size and were familiar with how to use it. When the microcurrent generator is operated after wearing leggings, the microcurrent is transmitted to the body without the subject recognizing it at all. And they were required to wear the leggings for eight hours a day during their daily lives for four weeks, and monitor personnel checked that daily.

2.3.2. Combined exercise program

Based on the results of previous studies [25-27], the exercise program was developed in the form of a combined exercise with aerobic and resistance exercises, and was conducted three times per week on non-consecutive days for four weeks. Each exercise was consisted of a total of a 65 minute of warm-up, aerobic exercise, resistance exercise and cool-down. The exercise program was instructed to the subjects and their performance was supervised by professional trainers, and performed it in gym of N University located at Cheonan.

For warm-up, light walking and stretching exercise were performed for 10 minutes. Aerobic exercise was consisted of fast steps and running on a urethane track. It was conducted for 30 minutes and the exercise intensity was based on the individual maximum heart rate calculated using the Karvonen formula [28]: it started at 55% and was gradually elevated to 75% during the exercise for the first two weeks and 55-85% for the next two weeks. The heart rate was monitored using a wristband heart rate monitor. The resistance exercise used exercise band and was performed on the muscle groups of the arms and legs for 20 min. It was performed under the instruction and supervision of a professional trainer to perform accurate movement and secure safety. For cool down, stretching exercise on the muscles and joints used in the resistance exercise was performed for five minutes. Between aerobic and resistance exercise, the subjects were permitted to take 5- to 10-minute rest.

2.3.3. Intervention for control group

In order to avoid the side effects of skin pressure caused by wearing leggings on changes in measurement variables, subjects in the control group were also asked to wear leggings. The leggings they wore were the same as those worn by subjects in the microcurrent stimulation group, but did not provide microcurrent stimulation.

2.3.4. Nutrition and supplements

The subjects were asked not to change their dietary habits during intervention. They were contacted every week by a nutritionist to ensure that no dietary changes occurred.

2.4. Statistical analysis

The statistical analysis was performed utilizing SPSS for Windows(Ver. 29.0) and descriptive statistics included the mean±SD. Paired t-test was conducted to analyze the difference between the time of measurement according to the group. Repeated measures ANOVA was conducted to analyze the effects of intervention according to groups. Alpha value of 0.05 was set for statistical significant.

3. Results and discussion

3.1. The changes in body composition

The results of analyzing changes in body composition variables such as weight, percentage body fat and waist circumference according to pre and post of 4 week's intervention for each group are shown in Table 2 below.

Weight results between times showed no statistically significant differences in the control group and combined exercise group, but showed significant decrease in the microcurrent stimulation group (t=3.075, p=.005). And showed the main effect according to time (F=8.927, p=.006) and the interaction effect between time and groups (F=7.454, p=.003) were significant.

Percentage body fat results between times showed no statistically significant differences in the control group and combined exercise group, but showed significant decrease in the

Table 2. The Changes in body composition

Variables	Group	Pre	Post	t	Source	F
Weight	CG	62.82±7.67	63.08±7.50	-1.847	group	.189
	CEG	64.63±10.44	64.18±10.30	1.620	period	8.927**
	MCSG	62.54±8.13	61.45±8.62	3.705**	group×period	7.454**
% body fat	CG	35.10±3.72	35.30±3.57	-1.348	group	.206
	CEG	36.47±4.28	35.84±4.19	2.212	period	10.107**
	MCSG	35.63±4.15	34.62±4.17	3.247**	group×period	5.549*
Waist circumfer-ence	CG	73.90±5.97	73.90±5.66	.035	group	.208
	CEG	75.50±8.95	74.26±8.42	2.557*	period	17.299**
	MCSG	73.57±6.01	72.15±6.48	4.644**	group×period	4.287*

Values are M±SD. * p <.05, ** p <.01

CG: control group, CEG: combined exercise group, MCSG: microcurrent stimulation group

microcurrent stimulation group (t=3.247, p=.010). And showed the main effect according to time (F=10.107, p=.004) and the interaction effect between time and groups (F=5.549, p=.010) were significant.

Waist circumference result between times showed no statistically significant differences in the control group, but showed significant decrease in microcurrent stimulation group (t=4.644, p= .001). And showed the main effect according to time (F=17.299, p=.001) and the interaction effect between time and groups (F=4.287, p=.024) were significant.

3.2. The changes in blood lipid profile

The results of analyzing changes in blood lipid profile variables such as trigluceride(TG), total cholesterol(TC) and apolipoprotein according to pre and post of 4 week's intervention for each group are shown in Table 3 below.

TG results between times showed no statistically significant differences in all groups, but showed in a slight decrease in combined exercise group and microcurrent stimulation group. And showed the interaction effect between time and groups was significant (F=3.669, p= .039).

TC results between times showed no statistically significant differences in the control group and microcurrent stimulation group, but showed significant decrease in combined exercise group (t=2.839, p= .019). And the main effect according to time was significant (F=4.341, p=.047).

Apolipoprotein results between times showed no statistically significant differences in the control group and combined exercise group, but showed significant decrease in microcurrent stimulation group (t=3.394, p=.008). And the main effect according to time (F=7.922, p=.009) and the interaction effect between time and groups (F=3.716, p=.038) were significant.

3.3. Discussion

Recently due to the false lookism that the skinny body is beautiful, not only obese people but also even those who are underweight or normal weight are trying to reduce their weight in various ways to develop their appearance and body shape. Previous studies [29,30] reported that many of the female college students who try to control their weight were found to have a beautiful appearance, not for their health, and these results are a natural phenomenon caused

Table 3. The Changes in blood lipid profile

Variables	Group	Pre	Post	t	Source	F
Trigly-ceride	CG	93.60±29.12	97.80±22.79	-1.311	group	.261
	CEG	92.40±24.74	87.80±25.56	1.434	period	2.541
	MCSG	94.30±11.20	84.50±13.53	2.170	group×period	3.669*
Total cholesterol	CG	179.60±25.95	177.40±24.50	.484	group	.075
	CEG	183.40±24.79	157.70±27.39	2.839*	period	4.341*
	MCSG	187.10±35.33	179.30±36.58	1.174	group×period	.427
Apolipo-protein	CG	5.33±0.93	5.38±0.99	-.270	group	.284
	CEG	5.37±1.52	5.09±1.23	1.784	period	7.922**
	MCSG	5.47±1.32	4.84±.97	3.394**	group×period	3.176*

Values are M±SD. * p ⟨.05, ** p ⟨.01
CG: control group, CEG: combined exercise group, MCSG: microcurrent stimulation group

by women's beauty standards in our society giving value to tall and thin bodies.

Especially the accumulation of localized adipocytes in the abdominal region is a major concern with body aesthetics [31]. Abnormal or excessive adipose tissue accumulation occurs when lipids accumulate in adipocyte due to an imbalance between calorie intake and energy expenditure, and these cause the risk of being overweight and obesity [32]. Abdominal obesity, namely visceral and deep subcutaneous adipose tissue, are associated with a greater risk for the development of metabolic and cardiovascular complications than in other regions of the body [9].

Lifestyle modification is the main intervention for managing obesity. Weight loss can be achieved by increasing energy expenditure (exercise) and reducing calorie intake (diet) [33]. However, as already described in the introduction of previous study, people want to reduce weight and body fat in an easier and more effective way because they think lifestyle modification is never easy and the effect is not great compared to the effort.

Microcurrent stimulation has been studied as an important intervention for greater lipolytic activity based on the study conducted by Hamida et al. [20] in which they showed that electrical stimulation has a potential effect on the activation of lipolysis in adipocytes in vitro.

Recently, microcurrent therapy has been applied in clinical practice and thus, studies are being conducted on humans.

Smith et al. [34] reported that microcurrent stimulation can effectively modulate human fat metabolism, potentially offering a promising non-invasive approach for managing adiposity and supporting weight management goals. Melo et al. [23] reported that clay body wrap with microcurrent leaded decrease in skinfold of the abdominal region, fat percentage and fat layer, and could play a role in abdominal subcutaneous and visceral fat reduction.

In addition, more recently, clothing products that provide microcurrent stimulation have been developed, and studies on its wearing effect have also been conducted. Cho et al. [18] reported that body fat and waist circumference decreased as a result of providing microcurrent stimulation for 8 hours a day during daily life using underpants designed to transmit microcurrent to the skin of the abdominal region. They also reported that the degree of reduction was found to be proportional to the microcurrent stimulation time, so microcurrent stimulation is not only safe but also suitable as an obesity management technique that can accompany body improvement. Kang et al. [15] reported that as a result of performing a treadmill running exercise for 60 minutes while wearing a sports bra equipped with a small microcurrent generator, the weight was reduced more than that of the general bra-wearing group, because the amount of sweating increased due to the stimulation of microcurrent.

Most of the previous studies on the effect of microcurrent stimulation predicted the effect on the human body through in vitro or animal research [10,20]. And most studies on humans used microcurrent stimulation before and after exercise as an auxiliary means to increase the effect of exercise[9,16-17,23]. Therefore, studies on the effect of microcurrent stimulation itself, excluding the effect of exercise, on fat metabolism in the human body are very scarce. In addition, it is difficult to determine the effectiveness of microcurrent stimulation on fat metabolism in the human body as few studies have been conducted. Therefore, the present study attempted to investigate the effect of microcurrent stimulation, which removed other variables that affect fat metabolism, on fat metabolism independently, and to determine how much microcurrent stimulation improves body composition and blood lipid profile through comparison with the combined exercise group.

In present study, obese female college students were required to wear leggings made of conductive fibers and equipped with small and light microcurrent generators for eight hours a day during their daily lives for four weeks, and their weight, percentage body fat, and waist circumference were measured before and after four weeks of wearing and compared with the control group. The measurement data analysis showed no difference in all variables in the control group wearing leggings without microcurrent generators for the same time, while weight, body fat percentage, and waist circumference all decreased significantly in the microcurrent stimulation group. Therefore, such a reduction can be said to be the effect of microcurrent stimulation entirely. These study results are supported by previous studies [2,3,7,15,18,20] that reported that microcurrent stimulation activates lipolysis in adipocyte and reduces body fat.

However, studies have also reported that microcurrent stimulation did not increase the use of fat as an energy source [3], which is inferred because microcurrent stimulation time was insufficient to promote fat metabolism. Therefore, additional research on microcurrent stimulation time, which is effective for reducing body fat, should be conducted.

Individual with visceral obesity have impaired plasma lipid metabolism including increased triglyceride, apolipoprotein B and low-density lipoprotein cholesterol, and decreased high-density lipoprotein cholesterol levels [35]. Generally, accumulation of abdominal and visceral fat is associated with an increased risk of thrombosis and elevation of inflammatory markers, all of which contribute to the development of unstable atherosclerotic plaque and unstable angina pectoris [36]. TG is located in adipose cells and in the musculoskeletal system, and works as an energy source to produce ATP through energy metabolism in vivo [37]. Previous study by Curtis et al. [38] reported that microcurrent helps triglyceride degradation by increasing blood flow and metabolism, provoking changes in cell membrane polarity and activating triglyceride lipase and hormone-sensitive lipase enzymes.

Previous studies reported that microcurrent stimulus may have a modulating effect on total cholesterol levels and that significant reduction in TC levels following a series of microcurrent treatments in patients with hypercholesterolemia.

Apolipoproteins are a class of proteins that play a pivotal role in lipid transport and metabolism, functioning as structural components of lipoproteins and serving as key regulators of cholesterol homeostasis [39]. Regular exercise has been shown to have a positive impact on apolipoprotein profiles, with studies indicating that aerobic exercise can lead to beneficial alterations in apolipoprotein levels, contributing to improved lipid metabolism and a reduced risk of cardiovascular diseases [40]. Previous studies have indicated that microcurrent therapy may have a positive impact on human blood components, potentially leading to improvements in parameters such as triglyceride levels, total cholesterol, and apolipoprotein profiles. However, the specific outcomes and mechanisms may vary depending on the study design and population under investigation.

In the present study, apolipoprotein was significantly decreased post intervention in the microcurrent stimulation group. In addition, TG and TC also showed a tendency to decrease, although not statistically significant. These results are supported by previous studies showing that blood lipid profile was decreased by microcurrent stimulation.

However, on the contrary, negative research results have also been reported. Park et al.[37] reported that there was no significant difference as a result of analyzing TG and TC after having women in their 20s with a body fat percentage of 26% or more wear shoes equipped with microcurrent generators for four weeks. These results can be inferred because the microcurrent generated in the shoe did not conduct well to the adipose tissue. Therefore, in future studies, it will be necessary to check whether microcurrent stimulation is well conducted to the target tissue before intervention.

In the present study, the effect of microcurrent stimulation on body composition and blood lipid profile were verified, and the magnitude of the effect was compared with the effect of combined exercise. The present study showed that two variables were significantly reduced in the combined exercise group: waist circumference and TC, while four variables were significantly reduced in the microcurrent stimulation group: weight, body fat percentage, waist circumference, and apolipoprotein. It may not be scientific to compare the size of the effect based on the number of variables with significant differences, but at least it has been confirmed that microcurrent stimulation has a similar effect to combined exercise.

Previous studies [26,41-44] reported that combined exercise improved overall body composition and blood lipid profile of obese people, but only waist circumference and TC were significantly reduced. This can be inferred because the exercise duration of the previous studies was at least 8 weeks, whereas this study was only 4 weeks, so there was not enough time for the human body to fully physiologically adapt to exercise. Therefore, it is not certain that microcurrent stimulation will be more effective than combined exercise even if the exercise duration is longer.

Even if so, microcurrent stimulation can be considered an effective obesity and body shape improvement intervention considering that less effort can achieve effects similar to complex exercise. In future studies, it is required to set the intervention duration longer and verify changes accordingly.

4. Conclusion

The present study aimed to verify the usefulness of microcurrent stimulation as an effective method for managing body shape. Thirty female college students with a body fat ratio of 30% or more participated as subjects and belonged the one of three groups; control group, combined exercise group, microcurrent stimulation group. Based on the results of analyzing the measurement data from pre- and post-intervention for four weeks for each group, the following conclusions were obtained.

There was no statistically significant difference in all measured variables in the control group. However waist circumference and TC were significantly reduced in the combined exercise group, and weight, percentage body fat, waist circumference, and apolipoprotein were significantly reduced in microcurrent stimulation group.

Considering the above conclusions, it can be suggested that microcurrent stimulation could be an effective intervention to improve body composition and blood lipid profile to have a healthy body.

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