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Effects of Interferential Current Therapy Using Intermediate Frequency Currents on Obesity

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Abstract—**The purpose of this study was to investigate the effect of interferential current therapy combined with abdominal muscle strengthening exercises on the reduction of visceral fat mass and abdominal circumference in obese women. The subjects of this study were obese women(20 subjects). The subjects were randomly assigned to an experimental group (n = 10) that would perform abdominal muscle strengthening exercises after receiving interferential current therapy or to a control group (n = 10) that would only perform abdominal muscle strengthening exercises. Waist circumference was measured in cm using a tape measure with the patient standing upright. The length of visceral fat was measured using a high-resolution B-mode ultrasound machine. The amount of change in waist circumferences and abdominal visceral fat lengths was statistically significantly different between groups, with larger changes observed in the experimental group compared to the control group. These results can be the grounds for not only the effects of interferential current therapy but also the fact that combined therapy with abdominal muscle strengthening exercises is an effective treatment intervention for obesity management.**

Index Terms— **Interferential current therapy, Obesity, visceral fat, abdominal circumference**

I. Introduction

Obesity refers to the condition where the amount of fat accumulated in the body is medically larger than normal. This is generally due to an excessive intake of food, insufficient activity, or other pathogenic elements. The condition where the amount of excess accumulated fat exceeds 10–20% of the standard weight is called overweight and the condition where the amount of excess accumulated fat exceeds 20% of the standard weight is called obesity[1].

Women begin to undergo body shape changes in their 30s due to their experiencing pregnancy and delivery. As women enter their 40s, their metabolic rates decrease due to changes in hormone secretion, which causes them to easily gain weight and obesity becomes more prevalent. Starting from the age of 50, women's body shapes adopt certain characteristics, such as a decrease in the circumference of the neck, the upper arm, and the chest. To review the physical characteristics of obese women by region, the waistline is not clearly distinguished, the belly is protruding, the shoulder area is rounded, and the fat on the back of the neck increases. These changes in female body shape appear more noticeably in their late 40s[2].

Increases in body fat due to obesity lead to body composition imbalance and metabolic function deterioration of the human body, thereby increasing disease incidences and adversely affecting the cardiovascular system. In addition, excessive fat accumulation in the abdomen has been reported to affect the risk and mortality of coronary artery diseases. Currently, clinical treatment for obesity includes drug therapy, lipolysis, IMS, electro-acupuncture, intermediate frequency therapy, low-frequency therapy, and cognitive-behavioral therapy[3]. Hydrotherapy, electrotherapy, and stimulation therapy have also been applied as physiotherapy for obesity management for many years. However, as the application of exercise programs becomes more difficult to follow due to the busy daily lifestyle of modern times, management of obesity through electrotherapy has started to garner more attention.

Interferential current therapy is based on the intermediate frequency currents 3000 Hz and 6000 Hz, and combines two similar currents, such as 4000 Hz and 4100 Hz, to induce an interferential current in a range of 1–250 Hz to the desired treatment site. The frequency of depolarization when the bi-directional pulses of interferential currents are used is neither the frequency of the current nor the depolarization frequency of other nerve fiber fascicles, rather, it is the depolarization frequency of nerve fibers according to the summation principle[4]. This is known as the Gildemeister effect, which can be otherwise described as stimulation asynchronous depolarization. Additionally, based on the theory that the higher a frequency, the lower the capacitance resistance becomes, which allows currents to pass through the skin more easily. Thus, by using intermediate frequency currents, tissue can be more effectively stimulated with much less skin irritation as compared to low frequency currents.
Currently, in South Korea, although devices or drugs that can effectively remove or reduce fat in part are used indiscriminately, results from proper studies of the effects of such devices or drugs have been rare. In addition, although many studies have been conducted to reduce subcutaneous fat mass, studies for the reduction of visceral fat have been rare[5]. The purpose of this study was to investigate the effect of interferential current therapy combined with abdominal muscle strengthening exercises on the reduction of visceral fat mass and abdominal circumference in obese women.

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II. Study Method

A. Subjects

The subjects of this study were obese women who had no history of diabetes, endocrine disease, or renal dysfunction, and were not taking any oral contraceptive, antihypertensive agent, or antihyperlipidemic agent. Subjects were chosen from among patients who were visiting the hospital for obesity management. There were 20 subjects selected for this study with a body mass index no lower than 25 kg/m2 and a BDI (Beck Depression Inventory) exceeding 16. The subjects were randomly assigned to an experimental group (n = 10) that would perform abdominal muscle strengthening exercises after receiving interferential current therapy or to a control group (n = 10) that would only perform abdominal muscle strengthening exercises. Patients who were being treated with medicines such as analgesics, had vestibular or neurological disorders, had experienced dizziness or unexpected falls during the past six months, or had any brain disease were excluded from the study. The purpose, plan, and progression of the study were explained to all study subjects before the study began.

B. Treatment

Interferential current therapy was performed using a device that generates interference waves (Nemectron GmbH, Germany) with cuffs wrapped around the abdomen for 45 minutes per session, 3 times per week for 4 weeks; in other words, a total of 12 sessions. One of the device's pre-programmed treatment options was used. The program consisted of the application of an interference wave with a frequency 3 Hz for 30 minutes, followed by 50 Hz for 5 minutes, and finally 10 Hz for 10 minutes.

The abdominal muscle strengthening exercises were performed using a method meant to induce efferent contraction of the rectus abdominis muscle during isometric contraction of the transverse abdomen muscle[6]. The exercise began with patients in a supine position at a 90° hip flexion and 90° knee flexion. The patients were instructed to induce isometric contraction of the transverse abdomen muscle before engaging in efferent contraction of the rectus abdominis muscle. After relaying the exercise instructions, the therapist placed his hands at the areas of the Achilles tendon on both sides of the patient to hold the patient's legs at the starting position of the exercise. With an oral order of "slowly lower," the patient lowered both legs toward the targeted muscle groups until the angle of hip flexion became 45° while maintaining the 90° knee angle. The patient performed the efferent contraction of the rectus abdominis muscle 10 times during the isometric contraction of the transverse abdomen muscle and then took a rest for 3 minutes. The patient performed a total of 3 sets of the exercise per day and considered 10 repetitions of the exercise as one set. The patient performed the exercise 3 times per week for 4 weeks; in other words, a total of 12 times.

C. Assessment

Waist circumference was measured in cm using a tape measure with the patient standing upright. The length of visceral fat was measured using a high-resolution B-mode ultrasound machine (HDI 5000, ATL, Phillips). The visceral fat length was measured by the same examiner at 1 cm above the umbilicus at the end of expiration using a 3.5 MHz probe while the subject was in a comfortable lying position. Visceral fat length was defined as the length from the inner surface of the abdominal erector muscle to the anterior wall of the aorta. Preliminary assessments of the subjects were conducted before the experiment and ex post facto assessments of the subjects were conducted after applying the last intervention four weeks later.

D. Data analysis

Data was analyzed using SPSS 20.0 for Windows. Paired t-tests were used to compare differences in pain and balance for before and after the experiment and independent t-tests were used to compare differences in pain and balance between groups. All data values were indicated as mean ± standard deviation and the significance level was set to $\alpha < 0.05$.

III. Results

In intragroup assessments, the waist circumferences of all groups statistically significantly decreased after the experiment compared to before the experiment ($p < 0.05$)(Table 1). The amount of change in waist circumferences was statistically significantly different between groups, with larger changes observed in the experimental group compared to the control group ($p < 0.05$).

Table 1. Comparison of waist size between groups.

	Experimental group (n=10)	Control group (n=10)	*t*	*p*
Pre-test	83.89±12.57	84.56±12.46	2.145	0.000*
Post-test	77.34±7.29	80.81±8.06		
t	5.845	3.346		
p	0.000*	0.000*		

*$p<0.05$, unit: cm

In intragroup assessments, the length of abdominal visceral fat statistically significantly decreased after the experiment compared to before the experiment in all groups ($p < 0.05$)(Table 2). The amount of change in abdominal visceral fat lengths was statistically significantly different between groups, with larger changes observed in the experimental group compared to the control group ($p < 0.05$).

IV. Discussion

Obesity is not just heavy weight, rather, it is the overaccumulation of body fat that occurs when the balance

Table 2. Comparison of visceral fat distance between groups.

	Experimental group (n=10)	Control group (n=10)	*t*	*p*
Pre-test	5.23±1.16	5.52±1.38	1.034	0.048*
Post-test	3.15±0.13	4.22±0.62		
t	2.375	1.374		
p	0.000*	0.024*		

*$p<0.05$, unit: cm

between energy intake and energy consumption has been broken, and is closely related to diverse changes in the body structure, a reduction in the ability to exercise, and frequent fatigue[7]. In addition, obesity is becoming an important subject of concern in that it is a risk factor for degenerative diseases such as diabetes, fatty liver, hypertension, hyperlipidemia, cardiovascular disease, and cancer[8]. In general, the risk of complications due to obesity increases with the level of obesity. Although the overall amount of excess fat should be considered, it is also important to note where in the body the fat is distributed. Upper body fat, especially in the abdomen, involves much higher health risks than fat in other areas[9]. Therefore, the loss of abdominal fat following weight loss may be a way to reduce health risks that result from obesity in the first place.

Treatments for obesity include drug therapy, electro-acupuncture, aerobic exercise, muscle strength training, intermediate-frequency therapy, low-frequency therapy, and cognitive-behavioral therapy[10]. Interferential current therapy is a non-invasive method for the management of obesity that can more effectively stimulate tissue with much less skin irritation compared to low-frequency currents based on the theory that the higher the frequency, the lower the capacitance resistance becomes, which allows a current to pass through the skin with greater ease. That is, since the current hardly stimulates the skin's noxious receptors when it passes through the skin, the subject will feel much more comfortable. Interferential current is an electrotherapy method used to treat patients with deep pains or delayed or non-united fractures for the aforementioned reasons. The mechanism of pain relief stems from polar effects or electrophysiological effects thanks to enhanced circulation felt from muscle spasm relaxation.

To reduce and maintain weight for the treatment of obesity, energy intake and consumption must be balanced. That is, since weight increases when total energy intake (or fat intake) is higher than the consumption of that energy, a balance can be achieved by consuming energy through exercise[11]. Obesity is not simply an increase in weight, but an increase in the body's fat mass, which increases disease incidences and negatively affects the cardiovascular system. There is a growing interest in the prevention and treatment of obesity because of this, and dietary and exercise therapies are the primary recommendations. Recent reports indicate that an ideal weight loss program will bring about positive changes in body composition[12].

This study was carried out to investigate the effects of interferential current therapy using intermediate frequency currents combined with abdominal muscle strengthening exercises. Waist circumference and abdominal visceral fat length within the experimental group that performed abdominal muscle strengthening exercises after interferential current therapy decreased statistically significantly compared to the control group. The results of this study showed that muscle strengthening exercises after interferential current therapy applied to the abdomen could reduce waist circumference and visceral fat length. These results can be the grounds for not only the effects of interferential current therapy but also the fact that combined therapy with abdominal muscle strengthening exercises is an effective treatment intervention for obesity management. These results can also be used as evidentiary materials for the fact that combined therapy can prevent adult diseases and cardiovascular diseases caused by obesity and can reduce risk factors that increase the fatality and lethality of diseases. In addition, the results of this study can be used as basic data to develop treatment equipment that can reduce abdominal visceral fat by a more precise and comprehensive amount. Limitations of this study include the small number of subjects, the short treatment intervention period, and the fact that the results of this study cannot be generalized because they were assessed only by waist circumference and abdominal visceral fat length. In addition, this study did not examine the effects of the therapeutic intervention when applied for an extended period of time. Future studies should be conducted using more study subjects to evaluate the effects of the multilateral therapy methods and examine the duration of the treatment's effects.

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