Abstract

The purpose of this study was to examine the effects of combined exercise training for 16 weeks on obesity indices and artery intima media thickness and cardiovascular risk factors in obese middle-aged women. The subjects of this study were obese middle-aged women of 45-48 years old. They were divided into a control group (n=17) and a combined exercise group (n=14). In the combined exercise group, a combined exercise consisting of walking and resistance exercise for 16 weeks has been conducted. The results showed that there was no significant difference of change in the BMI but WHR was significantly decreased in the combined exercise group compared to the control group. VEGF levels were significantly increased after the exercise in the combined exercise group compared to before the exercise. Endothelin-1 levels were significantly decreased after the exercise in the combined exercise group compared to before the exercise.

[Keywords] Training, Combined Exercise, VEGF, Endothelin-1, Women

1. Introduction

In Obesity is the excess accumulation of body fat, resulting in various diseases, structural and functional changes of vessels such as vascular wall thickening, vascular flexibility reducing, and abnormal vascular endothelial cell[1]. Also increases the risk of cardiovascular disease, prevalence of chronic diseases such as hypertension, diabetes, cerebrovascular disease, cardiovascular disease.

In Korea, cerebrovascular and cardiovascular diseases are high risk and major causes of death. According to the National Statistical Office, 25% of all deaths in 2010 were reported to be brain vessel disease and cardiovascular disease, ranking second among the causes of all deaths and ranking first among the causes of deaths by single illness[2].

The vascular endothelial growth factor (VEGF) is a potent creating blood vessel factor in obesity associated with fat tissue reproduce[3]. The increase in blood triglycerides (TG) is reported to cause disorders in vascular endothelial cell, causing ischemic cerebral blood vessel disease and cardiovascular disease[4].

Endothelin(ET-1) is produced in vascular endothelial cell. However, it is confirmed that ET-1 receptor is not only in a smooth muscle but also in other many tissues and cells. Heart cells and endothelial cells produce ET-1 which causes contraction of blood vessel and heart thickening[5]. ET-1 levels of the heart tissue increase significantly in cardiovascular disorders such as myocardial infarction and cardiac insufficiency[6].

Therefore, this study aims to provide basic data for preventing and eliminating obesity in middle-aged women by presenting the need of complex exercise program for preventing and managing cardiovascular disorders among complications which is a complication
caused by obesity, by studying the effects of complex exercise program on plasma VEGF and ET-1 of middle-aged women with obesity.

2. Materials and methods

2.1. Subject of study

The study participants were obese middle-aged women aged 45 to 48 years old in K city, who have not participated in a program with a planned exercise program in the past 12 months with a body mass index of more than 26 kg/m², the ratio of waist and hips of more than 0.8, and were categorized into complex exercise group(EG/20 people) and non-training group(CG/20 people). In the beginning, 20 people took part in the exercise group, but 6 people gave up because of their personal ill-health and suspension of exercise, and 3 people gave up in the control group. Their physical traits of participants are shown in <Table 1>.

Table 1. The physical characteristics of subject.

<table>
<thead>
<tr>
<th>Items</th>
<th>N</th>
<th>Age (Years)</th>
<th>Height (Cm)</th>
<th>Weight (Kg)</th>
<th>BMI (kg/m²)</th>
<th>WHR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise group</td>
<td>14</td>
<td>47.12±1.25</td>
<td>163.21±2.23</td>
<td>66.13±2.14</td>
<td>26.70±0.47</td>
<td>0.87±1.01</td>
</tr>
<tr>
<td>Control group</td>
<td>17</td>
<td>47.38±1.88</td>
<td>162.93±1.79</td>
<td>67.12±2.18</td>
<td>26.78±0.41</td>
<td>0.87±0.01</td>
</tr>
</tbody>
</table>

Note: Value are means±SD.

2.2. Exercise program

2.2.1. Walking exercise program

Aerobic exercise program uses the methods of Kim Hyung-Don et al[7]. Performed on the treadmill for 45 to 70 % HRmax of the recommended American Sport Medical Association[8], 4 times in a week for 16 weeks. The specific walking exercises are shown in <Table 2>.

Table 2. Walking exercise program.

<table>
<thead>
<tr>
<th>Items</th>
<th>1 week</th>
<th>2-4 week</th>
<th>5-8 week</th>
<th>9-12 week</th>
<th>13-16 week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise</td>
<td>Walking</td>
<td>Walking</td>
<td>Walking</td>
<td>Walking</td>
<td>Walking</td>
</tr>
<tr>
<td>Speed (km/h)</td>
<td>4-5</td>
<td>5.5</td>
<td>6</td>
<td>6.5</td>
<td>7</td>
</tr>
<tr>
<td>Stage</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Time (min)</td>
<td>40</td>
<td>45</td>
<td>50</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td>Frequency (day/week)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Intensity (bpm)</td>
<td>HRmax</td>
<td>HRmax</td>
<td>HRmax</td>
<td>HRmax</td>
<td>HRmax</td>
</tr>
<tr>
<td>1RM(%</td>
<td>45~50%</td>
<td>51~55%</td>
<td>56~60%</td>
<td>61~65%</td>
<td>66~70%</td>
</tr>
<tr>
<td>Repetition</td>
<td>10-15</td>
<td>10-15</td>
<td>10-15</td>
<td>10-15</td>
<td>10-15</td>
</tr>
<tr>
<td>Set</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Time(min)</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

2.2.2. Resistance exercise program

Resistance exercise program(chest press, lat pull down, shoulder press, leg curl, leg extension) uses the methods of Hur sun[9]. After completing the Walking exercise, the resistance exercise program performed 4 times in a week for 16 weeks. In order to measure 1RM, the participants were selected mass to perform repetitive exercise which exercise of 7 to 8 times in each event. At this time, 1RM was calculated with the weight and number of repetitions applied. The intensity of the exercise was 50 % of 1RM for the 1st to 6th weeks. Rest time between each event was 30 seconds, and the rest time between each set was 60 seconds. The exercise ability was evaluated every 5 weeks to readjust exercise time and exercise intensity. Specific resistance programs are shown in <Table 3>.

Table 3. Resistance exercise program.
handle, then analyzed body mass index in order to the measurement sequence. BMI was used in this study.

2.3.2. WHR

Measurements of the waist measurement and hip circumference were measured with a tapeline. Based on WHO criteria, it was measured in a standing posture that breathe calmly. Waist measurement was measured the middle section of the lowest rib and crista iliaca(navel). Hip circumference was measured by the most prominent area. The waist to hip ratio(WHR) was obtained using the formula to calculate the abdominal obesity rate.

2.3.3. VEGF concentration in plasma

Immediately after blood collection, VEGF concentration was measured by 3000rpm centrifugation at 4°C for 5minutes and analyzed by human ELISA kit(enzyme-linked immunosorbent assay, ELISA, R&D systems minneapolis, USA) which include Monoclonal VEGF Antibody. The unit was made of pg/ℓ.

2.3.4. Endothelin-1 concentration in plasma

ET-1 concentration in plasma was analyzed by Sandwich enzyme-linked immunosorbent assay(Sandwich ELISA). At first, target antibody(mouse polyclonal antibody; abnova, USA) diluted coating buffer(100 mM NaHCO₃ + 0.02 % NaCO₃ , pH 9.6) with 1:500. After putting 50ul into each well, let them to 96 well plate(corning incorporated, USA) at 4°C for 12hours, then washed them 4 times with 200ul buffer(0.05 % PBST). Then after adding 100ul blocking buffer(1 % BSA in PBS), let them at 37°C for 2hours. Then after adding 50ul standard solution(sigma-aldrich, USA) and 50ul at 37°C for 1hours, then washed them 4 times. After detection antibody(rabbit polyclonal antibody; abnova, USA) diluted PBS with 1:1000, putting 50ul into each well at 37°C for 2hours. Then washed 4times. After anti-rabbit IgG HRP(Dako, USA) diluted PBS with 1:3, putting 50ul into each well at 37°C for 90minutes. Then washed 4times. After substrate solution(Tetra methyl benzidine; TMB, usb, USA) putting 50ul into each well at 37°C for 30 minutes in darkroom. After adding 50ul stop solution(2NH₂SO₄ ; Junsei chemical, Japan), measured at 450nm absorbance.

2.4. Data process

The data of this study has been processed with SPSS 20.0 program. After calculating average and standard deviation of all collected data, analysed for interaction between group and measurement timing by two-way repeated measures(ANOVA). The p-value less than 0.05 was taken as significant.

3. Results

3.1. The change of obesity index

The change in body composition according to balance training and stretching training are shown in <Table 4>. Weights decreased both pre-training and post-training in balance training and stretching training, but was not shown a significant change statistically. BMI and WHR increased both pre-training and post-training, but were not shown a significant change statistically.

### Table 4. The changes of obese index.

<table>
<thead>
<tr>
<th>Item</th>
<th>Control group(n=17)</th>
<th>Exercise group(n=14)</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td><strong>BMI</strong> (kg/m²)</td>
<td>26.78± 0.41</td>
<td>26.89± 0.44</td>
<td>26.70± 0.47</td>
<td>26.01± 0.58</td>
</tr>
<tr>
<td><strong>WHR</strong></td>
<td>0.87±0.01</td>
<td>0.88±0.01</td>
<td>0.87±0.01</td>
<td>0.82±0.02</td>
</tr>
</tbody>
</table>

3.2. The change of VEGF

After 16 weeks of complex exercise, the change of VEGF is as shown in <Table 5>. VEGF of exercise group increased significantly, VEGF of time and time group were shown a significant difference statistically(p<.05).
Table 5. The changes of VEGF levels.

<table>
<thead>
<tr>
<th>Item</th>
<th>Control group (n=17)</th>
<th>Exercise group (n=14)</th>
<th>F value</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VE</td>
<td>44.72±1.11</td>
<td>44.59±1.16</td>
<td>16.8</td>
<td>.00</td>
<td></td>
<td>15</td>
<td>.00</td>
<td></td>
</tr>
<tr>
<td>GF</td>
<td>1.11</td>
<td>1.16</td>
<td>29.2</td>
<td>.00</td>
<td></td>
<td>18</td>
<td>.35</td>
<td></td>
</tr>
</tbody>
</table>

3.2. The change of VEGF

After 16 weeks of complex exercise, the change of ET-1 is as shown in Table 6. ET-1 of exercise timing group decreased significantly. In particular, ET-1 of time and time group were shown a significant difference statistically (p<.05).

Table 6. The changes of endothelin levels.

<table>
<thead>
<tr>
<th>Item</th>
<th>Control group (n=17)</th>
<th>Exercise group (n=14)</th>
<th>F value</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endothelin</td>
<td>1.74±0.03</td>
<td>1.75±0.03</td>
<td>38.7</td>
<td>.00</td>
<td></td>
<td>78</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

4. Discussion

Obesity causes multiple complications. In particular, there is a lot of research in the cardiovascular system, and studies have been conducted in various fields to prevent.

The study was conducted to demonstrate the need for a complex exercise to prevent and control cardiovascular disease among many complications caused by obesity. In order to achieve this goal, after we conducted a complex exercise in obese middle-aged women, and observed VEGF and Endothelin of Cardiovascular risk factor. As a result, effect of complex exercise was shown improvement in the obesity index and plasma therapy and Endothelin.

Obesity is a major risk factor for cardiovascular disease, cerebral stroke, diabetes, hypertension, hyperlipidemia, musculoskeletal system disorder, cancer, and serious threats to national health. Because Obesity and ischemic heart disease are the most significant factor in obesity, the importance of obesity management is very large for chronic diseases prevention and health promotion[10]. In this study, measured and compared BMI and WHR to observe effect of complex exercise on obesity. As a result, complex exercise group showed that decreased BMI and WHR, making it a suitable exercise for obesity. These results are consistent with research which 10 weeks of aerobic exercise(Tae-bo) improved BMI and WHR of overweight women by Mathunjwa et al[11]. In addition, with these changes, this study observed the chage of plasma VGEF and Endothelin among many cardiovascular risk factors to determine whether the complex exercise improve in cardiovascular risk factors caused by obesity.

VGEF is a factor that creates a strong vein[12], which help permeability of blood vessels and promotes angiogenesis[13]. The report showed that caused vasoganglion disorder from lack of VGEF in rat’s skeletal muscle[14]. Regular exercise induces adaptive of skeletal muscles. Repeated muscle contractions increase the blood flow rate and shear forces by arteriolar expansion[15]. Capillary density increased by microcirculation increase[16]. VEGF is reported to play a very important role in changes of capillary blood vessels due to exercise or training[17]. Similar to this prior study, complex exercise in this study also contributed to the increase in the growth factor of VEGF.

Endothelin, a substance that has a strong contraction effect, was first discovered in the main artery of the pig's aorta in 1988[18]. It is peptide that contract blood vessel and consist of 21 amino acid[19]. Up to now, there are three types(ET-1, ET-2, ET-3) of mammals that include humans. They are expressed separately by individual genes and exhibit unique organizational distribution patterns[20]. Among them, ET-1, strong factor, is the only Endothelin that has been separated from the human blood cell, and has been known to be secreted from vascular endothelial cell[21]. The eight weeks of aerobic exercise aimed at healthy adults reported that the effects of ET-1 decrease and nitrogen oxide(NOx) increase
had a positive effect on blood vessel relaxation and antiatherogenic. In 2003, when reg-
ular aerobic exercise was conducted to senior for three months, ET-1 decreased significantly[22]. In addition, ET-1 has also to do with exercise time, whereas ET-1 has not decreased in exercise for less than 30 minutes, but decrease in more than 30 minutes[23]. Concentration of coronary artery patients is higher than normal significantly. When the elderly woman with normal blood pressure conducted an aerobic workout for 12 weeks, ET-1 and blood pressure decreased significantly. NOx increased, but were not shown a significant difference statistically[24]. After 12 weeks of aerobic exercise for adult smokers, the blood NOx increased and ET-1 decreased. As a result, this study found that complex exercise effect on blood NOx increase and ET-1 decrease[25].

5. Conclusion

This study was conducted to demonstrate the need for a complex exercise to prevent and control cardiovascular disease among many complications caused by obesity. To accomplish this goal, 40 obese middle-aged women performed complex exercise for 16 weeks, and The following conclusion was drawn after observing the BMI, carotid intimamedia thickness, and Cardiovascular risk factor.

1. After complex exercise program, The change in BMI and WHR of obese middle-aged women decreased significantly(p<.05).

2. After complex exercise program, The change in VEGF of obese middle-aged women increased significantly(p<.05).

3. After complex exercise program, The change in ET-1 of exercise group increased significantly(p<.05).

In conclusion, it is found to be true that complex training is an effective way of exercise for obesity improvement, vascular endothelial cell function and ET-1 decrease. However, it is expected to require more research on various forms of exercise to improve the cardiovascular disease resulting from obesity.

6. References

6.1. Journal articles


[8] Berg BR & Cohen KD & Sarelius IH. Direct Coupling between Blood Flow and

6.2. Books
[8] ACSM. ACSM’s Guidelines for Exercise

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