**Effect of Golf Swing Exercise on the Vascular Compliance and Metabolic Syndrome Risk Factors in Elderly Women**

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**Abstract**

This study applied golf swing program to investigate the effect on the blood vessel elasticity and metabolic syndrome risk factors of old aged women. Hence Control Group (CG) and Golf Group (GG) were set to compare the treatment effects. The golf swing program was conducted 5 times a week for 8 weeks. Through the process of this study, elasticity of blood vessel was improved in each part of body after the golf swing program whereas metabolic syndrome risk factors such as blood pressure, TG, HDL, and fasting glucose were positively improved.

**Keywords:** Blood Vessel Elasticity, Elderly Women, Golf Swing Program, Metabolic Syndrome Risk Factors

**1. Introduction**

Elderly health is an important factor to influence the quality of life, in relation to physical activity performance in daily life. For improving life quality of the elderly, there is a need to enhance physical strength and the important thing here is that physical strength improvement should be focused on safe and effective activities in daily life.

Though it is impossible to avoid aging artificially, many studies say aging can be delayed through regular exercise. According to the report by¹, physical changes in old age are important factors, which affect behaviors and adaptation abilities of the elderly.

A proper level of regular exercise positively influences life behaviors of the aged in many respects and even the aged with the lowest level of physical strength can enjoy their daily life by performing regular exercise and adapt to the changing society through physical activities². Moreover, regular physical activities reduce body fat rate, blood pressure, blood lipids, early mortality and morbidity of cardiovascular disorders, increase insulin sensitivity and improve psychological stability and life quality³.

Blood lipids are helpful indicators to identify the effects of Total Cholesterol (TC), Triglyceride (TG), High-density Lipoprotein Cholesterol (HDL) and Low-Density Lipoprotein cholesterol (LDL) on health of blood vessels and obesity improvement and recently, cytokine is used in identifying obesity improvement and exercise effects.

Aged people are reported to have higher risk of cardiovascular disorders⁴, and the causes of such disorders are changes of vessel wall thickness, decline of vessel elasticity, and malfunctioning of endotheliocyte which result in the increase of arterial stiffness. Such phenomenon is led to left ventricular hypertrophy and reduction of coronary arterial flow, and eventually results in higher risk of cardiovascular disorders⁵.

In particular, elderly women can suffer from various serious health problems due to a reduction in female hormones in menopause after pregnancy and delivery⁶.

Instead of looking golf as simple leisure sports, this study intends to approach golf as a means of improving physiological health function in the perspective of improvement of cardiovascular function of aged people.

This study aims to apply golf swing program to aged women in order to identify the blood vessel elasticity and metabolic syndrome risk factors.
2. Study Method

2.1 Subject of Study
The 20 research subjects were selected from women in 70s living in Gangwon-do Korea who did not participate in regular physical activity for last three months. The 20 subjects were assigned to Golf Group (GG) and Control Group (CG) for comparison of the treatment effects. During the process of the program, 2 subjects were excluded for absence and inactive participation. Therefore 18 subjects participated in this study Table 1.

Table 1. Physical characteristic of subjects (M ± SD)

| Group | N  | Age (yr) | Height (cm) | Weight (kg) | Fat (%) |
|-------|----|----------|-------------|-------------|---------|
| GG    | 9  | 68.25 ± 3.13 | 152.58 ± 2.82 | 65.26 ± 3.11 | 29.54 ± 1.05 |
| CG    | 9  | 67.83 ± 3.55 | 153.50 ± 3.16 | 65.03 ± 2.88 | 29.77 ± 1.11 |

GG: Golf Group CG: Control Group

2.1.1 Experiment Program
This study examined the changes in blood vessel elasticity and metabolic syndrome risk factors of study subjects through 8 weeks of golf swing program. The GG had 5 times of 60-minute sessions every week (Mon, Tue, Wed, Thu, Fri) for 8 weeks which included warm-up and cooling down. During the golf swing program, foods with calories were not allowed and subjects could only drink water. During the participation on the program, these subjects were educated to maintain their regular diet. Also, participating in excessive physical activities and other kind of exercise program were prohibited during this program. The control group did not have special restrictions during the 8 weeks Table 2.

Table 2. Golf swing Program

| Category         | Methods           | Intensity/time |
|------------------|-------------------|----------------|
| Warming up       | Upper stretching  | Vo2max< 30%,   |
|                  | lower stretching  | 5-10min        |
| Golf swing       | Golf swing (1/30sec) | RPE<17,40     |
|                  |                   | 50min          |
| Cooling down     | Upper stretching,  | Vo2max< 30%,   |
|                  | lower stretching  | 5-10min        |

2.1.2 Measurement Factor
During the 8 weeks of program, the blood vessel elasticity and blood test related factors were measured from GG and CG before and after treatment to examine the effect of golf swing program. The collected bloods were requested to specialized nuclear medicine institution.

2.1.3 Data Treatment
The PASW 18.0 statistical program was used on pretest and post test data to investigate the effect of golf swing program. Descriptive statistics were suggested for each measurement period and 2-way RGRM ANOVA was applied to investigate the interactions of treatment effects. The significance level was set to be .05.

3. Results

3.1 Chang in Blood Vessel Elasticity
Among the blood vessel elasticity factors, right upper limbs showed significant interaction effect between GG and CG with F (1,16) = 11.231, p<.01 whereas the left upper limbs showed significant interaction effect with F (1,16) = 6.322, p<.05 Table 3, Table 4. The right lower limb showed significant interaction effect between GG and CG with F (1,16) = 4.635, p<.05 whereas the left lower limb showed significant interaction effect with F (1,16) = 11.438, p<.01 Table 5, Table 6.
3.2 Chang in Metabolic Syndrome Risk Factors

Among the metabolic syndrome risk factors, systolic blood pressure showed significant interaction effect between GG and CG with $F(1,16) = 17.356, p<.01$ whereas diastolic blood pressure showed significant interaction effect with $F(1,6) = 5.298, p<.05$. Triglycerides (TG) showed significant interaction effect between GG and CG with $F(1,16) = 4.822, p<.05$, High Density Lipoprotein (HDL) showed significant interaction effect between GG and CG with $F(1,16) = 9.429, p<.01$. Table 7, Table 8, Table 9, Table 10. The fasting glucose showed significant interaction effect between GG and CG with $F(1,16) = 5.55, p<.05$ Table 11.

**Table 6.** Left lower limbs ANOVA

| Source     | SS    | df | MS    | F     | p     |
|------------|-------|----|-------|-------|-------|
| group      | 136.196 | 1 | 136.196 | .474  | .501  |
| error      | 4596.466 | 16 | 287.279 |       |       |
| factor     | 108.374 | 1 | 108.374 | 6.079 | .025  |
| group* factor | 203.927 | 1 | 203.927 | 11.438 | .004 |
| error      | 285.265 | 16 | 17.829 |       |       |

**Table 7.** Sbp ANOVA

| Source     | SS    | df | MS    | F     | p     |
|------------|-------|----|-------|-------|-------|
| group      | 0223.781 | 1 | 223.781 | .0151 | .237  |
| error      | 2371.555 | 16 | 148.222 |       |       |
| factor     | 0242.092 | 1 | 242.092 | 12.812 | .003  |
| group* factor | 0327.947 | 1 | 327.947 | 17.356 | .001  |
| error      | 0302.328 | 16 | 18.895 |       |       |

**Table 8.** Dbp ANOVA

| Source     | SS    | df | MS    | F     | p     |
|------------|-------|----|-------|-------|-------|
| group      | 076.799 | 1 | 76.799 | 1.873 | .190  |
| error      | 656.169 | 16 | 41.011 |       |       |
| factor     | 048.909 | 1 | 48.909 | 4.127 | .059  |
| group* factor | 062.782 | 1 | 62.782 | 5.298 | .035  |
| error      | 189.597 | 16 | 11.850 |       |       |

**Table 9.** Tg ANOVA

| Source     | SS    | df | MS    | F     | p     |
|------------|-------|----|-------|-------|-------|
| group      | 00544.813 | 1 | 544.813 | 0.089 | .769  |
| error      | 98002.164 | 16 | 6125.135 |       |       |
| factor     | 00573.183 | 1 | 573.183 | 9.190 | .008  |
| group* factor | 00300.719 | 1 | 300.719 | 4.822 | .043  |
| error      | 00997.887 | 16 | 606.268 |       |       |

**Table 10.** Hdl ANOVA

| Source     | SS    | df | MS    | F     | p     |
|------------|-------|----|-------|-------|-------|
| group      | 008261  | 1 | 8261  | 0.266 | .613  |
| error      | 496862  | 16 | 31.054 |       |       |
| factor     | 020198  | 1 | 20198 | 5.145 | .038  |
| group* factor | 037017  | 1 | 37017 | 9.429 | .007  |
| error      | 062814  | 16 | 03.926 |       |       |

**Table 11.** Fasting glucose ANOVA

| Source     | SS    | df | MS    | F     | p     |
|------------|-------|----|-------|-------|-------|
| group      | 0186784 | 1 | 186784 | 0.407 | .533  |
| error      | 7345914 | 16 | 459120 |       |       |
| factor     | 0277785 | 1 | 277785 | 5.399 | .034  |
| group* factor | 0285843 | 1 | 285843 | 5.555 | .031  |
| error      | 0823254 | 16 | 051453 |       |       |

4. Discussion

It is reported that arteriosclerotic cardiovascular diseases caused by fat accumulated in coronary arteries and the aorta and fibrous spots are the most frequent lesion factors related to obesity\(^7,8\) and these increase the possibility of the rapid outbreak of diseases in addition to aging.

The body and the changes of body composition should be managed properly depending on the stages of childhood, adolescence, middle age and late middle age. Reference\(^9\) said that the failure in dietary control, or too much salt accumulated in the body, or irregular life habits increase blood pressure.

Once liquid components of plasma move to the cellular matrix after exercise, plasma volume and stroke volume are reduced and this is one of the mechanisms for lowering blood pressure. The reduced stroke volume brings reduction in cardiac output and blood pressure by decreasing the full load and increasing the after load of the heart\(^10\).

Reference\(^11\) reported that vascular compliance of the upper and lower limbs improved in all the groups in their thirties, forties, fifties and sixties after they performed treadmill exercise for 30 minutes, in his study on the changes of vascular compliance depending on age and exercise.

Reference\(^12\) reported than the participation in dance sports significantly improved vascular compliance in middle-aged women.
This shares the same context with this study applying a golf swing program and especially, it is thought that the vascular compliance of aged women improved by the golf swing program is significant.

Reference19 reported that both aerobic exercise and combined exercise improved cardiovascular risk factors and announced that an aerobic exercise program using dumbbells positively influenced the improvement of cholesterol in middle-aged women.

On the other hand15, reported that LDL declined, while TC and HDL showed no significant changes when a 24-week walking program was carried out for 60 minutes three times a week.

Reference16 indicated that combined exercise brought positive changes in HDL and TG of aged women.

Reference17 conducted a logistic regression analysis to see a correlation between fasting blood glucose and TG and concluded that impaired fasting blood glucose has a high possibility of causing hypertriglyceridemia. From this perspective, it is considered that the significant differences in fasting blood glucose changes by the golf swing program are meaningful.

Reference18 insisted that in terms of energy consumption, the golf swing program’s exercise effect is as big as other aerobic exercise programs and predicted that the golf swing program can bring changes in physiological variables.

According to19 the golf swing program significantly changed cardiovascular risk factors, but the study is limited to males in their twenties. This study proved that the golf swing program applied to aged women positively changed vascular compliance and cardiovascular risk factors and it is thought this result is significant.

5. Conclusion

This study applied short term, 8 week, golf swing program and observed changes in the blood vessel elasticity and metabolic syndrome risk factors of aged women. This study is meaningful in applying golf swing program to aged women. Also, this study has significance in treating golf as not just a leisure sport but an exercise that may be helpful for health promotion and obesity resolution.

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