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Effects of 8-week resistance exercise on gait-related isokinetic muscle function in males by age

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Abstract

The purpose of this study was to examine the effects of 8 weeks of resistance exercise on gait-related abilities and the differences in age groups to provide reference materials for application of training by age group. Subjects in their 30s, 40s, and 50s were recruited and subjected to a lower extremity exercise, in which the intensity gradually increased three times a week for eight weeks. The gait-related variables, torque at 0.18 sec, acceleration time, and torque at 30°, were assessed through isokinetic tests before and after the 8-week training. The torque at 0.18 sec showed a significant increase in the 50s group. There was no significant difference in acceleration time according to time and group. The torque at 30° showed a significant increase in the 30s group. In conclusion, 8 weeks resistance training can increase neuromuscular activity in adults in their 50s group, and changes in training variables are needed to increase torque at 30° that affects knee stabilization in adults over 40s group.

Keywords: *Resistance exercise, Gait, Age, Isokinetic Muscle function.*

1. Introduction

Normal walking is to move the center of gravity of the body effectively and smoothly with minimal energy. Factors affecting gait include age, gender, balance of posture, and lower limb strength [1]. Disease or injury to the nervous system or musculoskeletal system interferes with normal walking. Compensation to maintain functional gait creates abnormal gait and increases energy expenditure [2].

Correct walking can cause the foot to fall completely off the ground because it maintains proper balance of the lower body support, head, arms, and trunk [3-4]. On the other hand, decreased walking speed is associated with falls, disability, and death, and abnormal walking increases fatigue throughout the body structure [5]. In

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addition, many researchers agreed that abnormal gait has a negative health impact and emphasized the importance of correct gait [6].

The human gait function gradually decreases as the body changes from aging, and the pattern changes. Previous studies investigating gait by life cycle group reported that elementary and college students with mature neuromuscular development had the fastest gait speed, and the elderly showed a slow tendency [7-8].

As gait is used as an important indicator of the degree of aging, it is a key indicator of health along with sarcopenia in the elderly, and it is said that the older the elderly who have difficulties in performing normal daily life, the higher the risk of falls. Therefore, maintaining an appropriate gait speed and analyzing and objectively and quantitatively accurately evaluating posture and muscle function related to walking are very important in solving gait problems [9-10].

The isokinetic muscular strength is determined by the maximum muscular strength, the expression angle of the maximum muscular strength, and the expression time [11-12], and the test using the isokinetic dynamometer can determine the force and the expression speed of the force at the clinical angle of the knee joint related to gait [13-14].

In particular, the rate torque development (RTD), which is the ability to accelerate body segments, can be used as an indicator to evaluate various exercise performance because the torque can be known at the initial muscle contraction interval [15-16]. The main factors classified as RTD are torque at 0.18 sec, acceleration time, and torque at 30° and are applied to the evaluation of knee function for walking.

Therefore, the purpose of this study was to measure the factors related to gait through knee isokinetic measurement to confirm the effect of 8 weeks of lower extremity resistance exercise on gait-related ability and the differences by age group.

2. Experiment Materials and Methods

After selecting the subjects, the isokinetic strength test of the knee was conducted as a pre-test. After that, all subjects participated in lower extreme resistance training three times a week for eight weeks. Eight weeks later, the isokinetic strength test of the knee was performed with post-test to analyze torque at 0.18 sec, acceleration time, and torque at 30°.

2.1 Subject

The subjects of this study were a total of 39 healthy men in their 30s (n=13), 40s (n=13), and 50s (n=13) with less than 6 months of resistance exercise experience. To determine the number of mixed design two-way ANOVA subjects, G-power 3.0 program was used to calculate statistical significance level of .05, effect size of 0.6, and power of .90. The final subjects fully explained the significance, purpose, and procedure of the study and conducted the study with sufficient knowledge of the expected benefits, inherent risks, and inconveniences of participating in the experiment. The physical characteristics of the subject are shown in Table 1.

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

Group	Age(year)	Weight(kg)	Height(cm)
30s(n=13)	34.28±3.21	75.02±10.57	174.67±3.21
40s(n=13)	44.78±2.58	73.11±8.37	173.17±5.32
50s(n=13)	53.90±2.70	71.05±6.83	170.66±4.09

2.2 Exercise program

The resistance exercise program of this study was conducted at the fitness center of D University in Cheonan City, and researchers and professional instructors were put into every session. It was conducted for a total of 8 weeks, and the exercise intensity was progressive gradually increased. Resistance exercise consisting of five lower extremity movements was conducted for a total of eight weeks, and exercise intensity progressive increased. The plan for each training element of the 8-week resistance exercise program is shown in Table 2.

Table 2. 8-week resistance training program

Week	Intensity	Volume	Rest	Exercise
1~2	20~25RM	1set/3cycle	30sec / set 3min /cycle	Squat Lunge Leg press Leg extension Leg curl
3~4	10~20RM	4set	1.5 min / set	
5~6	15~20RM	5set		
7~8	10~15RM	6set		

2.4 Isokinetic muscle function measurement

The biodex system pro 4 was used to evaluate the gait-related isokinetic muscle function of the knee by age and period following the 8-week strength resistance exercise program. Before measurement, the direction of the dynamometer was adjusted to 90°, the tilt to 0°, the direction of the seat to 90°, and the tilt of the backrest to 70-85°. Then, make the lateral femoral condyle of the subject exactly match the central part of the dynamometer, and adjust the length of the lever arm from the knee joint, which is the strength point, to the shin pad at the point 2 cm above the ankle joint, and fix it with a strap. Before the test, the range of extension and flexion of the knee and the reference angle were set, gravity correction was performed, and the test was repeated 5 times at 60°/sec.

2.5 Static Analysis

For all data collected in this study, the mean and standard deviation of the variables were calculated using the IBM SPSS statistics (ver 22.0) statistical program, and the differences according to the group and measurement period were analyzed using the mixed design two-way ANOVA method. If there was a significant difference, the post-hoc test was conducted using the Bonferroni. The statistical significance level was set at α=.05.

3. Result

3.1 Change in torque at 0.18 sec

The results of two-way ANOVA analysis of torque at 0.18 sec according to 8-week resistance training are shown in Table 3. Torque at 0.18 sec showed a high F value (F=8.612) and a significant difference (*p*=.006). As a result of post-hoc analysis, there was a significant increase in the 50s group. Torque at 0.18 sec showed a low F value (F=1.537) and no significant difference (*p*=.228). The interaction effect according to time and group showed low F value (F=1.540), and there was no significant difference (*p*=.227).

Table 3. Changes in torque at 0.18 sec (N-m)

Group	Pre	Post		F	*p*
30s	117.18±26.91	121.66±38.9	Time(T)	8.612	.006
40s	104.84±30.51	122.06±46.30	Group(G)	1.537	.228
50s	86.92±26.36	116.69±21.62†	T X G	1.540	.227

Mean±SD, †Significant differences between time

3.2 Change in Acceleration Time

The results of two-way ANOVA analysis of Acceleration Time according to 8-week resistance training are shown in Table 4. Acceleration time according to time showed low F value (F=1.748) and no significant difference (*p*=.194). Acceleration time according to the group showed a low F value (F=1.028), and there was no significant difference (*p*=.367). The interaction effect according to time and group showed low F value (F=2.554) and no significant difference (*p*=.091).

Table 4. Changes in acceleration time (msec)

Group	Pre	Post		F	*p*
30s	36.67±18.75	39.58±23.01	Time(T)	1.748	.194
40s	38.93±18.21	37.50±19.29	Group(G)	1.028	.367
50s	39.33±17.10	24.00±9.86	T X G	2.554	.091

Mean±SD

3.3 Change in torque at 30°

The results of two-way ANOVA analysis of torque at 30° according to 8-week resistance traning are shown in Table 5. Torque at 30° showed a high F value (F=5.975) and a significant difference (*p*=.019). As a result of post-hoc analysis, there was a significant increase in the 30s group. Torque at 30° showed a low F value (F=1.435) and no significant difference (*p*=.251). The interaction effect according to time and group showed low F value (F=.741), and there was no significant difference (*p*=.483).

Table 5. Changes in torque at 30° (N-m)

Group	Pre	Post		F	*p*
30s	105.48±42.45	121.98±13.54†	Time(T)	5.975	.019
40s	120.25±33.02	123.71±26.07	Group(G)	1.435	.251
50s	100.16±25.42	113.41±21.12	T X G	.741	.483

Mean±SD, †Significant differences between time

4. Discussion

The human musculoskeletal system begins to degenerate after the age of 30s, which causes muscle strength to decrease [17]. A decrease in muscle strength causes a decrease in gait ability [1]. Muscles around the knee joint play an important role in daily life and gait. Resistance exercise has been proposed to increase muscle strength. However, studies on the comparison of resistance exercise effects by age after the age of 30s are lacking. Therefore, this study compared the effect of resistance exercise according to age by measuring knee isokinetic muscle function in people in their 30s, 40s, and 50s. Torque at 0.18sec means the muscle strength be revealed for 0.18 seconds during contraction begins when measuring isokinetic muscle strength, and acceleration time means the time required to reach the maximum torque. These two factors are used as gait-related indicators because they have the meaning of expressing muscle contraction. As a result of the experiment of this study, torque at 0.18sec showed a significant increase in the 50s. Torque at 30° showed a significant increase in the 30s. There was no significant difference in acceleration time, but it showed a tendency to become faster in the 50s. Torque at 0.18sec showed a significantly higher increase in the 50s. Torque at 0.18sec and Acceleration Time mean fast power exertion. To exert power at high speed, muscle strength must be improved. Strengthening improves exercise capacity by increasing the speed at which arms and legs use force [15]. The experiment in this study was conducted with resistance exercise beginners. Therefore, it seems that only 8 weeks of resistance exercise increased muscle strength. In particular, the high rise in the 50s is thought to be because the intensity of the exercise program in this study was applied at a relatively high intensity compared to those in their 30s and 40s due to the increase in RTD in their 50s [16].

Torque at 30° means the force generated from 30° of the knee angle. The angle 30° of the knee is the angle at which the connective tissue attached to the knee is most relaxed and is an important angle for muscle stability. Therefore, Torque at 30° can be used as an indicator of knee stabilization. In this study, Torque at 30° showed a significantly higher change in people in their 30s group. During standing exercise, the torque at an angle of 30 degrees due to the movement of the femur relative to the shinbone is not about 30% of the maximum torque. Conversely, the external torque at an angle of 30 degrees due to the movement of the shin bone relative to the femur in a sitting position exceeds 70% of the maximum torque [18]. Therefore, in general, an exercise for performing an exercise for maximal extension by movement of the shinbone with respect to the femur is performed at low intensity.

If the leg press, squat, and lunge performed in this study are fully extended, injury may occur. Therefore, it was instructed to stand up with a margin of about 10 degrees in the extension angle of the knee. In addition, in the case of leg extension, external torque is strong as the knee angle exceeds 45 degrees, so it is difficult to perform it with maximum extension if the relative intensity is not low. As described above, in terms of the

functional anatomy of the knee, it is considered that the exercises conducted in this study were insufficient as conditions for improving Torque at 30°. However, in their 30s group, the decrease in fast twitch muscles was relatively small, and it is thought that the improvement in torque at 30° occurred by overcoming the high torque at the knee angle of 30° during leg extension.

4. Conclusion

The purpose of this study was to investigate the effects of resistance exercise on gait ability by observing gait-related isokinetic muscle function indices in men in their 30s, 40s, and 50s. As a result of applying the lower extremity resistance exercise for 8 weeks, torque at 0.18 showed a significant increase only in the 50s, and acceleration time showed no significant difference according to the time and group. torque at 30° showed a significant increase only in the 30s.

In conclusion, it was confirmed that 8-week resistance training could increase neuromuscular activity by increasing torque at 0.18 sec in adults in their 50s, and torque at 30°, an indicator of knee joint stability, increased only in their 30s group, which could limit muscle strength improvement for joint stabilization from their 40s. To change the acceleration time and torque at 30° of the 40s and 50s groups, it is necessary to change the training variables such as the strength or duration of the resistance exercise.

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