Effect of slow-resistance exercise training combined with supplementation on muscular and physical functions in the elderly

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The purpose of this research was to investigate the effects of slow-resistance exercise training combined with protein supplementation on muscle mass and muscular and physical functions relating to the daily activity in the elderly people. Twenty-one healthy elderly people aged between 60 and 80 years were randomly assigned into two groups. Both groups performed an 8-week program of slow-resistance exercise training by using own weight. Additionally, one group took peptide supplements (peptide group) and the other group took casein supplements (casein group) during the 8-week training period. Muscle size, strength and physical functions were measured before and after the intervention period. Eight week slow-resistance exercise training by using own weight with protein supplementation was effective to improve the muscular and physical functions as well as muscle thickness in the healthy elderly people. On the other hand, this experiment could not show the advantage of peptide supplementation in order to enhance the effect of slow-resistance exercise.

Key words: Slow-resistance exercise, Body weight exercise, Peptide supplement, Protein supplement, Muscular and physical functions

1 Introduction

According to The United Nations Department of Economic and Social Affairs, the number of elderly people is constantly increasing. In 2015, there are approximately 900 million of people globally who are over 60 years old. The number is expected to be 1.4 billion by 2030 and reach nearly 2 billion by 2050. In Japan, Ministry of Internal Affairs and Communication released a demographic estimation in 2014 indicating that 33% of total Japanese populations are the persons aged 60 years old or above, 25.9% are persons aged 65 years old or above, 12.5% are persons aged 75 years or above[1].

Even though there is globally steady increase in life expectancy, the elderly are prone to have at least one chronic disease, such as diabetes and hypertension, or physical change (i.e. sarcopenia).

Insufficient protein and food calory intakes (malnutrition) are major causes leading to muscle loss for elderly people. The decrease in both muscle size and strength is common symptom in the elderly with sarcopenia and frailty, which is considered as a predictor of falling. Sarcopenia is a condition known as age-related wasting muscle, in terms of a progressive decline in skeletal muscle mass, strength and power[2]. The progressive decline in skeletal muscle mass, strength and power will especially occur in lower limb muscle[3]. The degenerative loss of skeletal muscle mass will be 0.5–1% loss per year after the age of fifty[4].

Several studies about the training effects on muscle size and strength for the elderly have been performed from the aspect of training intensity and frequency. Resistance exercise training with slow movement is shown to be effective intervention to increase muscle mass and strength in the elderly[5]. In addition, the combination of protein nutrition and exercise is considered optimal for maintaining muscle function[6]. Furthermore, a recent study with rats showed that supplementation of peptides extracted from fish can enhance protein synthesis in muscles after strenuous endurance exercise[7].

Thus, this research hypothesized that slow-resistance exercise combined with protein supplementation would beneficially affect muscle mass and strength in the elderly. Therefore, the 1st purpose of this study is to investigate the effects of an 8-week slow-resistance exercise training using own weight combined with protein supplementation on muscle mass and muscular and physical functions in the elderly. Moreover, the 2nd purpose is to investigate the effects of peptide supplementation compared with common used protein (casein) supplementation on muscle mass and muscular and physical functions in the elderly.

2 Methods

2.1 Participants

Twenty-one healthy and physically active elderly men and woman aged 60-80 years (mean±SD, 66.6±4.1 years) were recruited. Initially there were 23 subjects but 2 subjects (from peptide group) ceased to participate in the experiment because of individual reason. Thus, 21 subjects were divided into two groups (9 subjects participated in peptide group and 12 subjects participated in casein group, respectively). Prior to the commencement of the study, the experimental purpose and procedure were informed and the written content were obtained.

2.2 Study design

This study used two groups with randomized assignment trials. Both groups performed an 8-week exercise intervention. Additionally, peptide group took peptide supplements and casein group took casein supplements during the 8-week intervention period.

2.3 Exercise intervention

The slow-resistance exercise training using participant's own weight was conducted three sessions per week (one session per day) for 8 weeks at participant's home. The training program consisted of squat, split squat, and knee-to-chest. One movement cycle (one repetition) took 8 seconds for all of three exercises (slow movement). In one session, subjects performed 3 sets of 8 repetitions for each exercise. It took approximately 30 minutes to complete one session of exercise.

2.4 Protein supplementation

Participants took either peptide supplements which are extracted from fish or casein supplements which contained fish-flavored milk casein, two times per day (after lunch and before sleep). The number of tablets for protein supplementation per one time were 11 tablets (22 tablets per day; peptide content, 5.3 g). On training day, participants took supplements immediately after training and before sleep.

2.5 Measurements

The measurements were made twice: pre and post 8-week intervention period. Post measurements were completed within 1 week after the intervention period finished.

2.5.1 Body composition: Body mass index (BMI), muscle mass, fat mass and weight were measured by using Body Composition Analyzer (BC-118E, TANITA CO., Ltd.) The height was measured by height measuring scales.

2.5.2 Muscle and Fat thickness: Vastus lateralis thickness of the right leg was measured by B-mode ultrasonography imaging (Aloka Echo camera SSD-650CL, ALOKA Co., Ltd.). During the measurements participants stood upright with 20 cm distance between 2 legs. Measurement position on right leg was set at the intermediate between greater trochanter and lateral condyle of the femur. Transverse images were obtained using a real time linear electronic scanner with a 7.5-MHz scanning head. To get clear images, water-soluble transmission gel was pretreated on the scanning head. The measurement was conducted 3 times and the mean of 3 values was used for analysis.

2.5.3 Physical functions: The tests included stand-up, two-step, timed up and go, five times sit to stand, functional reach, walking speed, Kraus-Weber, one leg stand time, maximum leg extension power (Anaeropress 3500, Combi Co., Ltd.), and isometric/isokinetic strengths of knee extension and flexion. Isometric knee extension/flexion strength was measured at a knee angle of 60 and 80 degree using a isokinetic dynamometer (Myoret RZ450, Kawasaki Heavy industries, Ltd.). The isokinetic torque was measured at an angular velocity of 90 degree per second and the range of angular movement of joints was limited between 0 degree and 100 degree of the anatomical knee angle.

2.6 Statistical analysis

All data were presented as mean (SD). A paired Student's *t*-test was used to examine differences between pre- and post-measurements. Unpaired Student's *t*-test (two-sample equal variance) was used to examine differences between peptide group and casein group. The level of statistical significance was set at $p<0.05$.

2.7 Adverse events and pursuance to supplementation and exercise protocol

Adverse events and pursuance to exercise training program and supplementation protocol were checked through the intervention period. Researcher contacted each participant by telephone to remind about training, supplementation and to received comments at the same time. In addition, participants were free to contact the researcher during the experiment period when they have some questions or facing difficulties.

3 Results

The result of the experiment divided into 2 parts. First part showed the results between pre- and post-measurements for all subjects and the second part showed the results between peptide and casein groups.

3.1 Results between pre- and post-measurements

Twenty-one subjects completed the present exercise and protein ingestion program. Both peptide and casein groups showed the improvement in muscle thickness, fat thickness (Table 1), two-step test, time up and go test, functional reach test, walking speed test (fast) Kraus-Weber test (Table 2), and maximum leg extension power of both legs (Table 3) after 8-week training.

Table 1 Result of body composition and muscle/fat thickness between pre- and post-interventions.

Measurement Items	Pre (n=21)	Post (n=21)	P-value $
Body composition			
Height	156.4(7.9)	156.5(8.0)	0.33
Weight	56.6(9.3)	57.0(9.3)	0.07
BMI(kg/m2)	23.0(2.6)	23.2(2.5)	0.12
Body fat(%)	26.8(6.6)	28.1(6.5)	<0.001*
Muscle and fat thickness			
Muscle thickness(cm)	1.6(0.2)	1.7(0.2)	0.003*
Fat thickness(cm)	0.9(0.5)	0.8(0.0)	0.02*

Table 2 Result of physical functions between pre- and post-interventions.

Measurement Items	Pre (n=21)	Post (n=21)	P-value $
Physical functions			
Stand-up test(8grades)	4.1(1.0)	4.5(1.2)	0.13
Two step test(cm)	233.7(22.7)	240.8(25.8)	0.02*
Timed up and go(sec)	4.9(0.6)	4.6(0.6)	0.04*
Five times sit to stand(sec)	6.4(2.3)	5.6(1.5)	0.08
Functional reach test(cm)	32.2(5.8)	35.8(5.0)	<0.001*
Walking speed			
- slow(m/s)€	10.6(2.3)	10.3(1.6)	0.42
- normal(m/s)€	7.6(1.1)	7.8(0.9)	0.54
- fast(m/s)€	5.2(0.4)	5.0(0.6)	0.01*
The Kraus-weber test(17scores)	11.5(4.5)	13.8(3.5)	0.002*
One leg standing time(s)	92.3(38.2)	100.1(37.4)	0.23

Table 3 Result of muscle functions between pre- and post-interventions.

Measurement Items	Pre (n=21)	Post (n=21)	P-value $
Muscle functions			
Maximum leg extension power(w)			
- both legs	468.9(220.8)	545.3(276.5)	0.02*
Isometric knee extension strength(Nm/kg)			
- 80°right-extension	1.9(0.5)	1.9(0.5)	0.96
- 80°right-flexion	0.7(0.3)	0.7(0.2)	0.57
- 80°left-extension	1.7(0.5)	1.8(0.5)	0.25
- 80°left-flexion	0.6(0.2)	0.7(0.2)	0.11
- 60°right-extension	1.7(0.4)	1.8(0.4)	0.09
- 60°right-flexion	0.8(0.2)	0.8(0.3)	0.38
- 60°left-extension	1.9(0.5)	1.9(0.4)	0.68
- 60°left-flexion	0.8(0.2)	0.9(0.3)	0.24
Isokinetic knee extension strength(Nm/kg)			
- right-extension	1.3(0.3)	1.3(0.3)	0.79
- right-flexion	0.7(0.2)	0.7(0.3)	0.13
- left-extension	1.3(0.4)	1.4(0.3)	0.12
- left-flexion	0.6(0.2)	0.7(0.2)	0.28

Data are reported as mean (SD)

$ paired *t*-test, p<0.05

€,Walking speed (slow, normal, fast) Pre(n=19), Post(n=19)

*indicates significant differences (p<0.05) between the pre- and post-test values

3.2 Results between peptide and casein groups

There were no significant differences between peptide and casein groups in any parameters other than two-step test and isometric knee extension strength at a knee angle of 60° of right leg (Table 4-6). There was a nearly significant difference in isometric knee extension strength at a knee angle of 80° of right leg (p = 0.052).

Table 4 Differences in body composition and muscle/fat thickness between pre- and post-interventions of peptide and casein group.

Measurement items	Peptide group (n=9) Sex (M/F) = 3/6	Casein group (n=12) Sex (M/F) = 4/8	P-value$
Body composition			
Height	-0.04(0.24)	0.18(0.47)	0.20
Weight	0.77(0.89)	0.14(1.01)	0.16
BMI(kg/m2)	0.32(0.36)	0.02(0.41)	0.09
Body fat(%)	1.50(1.30)	1.07(1.06)	0.41
Muscle and fat thickness			
Muscle thickness(cm)	0.05(0.07)	0.07(0.09)	0.68
Fat thickness(cm)	-0.13(0.17)	-0.09(0.22)	0.65

Table 5 Differences in physical functions between pre- and post-interventions of peptide and casein group.

Measurement items	Peptide group (n=9) Sex (M/F) = 3/6	Casein group (n=12) Sex (M/F) = 4/8	P-value$
Physical functions			
Stand-up test(8grades)	0.33(0.5)	0.42(1.44)	0.87
Two step test(cm)	-3.10(8.66)	14.84(9.47)	<0.001*
Timed up and go(sec)	-0.08(0.52)	-0.34(0.45)	0.23
Five times sit to stand(sec)	-0.21(1.09)	-1.33(2.59)	0.24
Functional reach test(cm)	2.96(2.13)	3.94(4.40)	0.54
Walking speed			
- slow(m/s)€	-0.62(1.39)	-0.15(2.17)	0.59
- normal(m/s)€	0.31(0.65)	0.00(1.09)	0.49
- fast(m/s)€	-0.11(0.28)	-0.24(0.32)	0.36
The Kraus-weber test(17scores)	1.44(2.83)	2.38(3.01)	0.30
One leg standing time(s)	19.54(36.35)	-1.02(18.38)	0.71

Table 6 Differences in physical functions between pre- and post-interventions of peptide and casein group.

Measurement items	Peptide group (n=9) Sex (M/F) = 3/6	Casein group (n=12) Sex (M/F) = 4/8	P-value$
Muscle functions			
Maximum leg extension power(w)			
- both legs	50.33(128.64)	96.08(140.06)	0.45
- left leg	5.89(44.66)	-7.00(54.19)	0.57
- right leg	-11.44(49.59)	-5.83(40.08)	0.78
Isometric knee extension strength(Nm/kg)			
- 80° right-extension	-0.18(0.26)	0.13(0.39)	0.05
- 80° right-flexion	-0.01(0.18)	0.04(0.13)	0.43
- 80° left-extension	0.06(0.33)	0.16(0.54)	0.64
- 80° left-flexion	0.09(0.24)	0.12(0.21)	0.69
- 60° right-extension	-0.04(0.25)	0.26(0.33)	0.04*
- 60° right-flexion	-0.01(0.21)	0.08(0.20)	0.35
- 60° left-extension	-0.04(0.38)	0.08(0.18)	0.36
- 60° left-flexion	0.07(0.18)	0.04(0.24)	0.74
Isokinetic knee extension strength(Nm/kg)			
- right-extension	-0.05(0.27)	0.01(0.31)	0.69
- right-flexion	0.08(0.17)	0.06(0.23)	0.88
- left-extension	0.04(0.34)	0.15(0.25)	0.40
- left-flexion	0.02(0.28)	0.08(0.19)	0.54

$ Unpaired *t*-test (two-sample equal variance), $p<0.05$

*indicates significant differences ($p<0.05$) between peptide group and casein group.

€Walking speed (slow, normal, fast) Peptide (n=8), Casein (n=11)

4 Discussion and conclusions

The results indicate that 8-week slow-resistance exercise training by using own weight with protein supplementation is effective to improve the muscular and physical functions as well as muscle thickness in the healthy elderly people. On the other hand, this experiment could not show the advantage of peptide supplementation in order to enhance the effect of slow-resistance exercise.

Recently study showed that slow-resistance exercise by using own weight and plyometric exercise can improve physical function in the elderly. Nevertheless, there was no effect to increase muscle mass[5]. In the present study, the increase in muscle mass was found in both peptide and casein groups after 8-week intervention. This is the first report showing muscle hypertrophy by slow-resistance exercise using own weight. Thus, with protein supplementation, slow-resistance exercise by using own weight method can enhance muscle hypertrophy in healthy elderly people.

Almost no significant differences were found between peptide and casein groups. I hypothesized that peptide supplementation had an advantage in terms of high efficiency of absorption compared with often used protein supplementation (casein supplementation in this study). One of the reasons may be the large effect of exercise training. Participants in peptide and casein group conducted the same and enough exercise program so the effect of peptide supplementation might be hidden by the effect of exercise.

The current study had limitations. Numbers of participants were smaller than the determination. Initially, the number of subject was decided at 30 peoples but can recruit 23 peoples. Finally, participants remained only 21 because 2 participants cased to participate the experiment during the intervention.

Further study should be conducted with larger subjects to investigate the effects of peptide supplementation more. In addition, decreased number of exercise program, such as 2 sets×2 days/week, are required to determine the effect of peptide supplementation. Moreover, current study recruited healthy and physically active elderly people. Recruitment of low physical/activity subject is necessary for further study.

5 References

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