J Int Acad Phys Ther Res 2013; 4(2): 611-617
ISSN 2092-8475

www.iaptr.org
http://dx.doi.org/10.5854/JIAPTR.2013.10.25.611

Effects of Resistance and Resistance & Stabilization Exercises on the Strength of Lumbar and Lower Limbs of the Elderly

The purpose of this study is to identify the effective lumbar area exercise program to prevent falls of the elderly by dividing 14 female elders over 65 living in Daegu into two groups such as resistance exercise group and resistance & stabilization exercise group, and applying a 60 minute exercise program three times a week for 12 weeks. The followings are the results.

First, both of resistance exercise and resistance & stabilization exercise brought improvement of lumbar strength and there was no significant difference between two groups.

Second, there was no significant difference in lower limb strength in resistance exercise group but resistance & stabilization exercise group showed significant increase in lower limb flexor strength.

To make a summary of the above results, it can be said that 12 weeks' resistance & stabilization exercise is effective to the lumbar strength and lower limb strength of the elderly. Accordingly, if combining resistance exercise and stabilization exercise appropriately, we can build a successful preventive program which even the elderly who cannot perform resistance exercise easily can follow.

Key words: *Resistance Exercise; Stabilization Exercise; Elderly*

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Received : 29 July 2013
Accepted : 24 September 2013

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INTRODUCTION

Hurt from a fall is a characteristic of degenerative disease showing decrease of muscle strength because of ageand it is resulted from decrease of total number of muscle fibers, the size of muscle fiber, or the degeneration of contract-relax(1). Among them, weakened lumbar strength coerces efficient functions of the body because of restrictions on the efficient movement of trunk and upper and lower limbs(2). It is reported that weakened lower limb strength of the elderly, in particular, can affect mobility or balance of the elderly because of weakened trunk muscle strength(3). Therefore, to train the elderly for functional stability, it is important to maintain the core of the body to be fixed or to be in neutral position and move distal part actively. With these exercises, efficiency of functional movements of the upper and the lower limbs can be enhanced by restricting the excessive movements of spinal segments(4). For this purpose, stabilization exercises are recommended. Stabilization exercise utilizes corset effects meaning co-contraction of lumbar and trunk muscle. It allows increasing abdominal pressure and stabilization in the whole body by connecting lower limbs with upper limbs and with abdominal fascia system at the same time(5).

From the biomechanical perspectives, simultaneous contraction of trunk muscle increases muscle tension, which increases stiffness and consequently increases the stability of joints(6). In previous studies, it is reported that stabilization exercises and resistance exercises are efficient to enforce deep stabilizer muscles and superficial stabilizer muscles respectively as lumbar stabilization exercises(7, 8). Accordingly, this study tried to identify an effective lumbar exercise program to prevent hurts from a fall by reviewing and analyzing the effects of resistance exercise and resistance & stabilization exercise as a method to enforce lumbar muscle strength on the elderly women.

METHODS

Subjects

The subjects of this study were 21 elderly females over 65 living in D city who were randomly sampled according to criteria and gave informed consent. They were divided into two groups such as resistance exercise group(n=10), and resistance & stabilization exercise group(n=11). Excluding incomplete measurement or drop-outs(3 from Resistance Exercise Group(REG) and 4 from Resistance & Stabilization Exercise Group(RSEG)), 7 from Resistance Exercise Group and 7 from Resistance & Stabilization Exercise Group were selected as the final samples. The inclusion conditions were those who did not have neurosurgical disease or severe musculoskeletal disorder, who did not take any medication affecting the balance before balance test(alcohol, opium, streptose, antibiotics and blood pressure regulators), and who could walk more than 10m independently and did not take regular exercises. The physical characteristics of subjects participating in this study are shown in Table 1.

Table 1. General characteristics of the subjects

Group	Age (years)	Height (cm)	Body Weight(kg)
REG(n=7)	74.14±2.47	150.57±3.70	59.79±2.92
RSEG(n=7)	75.86±4.91	151.57±4.19	64.99±6.86

Procedures

Isokinetic muscular strengthwas measured before and 12 weeks after the experiment. BIODEX SYSTEM 3 PRO(Biodex Medical Systems, Inc., USA) was used and peak torque was calculated with values measured at angular velocity of 60° /sec 9 times according to the method recommended by the manual. Isokinetic muscular strength was measured before, 6 weeks and 12 weeks after the experiment repeatedly. Measured items were flexion and extension for lumbar area and flexion and extension of knee joints for lower limbs.

We asked the subjects to have simple stretching and preparatory exercises for 15 minutes before measurement. Before the test, explanation of the test was given. They were asked to sit down on the measuring equipment. The height was adjusted to place rotation axis between the fifth lumbar vertebra and the first sacral vertebra of the subject judging the place where the extension of iliac crest meets the spine as between the 4thand the 5thlumbar vertebra. After fixing the lower limbs with thigh pad and scrum pad and fixing the upper body with chest pad, we asked them to hold chest pad with their hands. By adjusting the angle of the range of motion, we restricted exercise not to exceed the permitted angle, and let them be accustomed to isokinetic exercises by taking preliminary exercises three times(Fig. 1)

Fig. 1. Lumbar muscle strength test

To measure flexion and extension of knee joints, we asked subjects to sit down beside Dynamometer of Biodex at 90° gradient. Not to allow other parts of the body than knee joints act during the repetitive exercise, we fixed chest, abdomen and thighs with straps. We placed Dynamometer at 90° , and head slant at 0° and installed knee attachment in Dynamometer. We measured the isokinetic muscular strength by placing the rotation axis of Dynamometer on the knee joint axis(lateral thigh), tying lever arm near 1cm upper the lateral malleolus

Fig. 2. lower extremity muscle strength test

which is the strength point of Dynamometer, and setting the range of exercise from knee joint extension 0° to flexion 70° using Hold & Resume key from the rotation axis of Dynamometer. We let the subjects be accustomed to isokinetic exercises by taking preliminary exercises three times just as in lumbar muscular strength test(Fig. 2)

In this program, resistance exercises were same as the above program, but the number of sets was limited to 2. Stabilization exercise program was given as 10 minutes' exercise(10 minutes' preparatory exercise, 40 minutes' main exercise, and 10 minutes' wrap up exercise) three times a week for 12 weeks.

The most important element in the stabilization exercise was to maintain neutral position with transversus abdominis muscle and pelvic floor muscle contracted (9). Considering that the subjects are the elderly, stabilization exercises were chosen to be performed safely on the mattress. They were applied at 3 phases to make 4 weeks a cycle. For the intensity of exercise, weak link was identified and right before the weak link, they maintained the intensity for 5 seconds and then rested for 5 seconds. It was repeated 10 times in a set and 4 sets were given. Exercise time per set was 90–100 seconds, and resting time was 30 seconds.To increase intensity of exercise, we increased the resistance of weak link through more difficult position after 4 weeks, and increased again to make one set as 12 times after 4 weeks(10). Details of the exercise program are shown below(Table 3 and 4).

Table 2. Resistance exercise program

Type	Program	Time	Rest
Warm up	Stretching	10min	60sec/set
Main exercise	1. trunk flexion 2. trunk extension 3. trunk right rotation 4. trunk left rotation 5. trunk right, left sidebending 6. trunk right, left sidebending	40min 10times ×4set, 10min	
Cool down	Breathing & aerobic exercise		
Total		60min	

Table 3. Resistance & stabilization exercise program

Type	Program	Time	Rest
Warm up	Stretching	10min	60sec/set
Main exercise	Resistance exercise	40min 10times ×2set,	
	stabilization exercise	15min (10times ×1set) 90–100sec/set	
Cool down	Breathing & aerobic exercise	10min	
Total		50min	

Table 4. stabilization exercise program stage

Stage	Exercise	Time	Rest
1	1. Abdominal muscle drawing-in 2. Pushing the heel in abdominal drawing-in 3. Taking bridging posture 4. Supporting the upper body with the elbow in Prone 5. Lifting the upper body in Prone 6. Lumbar co-contraction in quadruped position	15min (10times ×1set) 90-100sec/set	90-100sec/set
2	1. Lifting the right leg in bridging posture 2. Lifting the left leg in bridging posture 3. Lifting the right leg in quadruped position 4. Lifting the left leg in quadruped position 5. Lifting the right arm and the left leg in quadruped position 6. Lifting the left arm and the right leg in quadruped position		
3	1. Lifting the right leg in bridging posture 2. Lifting the left leg in bridging posture 3. Lifting the right leg in quadruped position 4. Lifting the left leg in quadruped position 5. Lifting the right arm and the left leg in quadruped position 6. Lifting the left arm and the right leg in quadruped position		

Data Analysis

Collected data were processed using SPSS WIN 18.0 statistics program. Mean(M) and Standard Deviation/(SD) were calculated against each variable.To analyze difference in lumbar and knee muscular strength according to exercise method, independent sample t-test was performed, and for the comparison between before and after the exercise by exercise type paired t-test was performed. Statistical significance level was set as $\alpha = .05$.

RESULTS

Flexion and extension of lumbar muscles were significantly increased after exercise in both REG and RSEG($p<.05$) but there was no significant difference between groups($p<.05$). (Table 5).

Flexion of knee muscles were significantly increased after exercise only in RSEG ($p<.05$) and there was no significant difference between groups ($p<.05$). (Table 6).

Table 5 Lumbar muscles after 12 weeks of changing

(N/m)

Item		Group	Before exercise	After 12 weeks	T-value
lumbar		REG(n=7)	32.35±18.52	56.97±22.36	-3.994*
	Flexion	RSEG(n=7)	33.90±17.69	75.17±17.77	-5.054*
		t-value	-.159	-1.686	
		REG(n=7)	33.64±17.53	64.55±12.25	-9.099*
	Extension	RSEG(n=7)	49.47±15.02	77.05±19.99	-5.169*
		t-value	-1.814	-1.416	

※ Result=Mean ± SD, *: $p<.05$

REG: Resistance exercise group, RSEG: Resistance & Stabilization exercise group

Table 6 Lower extremity muscles after 12 weeks of changing (N/m)

Item		Group	Before exercise	After 12 weeks	T-value
lumbar		REG(n=7)	28.36±5.68	36.06±7.15	-.439
	Flexion	RSEG(n=7)	30.31±5.77	47.20±13.61	-2.769*
		t-value	.030	-1.993	
		REG(n=7)	46.34±15.00	48.76±14.29	-1.129
	Extension	RSEG(n=7)	41.53±14.82	69.36±16.05	-1.719
		t-value	.564	-.895	

※ Result=Mean ± SD, *: p<.05
REG: Resistance exercise group, RSEG: Resistance & Stabilization exercise group

DISCUSSION

The muscles related with the stabilization of lumbar area are deep stabilizer muscle and superficial stabilizer muscle. Great strength can be made by enforcing superficial stabilizer muscle which belongs to large muscle group and deep stabilizer muscle which belongs to topical muscle group(4). Therefore, the role of lumbar muscle is the contribution to the stabilization of the spine, and the increase of co-contractility of flexion muscle and extension muscle makes spine stable and increase the internal pressure of the abdomen and secure further stability(11). Additionally, most of deep parts of multifidus are muscle type Ⅰ(slow muscle) and are engaged with stabilization of lumbar being tensed at the movement of lumbar area or walking. On the other hand, superficial part of multifidus and erector spinae muscle are type Ⅱ(rapid muscle) and are engaged in the extension and rotation of the lumbar(12). Additionally, muscular strength around waist should be secured for the muscular functions of the lower limbs to be performed properly, as it exhibits primary strength in the lumbar and the strength of upper and lower limbs act secondarily based on the strength(13), and the weakened or imbalance of the muscular strength around waist may make adverse effects on the exhibition of the muscular strength around knee joints. Training for functional stabilization will increase efficiency of functional movements of upper and lower limbs of the elderly(4).

In this study, we executed exercise program by dividing subjects into resistance exercise group and resistance & stabilization exercise group to improve muscular strength of lumbar and knees. Although there was increase in muscular strength of flexion and extension muscles in both groups, there was no difference between groups.

In resistance exercise group, reported the improvement of lumbar muscular strength through resistance exercises using Medix on the lumbar(14), and the improvement of lumbar by applying lumbar muscular strength enforcement exercise program to the aged people with chronic backache. They were consistent with the results of this study(15).

In resistance & stabilization exercise group, reported significant increase of cross sectional areas around spine through spine stabilization and dynamic resistance exercises(7), t increase of muscular strength was observed in all of groups such as resistance exercise group, stabilization exercise group and combination exercise group in a 8 weeks' experimental study although there was no significant difference among groups(16). They all support this study as they are consistent with the results of this study.

It is considered that it increases muscular strength of rectus abdominis muscle which is lumbar flexor and backbone erector which is extensor in the resistance exercise group, and in combined exercise muscular strength is increased through simultaneous enforcement of superficial stabilizer muscles and deep stabilizer muscles because it applied resistance exercise and lumbar stabilization exercise program, which increased sectional area of muscle of multifidus and rotatores muscle which are deep stabilizer muscle of the lumbar.

However, there was no significant difference among exercise groups. In studies of the subjects were public, while in our study the subjects were the elderly(7, 15). It is interpreted that small load of exercise could bring increase of muscular strength because the elderly have imbalance of muscles and weakened

deep stabilizer muscles of the lumbar. As both of resistance exercise and resistance & stabilization exercise increased muscular strength of the elderly, there was not big difference between two groups. To think differently, it is expected to increase lumbar muscular strength of the elderly who have difficulties to take resistance exercise with small amount of exercise only.

When performing exercise program by classifying them as resistance exercise group and resistance & stabilization exercise group, only combined exercise group showed muscular strength in knee flexion muscle.

It was reported that muscular strength of the lower limbs was increased with resistance & stabilization exercise for 7 weeks among aged females with chronic backache(16). It is reported that bridge exercise which is a lumbar stabilization exercise increases muscle activity of the lower limbs than resistance exercise of erector spinae based on the trunk (18). In particular, reported that flexion and extension muscular strength of the lumbar had high correlation with flexion muscular strength of thighs in their study on soccer players(13), which supports the result of this study showing the improvement of flexion muscle of the lower limbs.

It is because you need to fix your feet on the ground to maintain bridge position. Here, the activity of two joint muscles that stop at the distal parts of knee and ankle joints increase significantly(19). Consequently, it is considered that bridge position and quadrupedal position which are closed chain exercises belonging to stabilization exercise trigger isometric contraction of the lower limbs and cause enforcement of the muscular strength of the lower limbs. Therefore, if we apply traditional resistance exercise and resistance & stabilization combined exercise all together, it will help enforcement of the muscular strength as well as the lumbar, which will help the elderly not to fall and to have stable walking.

CONCLUSION

This study performed resistance exercise and resistance & stabilization exercise on elderly females over 65 and got the following results.

First, both of resistance exercise and resistance & stabilization exercise are effective for the improvement of lumbar muscular strength.

Second, resistance & stabilization exercise is effective for the improvement of muscular strength of the lower limbs.

To make a summary, 12 weeks' resistance & stabilization exercise program is an effective for lumbar and lower limb muscular strength of the elderly. Therefore, if we combine resistance exercise and stabilization exercise appropriately as an exercise to prevent injuries, it can be a program that the aged people who feel resistance exercise difficult can easily follow. Additionally, it can prevent problems caused by falls and improve the quality of life of the elderly. It is expected that studies on various variables and the development and application of diversified exercise programs to prevent hurts from a fall could be made in the future.

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