

Effects of Lower Extremity Resistance Exercise Using Elastic Bands on Balance in Elderly People

The purpose of this study was to assess the effects of lower extremity resistance training using elastic bands on balance in elderly people. Eight elderly persons each were randomly assigned to a test group (resistance exercise group, REG) or a control group (CG). FRT and TUG test were used to compare balance before and after exercise. Exercise programs were implemented three times a week for 40 minutes for nine weeks. They did warm-up exercise for 5 minutes and then lower extremity resistance exercise using elastic bands for 30 minutes. And then they did cool-down exercise for 5 minutes. TUG and FRT significantly decreased but in the control group it did not significantly decrease. In comparison between the groups, TUG and FRT significantly reduced in the resistance exercise group compared to the control group. Lower extremity resistance training using elastic bands performed by elderly persons are considered to be effective in improving balance.

Key words: Resistance Exercise; Balance; Thera Band Exercise; Lower Extremities Activity; Elderly

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INTRODUCTION

Postural balance is an essential element for the performance of purposeful activities such as postural maintenance or gait and it decreases with age(1). Balance is an ability to maintain the center of gravity on base of support; it is a dynamic phenomenon where stability and mobility is in harmony; it is essential for postural maintenance and controlled and coordinating movement(2). Such postural balance ability decreases with age and triggers accidents like fall injuries in elderly people(3). Internal factors related with fall injuries may be divided into physical and psychological factors and physical factors include muscle strength weakness of the lower extremities, decreased gait ability, balance ability, grip strength, and sensory motor adjustment, and sensory decline like vision decline(4, 5).

The weakening of muscle strength as a main element for balance and gait ability resulting from aging has been reported as an important cause of disorder in elderly people(6). Muscle strength function decreases about 25% after the age of 65, which is a characteristic of degenerative diseases in the elderly and such muscle strength weakness results from decrease in the entire muscle fibers and the size

of muscle fibers and degeneration in muscle contraction and relaxation(7). Among others, decreased muscle strength of the lower extremities is a major etiology of muscle function decrease(4). In elderly women, decrease in the muscle strength of the lower extremities is fast compared to elderly men and such decreased muscle strength reduces balance, flexibility, and gait ability(8). In the elderly who frequently undergo fall injuries, muscle strength of both knees and ankles decreases; In particular, reduction of the couple force in the dorsiflexor muscles of the ankle joint is considerable and muscle strength of the lower extremities has been presented as a main factor for balance adjustment(9). Lower limb muscle strengthening exercise decreases the rate of fall injuries and improves range of motion, flexibility, and balance of the lower limbs; A diversity of muscle strengthening exercise has been applied to elderly people with reduced balance ability(10, 11, 12).

Elastic band exercise has merits in that it involves no spatial constraints and men and women of all ages may perform it and it is widely applied in homes, work sites, parks, and welfare service centers. The exercise has drawn attention as an efficient exercise to reduce the risk of injuries from exercise and to maximize improvement in physical strength

including body function and muscle strength in elderly people whose risk of injuries is relatively high(13). Resistance exercise with elastic bands was helpful to the improvement of muscle strength in the elderly(14).

This study intends to examine the effects of lower extremity resistance training using elastic bands on elderly people's balance and provide aid in improving their balance ability and forming fall injury prevention programs.

METHODS

Subjects

The present study was conducted from June 11, 2011 to August 3, 2011 at two senior citizen's centers

located in Yeongdeok-gun, Gyeongbuk with 16 elderly persons who were able to participate in exercise programs and agreed to the present study. Eight elderly persons each were randomly assigned to a test group(resistance exercise group, REG) or a control group(CG). General characteristics of the subjects are as follows(Table 1).

Experimental Procedure

Exercise programs were implemented three times a week for 40 minutes for nine weeks. FRT and TUG test were used to compare balance before and after exercise. They did warm-up exercise for 5 minutes and then lower extremity resistance exercise using elastic bands for 30 minutes. And then they did cool-down exercise for 5 minutes. Table 2 shows the exercise method.

Table 1. General characteristics of the subjects

	^a REG(n=8)	^b CG(n=8)	Total	p
Sex(male/female)	3/5	3/5	6/10	
Age(yr)	^c 72.63±6.02	72.63±3.58	72.62±4.79	1.000
Hight(cm)	158.13±6.27	159.38±7.42	158.75±6.67	.721
Weight(kg)	51.75±5.14	51.25±5.68	51±50±5.24	.856
MMSE-K(total score)	23.63±1.06	24.38±.92	24.00±1.03	.152

^aREG : resistance exercise group, ^bCG : control group ^cM±SD : mean±standard deviation

Table 2. Resistance exercise program

	Program composition(times × set)	Intensity	Times(min)
Warm-up exercise	Self stretching exercise		5
Main exercise	1. Hip flexion	10 times × 3 set	30
	2. Hip extension		
	3. Hip adduction		
	4. Hip abduction		
	5. Knee flexion	RPE : 13-14	
	6. Knee extension	Thera-band : Yellow, Red	
	7. Ankle dorsiflexion		
	8. Ankle plantar flexion		
	9. Ankle inversion		
	10. Ankle eversion		
Cool-down exercise	Self stretching & breathing exercise		

Measurement Scale

Functional reach test(FRT)

FRT is a test that can measure dynamic balance and flexibility during the performance of functional tasks and evaluates the limit of stability(16). A measure is placed horizontally on the shoulder level and from a distance of 10cm the subject places both feet shoulder width apart standing on the fixed base of support and raises up the arms in parallel with the measure. Then the location of the metacarpophalangeal joint was measured and the movement distance of the joint end was measured with the arms stretching forward to an maximum level on the maintained base of support. The test-retest reliability and inter-rater reliability was high at $r=.89$ and $r=.98$, respectively(16).

Timed Up & Go(TUG) test

TUG test may measure basic motility and balance and the subject sat on an elbow chair and walked 3 meters, came back, and then sat on the chair again. This test is much applied to patients with stroke, Parkinson's disease, and arthritis as well as elderly people(15).

Data Analysis

In the present study, the statistical program SPSS 18.0 was used for data analysis. General characteristics of the study subjects were produced as frequency analysis, means and standard deviations. Wilcoxon signed-ranks tests were conducted to examine changes in the elderly persons' balance between before and after the exercises and Mann-Whitney tests were conducted to examine differences in changes between the groups. To test statistical significance, the significance level was set to $\alpha = .05$.

RESULTS

Changes in the Result of TUG Test after the Training

In the resistance training exercise, TUG significantly decreased but in the control group it did not significantly decrease. In comparison between the groups, TUG significantly reduced in the resistance exercise group compared to the control group ($p<.05$)(Table 3).

Table 3. Comparison of TUG test result according to training type.

Group	Pre test (mean±SD)	Post test (mean±SD)	D-value (mean±SD)	Z	p	D-value (unit : sec)	
						Z	p
REG	14.40±2.54	11.74±2.35	-2.67±2.18	-2.521	.012*	-2.836	.005**
CG	11.57±1.013	11.76±.96	.19±1.15	-1.332	.183		

* $p<.05$, ** $p<.01$

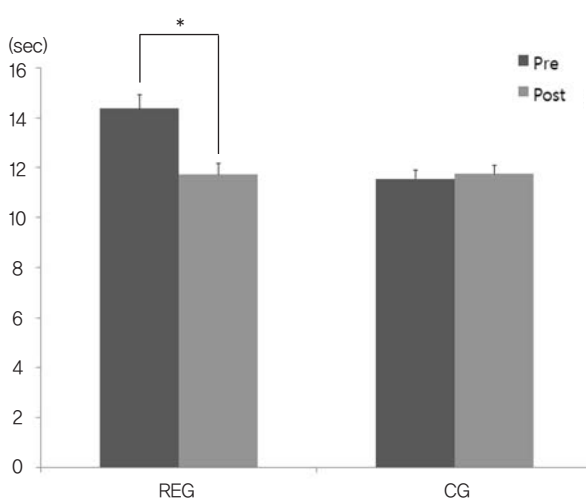


Fig. 1. Difference of TUG between pre and post test

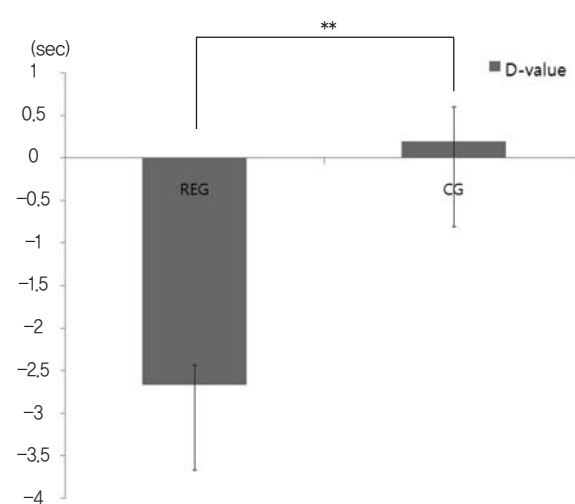


Fig. 2. Difference of TUG changes by exercise

Changes in the FRT Result

FRT significantly increased in the resistance exercise group after the exercise and TUG did not significantly differ in the control group between prior to

the training and after the training. In comparison between the two groups, FRT significantly decreased in the resistance exercise group relative to the control group ($p < .05$) (Table 4).

Table 4. Changes in the FRT result

group	Pre test (mean±SD)	Post test (mean±SD)	D-value (mean±SD)	Z	p	D-value (unit : mm)	
						Z	p
REG	250.88±49.30	329.88±26.96	79.00±51.08	-2.521	.012*	-3.366	.001**
CG	294.38±13.23	293.25±13.16	-1.13±9.58	-.140	.888		

* $p < .05$, ** $p < .01$

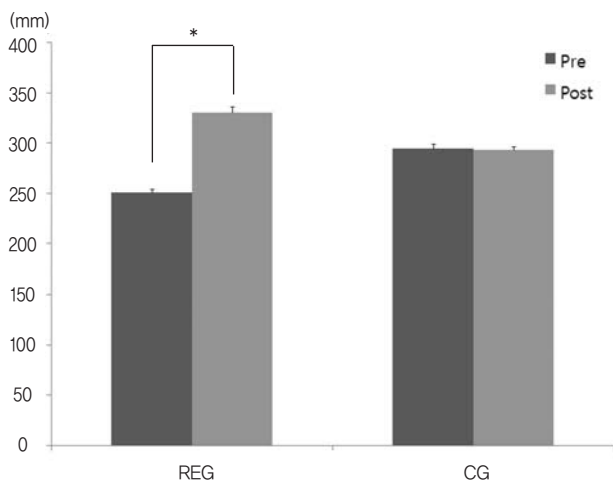


Fig. 3. Difference of FRT between pre and post test

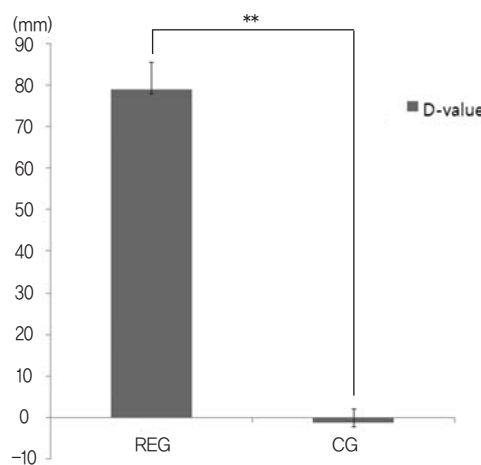


Fig. 4. Difference of FRT changes by exercise

DISCUSSION

The purpose of this study is to aid in designing exercise program for balance ability and preventing fall injuries by analyzing the effects of lower extremity resistance exercise using elastic bands on balance in elderly people. Declined muscle strength and balance sense resulting from physical aging reduces gait ability, triggering disability in daily life and fall injuries(17).

Those who frequently undergo fall injuries have muscle strength of their bilateral knees and ankles decrease and couple force in their dorsiflexor muscles of the ankle joint is considerable and lower limb muscle strength has been presented as an important factor for balance adjustment(9). In the present study as well, TUG test and FRT were conducted in

order to examine the effects of resistance exercise using elastic bands on balance. The result were significant difference between prior to and after the training in TUG test and FRT and TUG test and FRT test results significantly differed in the resistance exercise group between prior to and after the training.

Kim reported that lower limb muscle exercise using elastic bands resulted in improvement of bilateral balance ability of the lower limb exercise group and in significant decrease in the TUG test(18). Tinetti et al. observed that resistance exercise using elastic bands as a method to enhance weakened muscles of elderly people improved balance ability and prevented fall injuries(19). Moon applied resistance exercise using elastic bands and balance exercise to elderly women for 10 weeks and reported that their static and dynamic balance improved(20). Ballard et al. noted

that exercise was applied to elderly subjects for 15 weeks and their balance ability improved in Berg Balance Scale(BBS), Get-up and Go, FRTs(21). Hess and Woollacott reported that high intensity muscle strength exercise applied to elderly people with balance disability significantly increased lower extremity muscle strength and balance ability, reducing the risk of fall injuries(22). Shin reported that elastic resistance exercise applied to elderly people resulted in significant changes in TUG test(23). Lee et al. observed that resistance exercise using elastic bands was applied to elderly women during a proprioceptive neuromuscular facilitation pattern used in functional training for the lower extremity for 4 weeks and balance ability significantly improved and the method may be utilized as an effective fall prevention program(24). Kim reported that lower extremity muscle strengthening exercise using elastic bands increased muscle strength and the resulting increased muscle strength enhanced balance ability and gait ability(25). In frail elderly, the 50-week resistance training programme(row, leg press, leg curl and leg extension) was effective for the improvement of timed up and go test(26). Kim et al reported that contralateral training with unilateral isokinetic exercises increases the one-legged standing balance of the contralateral limb following a short duration of training(27). Power training improves balance, particularly using a low load, high velocity regimen, in older adults with initial lower muscle power and slower contraction(28). Results of the present study correspond with the results of earlier studies which reported that resistance exercise can be improved balance. These finding are in contrast to the results Topp et al. Topp et al reported that resistance exercise using elastic bands did not changed postural control(29).

CONCLUSION

Lower limb muscle strengthening exercise was applied for 9 weeks in order to look at the effects of lower extremity resistance exercise using elastic bands on elderly people's balance. TUG test and FRT was carried out in order to examine the effects of resistance exercise using elastic bands on balance. TUG test and FRT results were significantly different between prior to and after the training in the resistance exercise group and the results also significantly differed between the resistance exercise group and the non-exercise group.

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