J. Phys. Ther. Sci.
27: 1953–1955, 2015

Original Article

Effects of an elastic band resistance exercise program on lower extremity muscle strength and gait ability in patients with Alzheimer's disease

Nayoung Ahn[1)], Kijin Kim[1)*]

[1)] *Department of Physical Education, College of Physical Education, Keimyung University: 2800 Dalgubeoldaero, Dalseo-gu, Daegu 704-701, Republic of Korea*

Abstract. [Purpose] This study examined the effects of a resistance exercise programs aiming to improve muscular function in order to prevent and treat Alzheimer's disease in elderly people. [Subjects and Methods] Elderly patients with mild dementia were randomly assigned to an elastic band resistance exercise group (74.21±6.09 years). The experimental group (n=23) performed upper and lower extremity exercises three times per week for five months. Physical fitness was measured according to chair leg squat, one-leg stance, timed up-and-go test, 2-minute walking test, and gait ability before and after exercise. [Results] Static balance ability in which the participant stood on one foot with eyes open (left and right) increased significantly, but the dynamic balancing ability in the timed up-and-go test did not improve significantly. Cardiorespiratory function and gait speed improved significantly. [Conclusion] The five-month elastic band resistance exercise program improved muscle strength and endurance, cardiovascular function, and gait speed. Therefore, it may be an effective rehabilitation program for elderly patients with Alzheimer's disease.

Key words: Alzheimer's disease, Exercise, Muscular strength

(This article was submitted Jan. 15, 2015, and was accepted Mar. 14, 2015)

INTRODUCTION

Alzheimer's disease (AD) is an acquired neurologic disease that produces many difficulties in social and daily life owing to multiple cognitive impairments. Exercise is a method for preventing the risk factors of AD. Regular exercise is effective for increasing brain metabolism, which increases the secretion of neuronal transmitters and cerebral blood flow; in turn, these enhance muscle flexibility and balance ability, reducing the risk of falls[1)]. In the PS2 gene model mice of AD, treadmill running exercise performed for three months significantly decreased amyloid beta peptide concentration[2)]. A combination exercise program consisting of elastic band, ball, and balancing posture exercises improved the proprioceptive neuromuscular facilitation system and helped maintain correct posture in elderly women[3)]. These findings suggest exercise improves the deficits induced by AD or Parkinson's disease, specifically deactivation of cholinergic activity and the difficulties due to the lack of neurotransmitters[4, 5)]. Exercise increases muscle strength and endurance, which aid the activities of daily living of AD patients[6)]. As an exercise training program for improving muscular strength in the elderly, ACSM (American College of Sports Medicine) increases protein synthesis[7)]. Snijders et al. report that resistance exercise increases muscle mass, improves muscle function, and prevents the aging-related decrease in the number of satellite cells in elderly people[8)]. Muscle function is well known as an important factor for balance ability[9)] and cognitive function[10)] in the elderly. Therefore, the present study analyzed the effects of an exercise program aiming to improve muscle functions in order to prevent and alleviate AD in the elderly. We used elastic band exercises, targeting elderly patients with AD, in order to examine its effects on physical fitness and gait ability.

SUBJECTS AND METHODS

Subjects

Elderly patients with mild dementia (i.e., MMSE-K score, 10–19 points) were randomly divided into elastic band resistance exercise group (n=23, 74.21±6.09 years). The exercise group performed exercise three times per week for five months. The muscle strength of the lower extremities and gait ability were analyzed before and after the exercise program. Informed consent was obtained from all study participants. The study protocol was in compliance with the Declaration of Helsinki.

Methods

The resistance exercise program mainly consisted of the joint movement, which involves gait ability, of the hip and lower extremities with gradual increasing resistance.

*Corresponding author. Kijin Kim (E-mail: kjk744@kmu.ac.kr)

Table 1. Elastic band resistance exercise program

Stage	Contents	Time (min)
Warm-up	Arms: raise both arms, stretching; trunk: twist, waist stretching; neck: arch forward and backward, rotate left and right; legs: ankle abduction & adduction, stretch forward one leg at a time	10
Main exercise	Upper limb exercises (10×3 sets) Seated rows, overhead or military press, biceps curls, shoulder flexion to 90°, PNF D2 flexion, elbow flexion, archery pull for posterior shoulder Lower limb exercises (10×3 set) Hip flexion, hip extension, calf raises, leg press, standing hip adduction with knee extended, standing hip abduction with external rotation, long-sitting ankle plantarflexion	40
Cool-down	Stretching & breathing	10

Table 2. Physical fitness variables before and after elastic band resistance exercise

	Pre-exercise	Post-exercise
Chair leg squat (reps)	5.22 ± 5.07	11.89 ± 5.04***
Left one leg stance (s)	0.87 ± 0.74	4.18 ± 2.73***
Right one leg stance (s)	1.53 ± 1.46	4.48 ± 2.63***
TUG test (reps)	19.85 ± 10.19	18.22 ± 12.01
Walking 2 minutes (steps)	52.94 ± 40.64	169.71 ± 55.91***

TUG: timed up-and-go test.
Values are mean ± SD, *** p<0.001, pre- vs. post-exercise

Table 3. Gait ability before and after elastic band resistance exercise

	Pre-exercise	Post-exercise
Walking 8 m (s)	16.41 ± 6.90	13.18 ± 5.33***
Walking round 8 m (s)	31.35 ± 12.84	27.71 ± 10.09***
Gait speed (cm/s)	55.63 ± 18.30	68.97 ± 22.57***

Values are mean ± SD, *** p<0.001, pre- vs. post-exercise

We used elastic bands to perform resistance exercise three times per week over five months. The use of elastic bands is specifically recommended for this population, because intensity is easily moderated, which is an important concern for people who have low physical fitness levels, such as the elderly. The target heart rate was maintained (within the range of ±5 bpm) for 30–40 minutes using medium-intensity exercise at 60% maximum heart rate. The RPE (Ratings of Perceived Exertion) scale was checked during exercise to maintain a level of 10–12, so that the individual's condition and 60% of medium-intensity exercise could be maintained. Exercise intensity was determined by the extensibility of the elastic band; the yellow band, which is the easiest (i.e., lowest resistance), was used in the initial stage of exercise. The participant switched to the red or green band according to their exercise capacity in order to increase the level of resistance. Exercises of the lower extremities (i.e., bending, flexion and extension movements of the hip joint, knee joint, thighs, and ankle joint) and upper extremities (i.e., bending, flexion and extension of the upper arms, and shoulder joint movement) were performed repeatedly to improve muscle strength (Table 1). Lower extremity endurance was tested by the chair squat on a chair 46 cm tall without armrests; the number of repetitions in 30 s was recorded. Static balance ability was evaluated by the one-leg stance test, in which the participant stood on one foot with their eyes open. The timed up-and-go test (TUG) was used to evaluate dynamic balance ability. The number of gait on the same spot was measured for 2 min to measure cardiorespiratory function. Temporal distance gait analysis was performed by measuring the time it took to walk 8 m. Gait speed was determined by the total distance moved (8 m) divided by the total time spent (cm/s). Data are presented as mean ± SD and were analyzed by using SPSS version 17.0. Independent t-tests were used to compare the means of the two groups. Meanwhile, paired t-tests were used to compare changes before and after exercise in the exercise group. The level of significance was set at $p< 0.05$.

RESULTS

Regarding muscle endurance, the number of chair squats increased significantly ($p<0.001$) after the elastic band resistance exercise program. Regarding static balance evaluation, a significant improvement was observed in the ability of the participants to stand on one foot with eyes open (left and right) ($p<0.001$). However, there was no significant change in dynamic balance in the TUG test. Regarding cardiopulmonary endurance, the number of steps the participants took on the same spot for 2 min increased significantly ($p<0.001$) (Table 2). Regarding gait ability, the time required to walk 8 m and gait speed increased significantly ($p<0.001$) (Table 3).

DISCUSSION

In the present study, elderly patients with AD had diseases related to the brain, such as cerebral infarction, cerebral hemorrhage, cerebral embolism, and depression. They also had metabolic diseases such as high blood pressure, diabetes, chronic obstructive pulmonary disease, and heart failure as well as joint diseases such as arthritis, spinal fracture, upper-arm fracture, and osteoporosis. Resistance exercise not only increases muscle strength, but also enhances the ability to perform functional tasks and gait speed[11]. Thus, resistance

exercise should be emphasized to break the chain reaction of inactivity, muscle weakening, loss of functional ability, and development of metabolic diseases. Hunter et al. conducted resistance exercise on elderly patients 61–77 years old for 26 weeks; the subjects gained an average of 2 kg muscle mass and lost 2.7 kg body fat[12]. In addition, Shin et al. report that resistance exercise using elastic bands increases muscle strength in elderly women and improves ambulatory ability[13]. Frontera et al. report resistance exercise of the lower extremities improves muscle volume and strength[14]. Another study reports moderate to intense elastic band resistance training for muscle strengthening in inactive healthy and frail elderly subjects increases muscle strength 3–17% and 6–18%, respectively[15]. Shin et al. used elastic band resistance exercises for the hips and lower extremities, which are related to gait ability, on elderly women aged 58–67 years; after training 60 min twice per week for eight weeks, balance ability and muscle endurance increased significantly[13].

In the present study, static balance ability increased significantly after resistance exercise. This indicates the ability to stand on one foot and functions of the lower extremities, which were enhanced as a result of elastic band resistance exercise, can enhance and maintain balance ability in elderly people. Furthermore, significant improvements in cardiorespiratory endurance and gait speed were observed after exercise, showing that the elastic band resistance exercise program is effective for increasing muscle function and thus promoting active lifestyles for AD patients. As the five-month elastic band resistance exercise program improves the muscle strength and endurance, cardiovascular endurance, and gait speed of elderly AD patients, it can be used as an effective rehabilitation program for elderly AD patients.

REFERENCES

1) Toulotte C, Fabre C, Dangremont B, et al.: Effects of physical training on the physical capacity of frail, demented patients with a history of falling: a randomised controlled trial. Age Ageing, 2003, 32: 67–73. [Medline] [CrossRef]
2) Cho JY, Hwang DY, Kang TS, et al.: Use of NSE/PS2m-transgenic mice in the study of the protective effect of exercise on Alzheimer's disease. J Sports Sci, 2003, 21: 943–951. [Medline] [CrossRef]
3) Kim SK, Kim TU, Lim CK: The effects of combined exercise program on activities of daily living and functional fitness in the elderly women with mild dementia. J Sport Leis Stud, 2009, 38: 821–830.
4) Haas BM, Trew M, Castle PC: Effects of respiratory muscle weakness on daily living function, quality of life, activity levels, and exercise capacity in mild to moderate Parkinson's disease. Am J Phys Med Rehabil, 2004, 83: 601–607. [Medline] [CrossRef]
5) Tillerson JL, Caudle WM, Reverón ME, et al.: Exercise induces behavioral recovery and attenuates neurochemical deficits in rodent models of Parkinson's disease. Neuroscience, 2003, 119: 899–911. [Medline] [CrossRef]
6) Um SY, Kwak YS: The effects of regular exercise on cognitive function and blood lipid in woman patient with senile dementia. Int J Appl Sports Sci, 2004, 15: 57–65.
7) Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, et al. American College of Sports Medicine: American College of Sports Medicine position stand. Exercise and physical activity for older adults. Med Sci Sports Exerc, 2009, 41: 1510–1530. [Medline] [CrossRef]
8) Snijders T, Verdijk LB, van Loon LJ: The impact of sarcopenia and exercise training on skeletal muscle satellite cells. Ageing Res Rev, 2009, 8: 328–338. [Medline] [CrossRef]
9) Seo HS, Lee JH, Park YH: Effects of a task-specific exercise program on balance, mobility, and muscle strength in the elderly. J Phys Ther Sci, 2014, 26: 1693–1695. [Medline] [CrossRef]
10) Ohsugi H, Murata S, Kubo A, et al.: Verification of the correlation between cognitive function and lower limb muscle strength for the community-dwelling elderly. J Phys Ther Sci, 2014, 26: 1861–1863. [Medline] [CrossRef]
11) Fiatarone MA, Marks EC, Ryan ND, et al.: High-intensity strength training in nonagenarians. Effects on skeletal muscle. JAMA, 1990, 263: 3029–3034. [Medline] [CrossRef]
12) Hunter GR, Wetzstein CJ, Fields DA, et al.: Resistance training increases total energy expenditure and free-living physical activity in older adults. J Appl Physiol 1985, 2000, 89: 977–984. [Medline]
13) Shin SM, Ahn NY, Kim KJ: Effect of resistance training with elastic band on the improvement of balance and gait in the elderly women. Korean J Growth Dev, 2006, 14: 45–56.
14) Frontera WR, Meredith CN, O'Reilly KP, et al.: Strength conditioning in older men: skeletal muscle hypertrophy and improved function. J Appl Physiol 1985, 1988, 64: 1038–1044. [Medline]
15) Krebs DE, Jette AM, Assmann SF: Moderate exercise improves gait stability in disabled elders. Arch Phys Med Rehabil, 1998, 79: 1489–1495. [Medline] [CrossRef]