Effect of Stationary Cycle Exercise on Gait and Balance of Elderly Women

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Abstract. [Purpose] A stationary bicycle exercise and a treadmill exercise were conducted in order to determine the effect of these exercises on the balance and walking ability of elderly women. [Subjects and Methods] Twenty-four elderly women aged 65 or older were equally assigned to a stationary bicycle exercise group and a treadmill exercise group, and they performed exercise three times per week for 8 weeks for 20 minutes each time. In order to examine gait, step length and time were measured as parameters of walking ability, and in order to examine dynamic balance, subjects were evaluated with the Berg balance scale (BBS). [Results] After the intervention, step time and step length and BBS significantly increased significantly decreased, in both groups. A comparison of BBS after the intervention between the two groups revealed that the stationary bicycle group showed larger increases than the treadmill group. [Conclusion] The stationary bicycle exercise group and treadmill exercise group showed significant improvements in gait and balance. Stationary bicycle exercise can help to prevent falls by improving the balance of elderly persons.

Key words: Stationary bicycle exercise, Treadmill exercise, Elderly females

INTRODUCTION

A fall is one of the most frequently occurring incidents experienced by elderly individuals, and such incidents can cause serious injury[1]. Approximately 30% of elderly persons over 65 years old experience at least one fall a year, and 15% of individuals annually experience a fall twice or more[2]. Falls occur as a result of several factors, including decreased vision, impairment of somatosensory functions, lower extremity weakening, and decreased movement. Most falls experienced by the elderly occur during walking, particularly when walking while performing another exercise or cognitive task[3].

Due to aging, a decrease in muscle strength around the knees and ankles occurs more often in the elderly than in younger individuals, resulting in gait and balance impairments. Balance plays an important role in stability as well as mobility, and loss of balance is considered to have the highest risk factor for a fall[4]. Balance or postural control is dependent on interactions among various systems[5], but postural control mechanisms tend to become inefficient as aging progresses[6].

How to prevent falls by elderly individuals is a major area of study, but there are limitations to the application of successful methods to the elderly population in general[7]. Nonetheless, exercise can reduce the risk of a fall due to decrease in balance ability, thereby decreasing the risk of fall for an individual elderly person as well who lives in a local community[8, 9]. Dynamic resistance exercises[9], fall risk assessment and management programs consisting of multilateral elements[10], proprioception training programs[11], and programs utilizing music[12] and yoga[13] have all been found to improve the balance and walking ability of the elderly.

In the present study, a stationary bicycle exercise and a treadmill exercise, which have not been compared in previous studies, were conducted in order to determine the effect of these exercises on the balance and walking ability of elderly women.

SUBJECTS AND METHODS

The subjects of the present study were 24 elderly women from Gyunghi-do, Korea, who met the following selection criteria: over 65 years old, no experience of a fall for one year prior to the study, no specific disease that might influence task performance, no visual or hearing impairment, and no vestibular organ problem. Subjects also needed to sufficiently understand the experimental tasks. All subjects agreed to actively participate in the exercises once they had been given sufficient explanation of the tasks (Table 1).

The subjects were divided into two groups, a stationary bicycle group and a treadmill group, each with 12 subjects, and all subjects performed their respective exercises for 20
minutes a day, three times a week for eight weeks. All the subjects understood the purpose of this study and provided their written informed consent prior to their participation in the study, in accordance with the ethical principles of the Declaration of Helsinki.

The stationary bicycle was set to no resistance, while the treadmill was set to start increasing from 0.1 km/hour to the maximum walking speed that could be achieved by the subject in 20 minutes. Balance assessed using the Berg balance scale (BBS) before and after the exercise, while step length and step time were measured with an AP1105 (GaitRite CIR, USA) to measure the walking ability. The average ± standard deviation of group measurements were calculated.

SPSS for Windows (version 18.0) was used to analyze the data. The paired t-test was used to examine pre- and post-intervention differences, and the independent t-test was used to examine differences between the groups, both with a statistical significance level of α = 0.05

RESULTS

After the intervention, BBS and step length increased significantly (p < 0.05), and step time significantly decreased (p < 0.05) in both groups. A comparison of BBS after the intervention between the two groups revealed that the stationary bicycle group showed larger increases than the treadmill group (p < 0.05) (Table 2).

DISCUSSION

In order to compensate for reduced balance and stability during walking, elderly individuals show decreased cadence and stride length, an increase in the base of support, and a decrease in walking speed\(10\). As a result, elderly individuals are vulnerable to falls, an event more common in elderly women than any other group\(15\).

In this study, the two groups had similar physical characteristics before the start of the intervention. Following eight weeks of exercise, the stationary bicycle group showed notably improved balance compared to the treadmill group, and step length had also notably increased. In particular, the BBS score was higher in the stationary bicycle group than in the treadmill group, indicating that stationary bicycle exercise is more effective at improving the balance of elderly women than treadmill exercise.

BBS is a measure of dynamic balance, and Thorbahn et al.\(16\) reported that a BBS score of <45 indicates an increased risk of a fall. In this study, the lower limb weight movement and stability exercise of the stationary bicycle exercise had a positive effect on the BBS score of the elderly women. This result is consistent with that of Englund et al.\(17\) who showed that complex exercise through weight movement resulted in an increase in the BBS score.

The stationary bicycle group showed a greater improvement in the BBS score than the treadmill group because the bicycle exercise was a balance exercise on a narrow saddle, compared to the treadmill, which requires stable weight movement using two feet. In addition, in the bicycle exercise the right and left weight movement of the lower extremities, in which the center of mass is dependent on a saddle, has more effect on the lateral bending movement of the pelvis than walking on a treadmill. The subsequent increase in pelvic movement in the elderly women positively influenced their balance.

Balance impairment can result in unstable walking\(18\). The present study demonstrated that improved balance had a positive effect on step length. One limitation of this study was the small number of subjects, limiting the extent to which the results can be applied to elderly women in general. Future research will need to include a larger number of elderly women to determine the improvements of characteristics other than balance and walking resulting from stationary bicycle exercise.

As society ages, the need to study the causes of falls and preventative measures that can be applied to the elderly has been recognized, and effective exercise methods have been introduced. The stationary bicycle exercise can help to prevent falls by improving the balance of elderly women.

REFERENCES

1) Hausdorff JM, Rios DA, Edelberg HK: Gait variability and fall risk in community-living older adults: a 1-year prospective study. Arch Phys Med Rehabil, 2001, 82: 1050–1056. [Medline] [CrossRef]
2) Tromp AM, Smit JH, Deeg DJ, et al.: Predictors for falls and fractures in the Longitudinal Aging Study Amsterdam. J Bone Miner Res, 1998, 13: 1932–1939. [Medline] [CrossRef]
3) Bloem BR, Valkenburg VV, Slabbersda M, et al.: The multiple tasks test: development and normal strategies. Gait Posture, 2001, 14: 191–202. [Medline] [CrossRef]
4) Nohua MM, Dey AB, Hussain ME: Relevance of balance measurement tools and balance training for fall prevention in older adults. Journal of Clinical Gerontology and Geriatrics, 2013, 1–5.
5) Alexander NB: Postural control in older adults. J Am Geriatr Soc, 1994, 42: 93–108. [Medline]
6) Woollacott MH, Shumway-Cook A, Nashner LM: Aging and posture control: changes in sensory organization and muscular coordination. Int J Ag-

| Table 1. General characteristics of subjects |
|--------------------------------------------|
|                                            |
| Variable         | Group       |
| Age (year)       | Stationary Bicycle 69.1±3.3 | Treadmill 68.1±2.5 |
| Height (cm)      | 159.5±4.3 | 159.8±3.6 |
| Weight (kg)      | 57.3±5.1  | 56.4±4.5  |
| Mean±SD          |            |

| Table 2. Comparison of measurement values at pre-test and post-test |
|---------------------------------------------------------------|
| Variable         | Group       | Pre     | Post    |
| Step length (cm) | Stationary Bicycle 41.4±7.8 | Treadmill 42.5±9.3 |
|                  |             | 47.3±7.0* | 48.5±6.8* |
| Step time (sec)  | Stationary Bicycle 0.7±0.1  | Treadmill 0.7±0.1 |
|                  |             | 0.6±0.1* | 0.6±0.1* |
| BBS score        | Stationary Bicycle 42.4±1.9  | Treadmill 42.6±2.0 |
|                  |             | 48.0±2.8* | 45.6±2.4* |

* significant difference between pre-test and post-test, ^ significant difference between Stationary Bicycle and Treadmill at post-test
7) Gillespie LD, Robertson MC, Gillespie WJ, et al.: Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev, 2009, CD007146. [Medline] [CrossRef]

8) Sherrington C, Whitney JC, Lord SR, et al.: Effective exercise for the prevention of falls: a systematic review and meta-analysis. J Am Geriatr Soc, 2008, 56: 2234–2243. [Medline] [CrossRef]

9) Topp R, Mikesky A, Wigginsworth J, et al.: The effect of a 12-week dynamic resistance strength training program on gait velocity and balance of older adults. Gerontologist, 1993, 33: 501–506. [Medline] [CrossRef]

10) Trombetti A, Hars M, Herrmann F, et al.: Effect of a multifactorial fall-and-fracture risk assessment and management program on gait and balance performances and disability in hospitalized older adults: a controlled study. Osteoporos Int, 2013, 24: 867–876. [Medline] [CrossRef]

11) Martinez-Amat A, Hita-Contreras F, Lomas-Vega R, et al.: Effects of 12-week proprioception training program on postural stability, gait, and balance in older adults: a controlled clinical trial. Journal of Strength and Conditioning Research, 2013, 27: 2180–2188.

12) Hamburg J, Clair AA: The effects of a movement with music program on measures of balance and gait speed in healthy older adults. J Music Ther, 2003, 40: 212–226. [Medline] [CrossRef]

13) Krishnamurthy M, Telles S: Effects of Yoga and an Ayurveda preparation on gait, balance and mobility in older persons. Med Sci Monit, 2007, 13: LE19–LE20. [Medline]

14) Kang HG, Dingwell JB: Effects of walking speed, strength and range of motion on gait stability in healthy older adults. Journal of Biomechanics, 2008, 41: 2899–2905.

15) Fuller GF: Falls in the elderly. American academy of family physician, 2000, 61: 2159–2168.

16) Bogle Thorbahn LD, Newton RA: Use of the berg balance test to predict falls in elderly persons. Phys Ther, 1996, 76: 576–583. [Medline]

17) Englund U, Littbrand H, Sundell A, et al.: A 1-year combined weight-bearing training program is beneficial for bone mineral density and neuromuscular function in older women. Osteoporos Int, 2005, 16: 1117–1123. [Medline] [CrossRef]

18) Shumway-Cook A, Gruber W, Baldwin M, et al.: The effect of multidimensional exercises on balance, mobility, and fall risk in community-dwelling older adults. Phys Ther, 1997, 77: 46–57. [Medline]