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Acute Effects of 5 Min of Plantar Flexor Static Stretching on Balance and Gait in the Elderly

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Abstract. [Purpose] The purpose of this study was to examine the acute effects of five minutes of plantar flexor static stretching (PSS) on the balance and gait of the elderly. [Subjects and Methods] Twenty-five subjects aged 65 years and above performed 5 min of PSS in the form of wedge board standing. The sway length of each subject's center of mass was measured to examine the subject's static balance. It was measured by one minute of quiet standing with the eyes closed. Functional reach tests (FRTs), timed up and go tests (TUGs), and 10-meter walk tests (10MWTs) were performed to examine dynamic balance and gait before and after PSS. [Results] The outcome showed significant increases in sway distances (6.55 ± 5.03 cm) after stretching. However, in the FRTs, TUGs, and 10MWTs, the reach distance and time did not show any significant changes. [Conclusion] These results suggest that the elderly subjects temporarily experienced difficulties in maintaining balance immediately after the PSS but that their dynamic balance and gait were not adversely affected after a short period of time. Therefore, to prevent falls and perform exercises in a safe way, it is recommended to allow patients to rest after performing PSS.
Key words: Elderly, Static stretching, Postural balance

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INTRODUCTION

As our society has become an aging society, improving the quality of life has become one of the major interests in it. Impaired balance and gait abilities due to aging and diseases can lead to an increase in the risk of falls and secondary problems. Therefore, it is clear that balance problems can directly affect the quality of our lives. The physical activities of the elderly can be improved by diverse exercise programs and activities. It is important to perform stretching before exercises to prevent injuries and enhance exercise in a more efficient way[1)]. The common type of stretching is static stretching, and the effect of stretching may vary with the type applied, intensity, and time[2, 3)]. While stretching has positive effects (e.g., increases ROM, injury prevention, and improvement in the ability to perform exercises)[3)], negative effects (e.g., temporary decreases in maximum muscle power and stretch-induced impairment in reaction time and movement time) can appear immediately after stretching[4–6)]. In reality, some elderly individuals complain of temporary difficulties in balance control immediately after PSS. However, previous studies have been limited to the acute effects of stretching in terms of the histological and neurological changes during or after stretching[7–10)]. Furthermore, only a few studies have examined the temporary difficulties in balance and gait of elderly populations after stretching. Therefore, the purpose of this study was to examine the acute effects of stretching on balance and gait in the elderly.

SUBJECTS AND METHODS

Twenty-five community-dwelling elderly subjects voluntarily participated in this study under the following criteria: at least 65 years of age, no experience of falls in a year, able to walk at least 10 m independently without a walking aid or another person's help, and a Mini Mental State Examination-Korea (MMSE-K) score exceeding 24 points. Those who had any particular disease that could affect their performance such as vision or hearing damage, or any problems in their nervous systems, vestibular organs, or understanding the contents of the experiment were excluded. All included patients understood the purpose of this study and provided written informed consent prior to participation in

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Table 1. General characteristics of subjects

Gender (M/F)	1/24
Age (years)	79.1 ± 6.2
Height (cm)	150.1 ± 6.6
Weight (kg)	54.1 ± 7.5
MMSE-K (point)	25.6 ± 1.5

*$p < 0.05$ (mean ± SD)
MMSE-K: Mini Mental State Examination-Korea

the study in accordance with the ethical standards of the Declaration of Helsinki (Table 1).

Each subject performed PSS for 5 minutes on a wedge board with an attached nonslip mat on its contact surface. Subjects were instructed to maintain an upright posture while keeping their arms to their sides and looking straight ahead. The angle of inclination of the wedge board was adjusted to an angle (15–25°) at which the subject did not feel uncomfortable. To examine the changes in balance and gait following the application of 5 min of PSS, sway lengths during quiet standing for 1 min were measured and functional reach tests (FRTs), timed up and go tests (TUGs), and timed 10-meter walk tests (10MWTs) were implemented. To examine the subjects' static balance ability, each of the subjects was instructed to stand on a BioRescue (RM Ingenierie, Rodez, France) for 1 min with their feet shoulder width apart and eyes closed while the sway length of the center of mass was measured. In the FRTs, the subject was asked to stand with their bare feet shoulder width and to reach forward with both arms as far as possible without taking a step or touching the wall. The distance between the start and end point was measured. In the TUGs, the time required for the subjects to complete the following task was measured: rising from a chair, walking 3 m, turning around, walking back to the chair, and then sitting down on the same chair. In the 10MWTs, the subject was asked to walk 10 m without any aids, and the time required to walk the 6 m in the middle was measured; the first and last 2-m sections were excluded to account for the accelerating and decelerating phases. The FRTs, TUGs, and 10MWTs were repeated three times by each subject, and the best records were used. All measurements were recorded as mean ± standard deviation values. SPSS for Windows (version 18.0) was used to analyze the data. Differences between before and after stretching were evaluated with paired t-tests. The statistical significant level was set to $\alpha = 0.05$.

RESULTS

After stretching, the sway distance of the center of mass during 1 min of quiet standing without visual information increased significantly (by 6.55 ± 5.03 cm; $p < 0.05$). However, no statistically significant difference was shown in the FRTs, TUGs, or 10MWTs measured 1 min later ($p > 0.05$; Table 2).

Table 2. Comparison of balance and gait after 5 min of plantar flexor static stretching

Variable	Pre (Mean ± SD)	Post (Mean ± SD)
Sway length (cm)	38.4 ± 15.1	44.9 ± 17.1*
FRT (cm)	20.3 ± 8.5	18.1 ± 7.3
TUG (sec)	10.3 ± 1.8	10.0 ± 1.9
10MWT (sec)	7.6 ± 2.1	7.2 ± 1.6

* $p < 0.05$ (mean ± SD)
Sway length: sway length for 1 minute; FRT, functional reach test; TUG, timed up and go test; 10MWT, timed 10-meter walk test

DISCUSSION

PSS is frequently used for warming up or cooling down in exercise programs to reduce ankle stiffness, improve joint mobility, or increase physical activity[1]. This study was conducted to examine the acute effects of 5 min of PSS on balance and gait in the elderly after stretching. The results showed that despite the temporary increase in postural sway distance immediately after stretching, the subjects recovered their dynamic balance and gait abilities after a short period of rest.

The duration of stretching can also affect balance. Although stretching for a short time resulted in improvement of balance by promoting muscle activity[11], stretching for a long time adversely affected balance[6, 12]. Costa et al. (2009) stated that whereas 15 seconds of stretching improved balance, 45 seconds of stretching did not affect balance[11]. Other studies conducted by Nagano et al. (2006)[12] and Yuk (2012)[6], in which longer PSS was used, reported that postural sway lengths increased after 3 minutes and 15 minutes of static stretching. In this study, the sway lengths during quiet standing for 1 min immediately after the application of 5 minutes of stretching increased compared with before stretching.

Static stretching may alter the mechanical and neurologic characteristics of the calf muscle[13, 14]. Nakamura et al. reported that the passive torque of the gastrocnemius and the displacement of the myotendinous junction significantly changed at the 2-, 3-, and 4-min points with 5 min of PSS[15]. Behm et al. reported that reaction/movement time for regaining balance increased after 45 seconds of stretching[4]. Therefore, the temporary increase in the sway length immediately after stretching shown in this study is attributed to the mechanical and neurologic changes caused by stretching. However, in the FRTs, TUGs, and 10MWTs implemented to examine the subjects' dynamic balance and gait abilities, the reach distance and gait time did not show any significant difference compared with before stretching. This is likely due to the minor effects of PSS on gait. Similarly, stretching studies conducted with stroke patients did not show changes in walking speed after PSS[16, 17].

Limitations of the present study include not only the small sample size but also the fact that stretching exercises under diverse conditions were not compared with each other. Although the elderly subjects experienced temporary difficulties in maintaining balance after 5 min of PSS, their

dynamic balance and gait were not affected when a recovery time of approximately 1 min had passed. The authors of this study recommend that elderly individuals take a brief rest after PSS before walking or activities in exercise programs to prevent falls and perform exercises safely.

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