

The effects of dual-task gait training on foot pressure in elderly women

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Abstract. [Purpose] The purpose of this study was to evaluate the effect of dual-task gait training on foot pressure in elderly women. [Subjects and Methods] Twenty elderly people in local communities performed dual-task gait training for 20 minutes three times per week for 8 weeks. Foot pressure was measured using an F-scan System (Tekscan, South Boston, MA, USA) before the intervention and in the 4th and 8th weeks of the intervention. [Results] Foot pressure increased significantly between the 4th and 8th weeks of the intervention in the CFF (central forefoot); between before the intervention and the 4th week, between the 4th and 8th weeks, and between before the intervention and the 8th week in the MF (midfoot); and between before the intervention and the 4th and 8th weeks in the HL (heel). [Conclusion] The results of this study indicate that dual-task gait training may improve the gait ability of elderly persons residing in the community.

Key words: Aging, Gait, Dual tasks

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INTRODUCTION

Gait is important in daily life and determines functional independency of activities of daily living (ADL), which affects quality of life¹⁾. Generally, one foot is advanced forward while the other supports the body weight during gait, with the stance phase and swing phase taking place in both feet alternately and the COG (center of gravity) moving to the outside of the BOS (base of support) temporarily, causing an increase in instability of posture, which leads to balance control to correct the instability²⁾. The feet are important in this balance control; they store and release energy for movement as they make contact with the ground during gait to provide momentum and to change direction, and they absorb shock in this process and directly control the balance of the body to prevent falls³⁾.

Elderly people experience a functional change in the feet due to aging. Therefore, their feet fail to work normally, causing a decrease in posture stability, and they can also have problems with cognitive functions that control movement, causing a risk of falls due to decreases in gait ability and balance control ability^{4–6)}. Dual-task training is widely used to reduce the risk of falls, and it trains not only the physical part of gait but also the cognitive part to increase stability and gait ability^{6, 7)}. It is also known that proper weight distribution and foot function can be analyzed by measuring foot pressure⁸⁾. The purpose of this study was

to evaluate the effect of dual-task gait training on foot pressure in elderly women.

SUBJECTS AND METHODS

This study was conducted with 20 elderly women who resided in communities in D city. The selection criteria for the subjects were as follows: at least 65 years old, no falls within the last year, and no disease that might affect conduct of the test. Those who had visual impairments, hearing damage, or nervous system or vestibular organ problems or were unable to understand the nature of the experiment were excluded. All the subjects understood the purpose of this study and provided written informed consent prior to participation in the study in accordance with the ethical standards of the Declaration of Helsinki.

The average age, height, and weight of the subjects were 80.1±2.1 years, 157.1±6.4 cm, and 53.5±7.2 kg, respectively. Dual-task gait training was performed by adding the task of holding a tray containing a paper cup filled to 80% of its capacity with water to the task of walking 5 m. The subjects performed the training for 20 minutes three times per week for 8 weeks. Subjects had plenty of rest during the training when fatigued. An F-scan system (Tekscan, South Boston, MA, USA) was placed in the subjects' shoes in the form of insoles to measure foot pressure during training. The plantar side of the foot, the measurement point for foot pressure, was divided into 8 parts, the HL (heel), MF (midfoot), MFF (medial forefoot), CFF (central forefoot), LFF (lateral forefoot), Mt (medial toe), and Lt (lesser toe).

SPSS for Windows (version 20.0) was used to analyze the data. Repeated measure ANOVA was used to examine foot pressure according to gait period, and Fisher's Least Significant Difference test was used for post hoc analysis. The statistical significance level was set to $\alpha = 0.05$.

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RESULTS

Foot pressure increased significantly between the 4th and 8th weeks of the intervention in the CFF (central forefoot; $p < 0.05$); between before the intervention and the 4th week, between the 4th and 8th weeks, and between before the intervention and the 8th week in the MF (midfoot; $p < 0.05$); and between before the intervention and the 4th and 8th weeks in the HL (heel; $p < 0.05$; Table 1).

DISCUSSION

Dual-task gait training was conducted to improve the gait ability of the elderly in this study. Performing dual-task gait training can be very effective, since it trains not only physical parts but also cognitive parts^{6,7}. Additionally, foot function is most important in gait because the feet perform an essential role in balance control by absorbing shock, providing momentum, and changing directions. Foot function can be examined through measurement of foot pressure^{8,9}. Therefore, gait and foot function were evaluated by measuring foot pressure before dual-task gait training and at 4 and 8 weeks of dual-task gait training.

Generally, elderly people experience changes in foot function due to aging. In the case of plantar pressure, the foot COP (center of pressure) in the elderly is less evenly distributed over the foot than in younger people, and this asymmetric plantar pressure inhibits the normal foot functions that absorb shock and support the body weight. Generally, the feet shift body weight to the midfoot and heel through the longitudinal arch, but repeated asymmetrical transfer of the body weight to the midfoot and heel causes a decrease in proprioception and structural deformity of the foot, which leads to instability of the gait^{10,11}. The foot was divided into 7 parts to evaluate foot pressure in this study, and a gradual increase in foot pressure in the central forefoot and midfoot was observed during the intervention. Foot pressure increased significantly between before the intervention and the 4th week, between the 4th and 8th weeks, and between before the intervention and the 8th week in the midfoot and between before the intervention and the 4th and 8th weeks in the heel. As a result, weight distribution increased after 4 weeks in the midfoot and heel and after 8 weeks in the central forefoot, midfoot, and heel during the dual-task gait training, which is consistent with the results of the research of Redmond et al. in that the shock absorbing arch support mechanism of the foot, if it functioned normally, shifted loads in the forefoot and heel to the midfoot and increased the pressure value in Redmond's study; therefore, the function of the longitudinal arch is considered to be performed properly as a result of dual-task gait training¹². The foot pressure values of the heel and midfoot are most affected by heel strike and midstance. The results of this study, that the pressure in the heel and midfoot increased, indicate an improvement in stability, as in that study of Kimmeskamp et al., who also showed that the heel strike and midstance components of the gait can be strengthened¹³.

Control of foot pressure control while standing is related to cognitive function and improvement of cognitive function through task training can improve gait and posture

Table 1. Change in foot pressure according to duration

Period	Before	4 weeks	8 weeks
MT (kg)	13.5±7.4	15.2±6.5	13.7±8.4
LT (kg)	11.0±7.7	8.5±3.7	10.4±6.7
MFF (kg)	26.5±8.8	27.0±8.9	28.5±11.4
CFF (kg)	5.8±3.8	4.5±2.8	7.0±4.5 ^b
LFF (kg)	37.1±10.9	38.4±8.6	37.7±7.9
MF (kg)	5.5±3.7	7.9±4.6	13.9±9.1 ^{abc}
HL (kg)	7.5±3.7	9.5±3.9	11.3±5.9 ^{ac}

* $p < 0.05$ (mean±SD)

^aBefore vs. 4 weeks. ^b4 weeks vs. 8 weeks. ^cBefore vs. 8 weeks. HL, heel; MF, midfoot; MFF, medial forefoot; CFF, central forefoot; LFF, lateral forefoot; Mt, medial toe; Lt, lesser toe

stability¹⁴. In addition, dual-task gait training can be more effective for posture stability, gait ability, and preventing falls. A limitation of this study is that representativeness could not be secured because the number of subjects was relatively low. The duration of the improved balance and gait ability in the elderly resulting from dual-task gait training should be investigated through follow-up testing.

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