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The Influence of Ankle Joint Mobilization on ROM of the Ankle Joint and Maintenance of Equilibrium in Elderly Women

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Abstract. [Purpose] Small changes in equilibrium while walking or standing up can lead to loss of balance for elderly people, who have relatively low activity levels compared to normal adults. This paper examined the effect of ankle joint mobilization on the ankle joint range of motion (ROM) and maintenance of equilibrium in elderly women who have decreased ankle joint mobility. [Subjects] We divided the study subjects into 2 groups: ankle joint mobilization group (AJMG) (n=20) and control group (CG) (n=20). [Methods] The AJMG received 20-minute Maitland joint mobilization sessions three times a week for four weeks. The ROM of dorsiflexion and plantar flexion and equilibrium maintenance during quiet standing were measured before and after the mobilization procedure. [Results] There was a significant improvement in the ankle joint ROM and ability to maintain equilibrium among the AJMG members before and after the intervention. [Conclusion] The Ankle ROM and ability to maintain equilibrium in elderly women improved after ankle joint mobilization.
Key words: Ankle joint mobilization, Ankle ROM, Equilibrium

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INTRODUCTION

With advances in mechanical machines and transportation, human beings are faced with environmental factors that reduce their physical activities. As the need for social activities is especially low among elderly citizens, they shows drastic decreases in body strength resulting from limited physical activity[1)]. In the case of the ankle joint, when the range of motion (ROM) decreases, other new strategies are required to maintain equilibrium for standing and walking. In reduced ankle ROM, movements of the hip joint and body trunk are invoked in order to supplement the decrease in postural control that results from the limitations in ROM[2)]. Every movement in the ankle is related to maintaining balancing during walking, and the ankle joint also controls the interaction between feet and the ground. Therefore, ankle movement is an essential component of walking and maintenance of equilibrium[3)].

Equilibrium is defined as the ability to maintain the center of weight within a base of support and to steadily maintain that balance while moving[4)]. Thus, equilibrium is thus a complex procedure in which an individual maintains a particular posture by appropriately responding to the external stimulus experienced during voluntary movement[5)]. Recent interventions have focused on particular exercises that reduce the physical factors that lead to falling[6)], which include weakening of leg muscle strength, equilibrium disruption, and walking disabilities. The development of an optimal exercise program that can prevent falling accidents still requires more research[7)], and it must recognize that even small changes in equilibrium while walking or standing lead to loss of balance in elderly people who have low movement ability for activity[8)]. The present study examined the effects of ankle joint mobilization on the ankle joint range of motion (ROM) in elderly women with decreased ankle joint mobility and their subsequent ability to maintain equilibrium.

SUBJECTS AND METHODS

Among the members of S Welfare Centers for the Elderly located in D-city, South Korea, those who were over 65-years-old and who volunteered to participate in the study were selected as research subjects. Patients who were undergoing regular muscle strengthening exercise or balancing training, with leg surgery history for severe injury, or with neurosurgical disease, or with structural differences in leg length, or with problems in cognitive ability were excluded from the sample. The subjects were randomly divided into an ankle joint mobilization group (AJMG) and a control group, each containing 20 subjects. Before the experiment, the participants received an explanation of the full experimental procedure and voluntarily agreed to participate.

The mean age of the AJMG was 69.50 ± 4.38 years, meam height was 158.30 ± 7.21 cm, and meam weight was 54.30 ± 6.70 kg. The mean age of the control group was 68.90 ± 5.53 years, meam height was 151.70 ± 4.90 cm, and meam weight was 54.55 ± 6.94 kg. Analysis based on sex using the chi-square test, and the independent t-test was used to analyze the relationship of age, height, and weight. These tests showed no significant differences ($p>0.05$) in age, height and weight between the groups, thus confirming their homogeneity of both groups.

Ankle joint mobilization for the AJMG in this study consisted of 20-minute sessions of Maitland joint mobilization three times a week for four weeks. Maitland joint mobilization can be applied at four levels, Levels 1 and level 2 involve the beginning and middle range of accessory movement, while levels 3 and level 4 are concerned with the end range of accessory movement. Since the purpose of Maitland joint mobilization is to reduce pain and to improve mobility by enhancing the flexibility of connective tissue surrounding the joint, we applied levels 3 and level 4 in this study[9)]. For the purpose of increasing mobility in dorsiflexion and plantar flexion of the ankle joint, anteroposterior gliding was applied to the talocrural joints and mediolateral gliding was applied to the subtalar joints that affect inversion and eversion of the feet. Anteroposterior gliding, torsion, flexion, and extension were applied to the midtarsal joints, while anteroposterior gliding and rotation were applied to the tarsometatarsal joints. Each mobilization was performed at the end range of ROM, considering the concave-convex rule of joints for the purpose of increasing ROM[10)]. All corrections were performed by the same person, who had over 10 years of clinical experience.

Measurements of active dorsiflexion and active plantar flexion of the ankle joint ware performed with a Goniometer (Sammons Preston Company). Specifically, active dorsiflexion and active plantar flexion were measured with a fixed ruler on the horizontal line of the crural bone axis and a moving ruler on the fifth metatarsal bone, with the research subject in a supine position on a bed. The measurements were performed before and after the intervention. The ability to maintain equilibrium during quiet standing was measured with a balance performance monitor (BPM, SMS Health Care, UK). The validity of the device was confirmed by a single-case experimental design experiment. The BPM consists of a computerized platform for standing on with both feet and feedback devices that provide diverse visual and auditory feedback information. The device provides accurate information of the distribution of the body center, along with an assessments of equilibrium, while standing 1 minute, such as sway area, sway path length, and sway maximum velocity, through a computerized measurement and calculation during standing for 1 minute. This device is widely used as a training and evaluation tool in clinical equilibrium assessment[11)]. Equilibrium was measured before and after the mobilization intervention. The measured data were analyzed with SPSS 18.0 KO (SPSS, Chicago, IL, USA) statistical software and the collected data are presented as means and standard deviations. In order to compare the ankle joint ROM and ability to maintain equilibrium before and after the experiment, a paired sample t-test was conducted. The level of statistical significance, level α, was chosen 0.05 for all data.

RESULTS

A significant improvement in ROM was observed in right dorsiflexion, right plantarflexion, left dorsiflexion, and left plantarflexion among the AJMG members before and after the intervention($p<0.05$) (Table 1).

A significant improvement in body equilibrium was also observed with respect to sway area, sway path length, and sway maximum velocity among the AJMG members before and after the intervention ($p<0.05$) (Table 2).

DISCUSSION

Equilibrium refers to the procedure of maintaining postural stability at a steady level. An ability to maintain equilibrium is one of the most fundamental requirements for human beings to lead an everyday life and to do meaningful

Table 1. Comparison of ankle joint ROM of each groups (unit: degree)

	Group	Pre-intervention	Post-intervention
Rt dorsi flexion	AJMG *	8.60 ± 1.90	15.70 ± 1.89
	CG	9.50 ± 1.96	10.80 ± 2.90
Rt plantar flexion	AJMG *	28.80 ± 1.75	43.00 ± 1.63
	CG	28.90 ± 1.85	30.60 ± 3.92
Lt dorsi flexion	AJMG*	8.20 ± 1.62	17.60 ± 1.58
	CG	8.90 ± 1.52	10.70 ± 1.57
Lt plantar flexion	AJMG *	29.10 ± 1.85	46.30 ± 1.34
	CG	28.60 ± 1.78	27.90 ± 1.91

*$p<0.05$, AJMG: ankle joint mobilization group, CG: control group, Rt: right, Lt: left.

Table 2. Comparison of postural sway of each groups

	Group	Pre-intervention	Post-intervention
Sway area (mm2)	AJMG *	142.00 ± 87.28	56.30 ± 22.66
	CG	117.90 ± 35.56	111.20 ± 33.88
Sway path length (mm)	AJMG *	231.70 ± 44.80	149.70 ± 41.19
	CG	218.10 ± 29.80	216.40 ± 39.78
Sway max velocity (mm/s)	AJMG *	55.50 ± 18.23	32.00 ± 5.35
	CG	48.00 ± 6.00	44.00 ± 6.68

*$p<0.05$.

activities[12]. However, in the case of elderly people who have insufficient exercise, range of motion decreases as atrophy and loss of bone density advances and muscle contractility decreases due to reductions in muscle fiber. All of these factors result in decreased ability to maintain equilibrium. As a result, the frequency of falls accidents among elderly people increases, resulting in increased use of limited medical resources[13].

Toulotte et al. reported a decrease in postural sway in a sample of elderly people after sixteen weeks of exercises designed to improve muscle strength, proprioception, static and dynamic equilibrium, and flexibility[14]. Vaillant et al. examined the immediate effects of massage and joint mobilization of the feet and ankles of 28 elderly people aged between 65 and 95 and reported improved balance results in the Single Leg Balance test and the Timed Up and Go test[10]. Freitas et al. examined the impact of joint immobilization on postural sway during quiet standing and found an increased postural sway in the anterior-posterior direction in cases of immobilized knees, hips, and trunk. These results imply that joint immobilization has a negative impact on body balance, which is inconsistent with our study where ankle joint mobilization has a positive effect on improved balance ability[15]. A significant enhancement of walking and balance ability after a ROM-promoting program was also reported by Lee[16]. This is also consistent with our experimental findings. The positive impact of ankle joint mobilization on postural sway found in the present study can be explained by the ROM of the ankle joint having increased from its low abnormal range to the normal range following four weeks of mobilization of the ankle joint. This eventually improved equilibrium while maintaining the stability of the ankle joint.

In summary, joint mobilization applied to the ankle joints of elderly women not only increased the ankle joint ROM, but also improved the subjects' ability to respond to micromotion, contributing to the enhancement of their ability to maintain equilibrium. The experimental results reported here are expected to be useful in fall prevention and for improving equilibrium among elderly people.

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