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Effect of Ankle Joint Mobilization on Range of Motion and Functional Balance of Elderly Adults

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Abstract. [Purpose] This study was conducted to investigate the effect of mobilization of the ankle joint in elderly adults on range of motion and functional balance of elderly adults. [Methods] Thirty-three healthy elderly adults were randomly allocated to two groups: the mobilization (MT) group and the control (CT) group, comprised of 18 and 15 subjects respectively. Traction, anterior gliding and posterior gliding of the talocrural joint were performed in the MT group, whereas no intervention was made in the CT group. [Results] The average change of ankle ROM was 7.02° in the MT group and −0.08° in the CT group, showing a significant difference (F=52.67). The average change of execution time in the OLB test was 6.88 seconds in the MT group and −0.49 seconds in the CT group, showing a significant difference (F=107.33). The average change of execution time in the TUG test was −2.88 seconds in the MT group and −0.34 seconds in the CT group, showing a significant difference (F=36.44). The average change of reaching distance in the LR test was 13.61 mm in the MT group and 0.48 mm in the CT group, also showing a significant difference (F=11.13). [Conclusion] We presume that mobilization of the ankle joint of elderly adults increases range of motion and improves functional balance.
Key words: Mobilization, Functional balance, Elderly adults

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INTRODUCTION

Despite the contracture of the ankle muscles with aging, the passive resistive torque of stretched connective tissue increases in the elderly[1)]. Although range of motion decreases significantly in all joints with aging[2)], the ankle range of motion is correlated with balance[3)]. Bennell and Goldie[4)] reported that decrease in ankle joint ROM was related to decreased balance. Additionally, Mecagni et al.[3)] found, in their study of elderly females living in local communities, that ankle joint ROM was related to balance. These studies showed that limited ankle joint ROM affects daily living.

Among studies on balance related to falls, Province et al.[5)] showed that flexibility exercises decreased the fall incidence ratio. Vandervoort et al.[6)] reported that accurate sensory input was necessary in organizing motor programs and generating effective motor responses. Perry et al.[7)] and Perry[8)] reported that sensation transmitted through the sole played an important role during dynamic postural response.

Previous studies have shown that mechanical foot stimulation and foot massage and manipulation are effective at improving postural control while standing[9, 10)], but their effect on functional balance has not been studied sufficiently. Mecagni et al.[3)] reported that the range of motion of the ankle joint is correlated with the functional reach test result and concluded that a study should be conducted to determine whether or not ankle joint ROM developed through therapy improves balance.

On the basis of these previous studies, we conducted the present study to investigate the effect of ankle joint manual therapy on joint ROM and functional balance of healthy elderly subjects.

SUBJECTS AND METHODS

Subjects

Thirty-three healthy elderly adults were randomly allocated to two groups, the mobilization (MT) group and the control (CT) group, comprised of 18 and 15 subjects, respectively. On average, the subjects were 68.48 years old, 159.57 cm in height, and 66.24 kg in weight (Table 1).

Methods

Ankle joint ROM was measured with an electrical goniometer (MicroFET3; Hoggan, USA). To measure functional balance, the one leg balance test (OLB), the timed up-and-go test (TUG) and the lateral reach test (LR) were each performed three times and their mean values were calculated.

We measured the maximal active ankle dorsiflexion angle while subjects were in the long sitting position with the knees flexed (45 degrees) and we measured the maximal active ankle plantar flexion angle while subjects were in the long sitting position, and the two measurements were added.

The OLB test was performed with the subjects barefoot. The subjects were asked to stand on the right foot and then on the left foot, and the execution time was measured with a stopwatch[11]. For the TUG test, the subjects were asked to sit on a corner chair, and the time it took for the subjects to get up and touch the wall 3 m in front them, return, and sit on the chair again was measured[12]. For the LR test, the subjects stood facing away from a wall and not touching it, while keeping a distance of 10 cm between the heels and positioning the feet at an angle of 30 degrees. Then, the subjects were asked to raise both their arms at a 90 degree angle in the coronal plane and stand for 10 seconds, keeping their weight balanced equally to both sides. After a signal, the subjects were asked to reach to the side as far as possible without losing their balance, while keeping the arm on the opposite side by the trunk and keeping both feet on the floor. The reaching distance was measured within the range in which lower limb flexion, trunk flexion and rotation did not occur[13].

Mobilization was carried out by a physical therapist whose clinical practice experience in manual therapy was more than 10 years. Mobilization, traction, anterior gliding and posterior gliding of the talocrural joint were performed over four weeks, three times a week, with 30 seconds for each mobilization. Mobilizations were performed at Grade III while the subjects were in the supine position[14].

The data were analyzed with SPSS 18.0, and the mean and standard deviation were calculated for the individual variables. The paired-t test was performed to verify the difference between pre- and post-intervention value. An analysis of covariance (ANCOVA) was performed to verify the differences between the groups with the pre-intervention values as the covariant. The statistical analysis was conducted with a 95% confidence level. The significance level (α) was chosen as 0.05.

RESULTS

No significant differences for age, height, weight or gender were found between the MT group and the CT group. The ROM, OLB, TUG and LR post-intervention values were significantly different from their respective pre-intervention in the MT group ($p<0.05$). However, in the CT group, there were no significant differences. The average change of ankle ROM was 7.02° in the MT group and −0.08° in the CT group, showing a significant difference ($F=52.67$, $p<0.05$). The average change of execution time in the OLB test was 6.88 seconds in the MT group and −0.49 seconds in the CT group, showing a significant difference ($F=107.33$, $p<0.05$). The average change of execution time in the TUG test was −2.88 seconds in the MT group and −0.34 seconds in the CT group, showing a significant difference ($F=36.44$, $p<0.05$). The average change of reaching distance in the LR test was 13.61 mm in the MT group and 0.48 mm in the CT group, also showing a significant difference ($F=11.13$, $p<0.05$) (Table 2).

Table 1. Characteristics of the subjects

	MT group (n=18)	CT group (n=15)	Total (N=33)
Age (years)	68.11 ± 4.1	66.2 ± 3.5	67.2 ± 3.9
Height (cm)	158.2 ± 5.4	161.2 ± 3.6	159.5 ± 4.8
Weight (kg)	65.8 ± 3.6	66.6 ± 4.6	66.2 ± 4.1
Male	7 (38.9%)	7 (46.7%)	14 (42.6 %)
Female	11 (61.1%)	8 (53.3%)	19 (57.6 %)

Values are Mean ± SD or N (%), MT group, mobilization group; CT group, control group.

Table 2. Comparison of all variables between groups

		MT group (n=18)	CT group (n=15)
ROM(°)	Pre	73.8 ± 7.3	71.1 ± 7.2
	Post	80.8 ± 6.7*	71.0 ± 7.5
	Change	7.0 ± 3.8	–0.0 ± 1.0†
OLB(s)	Pre	19.6 ± 4.2	18.8 ± 3.3
	Post	26.5 ± 3.5*	18.3 ± 3.4
	Change	6.8 ± 2.7	–0.4 ± 1.5†
TUG(s)	Pre	22.6 ± 6.1	24.5 ± 5.0
	Post	19.7 ± 5.0*	24.1 ± 4.9
	Change	–2.8 ± 1.9	–0.3 ± 0.9†
LR(mm)	Pre	109.4 ± 23.3	91.6 ± 14.2
	Post	123.4 ± 28.8*	92.1 ± 15.4
	Change	13.6 ± 11.5	0.4 ± 2.2†

*: Significant difference between Pre and Post ($p<.05$); Values are Mean ± SD; MT group, mobilization group; CT group, control group; †: Significant difference between MT and CT($p<.05$). Pre, pre-intervention; Post, post-intervention; ROM, range of motion test; OLB, one leg balance test; TUG, timed up and go test; LR, lateral reach test.

DISCUSSION

In previous studies, Vaillant et al.[10] stated that ankle joint ROM plays an important role in balance and locomotion performance and is related to the mechanical effects. Mecagni et al.[3] reported that improved ankle joint ROM may increase the effectiveness of balance improvement methods. Bennell and Goldie[4] reported that limited ankle motion impaired postural control. Hoch et al.[15] stated that there is a correlation between ankle ROM and dynamic postural control. Based on these reports, we assumed that functional balance might be affected by increased joint ROM, and our present results suggest that increased joint ROM appears to be an important factor affecting balance.

Postural control is acquired through sensory information, feedback or feed-forward, personal experience (memory) and afferent inputs from the muscles and joints[16], and the foot and ankle play the role of allowing segmental adjustments by stimulating the proprioceptors. Previous studies have shown that sensory information or afferent input is necessary for postural control.

One study showed that spinal manipulation directly affected the proprioceptive system[17]. Heikkila and Wenngren[18] stated that joint manipulation affected postural control by enhancing afferent input through the induction of proprioceptive stimulation. These previous studies showed that proprioception can be stimulated by mobilization. In our study, the ankle mobilization allowed segmental adjustment by stimulating the proprioceptors. According to Perry et al.[19], application of sensory stimulation have an effect on standing stability through causing a displacement of the center of pressure. Symons et al.[20] showed that manipulation modified the transmission of proprioceptive input. Additionally, Taesung et al.[21] reported that exercise including manual therapy improved proprioception and the functional performance of the lower limbs. Based on these previous studies, we presume that the significant differences in the OLB, TUG and LR test results between the MT group and the CT group, found in our study, arise from mobilization of the talocrural joint affecting standing stability by stimulating proprioception of the ankle joint. Mecagni et al.[3] and Tinetti[22] stated that falls by the elderly are the result of a combination of various factors. Mecagni et al.[3] also stated that it was difficult to eliminate these various factors. Even though it is difficult to improve all the conditions affecting balance, our results show that improvement of the joint ROM can help to improve functional balance. The results of this study also show that afferent sensory information decreases with aging and, as suggested by Vaillant et al.[10], can be positively affected by the stimulation of proprioception. Methods to improve the various factors related to falls need to be investigated by conducting a more detailed study of the effect of mobilization and balance in the lower limbs of elderly patients.

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