

The Effects of Ankle Exercise on Balance in Stroke Patients

The purpose of this study was to assess the effects of Ankle exercise on balance ability of stroke patients. Participants' balance ability were measured prior to the training and they conducted ankle exercise. As for ankle exercises, ankle stretching training and ankle muscle strengthening training were performed for 10 minutes respectively. They did warm up exercise for 5 minutes and then ankle exercise for 20 minutes. And then they did cool-down exercise for 5 minutes. Their balance ability was measured after 9 weeks. According to the results of analyzing the change of balance ability that timed up and go and Berg balance scale score significantly improved but in the control group it did not significantly decrease. In comparison between the groups, Berg balance scale score significantly improved in the ankle exercise group compared to the control group. Ankle exercise performed by stroke patients are considered to be effective in improving balance ability.

Key words: *Ankle Exercise, Balance, BBS, TUG, Stroke*

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INTRODUCTION

Stroke is a disease which occurs when the blood flow to the brain is cut off due to hemorrhage or inchemia in the blood vessels(1,2).

Stroke patients experience various symptoms such as sensory disorder, mobility defects, and cognitive disorder which negatively affect functions for carrying out activities of daily living(3). In particular, patients with hemiplegia caused by stroke have difficulty standing up, moving, walking and climbing up stairs due to loss of proprioceptive and static senses from the weakened central nervous system, asymmetric posture, impairment of balance, and restricted mobility(4).

Stroke patients suffer contracture in the ankle joint, and such contracture in the ankle joint and weakened muscular strength hamper functional improvement(5). Functional disorder of the ankle joint negatively affects balance ability and walking, increasing risks of fall(6).

For balance adjustment to ensure physical sta-

bility, the role of the hip joint and ankle joint is important. When the range of postural change is large, the hip joint is activated, while the ankle joint operates when the range of postural change is small(7,8). Minor movements occur in a static standing position, and it is known that the ground reaction force generated with the contraction of gastrocnemius muscle, soleus muscle, and tibialis anterior muscle in the ankle joint is utilized to adjust balance(9).

Spasticity in the ankle joint of stroke patients causes muscle stiffness of ankle plantar flexor, and restricts voluntary movement. In particular, spasticity of the ankle plantar flexor undermines balance ability(10–12). Therefore, to help stroke patients maintain balance, a sufficient range of motion, muscle power, and the proprioceptive sense are needed.

Hence, the current study seeks to examine the effect of muscle strengthening training and stretching training for the ankle joint on improving balance ability of stroke patients.

METHODS

Subjects

The present study was conducted from March 10, 2015 to April 20, 2015 at D hospital located in Yong-in city with 16 stroke patients who were able to participate in exercise programs and agreed to the present study. General characteristics of the subjects are as follows (Table 1).

Table 1. General characteristics of the subjects

	^a AEG(n=8)	^b CG(n=8)
Sex(mal/female)	3/5	3/5
Age(yr)	69.87±2.69	69.87±2.69
Hight(m)	1.57±.05	1.57±.05
Weight(kg)	57.75±3.45	57.75±3.45
Paretic side(Right/Left)	6/2	5/3
MMSE-K(total score)	23.62±1.18	23.62±1.18

Values are mean±standard deviation, ^aAEG:ankle exercise group, ^bCG:control group

Experimental Procedure

Participants' balance ability was measured prior to the exercise and they conducted ankle exercise using elastic bands. They did warm-up exercise for 5 minutes and then ankle exercise using elastic bands for 20 minutes. And then they did cool-down exercise for 5 minutes. Their balance ability was measured after 9 weeks.

As for ankle exercises, ankle stretching training and ankle muscle strengthening training were performed for 10 minutes respectively. Ankle stretching exercises were conducted for 10 minutes using the incline board with dorsiflexion of the ankle joint maintained at 20°. As for ankle muscle strengthening training, isometric resistance training was performed on the ankle dorsiflexor muscle for 10 minutes.

Table 2. Comparison of TUG test result according to exercise type

group	Pre test (mean±S.D.)	Post test (mean±S.D.)	D-value (mean±S.D.)	Z	p	D-value	
						Z	p
AEG	25.12±1.88	22.00±1.06	-3.12±2.16	-2.539	.011*	-1.659	.097
CG	26.37±1.18	25.50±1.60	-.87±1.24	-1.725	.084		

*p<.05, **p<.01

Measurement scale

Timed Up & Go (TUG) test

TUG test may measure basic motility and balance and the subject sat on an elbow chair and walked 3 meters, came back, and then sat on the chair again. This test is much applied to patients with stroke, Parkinson's disease, and arthritis as well as elderly people(14).

Berg' balance scale(BBS) test

The BBS test is widely used to assess balance ability of patients with hemiplegia caused by stroke. The higher the score is, the better their dynamic balance ability is(15). Previous studies conducted with stroke patients reported that the test-retest reliability of the BBS was measured at ICC=.98(16).

Data Analysis

In the present study, the statistical program SPSS 18.0 was used for data analysis. General characteristics of the study subjects were produced as frequency analysis, means and standard deviations. Wilcoxon signed-ranks tests were conducted to examine changes in the stroke patients' balance between before and after the exercises and Mann-Whitney tests were conducted to examine differences in changes between the groups. To test statistical significance, the significance level was set to $\alpha = .05$.

RESULTS

Changes in the result of TUG test after the Exercise

In the ankle exercise, TUG significantly decreased but in the control group it did not significantly decrease. In comparison between the groups, TUG did not significantly in the ankle exercise group compared to the control group ($p < .05$) (Table 2).

Changes in the BBS result

BBS point significantly increased in the ankle exercise group after the exercise and BBS point did not significantly differ in the control group

between prior to the exercise and after the exercise. In comparison between the two groups, BBS point significantly improved in the ankle exercise group relative to the control group ($p < .05$) (Table 3).

Table 3. Changes in the BBS result

(unit : point)

group	Pre test (mean±S.D.)	Post test (mean±S.D.)	D-value (mean±S.D.)	Z	p	D-value	
						Z	p
AEg	35.62±1.68	38.25±2.81	2.62±2.72	-2.046	.041*	-2.163	.031*
CG	35.00±1.69	34.37±2.77	-.62±3.50	-.705	.481		

* $p < .05$

DISCUSSION

The present study aims to identify the effect of the strengthening and stretching exercises for the ankle joint on the balance ability of stroke patients.

Spasticity in the legs of stroke patients places the weight on the unaffected leg, making it difficult to manage balance (17,18). Moreover, stroke patients experience stiffness in the ankle plantar flexor due to spasticity, which reduces the range of motion of the ankle joint and leads to diminished muscle power of ankle dorsiflexor causing difficulties with ankle dorsiflexion (5)(10–12)(19).

Thus, the present study had stroke patients perform ankle strengthening and stretching exercises for 9 weeks, and examined changes in balance ability. As a result, the group that conducted both ankle strengthening and stretching exercises showed significant improvement in TUG and BBS.

Kim et al. reported that 6 weeks of proprioceptive exercises and ankle joint muscle strengthening exercises showed significant improvement in balance ability, and functional electrical stimulation and stretching exercises also resulted in significant progress in balance ability (20).

You et al. maintained that ankle strengthening exercises combined with motor imagery training produced improvement in balance ability of stroke patients. Significant improvement in balance ability was observed even with ankle strengthening exercises alone (21). Son et al. reported that 3 months of ankle strengthening exercises were effective to improve balance ability (5). Ma reported

that arm swing strength combined with ankle stretching exercises resulted in significant improvement in balance ability of stroke patients (22).

Results of the present studies correspond with the results of earlier studies which reported that balance ability of stroke patients can be improved ankle strengthening exercises and ankle stretching exercise.

The present study has limitations in that the findings are difficult to generalize for all stroke patients as the experiments were conducted with 16 stroke patients. Moreover, the result of the present study is not sufficient to prove the efficacy of ankle exercise in improving balance ability of stroke patients to carry out activities of daily living as the study assessed the effectiveness experimentally only.

CONCLUSION

Ankle exercise was applied for 9 weeks in order to look at the effects of on elderly people's balance. TUG test and FRT was carried out in order to examine the effects of resistance exercise using elastic bands on balance. TUG test and FRT results were significantly different between prior to and after the training in the resistance exercise group and the results also significantly differed between the resistance exercise group and the non-exercise group.

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