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Original Article

Effects of the Nerve Mobilization Technique on Lower Limb Function in Patients with Poststroke Hemiparesis

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Abstract. [Purpose] The purpose of the study was to determine the effects of a sciatic nerve mobilization technique on improvement of lower limb function in patient with poststroke hemiparesis. [Subjects] Twenty- two stroke patients participated in this study. [Methods] They were randomly selected based on selection criteria and divided into two groups. In the subject group (n=10), sciatic nerve mobilization with conventional physical therapy was applied to patients. In the control group (n=10), only conventional physical therapy was applied to stroke patients. [Results] There were significant differences between the two groups in pressure, sway, total pressure, angle of the knee joint, and functional reaching test results in the intervention at two weeks and at four weeks. [Conclusion] The present study showed that sciatic nerve mobilization with conventional physical therapy was more effective for lower limb function than conventional physical therapy alone in patient with poststroke hemiparesis.

Key words: Sciatic nerve mobilization, Foot pressure, Knee joint angle

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INTRODUCTION

In the treatment of stroke patients, the action of the hamstring muscle is an essential element in adjusting knee joint extension, which is related to gait; shortening of the hamstring muscle decreases gait ability[1)]. Mechanical problems resulting from neurological disorders in these areas may reduce the range of motion of the knee joint. This affects the physiological movement of both the pelvis and the spine[2–5)], triggering asymmetric weight bearing and excessive pelvic inclination during gait. These problems also increase posture disturbance and cause hypertension in the lower limbs, which negatively affects both balance ability and gait ability[4, 5)].

The sciatic nerve mobilization technique improves the nerve mobility of the hemiparetic lower limb in a nervous system patient and is helpful in increasing ROM of the lower limbs without resistance. Improvement in sciatic nerve mobility in stroke patients with functional disorders in the upper extremities facilitates muscle tension and inhibits spasticity, which are essential to the functional recovery of the lower limbs. Furthermore, sciatic nerve mobility is important in rehabilitation and the prevention of injury to the nervous system[2, 6, 7)]. Several previous studies of nerve mobilization techniques have been conducted. However, they concern mainly peripheral nerve system disorders, such as carpal tunnel syndrome, and do not focus on reduction of low back pain and improvement of flexibility. There has been almost no research on the nerve mobilization technique, which has been presented as an effective treatment in improving the function of the lower limbs in stroke patients[2, 8)]. Therefore, the present study examined the effects of the sciatic nerve mobilization technique on the lower limbs of stroke patients by measuring the variables of sway, total pressure, and angle of the knee joint. The functional reaching test and timed up go test were also used as measurement instruments.

SUBJECTS AND METHODS

The subjects of this study were 20 patients who were diagnosed with a stroke at least 6 months previously. The exclusion criteria were as follows: angle less than 80° in the straight leg raise test[9)], mini-mental state examination (MMSE) score of 24 or higher, no cognition deficiency[10)], no surgical history in the spine and lower limb joint, no contracture in the lower limb joint, and abnormality in the cervical region. The general characteristics of the subjects are shown in Table 1. All of the protocols used in this study were approved by the University of Daejeon. Before participation, the procedures, risks, and benefits were explained to all the participants, who gave their informed consent. The participants' rights were protected according to the guide-

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Table 1. General and medical characteristics of the subjects (n= 20)

	EG (n=10)	CG (n=10)
Gender (male/female)	6/4	6/4
Age (years)	63.00±10.30[a]	60.50±11.24
Causes (infarction/hemorrhage)	7/3	6/4
Affected side (left/right)	5/5	5/5
Months since onset	28.1±15.5	26.5±12.8
MMSE-K (score)	26.6±3.9	27.7±4.4
Modified Ashworth Scale (G0/G1/G1+)	7/2/1	6/4/0

[a]Mean±SD, EG, experimental group; CG, control group

lines of the University of Daejeon.

All the subjects received two daily 30-minute sessions of conservative physical therapy for the lower limb region five times a week for four weeks. The conservative physical therapy was based on functional treatment, including sitting to standing, climbing and descending stairs, and using an alternative anteroposterior step[11]. The experimental group received the sciatic nerve mobilization technique for the lower limb after conservative physical therapy.

The sciatic nerve mobilization technique was conducted in three stages for relaxation of the sacral nerve[2]. First, in a supine position, the subject placed the neck and trunk in a neutral position. Both sides of the knee joint were then fixed so that they did not bend. The lower limb on one side was placed in the maximum straight leg raise position. In this state, a slight vibration was applied, held for 20 seconds, and repeated three times. In the second stage, ankle joint dorsiflexion accompanied performance of the straight leg raise, and hip joint adduction and internal rotation were applied. In the third stage, cervical flexion was sequentially applied so that the sacral nerve became tense and reached the maximum level. The second and the third stages were held for 20 seconds and were repeated six times. All procedures were performed repeatedly for the contralateral lower limb. The application time for all stages was about 10 minutes[3, 12].

The foot pressure test (Gaitview System AFA-50, Alpus, Seoul, Republic of Korea) was used to measure the pressure distribution of the soles of the feet and disturbance in a standing position. To measure plantar pressure, a foot scan board was installed on the ground and connected to a computer before the static balance test was conducted. Under the oral instruction to “maintain a straight position as best as possible,” the overall pressure distribution and postural sway degree of both feet were measured for 10 seconds.

To measure the knee joint angle, the joint was photographed and then analyzed by a two-dimensional imaging analyzer system (Dartfish ProSuite, Dfkorea, Seoul, Republic of Korea). In order to increase the precision of the knee joint angle measurement, a blue reflective mark was attached to the greater trochanter of the lower limb, lateral epicondyle, and lateral malleolus of the joint on the paretic side. The subject lay on a bed, and the hip joint and knee joint on the paretic side of the lower limb were flexed at 90°. During measurement, the examiner maintained the ankle joint on the paretic side in plantar flexion and manually extended the knee joint to the maximum degree[13].

In order to test the dynamic balance ability of the subject, the functional reaching test was conducted[14]. The subject spread both feet at shoulder width and stood beside a wall, stretching the non-paretic hand towards the front and flexing the shoulder joint at 90°. The patient maintained his/her balance at the maximum level and lowered the trunk toward the front. The distance (cm) at the end of the third metacarpal bone was measured.

SPSS 12.0 for Windows was used for the statistical analysis. A one-way repeated measures analysis of variance was performed in order to compare the measurements from before intervention, after intervention for 2 weeks, and after intervention for 4 weeks. When there were significant differences, the Bonferroni method was used as a post hoc comparison test. In order to compare significant differences between the two groups at each measurement time, an independent t-test was conducted. The statistical significance level was set at $\alpha = 0.05$.

RESULTS

There were significant differences between the two groups in pressure, sway, total pressure, angle of the knee joint, and functional reaching test results after intervention for two and four weeks ($p<0.05$). Comparison of the measurement times in the experimental group showed significant increases in all variables ($p<0.05$). The post hoc test results showed significant differences in the measured values between before the intervention and after the interventions and between after two weeks of intervention and after four weeks of intervention. On the other hand, the control group showed significant differences in the angle of the knee joint and the functional reaching test ($p<0.05$). In addition, the post hoc comparison test results for the control group showed significant differences between prior to the intervention and after four weeks of intervention (Table 2).

DISCUSSION

According to the results of this study, the sciatic nerve mobilization technique had a positive effect on the functional improvement in the lower limbs of stroke patients. In the experimental group, pressure, sway, and total pressure significantly increased after the nerve mobilization technique compared with the control group. These results alleviated the mechanical sensitivity that had been heightened by loss of nerve mobility. Furthermore, the adaptability of the peripheral nerve increased, and compression, excessive friction, and tension in the sacral nerve decreased. Cowell and Phillips (2002) reported that the nerve mobilization technique reduced nerve conduction resulting from injuries to the nervous system and improved the nervous system structure and flexibility of the muscles, alleviating sensory and motor disorders[15]. Similarly, the present study found that improvement in hamstring flexibility might contribute to improving lower limb movement and balance ability. Factors that interrupt independent daily life in stroke patients include decreased flexibility of the hamstring, which

Table 2. Comparison between the experimental group and the control group (n= 20)

		EG (n=10)	CG (n=10)
Pressure (%)	Before	31.4±11.4[a]	30.3±1.0
	2 weeks	38.4±12.9	33.9±11.0
	4 weeks*	48.9±13.8*	34.9±11.0
Sway (mm)	Before	130.2±21.9	132.9±30.5
	2 weeks	121.9±20.6	127.4±26.9
	4 weeks*	102.4±16.8**	126.7±29.1
Total pressure (Kpa)	Before	70.4±18.0	68.3±12.9
	2 weeks	76.7±14.5	70.9±11.8
	4 weeks*	96.8±17.4*	76.7±18.1
Angle of knee joint (°)	Before	45.1±13.7	47.5±15.3
	2 weeks	53.2±12.9	49.6±14.2
	4 weeks*	66.3±15.4**	51.4±13.4*
Functional reaching test (cm)	Before	12.3±3.5	11.2±4.1
	2 weeks**	19.4±3.1	12.60±4.1
	4 weeks*	29.6±7.6**	22.20±6.5**

[a]Mean±SD, *p<0.05; ** p<0.01, EG, experimental group; CG, control group

triggers step reduction[16]. In addition, hip joint extension is predominantly used, resulting in an inappropriate response by the gluteus maximus and the rectus abdominals, triggering instability in the trunk muscles and causing loss of balance ability in the trunk[17].

The results of the measurements of the knee joint angles showed significant improvements in the experimental group compared with the control group. The present results are similar to those of a previous study that found that the sciatic nerve mobilization technique promoted relaxation of the hamstring, increased range of motion of the knee joint, and contributed to recovery of the normal length of the hamstring[18]. The sciatic nerve mobilization technique increases the flexibility of the peripheral nerve and activates neurotransmission fibers related to motor function and sensory disorders, thus improving the movement and motor ability of the lower limbs[2, 4].

The results of the functional reach test showed that the experimental group had significantly higher post-intervention values than the control group did, which suggests that the sciatic nerve mobilization technique applied to the experimental group was helpful in enhancing hamstring flexibility. Coutinho et al. (2006) explained the possibility that muscle performance improved because of increases in the cross-sectional areas of muscle fibers and in the number of consecutive sarcomeres after stretching the nerves and muscles[19]. This finding is similar to the present results, which showed that hamstring flexibility significantly increased and that the nerve mobilization technique improved sciatic nerve mobility and contributed to the improved flexibility of the stroke patients.

The therapeutic mechanism of the nerve mobilization technique improves the axonal transport system, promoting nerve conduction and reducing intraneural compression within the nerves, thus improving circulation to the nerves[4].

This study has limitations. It was conducted over a short period of four weeks, so the long-term effects were not evaluated. There is also a limitation in quantifying the power exerted during stretching in each subject. Therefore, future studies should overcome the present limitations and research the long-term effects of the nerve mobilization technique.

The results showed that application of the sciatic nerve mobilization technique to stroke patients improved their lower limb function. Therefore, the sciatic nerve mobilization technique may be considered a treatment method to reduce the mechanical sensitivity of peripheral nerves and activate nervous system function, thus alleviating functional disorders of the lower limbs.

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