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Immediate effects of a neurodynamic sciatic nerve sliding technique on hamstring flexibility and postural balance in healthy adults

Jaemyoung Park[a], Jaeyun Cha[b], Hyunjin Kim[b], Yasuyoshi Asakawa[c]

[a]Seoul Medical Center, Seoul, Republic of Korea
[b]Department of Physical Therapy, The Graduate School, Sahmyook University, Seoul, Republic of Korea
[c]Department of Physical Therapy, School of Health Sciences, Gunma University, Gunma, Japan

Objective: In this study, we applied a neurodynamic sciatic nerve sliding technique to healthy adults to elucidate its effects on hamstring flexibility and postural balance.
Design: Cross-sectional study.
Methods: This study targeted twenty four healthy adults (16 men, 8 women). A neurodynamic sciatic nerve sliding technique was applied 5 times to all subjects' dominant leg. The subjects were asked to sit on the bed while performing cervical and thoracic flexion, as well as knee flexion with ankle plantar flexion. Then, they were asked to perform cervical and thoracic extension and knee extension with their ankle in dorsiflexion and maintain the position for 60 s. For postural balance, we measured postural sway while the subjects maintained a one-legged standing posture using the Good Balance System and measured the hip joint flexion range of motion using a standardized passive straight leg raise (SLR) test.
Results: SLR test increased significantly from 79^o before the intervention to 91.67^o after the intervention (p<0.05). Regarding the participants' balance evaluated using the one-legged standing test, the X-speed decreased significantly from 18.61 mm/s to 17.17 mm/s (p<0.05), the Y-speed decreased from 22.28 mm/s to 20.52 mm/s (p<0.05), and the velocity moment was significantly decreased from 89.33 mm^2/s to 74.99 mm^2/s after the intervention (p<0.05).
Conclusions: Application of the neurodynamic sciatic nerve sliding technique exhibited improved hamstring flexibility and postural balance of healthy adults.

Key Words: Neurodynamic technique, Postural balance, Range of motion

Introduction

The hamstring muscles play an important role in the performance of daily activities such as controlled movement of the trunk, walking, running, and jumping [1], and it is an important muscle involved in maintaining balance and posture in standing position [2]. The hamstrings significantly affect flexibility of the body, and reduced hamstring flexibility results in decreases in trunk stability and balance due to improper adjustment of the gluteus maximus and abdominal muscles [3].

To maintain balance, controlled voluntary movement and reflective muscle reaction are required [4], and the factors controlling balance include posture alignment during motor response and musculoskeletal flexibility [5]. Flexibility can be said to be essential in the maintenance and improvement of correct posture, promotion of appropriate and elegant behavior, and promotion and development of motor skills [6]. Limited flexibility has a negative effect on normal biodynamic balance and function and causes musculoskeletal

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Corresponding author: Yasuyoshi Asakawa

Department of Physical Therapy, School of Health Sciences, Gunma University, 3-39-15 Showa, Maebashi, Gunma 371-8511, Japan
Tel: 81-27-220-8945 **Fax:** 81-27-220-8999 **E-mail:** yasakawa@health.gunma-u.ac.jp

damage, pain due to overuse, and reduction in physical performance [7-10]. Previously developed techniques to increase the flexibility of the hamstrings include static stretching, contract-relax stretching, thermo-therapy, massage, and neurodynamics [3,11-13]. Neurodynamics is a manual method of applying force to nerve structures through posture and multi-joint movement [14]. Based on the principle that the nervous system should be also stretched and contracted properly to maintain normal muscle tension and ensure range of motion [15], this technique is used for the recovery of soft tissue mobility [16]. Movement of the body both increases the strain on nerves and moves nerves associated with the surrounding tissue [17]. Reduced hamstring flexibility can result from immobilization of the sciatic, tibial, and peroneal nerves, which can then lead to an outcome of a compromised straight leg raise (SLR) test [18]. However, abnormal nerve mobilization may result in reduced muscle length while resting as well as changes in the perception of pain or stretching [19]. Some studies report that neurodynamics is effective for improving pain, flexibility, and muscle strength, but only a few studies assessed the effect of neurodynamics on balance. Thus, this study was designed to elucidate the effects of a neurodynamic sciatic nerve sliding technique on hamstring flexibility and postural balance.

Methods

Subjects

This study targeted 24 healthy adults (16 men, 8 women) attending universities located in Seoul, Korea. The general characteristics of the 24 subjects who participated in this study are listed in Table 1.

The inclusion criteria for eligible subjects were as follows: hamstring flexibility exceeding 70 degrees on the passive SLR test and (2) age of subjects between 20 and 30 years.

Table 1. General characteristics of subjects (N=24)

Characteristic	Value
Gender (male/female)	16/8
Age (y)	25.83 (5.10)
Height (cm)	170.75 (7.78)
Weight (kg)	64.25 (9.89)
Dominant foot (right/left)	22/2

Values are presented as n or mean (SD).

Potential subjects were excluded if they had (1) any neurological or orthopedic diseases affecting their lower limbs, (2) any history of hamstring surgery. Only those who fully comprehended the explanation of the purpose and methods of this study before the intervention and provided written consent were selected as subjects. The study was conducted after obtaining approval from the ethics committee of Sahmyook University.

Procedures

This study was a cross-sectional study design. The study measured hip joint range of motion (ROM) and balance during one-legged standing using a balance measurement system before applying the neurodynamic sciatic nerve sliding technique.

To measure hip joint ROM, the passive SLR test was conducted after fixing the pelvis and trunk of the subjects to the bed according to the anatomical position and aligning the dominant leg along the edge of the bed at a consistent height [20]. The axis of the goniometer was set at the greater trochanter of the thigh. One arm (fixed arm) was placed parallel to the bed, and the other arm (moving arm) was positioned in a straight-line direction along with the fibular head and lateral malleolus. The subjects' knees and ankles were maintained in an extended posture. We flexed the subjects' hip joint until pain was experienced in the posterior part of the thigh for the first time while holding the malleolus without rotation of the hip joint [21].

To measure balance, the subjects stood on their dominant leg and maintained this posture for 20 s. During the measurement, subjects were asked to fix their gaze toward the front and place both hands on their chest. To assess balance, X-speed (mediolateral sway), Y-speed (anterioposterior sway), and velocity moment were measured. A neurodynamic sciatic nerve sliding technique was applied to the dominant leg of each subject. The subjects were asked to sit on the bed while performing cervical and thoracic flexion, as well as knee flexion with ankle plantar flexion. Then, they were asked to perform cervical and thoracic extension and knee extension with their ankle in dorsiflexion and maintain the position for 1 min (Figure 1). They performed this active movement 5 times [22]. The one-legged standing balance and ROM of each subject were measured 3 times before and after intervention, and the mean value was obtained.

Figure 1. Neurodynamic sciatic nerve sliding technique.

Figure 2. Balance during one-legged standing.

Outcome measures

Good Balance System

For balance during the legged standing, a balance measurement system (Good Balance System; Metitur Ltd., Jyväskylä, Finland) was used (Figure 2). This equipment consisted of a regular triangular force plate connected to a computer. The inter-rater reliability was high (intraclass correlation [ICC]=0.97), and the test-retest reliability had an ICC of 0.95 [23].

Goniometer

To evaluate postural balance and hamstring flexibility according to a neurodynamic sciatic nerve sliding technique, we measured the hip joint flexion ROM via a simple long-arm goniometer (Goniometer; KASCO stainless made in Japan) with a 360 scale marked in one degree increments.

Data analysis

Statistical analysis was conducted using IBM SPSS Statistics 19.0 (IBM Co., Armonk, NY, USA). Descriptive statistics were used for the general characteristics of the subjects. To compare hamstring flexibility and postural balance among the subjects, a paired t-test was employed. The significance level for all statistical verification was set to $\alpha=0.05$.

Results

This study investigated the effect of neurodynamic sciatic nerve technique on hamstring flexibility and balance. Hamstring flexibility and balance showed significant improvement with use of neurodynamic sciatic nerve technique (Table 2).

Table 2. Comparison of range of motion (ROM) and static balance after nerve mobilization

Parameter	Pre-test	Post-test	*p*
ROM (^{o})	79.00 (4.50)	91.67 (6.74)	0.000
One leg standing			
X-speed (mm/s)	18.61 (4.76)	17.17 (3.34)	0.037
Y-speed (mm/s)	22.28 (4.35)	20.52 (3.44)	0.014
Velocity moment (mm^2/s)	89.33 (28.82)	74.99 (17.51)	0.022

Values are presented as mean (SD).

Hamstring flexibility as measured through the passive SLR test improved significantly from 79^o before the intervention to 91.67^o after the intervention ($p<0.05$). Balance as assessed via one-legged standing was also approved by the intervention. The X-speed changed from 18.61 mm/s before the intervention to 17.17 mm/s after the intervention ($p<0.05$), whereas Y-speed changed from 22.28 mm/s before the intervention to 20.52 mm/s after the intervention ($p<0.05$). In addition, the velocity moment was 89.33 mm^2/s before the intervention, versus 74.99 mm^2/s after the intervention ($p<0.05$).

Discussion

In this study, we compared the immediate effects of the application of a neurodynamic sciatic nerve sliding technique to the lower limbs on the hamstring flexibility and postural balance of healthy adults during one-legged standing.

We observed that the intervention significantly improved hamstring flexibility as evaluated using the passive SLR test ($p < 0.05$), resulting in a signicant increase in ROM ($p < 0.05$). In addition, one-legged standing balance measured using the Good Balance System revealed significant differences in X-speed, Y-speed, and velocity moment ($p < 0.05$) between before and after the intervention. The increase in ROM indicates improved flexibility of the knee joint. Méndez-Sánchez *et al*. [24] applied a neurodynamic sliding technique to the hamstrings of healthy male soccer players, observing a greater improvement in ROM than that after general stretching, and Castellote-Caballero *et al*. [25] also applied a neurodynamic sliding technique to 28 healthy football players, with a significant increase in ROM demonstrated using the passive SLR test. These findings were consistent with the results of this study. These findings can be explained as follows. If tension is applied to the nervous system while applying neurodynamics, the reduction of the cross-sectional area and increase in pressure in the nerve result in extension and movement of the sciatic nerve together with the hamstring and compliance of the nerve, resulting in increased flexibility [26,27].

Balance is the process of maintaining continuous postural stability, and it consists of interactions between reflective posture and voluntary movement [28,29].

When applying neurodynamics, tension occurs in the nervous system, and pressure within the nerve increases due to the decrease of the cross-sectional area, and the axonal transport system lengthens the sciatic nerve after shortening because of the influence of the surrounding related structures and hamstring flexibility [30]. After extention of the nerve and muscle, muscle performance is improved because of increases in the number of muscle fiber segments and cross-sectional area of muscle fibers [31]. Neurodynamics increases the activity of muscles more significantly than that observed at rest [32,33]. Previous studies reported reductions of muscle tone and muscle spasticity, suppression of hypertonus, improvement of grip, recovery of median nerve function [34,35], and pain relief [36] after the application of neurodynamics. After applying a neurodynamic sciatic nerve sliding technique in this study, significant differences were observed in X-speed, Y-speed, and velocity moment while measuring hamstring flexibility and one-legged standing balance. Both flexibility and balance were improved after the intervention in this study. This result is considered to be the result of the enhancement of muscle performance and activation of muscle.

This study has several limitations. First, it is difficult to generalize the results due to the small number of subjects. Second, it is somewhat difficult to determine the long-term effects of neurodynamics because only the immediate effects were observed. In the future, studies on the long-term effects of neurodynamics including more subjects should be performed.

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