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

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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° before the intervention to 91.67° 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 mm²/s to 74.99 mm²/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 biomechanical balance and function and causes musculoskeletal...
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.

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

| Parameter            | Pre-test     | Post-test    | p     |
|----------------------|--------------|--------------|-------|
| ROM (°)              | 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 (mm²/s) | 89.33 (28.82) | 74.99 (17.51) | 0.022 |

Values are presented as mean (SD).

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). Hamstring flexibility as measured through the passive SLR test improved significantly from 79° before the intervention to 91.67° 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 mm²/s before the intervention, versus 74.99 mm²/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 techni-
odu to the lower limbs on the hamstring flexibility and pos-
tural 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 significant increase in ROM \((p < 0.05)\). In addition, one-legged standing balance measured
using the Good Balance System revealed significant differ-
ences 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 demon-
strated using the passive SLR test. These findings were con-
sistent with the results of this study. These findings can be
explained as follows. If tension is applied to the nervous sys-
tem while applying neurodynamics, the reduction of the
cross-sectional area and increase in pressure in the nerve re-
sult 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 struc-
tures and hamstring flexibility [30]. After extension 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 reduc-
tions 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 im-
proved after the intervention in this study. This result is con-
 sidered to be the result of the enhancement of muscle per-
formance 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 ef-
fects were observed. In the future, studies on the long-term
effects of neurodynamics including more subjects should be
performed.

References

1. Lumbrosio D, Ziv E, Vered E, Kalichman L. The effect of kinesio
tape application on hamstring and gastrocnemius muscles in
healthy young adults. J Body Mov Ther 2014;18:130-8.
2. Park JH, Choi WJ, Lee SW. Effects of immediate unilateral
whole body vibration on muscle performance and balance in
young adults. Phys Ther Rehabil Sci 2013;2:115-8.
3. Sahrmann SA. Does postural assessment contribute to patient
care? J Orthop Sports Phys Ther 2002;32:376-9.
4. Fransson P, Johansson R, Hafström A, Magnusson M. Methods
for evaluation of postural control adaptation. Gait Posture
2000;12:14-24.
5. Horak FB. Clinical measurement of postural control in adults.
Phys Ther 1987;67:1881-5.
6. Ogura Y, Miyahara Y, Naito H, Katamoto S, Aoki J. Duration of
static stretching influences muscle force production in hamstring
muscles. J Strength Cond Res 2007;21:788-92.
7. Halbertsma JP, van Bothuis AI, Göeken LN. Sport stretching: ef-
fect on passive muscle stiffness of short hamstrings. Arch Phys
Med Rehabil 1996;77:688-92.
8. Hartig DE, Henderson JM. Increasing hamstring flexibility de-
creases lower extremity overuse injuries in military basic
trainees. Am J Sports Med 1999;27:173-6.
9. Hreljac A, Marshall RN, Hume PA. Evaluation of lower ex-
tremity overuse injury potential in runners. Med Sci Sports Exerc
2000;32:1635-41.
10. Forman J, Geertsen L, Rogers ME. Effect of deep stripping mas-
sage alone or with eccentric resistance on hamstring length and
strength. J Body Mov Ther 2014;18:139-44.
11. Herrington L. Effect of different neurodynamic mobilization
techniques on knee extension range of motion in the slump
position. J Man Manip Ther 2006;14:101-7.
12. de Weijer VC, Gorniak GC, Shamus E. The effect of static stretch
and warm-up exercise on hamstring length over the course of 24
hours. J Orthop Sports Phys Ther 2003;33:727-33.
13. Stephens J, Davidson J, Derosa J, Kriz M, Saltzman N.
Lengthening the hamstring muscles without stretching using
“awareness through movement”. Phys Ther Ther 2006;86:1641-50.
14. Coppieiers MW, Butler DS. Do ‘sliders’ slide and ‘tensioners’ ten-
sion? An analysis of neurodynamic techniques and consid-
erations regarding their application. Man Ther 2008;13:213-21.
15. Butler DS. Mobilization of the nervous system. London:
ChurchillLivingstone; 1991.
16. Kavlak Y, Uygur F. Effects of nerve mobilization exercise as an
adjunct to the conservative treatment for patients with tarsal tunnel syndrome. J Manipulative Physiol Ther 2011;34:441-8.

17. Butler DB, Gifford L. The concept of adverse mechanical tension in the nervous system part 1: testing for “dural tension”. Physiotherapy 1989;75:622-9.

18. Kornberg C, Lew P. The effect of stretching neural structures on grade one hamstring injuries. J Orthop Sports Phys Ther 1989;10:481-7.

19. Kaur G, Sharma S. Effect of passive straight leg raise sciatic nerve mobilization on low back pain of neurogenic origin. J Phys Occup Ther 2011;5:179-84.

20. Hsieh CY, Walker JM, Gillis K. Straight-leg-raisin test. Comparison of three instruments. Phys Ther 1983;63:1429-33.

21. Maitland GD, Hengeveld E, Banks K, English K. Maitland's vertebral manipulation. 7th ed. Edinburgh: Elsevier Butterworth-Heinemann; 2005. p. 499.

22. Butler DS, Matheson MJ. The sensitive nervous system. 1st ed. Adelaide: Noigroup Publications; 2000.

23. Era P, Sainio P, Koskinen S, Haavisto P, Vaara M, Aromaa A. Postural balance in a random sample of 7,979 subjects aged 30 years and over. Gerontology 2006;52:204-13.

24. Méndez-Sánchez R, Alburquerque-Sendín F, Fernández-de-las-Peñas C, Barbero-Iglesias FJ, Sánchez-Sánchez C, Calvo-Arenillas JI, et al. Immediate effects of adding a sciatic nerve slider technique on lumbar and lower quadrant mobility in soccer players: a pilot study. J Altern Complement Med 2010;16:669-75.

25. Castellote-Caballero Y, Valenza MC, Martin-Martin L, Cabrera-Martos I, Puenteuda EJ, Fernández-de-Las-Peñas C. Effects of a neurodynamic sliding technique on hamstring flexibility in healthy male soccer players. A pilot study. Phys Ther Sport 2013;14:156-62.

26. Cleland JA, Childs JD, Palmer JA, Eberhart S. Slump stretching in the management of non-radicular low back pain: a pilot clinical trial. Man Ther 2006;11:279-86.

27. Villafañe JH. Botulinum toxin type A combined with neurodynamic mobilization for lower limb spasticity: a case report. J Chiropr Med 2013;12:39-44.

28. Bloem BR, Allum JH, Carpenter MG, Honegger F. Is lower leg proprioception essential for triggering human automatic postural responses? Exp Brain Res 2000;130:375-91.

29. Shiratori T, Latash M. The roles of proximal and distal muscles in anticipatory postural adjustments under asymmetrical perturbations and during standing on rollerskates. Clin Neurophysiol 2000;111:613-23.

30. Webright WG, Randolph BJ, Perrin DH. Comparison of non-ballistic active knee extension in neural slump position and static stretch technique on hamstring flexibility. J Orthop Sports Phys Ther 1997;26:7-13.

31. Coutinho EL, DeLuca C, Salvini TF, Vidal BC. Bouts of passive stretching after immobilization of the rat soleus muscle increase collagen macromolecular organization and muscle fiber area. Connect Tissue Res 2006;47:278-86.

32. Balster SM, Jull GA. Upper trapezius muscle activity during the brachial plexus tension test in asymptomatic subjects. Man Ther 1997;2:144-9.

33. Boyd BS, Wanck L, Gray AT, Topp KS. Mechanosensitivity of the lower extremity nervous system during straight-leg raise neurodynamic testing in healthy individuals. J Orthop Sports Phys Ther 2009;39:780-90.

34. Baysal O, Altay Z, Ozcan C, Ertem K, Yologlu S, Kayhan A. Comparison of three conservative treatment protocols in carpal tunnel syndrome. Int J Clin Pract 2006;60:820-8.

35. Castilho J, Ferreira LA, Pereira WM, Neto HP, Morelli JG, Brandalize D, et al. Analysis of electromyographic activity in spastic biceps brachii muscle following neural mobilization. J Bodyw Mov Ther 2012;16:364-8.

36. Coppieters MW, Stappaerts KH, Staes FF, Everaert DG. Shoulder girdle elevation during neurodynamic testing: an assessable sign? Man Ther 2001;6:88-96.