〔研究報告〕

Introduction of the Neurodynamic Examination and Treatment Learned through the International Study Visit in the University of Colorado Physical Therapy Program

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Abstract

The purpose of this report is to introduce, by using the example of one patient with a history of low back pain and associated radiating pain, the examinations and interventions that focus on nerve mobilization and to describe occurrences of the nerve during body movement based on neurodynamics. The patient in this case presented with a history of low back pain and calf pain. Neurodynamics were examined using the straight leg raise (SLR) and slump tests. The results from the examination showed the patient's symptoms could be classified as peripheral nerve sensitization caused by nerve root or nerve trunk irritation. The neurodynamic sliding technique using "straight leg sliders on supine" was provided by a physical therapist. Through the intervention, the left SLR angle at onset of calf pain increased from 59° to 79°. The findings of this study suggest that neurodynamic examination and treatment techniques can be useful in managing and treating patients with low back pain and associated radiating pain in Japan.

Key words：low back pain, neurodynamics, physical therapy

Introduction

Low back pain is a common disorder that approximately 80% of Americans experience during their lifetime[1]. Although effects of low back pain for the public health is enormous, new clinical practice guidelines for the treatment of low back pain were published in the April 2012 issue of *JOSPT*[2]. The guidelines describe nerve mobilization procedures that should be utilized to treat low back pain and radiating pain based on research evidence. Murphy et al.[3] reported that patients with lumbar spinal stenosis were treated with nerve mobilization procedures and other interventions. Nerve mobilization procedures are hypothesized to gently move both the anatomical structures proximal to the neural elements that are compromised and the neural elements themselves[4]. Nerve mobilization, such as elongation, sliding, cross-sectional changes, angulation, and compression, occur during body movement[5]. When these dynamic mechanisms fail or are exceeded, symptoms such as radiating pain can develop. It would appear that utilizing nerve mobilization procedures would be important to maximize the benefit of treatment for patients with low back pain and radiating pain.

The purpose of this report was to introduce, by evaluating one case of low back pain with associated radiating pain, the examinations and interventions that focus on nerve mobilization procedures and describe occurrences affecting the nerve during body movement based on neurodynamics.

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Case description

History

The patient was an adult female faculty member who had an approximately 20-year history of back pain. She reported a history of hip dislocation on the right and femur fracture on the left, which occurred when she was 10 years old. She had a previous Jones fracture in her left foot and two screws were present there. She had a twisting fall approximately 7 years ago. After the fall, she started to experience severe pain and neural symptoms in her left buttock and down her leg and she was no longer able to raise her heel. She underwent 4 months of various conservative treatments and finally underwent microdiscectomy and laminotomy of L4-5. After the surgery, she had relief of the weakness, but some minor sensory change remained in her leg. Currently, 3 years later, she has some sensory change in her foot. Especially when she exercises a lot, she has moderate sensory changes in her big toe and lateral lower leg. However, a new lesion was not clearly found on magnetic resonance imaging.

Physical examination

A physical therapist performed a physical examination and made the following findings. The left extensor hallucis longus muscle and hamstring were found to be slightly weak. The deep tendon reflexes of left patellar and Achilles tendons were slightly delayed.

Neurodynamics were examined using the straight leg raise (SLR) and slump tests while the patient was sitting on the edge of the bed. The sensitizing maneuver of passive ankle motion was gently added to the SLR test until the patient reported the reproduction of the presenting symptoms (Fig. 1) and elicited both right and left lateral calf pain with ipsilateral ankle dorsiflexion. The calf pain on the right side was more intense than that on the left side. For the slump test, the patient was sitting with cervical flexion, with the hands behind the back and instructed to maintain this position for the duration of the test. The knee was actively extended until the patient reported reproduction of presenting symptoms. The slump test also produced both right and left lateral calf pain with fully knee extension and the cervical spine flexed (Fig. 2). In the knee extension position that the patient reported reproduction of presenting symptoms, the ankle was then additionally dorsiflexed, and it was determined whether the response was the same, better, or worse. When overpressure was applied through the trunk and the ankle was actively dorsiflexed, lateral calf pain was produced. In this provocative position, the patient was asked to extend her cervical spine, which resulted in a decrease in pain intensity. An additional SLR test was performed when the patient was supine. The examiner passively raised her limb into hip flexion with knee extension until significant resistance was detected by the examiner, or the patient reported the reproduction of the presenting symptoms, whichever occurred first. The SLR angle at the onset of calf pain was 65° on the right side and 59° on the left side. The sensitizing maneuvers of passive ankle plantarflexion, ankle dorsiflexion, and hip internal rotation were gently added to the SLR test (Fig. 3), and it was ascertained whether the calf pain was the same, better, or worse. Ankle dorsiflexion and hip internal rotation elicited ipsilateral calf pain.

Intervention and assessment

It was possible that the calf pain that occurred during the SLR and slump tests was due to an impairment associated with the mobility of the peripheral nerves. It has been suggested that impaired nerve mobility would improve with sliders instead of tensioners. Therefore, the patient was treated with neurodynamic sliding techniques. The neurodynamic sliding techniques consisted of “straight leg sliders on supine” and was provided by a physical therapist. These neurodynamic sliders are maneuvers performed in order to produce a sliding movement of neural structures relative to their adjacent tissues. Sliders involve application of movement/stress distally and then reversing the sequence.

The patient laid on her back and performed four exercises for the left leg as follows. The first exercise

Fig. 1. Straight leg raise test while sitting
(A) Full knee extension. (B) Added ankle dorsiflexion to evaluate sciatic neurodynamics. (C) Added ankle plantarflexion with foot inversion to evaluate peroneal neurodynamics.

Fig. 2. Slump test
(A) The patient placed her hands around her waist and slouched her trunk while keeping her head up. (B) Added head down. (C) Added overpressure through the trunk with knee extension and ankle dorsiflexion. (D) Head up with trunk slouching, knee extension, and ankle dorsiflexion.

Fig. 3. Straight leg raise (SLR) test while supine
(A) SLR with hip internal rotation to evaluate sciatic neurodynamics. (B) SLR with ankle dorsiflexion plus foot inversion to evaluate sural neurodynamics or plus foot eversion to evaluate tibial neurodynamics.

using the neurodynamic sliding technique was the alternating movement of straight leg raising with ankle plantarflexion, and straight leg lowering with ankle dorsiflexion (Fig. 4). The patient performed these active assisted movements of the left leg for approximately 60 s and repeated them 10 times. After the first exercise, the SLR angle at onset of calf pain in the left leg was 63°. Second, the patient performed the alternating movements of straight leg raising with cervical and thoracic extension and straight leg lowering with cervical and thoracic flexion using the neurodynamic sliding technique (Fig. 5). These active assisted movements of the left leg were performed for approximately 60 s and repeated them 10 times. After the second exercise, the SLR angle at onset of calf pain in the left leg was 66°. Third, the patient performed hold-relax stretching and dynamic stretching to improve the flexibility of the hamstring, which surrounds the nerve. Finally, the patient performed alternating movements of knee extension and flexion with hip flexion and ankle plantarflexion using the neurodynamic sliding technique (Fig. 6), performing these active movements of the left leg for approximately 60 s and repeating them 10 times. The SLR angle at onset of calf pain in the left leg was finally 79°. The patient performed 1 set of these exercises

Discussion

The results from the physical examination showed the patient's symptoms could be classified as peripheral nerve sensitization caused by nerve root or nerve trunk irritation. These symptoms can be examined through neurodynamic tests, such as the SLR and slump tests[6]. These tests elongate the sciatic nerve and associated nerve roots[7]. The painful responses to these tests may be seen as a sign of increased sensitivity to elongation. Additionally, movement and strain of the sciatic nerve and nerve roots during these tests are increased by the addition of ankle dorsiflexion[8]. The addition of ankle dorsiflexion loads the neural tissue. Therefore, the intensification of calf pain in response to the addition of ankle dorsiflexion may implicate abnormal mechanosensitivity of the sciatic nerve.

Abnormal nerve mechanosensitivity can potentially be addressed by the performance of neurodynamic sliders and neurodynamic tensioners[6]. The slider nerve technique is a neurodynamic maneuver to produce sliding/excursion movement of the neural structures relative to their adjacent tissues. The nerve sliding/excursion movement allows the tension and compression to be distributed throughout the nervous system[9]. Tensioners act like the neurodynamic tests that produce tension in the neural structures and do not surpass the elastic limit of the tissue. Therefore, the nerve sliding technique should be utilized and nerve tensioning or stretching techniques avoided in patients with radiating leg pain. Moksha et al.[10] reported that sliders were more effective in treating nonspecific low back pain with associated lower limb symptoms than tensioners. Hence, the increase in SLR angle before onset of calf pain could be attributed to improving the sciatic nerve's sliding movement through the use of neurodynamic sliders.

It is commonly believed that SLR range of motion (ROM) into flexion is restricted by the tension within the hamstring muscles and ankle joint ROM into dorsiflexion is restricted by the tension within the plantarflexor muscles. Although there is no plantarflexor muscle that crosses both the hip and ankle joints, a previous study[11] reported a remarkable decrease in the maximal ankle joint ROM into dorsiflexion when the hip joint was flexed from the neutral position to 90°. This finding has suggested two main hypotheses; a transmission of tension via lower limb fascial connections and a change of tension in the sciatic nerve tract. The architecture of the superficial and deep fascia system of the lower limb between hip and ankle joints has been documented[12], but the role of fascial tissue on force transmission between non-mechanically-related joints and muscle-tendon complexes during the SLR position remains unknown. Therefore, in this case, a possible explanation is that the change of tension in the sciatic nerve could occur the calf pain during neurodynamic tests.

This case demonstrates application of neurodynamic examination and treatment for a patient of low back

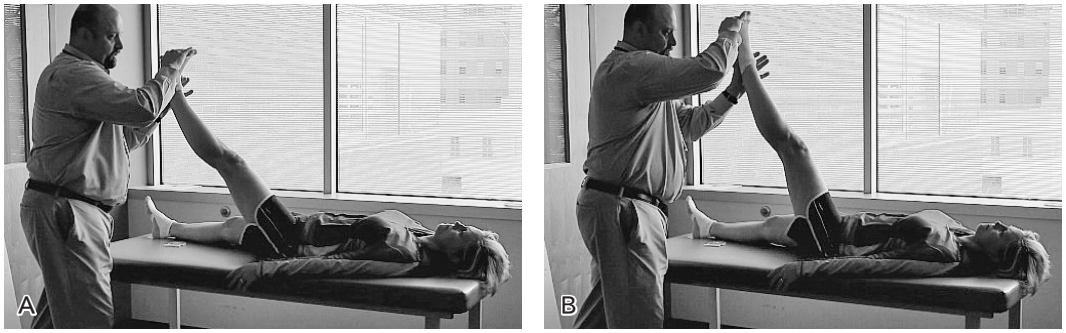

Fig. 4. The first exercise using the neurodynamic sliding technique
The patient raised her leg with the knee extended. She slightly lowered her leg with ankle dorsiflexion (A) and then slightly raised her leg with ankle plantarflexion (B). These alternating active assisted movements were performed for approximately 60 s and repeated 10 times.

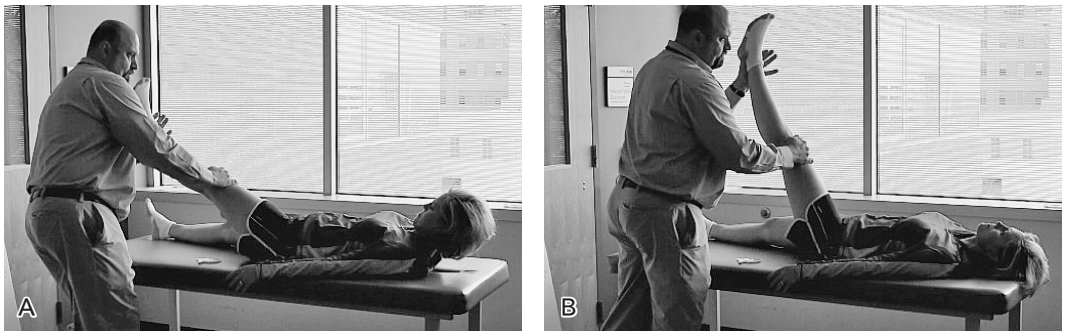

Fig. 5. The second exercise using the neurodynamic sliding technique
The patient raised her leg with the knee extended. She slightly lowered her leg with cervical and thoracic flexion (A) and then slightly raised the leg with cervical and thoracic extension (B). These alternating active assisted movements were performed for approximately 60 s and repeated 10 times.

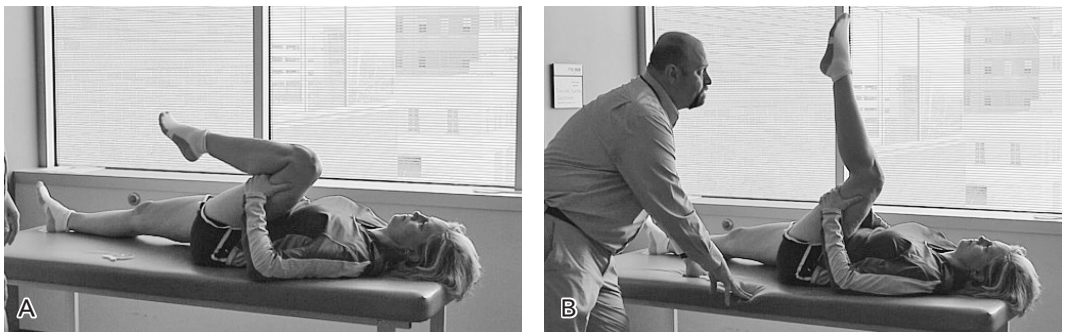

Fig. 6. The third exercise using the neurodynamic sliding technique
The patient pulled her thigh towards her body with the knee flexed and ankle plantarflexed (A) and then straightened her leg vertically with the ankle plantarflexed (B). These alternating active movements were performed for approximately 60 s and repeated 10 times.

pain with associated radiating pain. Although the results cannot be generalized to other population, it suggests that neurodynamic examination and treatment techniques can be useful in managing and treating patients with low back pain and associated radiating pain in Japan.

Conclusions

This study provides an example of how neurodynamic examination can be useful in managing low back pain and associated radiating pain. An example of neurodynamic intervention has been briefly introduced and shows how nerve sliders can be used to manage sciatic nerve mechanosensitivity.

Consent

Written informed consent has been obtained from the patient and physical therapist to publish their information and accompanying images in this manuscript.

Acknowledgements

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Conflict of interest

None declared

References

1) Manek NJ, MacGregor AJ. Epidemiology of back disorders: prevalence, risk factors, and prognosis. Curr Opin Rheumatol. 2005;17(2):134-40.
2) Delitto A, George SZ, Van Dillen LR, Whitman JM, Sowa G, Shekelle P, et al. Low back pain. J Orthop Sports Phys Ther. 2012;42(4):A1-57.
3) Murphy DR, Hurwitz EL, Gregory AA, Clary R. A non-surgical approach to the management of lumbar spinal stenosis: a prospective observational cohort study. BMC musculoskeletal disorders. 2006;7:16.
4) Hall TM, Elvey RL. Nerve trunk pain: physical diagnosis and treatment. Man Ther. 1999;4(2):63-73.
5) Shacklock M. Neurodynamics. Physiotherapy. 1995;81(1):9-16.
6) Shacklock M. Clinical neurodynamics. Philadelphia (PA): Elsevier Limited; 2005.
7) Boyd BS, Puttlitz C, Gan J, Topp KS. Strain and excursion in the rat sciatic nerve during a modified straight leg raise are altered after traumatic nerve injury. J Orthop Res. 2005;23(4):764-70.
8) Gilbert KK, Brismee JM, Collins DL, James CR, Shah RV, Sawyer SF, et al. 2006 Young Investigator Award Winner: lumbosacral nerve root displacement and strain: part 2. A comparison of 2 straight leg raise conditions in unembalmed cadavers. Spine (Phila Pa 1976). 2007;32(14):1521-5.
9) Herrington L, Bendix K, Cornwell C, Fielden N, Hankey K. What is the normal response to structural differentiation within the slump and straight leg raise tests? Man Ther. 2008;13(4):289-94.
10) Moksha J, Medha D, Swati M. Effectiveness of sliders vs tensioners on pain and disability in nonspecific low back pain with associated lower limb symptoms: A pretest posttest experimental study. IJHSR. 2019;9(9):46-52.
11) Mitchell B, Bressel E, McNair PJ, Bressel ME. Effect of pelvic, hip, and knee position on ankle joint range of motion. Phys Ther Sport. 2008;9(4):202-8.
12) Gerlach UJ, Lierse W. Functional construction of the superficial and deep fascia system of the lower limb in man. Acta Anat (Basel). 1990;139(1):11-25.

要　　旨

本研究報告の目的は，腰痛歴と腰痛に関連する放散痛を有する一症例を通して，神経モビライゼーションの手続きに着目した評価と治療方法を紹介し，ニューロダイナミクスに基づく身体運動中の神経の状態を概説することである．本症例となった被験者には腰痛歴と腓腹部痛がみられた．ニューロダイナミクスは SLR テストとスランプテストを用い評価された．評価の結果，被験者の症状は神経根または神経幹の刺激によって引き起こされる末梢神経感作に分類された．“背臥位での伸展下肢スライダー運動”を用いたニューロダイナミック滑走手技が理学療法士によって提供された．介入を通して，腓腹部痛が出現するまでの左 SLR 角度は最終的に 59 度から 79 度に変化した．ニューロダイナミック評価と治療は腰痛と関連する下肢痛のある本邦の患者においても有用であると考えられる．

キーワード：腰痛，ニューロダイナミック，理学療法