# The effect of neurodynamic technique of tibial nerve on range of motion, pain, and mechanosensitivity of the lower extremity in healthy individuals: A preliminary study

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## ABSTRACT

The aim of this study was to determine the effects of neurodynamic technique of tibial nerve on range of motion, pain, and mechanosensitivity of the lower extremity in healthy individuals. The study was a non-equivalent, one-group, and pre-post test design. Nineteen healthy adults participated in the study and conducted neurodynamic techniques of the tibial nerve. The outcome measures included range of motion, pain, and mechanosensitivity measured by electromyography during a straight leg raise test. Surface electromyography data were collected from the biceps femoris, medial gastrocnemius, lateral gastrocnemius, and tibialis anterior. There was a significant difference in range of motion and pain between the pre-test and the post-test. There was a non-significant difference in mechanosensitivity between the pre-test and the post-test. Therefore, we concluded that a neurodynamic technique of the tibial nerve reduced pain and increased range of motion in healthy adults. This neurodynamic technique is an effective intervention for improvement of lower limb pain and range of motion.

**Keywords:** Manual therapy; Pain reduction; Surface electromyography.

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## INTRODUCTION

Pain is the outcome of primary nociceptive afferents that are actually or potentially transmitted by tissue damaging and activities in nociceptive systems, and this type of pain is termed "*physiological pain*" (Treede et al., 2008). However, pain may also be caused by activities generated in the nociceptive system without proper stimulation of peripheral sensory endings, termed "*neuropathic pain*" (Treede et al., 2008).

Neuropathic pains have been reported to be caused by pressure and neural inflammation on neural and surrounding tissues (Beneciuk et al., 2009). This results in reduced neural elongation and sliding that leads to neural edema, fibrosis, and hypoxia, which induces pain (Nee & Butler, 2006).

Meanwhile, studies have reported that the nerve systems experience sliding, compression, and elongation in relation to the underlying construct during body movement (Coppieters & Butler, 2008), and introduced the concept of neural sensitivity as a protective mechanism of nerves against mechanical loads (Nee & Butler, 2006). Moreover, previous studies have demonstrated that mechanical stimulation such as limb movements that cause neural elongation in the state of increased neural mechanosensitivity lead to pain and that the nerve trunk palpation of the nerve root causes tenderness (Tampin et al., 2012).

Various attempts have been made to reduce neural mechanosensitivity (Ellis & Hing, 2008; Santana et al., 2015). Recent studies suggest the neurodynamic technique as an efficient way to decrease neural mechanosensitivity (Basson et al., 2017).

In previous studies, the neurodynamic technique was applied based on the theory that the nerve system must be properly elongated and relaxed to secure the range of motion of the spine. It was reported to be a scientific intervention that induces mechanical effects to the peripheral nervous system through body movement, which will also affect the central nervous system (Butler & Moseley, 2013). Moreover, it has been reported that the neurodynamic technique effectively promotes axonal transport system which leads to increased nerve conduction velocity, decreased pressure in the nerves, improved inflammation of neural tissues, and decreased pain (Maitland, 1985).

In a previous study that investigated the effects of neurodynamic technique, pain in cervical spine, shoulder, and thoracic region were improved (Cowell & Phillips, 2002). Structural changes were induced by reduced tension and sliding of nerves, which resulted in improved lumbar spine pain (Talebi et al., 2010). Moreover, the neurodynamic technique was also found to be an effective intervention for patients with carpal tunnel syndrome and plantar heel pain (Rozmaryn et al., 1998; Saban et al., 2014). However, a recent systemic review study that validated the efficacy of neurodynamic techniques demonstrated that the effects of the neurodynamic technique were verified only in patients who complained of low back, cervical, and upper extremity pain. These studies suggest that the effects of the neurodynamic technique on pain in other conditions remains controversial (Basson et al., 2017).

The present study aimed to identify the changes in range of motion (ROM), pain, and mechanosensitivity after performing the neurodynamic technique of tibial nerve in normal adults. In addition, basic data for the verification of the effects of neurodynamic technique on patients complaining of pain in the lower extremity and foot region will be provided.

## MATERIAL AND METHODOLOGY

### *Participants*

In total, 24 male and female college students who are currently attending G University located in G city were recruited. Five candidates were excluded for not meeting the selection criteria and this study was conducted on 19 participants. Written informed consent was obtained from every participant. Selection criteria included those with no evidence of hip or knee joint-related disease and no previous history of surgeries. General characteristics of participants were 23.94 ± 2.41 years of age, 171.15 ± 7.86 cm height, and 68.38 ± 13.84 kg body weight. This study was conducted after approval by the Ethics Review Committee of Gimhae College (GHCIRB-2019-004).

### *Measures*

#### *Pain*

A visual analogy scale (VAS) was used to investigate the changes in pain during an active straight leg raise test (ASLR). The experiments were conducted after each participant was familiarized with the questions of the VAS. Pain was classified into primary pain (P1) and secondary pain (P2). Primary pain (P1) was defined as the point of onset of symptoms of leg pulling or pain. Secondary pain (P2) was defined as the point of maximum toleration of symptoms of leg pulling and pain of the lower extremity. Moreover, the angles of P1 and P2 were recorded prior to the intervention, to compare changes in pain at the same angle after the intervention (Boyd et al., 2009).

#### *ROM*

During the ASLR test, a digital inclinometer (DUALER IQ, JTECH, USA) was attached to the leg on the lateral malleolus to measure changes in hip joint angles, and the angles of P1 and P2. The ROM of the ankle joint (plantar flexion and dorsi flexion) was measured using the digital inclinometer in a sitting position, before and after the intervention.

#### *Mechanosensitivity*

To measure the mechanosensitivity of the lower extremity during the ASLR test, muscle activation of biceps femoris, medical gastrocnemius, and lateral gastrocnemius was measured using surface electromyography (EMG) device (TeleMyo Desktop DTS, Noraxon, Scottsdale, AZ, USA). A previously published study was used as a reference to define the electrode attachment site (Cram & Criswell, 2010).

MyoResearch Master Edition 3.10 (Noraxon, Scottsdale, AZ, USA) was used to analyse the muscle activation data measured using the surface EMG. Prior to attaching the electrode, attachment sites were shaved to reduce skin resistance, wiped with an alcohol pad, and marked with a pen in a standing position. The signal extraction rate of the surface electromyography signal was set to 1024 Hz and a bandpass filter of 20~350 Hz was used to remove interference.

The EMG signal of each muscle, measured at the instance of contraction of the muscles at P1 and P2 during the ASLR test, were expressed as the root mean square (RMS) value. Muscle activation was measured for 3 seconds at P1 and P2. In order to normalize the measured values, maximal voluntary isometric contraction (MVIC) values for each muscle were collected and used to calculate %MVIC for each muscle. The participants were provided with maximum frequency resistance to find the MVIC of each muscle and were verbally instructed demonstrate maximum possible muscle length (Kendall et al., 2005). All the EMG signal values were collected three times for five seconds each time. The RMS values of each muscle, measured for three seconds (except for one second before and after), were used as measurement variables (Boyd et al., 2009).

### *Procedures*

The protocol was performed on 19 participants using a one-group pre-post-test design. Before performing the neurodynamic technique of the tibial nerve, all participants were equipped with the surface EMG, and changes in ROM, pain, and mechanosensitivity of the hip joint were measured during the ASLR test of the dominant leg (Boyd et al., 2009).

In order to prevent lumbar flexion and excessive pelvic posterior tilt of the participants, a Pressure of Biofeedback Unit (PBU, Chattanooga, USA) was placed under the lumbar spine. Participants were instructed to maintain a pressure of 40 mmHg, with a maximum of 10 mmHg changes allowed during the ASLR test. Moreover, a goniometer with a fixed 90-degree angle was placed on the outer surface of the ankle joint using a strap, in order to control the ankle joint during the ASLR test. The ASLR tests were performed three times each and the average value was used (Figure 1). This was done before and after the intervention.

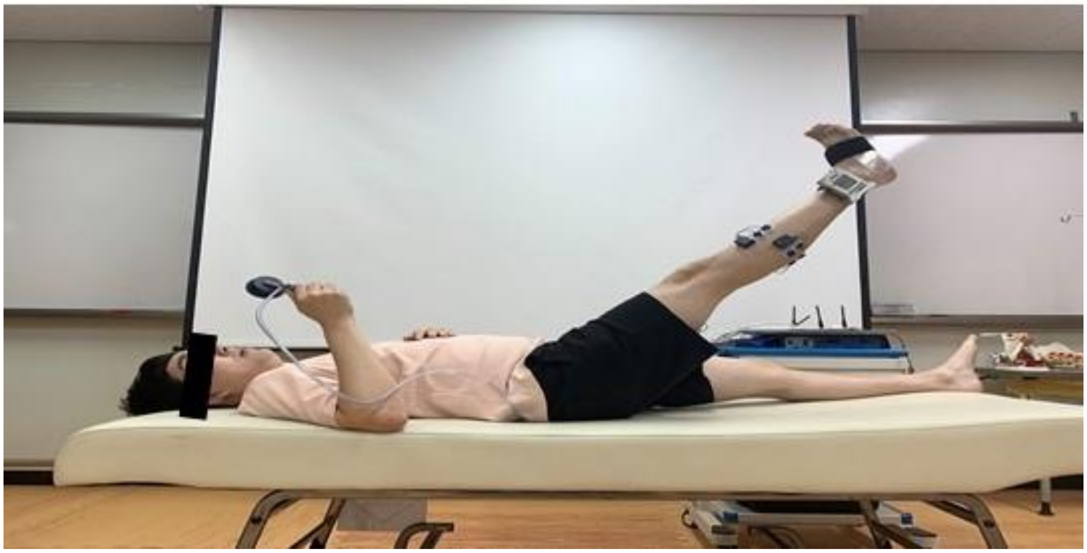

Figure 1. Measure the mechanosensitivity of the lower extremity during the ASLR test.

The participants were asked to maintain normal curvature of the head and spine and maintain both the hip and knee joints of the superior leg at 90-degree flexion in the supine position. The participant's knee and thigh were fixed by the therapist's arms and torso to control the movement of the hip and knee joints. The participant's foot was held using the opposite hand of the therapist. Subsequently, knee flexion, dorsi flexion, and eversion of the foot were performed on the subject in order to conduct the neurodynamic technique of the distal tibial nerve. To perform the neurodynamic technique of the proximal tibial nerve, knee extension, plantar flexion, and inversion of the foot were done simultaneously. These interventions were applied ten times for a total of 10~15 minutes (Herrington, 2006) (Figure 2).

### *Analysis*

In this study, for statistical analysis, the general characteristics of the participants were analysed with the average and standard deviation or frequency, using SPSS 21.0. The pain, ROM, and mechanosensitivity of the participants before and after the intervention was compared and analysed with a paired t-test, and all statistical significance levels were $p < .05$.

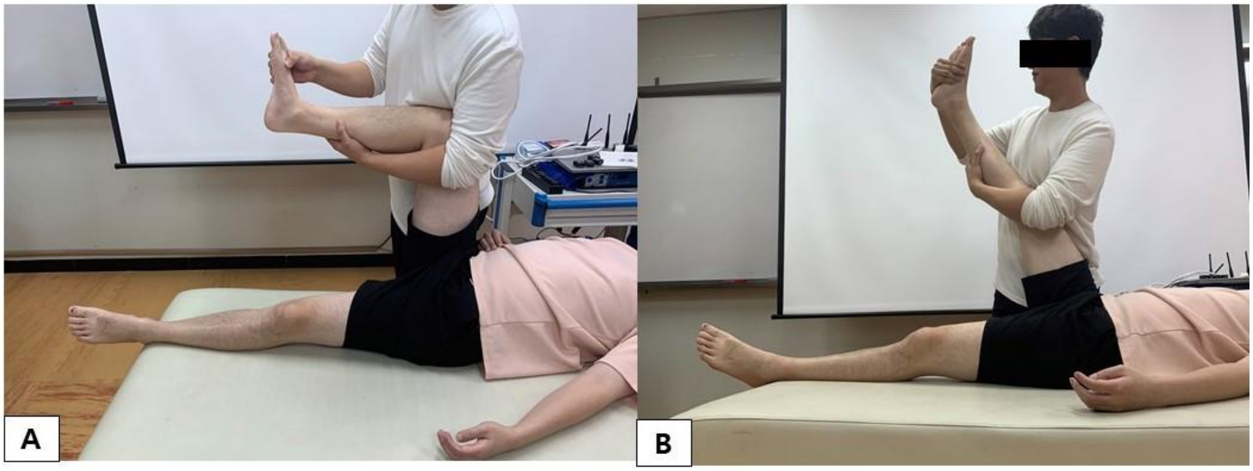

Figure 2. Neurodynamic sliding technique of tibial nerve, (A) Distal sliding technique, (B) Proximal sliding technique.

## RESULTS

Table 1. Comparison of hip and ankle joint range of motion, and pain, after intervention (n = 19).

| Variable | | Pre-intervention | Post-intervention | Change | t | p |
|---|---|---|---|---|---|---|
| Symptom Intensity | $P_1$ | 2.07 ± 1.00 | 1.33 ± 1.19 | 0.73 ± 1.19 | 2.67 | .015 |
| | $P_2$ | 4.56 ± 1.72 | 3.19 ± 1.99 | 1.36 ± 1.57 | 3.78 | .001 |
| Hip | $P_1$ | 45.43 ± 10.05 | 50.14 ± 10.00 | -4.70 ± 6.35 | -3.22 | .005 |
| | $P_2$ | 59.84 ± 10.37 | 64.54 ± 9.29 | -4.70 ± 8.83 | -2.32 | .032 |
| Ankle | DF | 22.47 ± 5.00 | 20.42 ± 7.67 | 2.05 ± 8.30 | 1.07 | .295 |
| | PF | 50.55 ± 10.96 | 54.05 ± 11.14 | -3.50 ± 6.27 | -2.36 | .030 |

*Mean ± SD, $P_1$: the onset of symptoms, $P_2$: the maximally tolerated position.*

Table 2. Comparison of muscle activation after intervention.

| Variable | | Pre-intervention | Post-intervention | Change | t | p |
|---|---|---|---|---|---|---|
| Biceps femoris | Resting | 4.19 ± 4.81 | 4.02 ± 6.05 | 0.17 ± 3.78 | 0.19 | .845 |
| | $P_1$ | 5.88 ± 5.13 | 6.44 ± 4.91 | -0.55 ± 1.91 | -1.27 | .220 |
| | $P_2$ | 7.03 ± 5.86 | 7.28 ± 5.17 | -0.25 ± 1.98 | -0.55 | .588 |
| Medial gastrocnemius | Resting | 4.30 ± 2.77 | 4.14 ± 2.93 | 0.16 ± 2.43 | 0.29 | .775 |
| | $P_1$ | 4.85 ± 4.13 | 4.80 ± 3.94 | 0.05 ± 1.30 | 0.18 | .855 |
| | $P_2$ | 6.44 ± 7.65 | 5.77 ± 5.33 | 0.66 ± 3.04 | 0.95 | .353 |
| Lateral gastrocnemius | Resting | 6.34 ± 7.33 | 9.99 ± 20.48 | -3.65 ± 20.45 | -0.77 | .446 |
| | $P_1$ | 5.70 ± 5.19 | 6.06 ± 5.06 | -0.36 ± 1.55 | -1.01 | .325 |
| | $P_2$ | 6.79 ± 8.01 | 6.63 ± 6.35 | 0.16 ± 2.40 | 0.29 | .775 |

*Mean ± SD, $P_1$: the onset of symptoms, $P_2$: the maximally tolerated position, Unit: % MVIC.*

The intensity of pain in the legs at P1 and P2 during the straight leg raise (SLR) test was decreased after the intervention, and the ROM of the hip and ankle joints significantly increased after the intervention ($p < .05$)

(Table 1).

However, the mechanosensitivity of biceps femoris, medial gastrocnemius, and lateral gastrocnemius did not show significant changes at P1 and P2 after the intervention (p > .05) (Table 2).

## DISCUSSION

Neuropathic pain is the root cause of pressure and inflammation of the neural and surrounding tissues, which leads to decreased neural elongation and sliding. It also causes symptoms of pain, paraesthesia, and muscle weakness through edema and fibrosis of the nerve itself (Beneciuk et al., 2009; Nee & Butler, 2006;). Many studies have suggested the neurodynamic technique to improve such symptoms (Basson et al., 2017; Santana et al., 2015). However, the benefits of the neurodynamic technique are controversial due to a lack of positive results of the neurodynamic technique on feet (Basson et al., 2017). Therefore, the present study aimed to confirm the effects of the neurodynamic technique of the tibial nerve by measuring changes in pain, ROM, and mechanosensitivity.

The neurodynamic technique is largely divided into two types; the slider technique and the tensioner technique (Butler & Moseley, 2013; Herrington, 2006). The slider technique used in the present study induces sliding without changing the neural length, and is a method based on the theory that proper elongation and relaxation of the nervous system must be achieved to secure the ROM of each joint (Butler & Moseley, 2013; Herrington, 2006). In addition, it is reported that the slider technique can be an effective intervention to induce high neural mobility and small neural deformations in cases of high neural mechanosensitivity (Basson et al., 2017).

On the other hand, the method of comparing primary and secondary pain points, which define the point of onset of pain and the point of maximally tolerated pain, is a reliable test regardless of the patient or asymptomatic subject for detecting the occurrence of pain (Boyd et al., 2009; Coppieters et al., 2002; ). Thus, the results of this study showing changes in pain would be considered more reliable.

In this study, pain significantly decreased at P1 and P2 after the neurodynamic technique of tibial nerve was performed. These results are consistent previous studies where neurodynamic technique was performed on upper and lower extremities (Coppieters & Butler, 2008; Saban et al., 2014; Villafañe et al., 2013;). This positive change in pain is attributed to the increased neural movements between the nerves and adjacent tissues, reduced pressure on nerves, increased blood flow, and controlled release of harmful substances that are induced by the neurodynamic technique (Butler & Moseley, 2013; Shacklock, 2005).

Meanwhile, ROM results in this study confirmed that hip flexion and the ankle plantar flexion increased. These findings are thought to be a result of improved neural mobility and reduced internal and external stress of nerve tissues (Ellis & Hing, 2008; Herrington, 2006; Shacklock, 2005) through the slider technique of the neurodynamic technique which led to increased ROM of each joint. Lastly, changes in the mechanosensitivity were verified through the surface EMG to assess the effect of neurodynamic technique. This technique was adapted from a method used to confirm protective reflexive mechanism of muscles in a previous study (Boyd et al., 2009). Constant neural tension and pressure in the human body leads to reflexive mechanisms to reduce stress of nerve tissues, and neurodynamic technique takes advantage of this mechanism to induce contraction and limit the movement of adjacent muscles (Balster & Jull, 1997; Van der Heide et al., 2001). Based on this theory, we hypothesized that muscle activation would be decreased because of a reduction in mechanosensitivity in P1 and P2 during the ASLR test after the neurodynamic technique of the tibial nerve.

However, no significant change in muscle activation was observed after the intervention. The cause of these results can be found in previous studies that could not confirm the differences in muscle activation between bassists with and without pain (Woldendorp et al., 2013). Woldendorp et al. (2013) argued that the pain is not simply caused by musculoskeletal problems, but rather induced by complex effects of various factors such as emotion, environment, and central brain mechanism. In the present study, there was no significant change in muscle activation despite observing a significant change in pain. It is thought that other factors have greater influence than muscle activation to induce changes in the pain of participants. Future studies need to verify the changes in mechanosensitivity induced by the elements of central brain mechanism and peripheral physical aspects of pain.

## CONCLUSION

It was confirmed that the neurodynamic technique on the tibial nerve is an effective intervention that can improve lower extremity pain and ROM by promoting neural mobility and improving the pressure of surrounding nerve tissues.

## AUTHOR CONTRIBUTIONS

Ju-Hyeon Jung: Conception and design of study, acquisition of data, and interpretation of data. Dong-Chul Moon (Corresponding Author): Drafting the manuscript, revising the manuscript critically for important intellectual content, and analysis of data.

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## DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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