Effect of Transcutaneous Electrical Nerve Stimulation Therapy and Manual Therapy on Foot Pressure Changes Related to Leg Length Discrepancy

Yeonkyo Lee¹ and Jemyung Shim²*

¹Department of Physical Therapy, Emergency Medical Rehabilitation, Kangwon National University, Samcheok-si, Gangwon-do, KS007, Korea; no1-754@hanmail.net
²Department of Physical Therapy, College of Health and Science, Kangwon National University, Samcheok-si, Gangwon-do, KS007, Korea; sjm7897@hanmail.net

Abstract

The purpose of this study was to examine the effect of Transcutaneous Electrical Nerve Stimulation therapy and manual therapy on foot pressure changes related to leg length discrepancy. The subjects of this study were 13 subjects (5 males, 8 females) with differences in leg length who agreed to participate in this study. Leg length was measured in a prone position, and foot pressure changes induced by weight support were determined using Gaitview (alFoots, Korea). The measurements were conducted prior to treatment, 15 minutes after TENS, and 40 minutes after manual therapy. One-way analysis of variance was used to compare the results derived prior to the experiment, after the TENS therapy, and after the manual therapy. No statistically significant difference in sole pressure was found among the pre-treatment, post-TENS treatment, and post-manual therapy results. But Pressure differences between the left and right feet tended to gradually decrease prior to treatment, after the TENS therapy, and after the manual therapy. And asymmetry in foot pressure tended to decrease, that is, in terms of foot pressure differences between the fore and rear feet. TENS and manual therapy for the treatment of differences in leg length do not considerably affect foot pressure but reduce differences in left and right leg pressure and pressure between the forefoot and rear foot, thereby positively affecting foot balance.

Keywords: Leg Length Discrepancy, Manual Therapy, Transcutaneous Electrical Nerve Stimulation Therapy

1. Introduction

Sustaining a stable erect posture is difficult because a high center of pressure should be maintained on a relatively small base of support by the feet¹–³. In terms of balance, therefore, differences in the length of lower extremities may considerably affect bodily stance. Differences in the length of lower extremities are a problem encountered by 40% to 70% of the population. Such variances lead to changes in posture, restrict movement, trigger tension of muscles and other soft tissues, and cause diverse clinical symptoms, such as low back pain and hip joint pain⁴,⁵.

Normal lower extremity alignment enables balance in weight movement, whereas abnormal alignment triggers imbalance, which may exert excessive load on soft tissues, such as tendons, muscles, bones, and articular cartilage and ligaments⁶.

Evaluating imbalance in functional leg length is very useful for the analysis of gait, movement, and weight load, as well as for the assessment of posture. Such evaluation is used in many specialized areas of medicine, including orthopedics, general internal medicine, physical therapy, foot orthopedics, obstetrics and gynecology, and surgery⁷.

Manual therapy induces changes in the mobility of the spine, the maintenance of a normal range of motion of joints, the reduction in protrusion of the intervertebral disc, the correction of the functional failure of posterior joints, the reduction in compression by nerve roots, the normalization of reflex activity, and the relaxation of muscles⁸. Manual therapy also stimulates the articular receptors within the

* Author for correspondence
spine, correct subluxation, and activate the nerve reflex center within the spinal cord or the higher center. Small changes in joint locations trigger abnormal stress around joints and causes pain. Manual therapy may reduce such pain and changes in joint location\textsuperscript{10}.

Transcutaneous Electrical Nerve Stimulation (TENS) is a non-invasive treatment method that is most widely used in physical therapy; it is an effective intervention technique for pain caused by neuropathy, articular sources, and myositis\textsuperscript{11,12}. As indicated in a report, an eight-week application of TENS significantly improved dynamic and static balance.

In this study, participants with differences in leg length were subjected to TENS and manual therapy to examine how weight support from the legs changes through foot pressure.

2. Materials and Methods

2.1 Test Subject

This study examined how weight support changes through foot pressure before and after TENS and manual therapy. The study was conducted from December 1, 2014 to December 30, 2014 and involved 13 subjects (5 males, 8 females) with differences in leg length. The subjects are in their 20s and 30s and did not experience trauma or suffer from congenital diseases. Additionally, none of the subjects underwent orthopedic surgery without complex lesions. They understood the purpose of this study and provided written informed consent prior to participation in accordance with the ethical standards of the Declaration of Helsinki (Kangwon National University IRB number - Project No. 2014–10–001–002). In terms of general characteristics, the average age, height, weight, shoe size, and average difference in leg length of the participants were as follows: 27.61±5.59 years old, 166.23±8.03 cm, 60.15±15.56 kg, 248.07±21.26 cm, and 7.69±2.75 mm, respectively (Table 1).

2.2 Test Method

Leg length was measured in a prone position, and foot pressure changes induced by weight support were determined using Gaitview (alFoots, Korea). The measurements were conducted prior to treatment, 15 minutes after TENS, and 40 minutes after manual therapy (Figure 1).

For the TENS (Saeik Medical, Korea) therapy, complex low frequency wave form of direct and alternating current of auto three type at 60 to 300Hz was applied to the quadratus lumborum muscle. For the manual therapy, the Thompson technique systematized by Dr. Clay Thompson was used. The displacement of the pelvis and spine was classified by the type of shift from these parts of the body. Manual correction was conducted on a Thompson table. During the treatments, pelvis, sacral, and hip joint correction and spinal displacement correction that were aimed at correcting differences in leg length were carried out; the tension-relaxation technique was concurrently applied to areas with tension in the fascia and muscles (Figure 2).
TENS therapy, and after the manual therapy. Statistical significance was set at \( \alpha=0.05 \).

Figure 2: Picture change leg length discrepancy of manual therapy pre post.

3. Result

As previously stated, participants with different leg lengths were recruited for this study to determine and compare foot pressure changes before treatment, after TENS treatment, and after manual therapy. As Table 1 shows, no statistically significant difference in sole pressure was found among the pre-treatment, post-TENS treatment, and post-manual therapy results (\( p>0.05 \)).

Pressure differences between the left and right feet tended to gradually decrease prior to treatment, after the TENS therapy, and after the manual therapy. Asymmetry in foot pressure tended to decrease, that is, in terms of foot pressure differences between the fore and rear feet. Despite such dissimilarity, however, no significant difference was found (\( p>0.05 \)) (Table 2).

4. Discussion

The imbalance in bodily posture resulting from differences in lower extremities triggers imbalance in the spine and pelvis, as well as poor posture, structural imbalance, and pain\(^{13-16}\). An analysis of static plantar pressure indicates that the considerable difference in the functional lengths of the lower extremities tends to be the substantial weight difference between the left and right sides of the body. Given these observations, the current work examined changes in foot pressure before treatment, after TENS treatment, and after manual therapy using plantar pressure.

The findings showed no considerable change in foot pressure before the treatment, after the TENS treatment, and after the manual therapy. However, differences in foot pressure between the left and right feet tended to gradually decrease before and after the treatments. In addition, foot pressure asymmetry tended to decrease in terms of foot pressure differences between the fore and rear feet. These results suggest that after the treatment for differences in leg length, foot pressure asymmetry decreased, thereby enabling balance in foot pressure at the right and left sides, as well as in the front and back sides of the body.

These results are consistent with a previous study wherein TENS was used to stimulate the muscle spindle and induce muscle contractions to enable postural stability\(^ {17,18}\). Our findings are also consistent with those of

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<th>Table 2. Comparison of Results before Treatment, after TENS treatment, and after Manual Therapy</th>
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researchers who conducted in situ inspection of the pelvis, correction of the unilateral pelvis, reduction of spinal misalignment, and reduction of lower limb misalignment by using manual therapy. In the study, manual therapy triggered changes in bilateral weight support, enabled postural maintenance, and increased postural stability.

Two other studies showed no difference in pressure on each foot. In the first study, one-time chiropractic manual therapy for the cervical spine did not result in statistically significantly different foot pressures, and in the second, no statistically significant differences in foot pressure distribution between pre- and post-chiropractic manual therapy (four weeks) were found.20

The limitations of the present research are as follows. First, identifying individual differences among the participants was difficult to accomplish during the participant selection process. Second, few participants were recruited. Given these limitations, further research based on a qualitative experimental study should be carried out on a larger sample of individuals with functional differences.

In conclusion, TENS and manual therapy for the treatment of differences in leg length do not considerably affect foot pressure but reduce differences in left and right leg pressure and pressure between the forefoot and rear foot, thereby positively affecting foot balance.

5. References

20. Kim SB. Effect of chiropractic treatment and low back rehabilitation exercise on EMG, foot pressure and MVAS in low back pain patients. Department of Physical Education. Graduate school of Kyunghee University; 2008.