



Original Article

## Edema and pain reduction using transcutaneous electrical nerve stimulation treatment

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**Abstract.** [Purpose] The purpose of this study was to investigate the impact on the edema and pain when applying transcutaneous electrical nerve stimulation. [Subjects and Methods] Eleven patients who were diagnosed with lymphedema were selected as the subjects of the study. The experimental group received transcutaneous electrical nerve stimulation treatment on edema regions three times per week for four weeks. Surface tape measurement was used to measure changes in lower extremity edema. Pain intensity was measured using the visual analog scale. [Results] The edema decrements in the experimental group were significantly larger than those in the control group. The pain decrements in the experimental group were significantly larger than those in the control group. [Conclusion] In conclusion, application of transcutaneous electrical nerve stimulation was confirmed to be effective in reducing edema and pain.

**Key words:** Edema, Pain, TENS

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### INTRODUCTION

Recently, the world has been affected by diverse changes, such as new developments in medicine, the acceleration of aging in society, increases in chronic diseases, and increases in demand for high-grade medical services as a result of the enhancement of the health consciousness of people worldwide. The need for physical therapy has rapidly increased, as patients with chronic conditions and aging populations have increased, as have the number of people with disabilities due to accidents<sup>1)</sup>.

Although the possibility of exacerbation of lower extremity edema and lower extremity pain and fatigue is very high—because the lower extremities are far from the heart, blood pushing out from the heart toward the lower extremities cannot be easily returned to the heart, and poor blood circulation in the lower extremities leads to waste congestion—interest in and management of the lower extremities are quite insufficient. In addition, researchers have reported that chronic lower extremity venous edema accompanied by varicose veins, lower extremity edema, and pain occurs only as a result of working in a standing posture for eight hours per day<sup>2)</sup>.

Depending on its causes, lymphedema can be divided into primary lymphedema and secondary lymphedema. It can be further divided into acute and chronic lymphedema, depending upon the duration of occurrence. Primary lymphedema is secondarily caused by lymphatic vessel aplasia, hypoplasia, or atresia, which can occur at any time. In addition, primary lymphedema occurs more frequently in females than in males, and in particular, it frequently occurs in the lower extremities, below the knees<sup>3)</sup>.

Because lymphedema cannot be completely cured once it has occurred, preventing further exacerbation and minimizing edema are essential. However, the threats and risk factors of lymphedema are underestimated, despite its frequent occurrence and diagnosis in medical clinics<sup>4)</sup>.

In severe cases, as the proteins exuded from blood vessels into tissues are deposited, edema is known to cause fibrosis

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of joints, muscles, nerves, and blood vessels, bacterial infection, joint contracture, pain, and restriction of the activities of daily living. Effective treatment of edema, regardless of its cause, increases blood flow through the lymphatic vessels and veins and includes lifting treatment, electrical stimulation, joint movement, pneumatic compression, elastic support bandage compression, and massage<sup>5</sup>).

Electrical stimulation treatment includes iontophoresis, electrical nerve stimulation, and repetitive magnetic stimulation. Transcutaneous electrical nerve stimulation (TENS), which is an electrical stimulation method, is known to effectively relieve pain in myofascial pain syndrome and can induce muscular contraction when the intensity and duration of stimulation are adjusted<sup>6</sup>). As mobile equipment has been developed to facilitate patient access to these treatments, electrical stimulation can be used without respect to location and is currently used by clinics in many areas for pain relief and functional improvement<sup>7</sup>).

However, studies on the treatment of lower extremity edema using TENS are rather sparse. Therefore, the present study was conducted to examine the effects of TENS on pain relief in lower extremity lymphedema patients.

## **SUBJECTS AND METHODS**

In the present study, 11 patients who were diagnosed with lower extremity lymphedema among patients who visited a hospital and who agreed to participate in the study were randomly assigned to an experimental group (TENS group) of six patients who received TENS treatment or a control group of five patients who received drug treatment. The experimental group received TENS treatment on edema regions three times per week for four weeks, and the control group took drugs prescribed by the doctor three times per week for four weeks. A preliminary evaluation was conducted before the interventions, and an ex post facto evaluation was conducted four weeks after the last intervention was completed. A general explanation of the study, including its content and purpose, was provided to the study subjects. All the subjects understood the purpose of the study. All provided written informed consent prior to participation according as the ethical standards of the Declaration of Helsinki.

Surface tape measurement, generally used to evaluate increases in the volume of extremities, was used to measure changes in lower extremity edema. Regarding the measurement technique, the tape measure was not pulled taut, and the skin was not pressed against at any time by the tape measure. Measurement was conducted three times, and the average value of these three measurements was recorded as the measured value (cm). The circumference of the calf was measured with the subjects in a sitting position and the knee joint bent to 90°, with the measurement being taken in the region ranging from the thickest part of the calf to the front of the tibia.

Pain intensity was measured using the visual analog scale. The visual analog scale consists of a 100 mm-long straight line. The left end of the straight line represents no pain, with a score of 0 points, and the right end of the line represents a state of maximum pain, with a score of 100 points. The therapist verbally asked the patient the degree of current pain and marked the degree of pain indicated by the patient as the measured value on the line.

The transcutaneous electrical nerve stimulation treatment was implemented using stimulation in the form of 100 Hz asymmetrical biphasic pulsed waves delivered by a portable Enraf Nonius 911 ENS (Netherlands). Surface electrodes were attached to the calf region, and stimulation at intensities lower than 39 mA, where muscle contraction occurs, was administered. The intensity at which local sensitization occurred without too much discomfort was determined by increasing the stimulation in 1 mA increments beginning at 10 mA. Stimulation at this intensity was sustained for 20 minutes.

The data obtained in the present study were statistically processed using IBM SPSS Statistics for Windows, version 20.0, and all measured values are presented as means and standard deviations. Paired sample t-tests were used to evaluate the differences between the before-experiment and after-experiment values in each group, and independent sample t-tests were conducted to examine intergroup differences in terms of the amount of change after the interventions between the two groups. The statistical significance level was set to 0.05.

## **RESULTS**

An intergroup comparison of the amount of change in the circumference of the lower extremities between the experimental group and the control group showed statistically significant differences: the edema decrements in the experimental group were significantly larger than those in the control group (Table 1).

In terms of intragroup comparison of lower extremity pain before and after the experiment, both the experimental group and the control group showed statistically significant differences. Intergroup comparison of the amount of change in lower extremity pain between the experimental group and the control group also showed statistically significant differences. The amount of change in the experimental group was significantly larger than in the control group. The pain decrements in the experimental group were significantly larger than those in the control group (Table 2).

**Table 1.** Comparison of edema between groups

	Pre-test (cm)	Post-test (cm)
TENS group (n=6)*	45.8 ± 5.1	37.9 ± 5.1
Control group (n=5)*	42.6 ± 6.1	39.75 ± 4.8
Intergroup	0.29 <sup>#</sup>	

Values are shown as the mean ± standard deviation. \*p<0.05 (intragroup), #p<0.05 (intergroup)

**Table 2.** Comparison of pain between groups (Mean ± SD)

	Pre-test (mm)	Post-test (mm)
TENS group (n=6)*	62.74 ± 12.75	27.62 ± 11.37
Control group (n=5)*	69.11 ± 10.46	47.39 ± 12.57
Intergroup	0.00 <sup>#</sup>	

Values are shown as the mean ± standard deviation. \*p<0.05 (intragroup), #p<0.05 (intergroup)

## DISCUSSION

The lymphatic system plays a role in absorbing excess water, proteins, fat, and dead cells in the empty spaces around cells and returning them to the blood vessel system. It transports wastes from tissues while enabling the human body to maintain its body fluid balance. Edema refers to an increased fluid volume in the body when the distribution of water, which is normally well distributed, becomes unbalanced. That is, when fat accumulates in blood vessels, leading to poor blood circulation, or there is an obstacle preventing the flow of lymph fluid, the homeostasis of the moisture content of cells is broken, leading to the development of edema<sup>3</sup>.

When the hydrostatic water pressure increases at the distal ends of the veinlets in the microcirculatory system, the filtration pressure increases, causing an increase in body fluid inflow from the blood vessels into the interstitial tissues, leading to edema. Edema causes a heavy feeling and a feeling of constriction, and it also causes discomfort because of the increased length of diffusion for movement of nutrients, causing nutrients to not be properly supplied and wastes to not be properly excreted. This condition is defined as lower extremity edema<sup>8</sup>.

The causes of lower extremity edema are diverse and include heart disease, overwork, and hypertension. Edema also can appear when amygdalitis or upper respiratory inflammation occurred. In addition, edema can occur in cases of high mental stress, poor nutrition, diets with salty foods or packaged foods, and excessive alcohol consumption, as a result of adverse drug effects of hormone drugs or anti-inflammatory analgesic drugs, or due to abnormalities in hormone secretions occurring before and after menstruation in females<sup>9</sup>.

In the case of chronic lymphedema that has progressed for three months or longer, the possibility of pitting edemas is low, and most cases are stage 2 or 3 lymphedema accompanied by tissue changes including thickening and hardening of the skin and subcutaneous tissues. Lymphedema in these cases may show changes, is likely to cause cellulitis and chronic skin ulcers, and is likely to have been reported as unresponsive to existing treatment methods, such as pneumatic compression, massage, and complex decongestive physical therapy<sup>10</sup>. Therefore, the importance of initial treatment of edema has been magnified, and in the case of chronic edema, the necessity of new treatment methods has come to the fore.

Electrical stimulation treatments are one of the initial treatment methods of edema that enable quantitative management of the intensity, duration, and frequency of treatment for consistent and accurate treatment of the region of edema<sup>11</sup>. In a study conducted by Bilgili et al. that examined the effects of TENS on the pain, joint range of motion (ROM), and edema of pain syndrome patients, the subjects were randomly divided into groups to examine treatment results. The researchers reported that, according to the results of the study, pain and edema decreased, while joint ROM increased in the experimental group that received TENS therapy<sup>12</sup>.

Likewise, in the present study, it was found that edema and pain statistically significantly decreased in the experimental group that received TENS when compared with the levels in the control group. These results are considered attributable to the fact that electrical stimulation caused repetitive muscle contraction and relaxation, such that the microenvironments of the muscle cells were controlled to maintain the homeostasis of cellular osmotic pressure and promote the decomposition of pain-causing substances.

Limitations of the present study include the fact that treatment effects cannot be generalized, because the number of study subjects was small, the onset of disease in the patients was not uniform, and intervention effects were not continuously observed over time. In addition, only edema and pain were evaluated, and a dynamic evaluation according to changes in cell levels and gait was not conducted. The author hopes that studies will be conducted in the future that address these limitations with more study subjects and evaluations conducted using multilateral methods over time.

## REFERENCES

- 1) Martin Ginis KA, Ma JK, Latimer-Cheung AE, et al.: A systematic review of review articles addressing factors related to physical activity participation among children and adults with physical disabilities. *Health Psychol Rev*, 2016, 5: 1–17. [Medline] [CrossRef]
- 2) Boccardo F, Valenzano M, Costantini S, et al.: LYMPHA technique to prevent secondary lower limb lymphedema. *Ann Surg Oncol*, 2016, 23: 3558–3563.

[Medline]

- 3) Scallan JP, Zawieja SD, Castorena-Gonzalez JA, et al.: Lymphatic pumping: mechanics, mechanisms and malfunction. *J Physiol*, 2016, 594: 5749–5768. [Medline] [CrossRef]
- 4) Paskett ED: Symptoms: lymphedema. *Adv Exp Med Biol*, 2015, 862: 101–113. [Medline] [CrossRef]
- 5) Wou J, Williams KJ, Davies AH: Compression stockings versus neuromuscular electrical stimulation devices in the management of occupational leg swelling. *Int J Angiol*, 2016, 25: 104–109. [Medline] [CrossRef]
- 6) Pal US, Kumar L, Mehta G, et al.: Trends in management of myofacial pain. *Natl J Maxillofac Surg*, 2014, 5: 109–116. [Medline] [CrossRef]
- 7) Karasuno H, Ogihara H, Morishita K, et al.: The combined effects of transcutaneous electrical nerve stimulation (TENS) and stretching on muscle hardness and pressure pain threshold. *J Phys Ther Sci*, 2016, 28: 1124–1130. [Medline] [CrossRef]
- 8) Elwell R: An overview of the use of compression in lower-limb chronic oedema. *Br J Community Nurs*, 2016, 21: 36–42, 38, 40 passim. [Medline] [CrossRef]
- 9) Gandhi SK, Powers JC, Nomeir AM, et al.: The pathogenesis of acute pulmonary edema associated with hypertension. *N Engl J Med*, 2001, 344: 17–22. [Medline] [CrossRef]
- 10) Hwang JH, Kwon JY, Lee KW, et al.: Changes in lymphatic function after complex physical therapy for lymphedema. *Lymphology*, 1999, 32: 15–21. [Medline]
- 11) Feger MA, Goetschius J, Love H, et al.: Electrical stimulation as a treatment intervention to improve function, edema or pain following acute lateral ankle sprains: a systematic review. *Phys Ther Sport*, 2015, 16: 361–369. [Medline] [CrossRef]
- 12) Bilgili A, Çakır T, Doğan ŞK, et al.: The effectiveness of transcutaneous electrical nerve stimulation in the management of patients with complex regional pain syndrome: a randomized, double-blinded, placebo-controlled prospective study. *J Back Musculoskeletal Rehabil*, 2016 [Epub ahead of print]. [Medline]