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Original Article

# Effects of concentric contraction of the wrists and transcutaneous electrical nerve stimulation cycle on pain and muscle strength in lateral epicondylitis patients

Yeong-Deok Choi, PhD[1)], Myung-Joon Kim, PhD[1)], Jung-Ho Lee, PhD[1)*]

[1)] *Department of Physical Therapy, Kyungdong University: Bongpo-ri, Toseong-myeon, Goseong-gun, Gangwon-do, Republic of Korea*

**Abstract.** [Purpose] This study examined the effects of transcutaneous electrical nerve stimulation and concentric contraction of the muscles surrounding the elbow joints on pain and muscular strength in the elbow joints of patients with lateral epicondylitis. [Subjects and Methods] The subjects of this study were 30 patients who visited our hospital with the main complaint of lateral pain in the elbow joint. All subjects were randomly and equally assigned to an experimental group that conducted concentric contraction exercises in sync with a transcutaneous electrical nerve stimulation cycle and a control group that performed concentric contraction after the application of transcutaneous electrical nerve stimulation. Patients used a 10 cm visual analogue scale to evaluate the level of pain in their elbow joints. To measure the strength of muscles around the elbow joints, the subjects' paretic grip strength was measured using an electronic grip strength dynamometer. [Results] No statistically significant difference in visual analog scale was found between the two groups. Regarding changes in grip strength, changes in the experimental group's grip strength were significantly greater than those in the control group. [Conclusion] These results can be used as a basis for reducing pain and improving strength in lateral epicondylitis patients.
**Key words:** Transcutaneous electrical nerve stimulation, Concentric contraction, Epicondylitis

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## INTRODUCTION

Lateral epicondylitis, or tennis elbow, is a common disease that triggers pain in the elbows. It is generally due to chronic overload on the lateral epicondyle arising from repetitive utilization of the carpal and the finger extensor tendons and, in particular, the extensor carpi radialis brevis muscle[1)]. Other etiologies of lateral epicondylitis include multicentric disruption at the origin of extensor tendons, bursitis, calcification at the origin of extensors, degenerative changes in the annular ligament, synovial hypertrophy, and compression of the radial nerve; diverse surgical methods exist to mitigate these problems[2)].

Lateral epiccondylitis pain is confined to the origin of the extensor at the epicondyle but is characterized by point tenderness; this disease is commonly witnessed in the orthopedic field. Diverse treatment methods have been designed and used to treat lateral epicondylitis, such as resting, drug therapy, restriction of joint movements, physical therapy, local injection of steroids, and surgical treatment. However, none of these have shown consistent or predictable outcomes; the best treatment method has not yet been established[3)].

Pain from lateral epicondylitis usually initiates after repetitive or excessive extension of the wrists in supination. Lateral epicondyulitis is characterized by continuous slight traumatic symptoms at the humeroradial joint and a gradual increase in such symptoms. Missing early treatment leads to a decrease in muscular strength[4)]. Pain is one of the problems experienced

*Corresponding author. Jung-Ho Lee (E-mail: ljhcivapt@naver.com)

by patients and can be potentially accompanied by physical, physiological, or psychological disability. For such patients, rehabilitation treatment is an option. As the major symptom of lateral epicondylitis is pain, a subjective decrease in pain should be the goal when selecting a treatment for this condition[5]).

Transcutaneous electrical nerve stimulation (TENS) is frequently used to reduce pain in clinical settings and is simple to apply and non-invasive. TENS selectively activates different nerve fiber groups. Nerve fibers with a large diameter, such as Aα and Aβ fibers, have a low threshold for activation by electrical stimulation compared to fibers with a small diameter, such as Aδ and C fibers[6]).

Methods to increase muscle strength include kinesitherapy utilizing isometric and isotonic contractions. Isometric contraction triggers muscular contractions without changing joint angles, thereby increasing muscle strength in a stable manner, but may result in elevated blood pressure and decreased patient motivation. In contrast, isotonic contraction causes muscular contractions through changes in joint angles, thereby increasing muscular strength, and can provide patients with feedback via their joint and muscular proprioceptive senses according to joint angles[7]).

TENS, which may reduce pain, and kinesitherapy, which may increase muscular strength, have been separately applied in rehabilitation treatments, although no research has simultaneously applied TENS and kinesitherapy. Accordingly, this study examined the effects of TENS and concentric contraction of the muscles surrounding the elbow joints on pain and muscular strength in the elbow joints of patients with lateral epicondylitis.

## SUBJECTS AND METHODS

The subjects of this study were 30 patients who visited our hospital with the main complaint of lateral pain in the elbow joint. All patients were diagnosed with lateral epicondylitis of the elbow joint and tested positive during the extensor carpi radialis brevis tension test. These patients had not undergone conservative treatments, including resting, drug therapy, fixation, physical therapy, or local injection of steroids, for longer than three months. This study excluded patients who had hemostatic disorder, were pregnant, had tumors, or had neurological disease. All subjects were randomly and equally assigned to an experimental group that conducted concentric contraction exercises in sync with a TENS cycle and a control group that performed concentric contraction after the application of TENS. All treatments and evaluations were carried out by one physical therapist with more than 10 years of clinical experience. Before the experiment, the purpose, process, and side effects of the experiment were explained in detail to the subjects. All provided written informed consent prior to participation according as the ethical standards of the Declaration of Helsinki.

A low frequency TENS stimulator, automatically set at a frequency of 3 to 20 Hz, was used. Two TENS pads were attached to the subjects: one to the flexor and one to extensor of the elbow joints. Electrical stimulation was then applied to the pads attached to the extensor and the flexor in a sequential and repetitive manner. The treatment intensity was heightened to the extent that the patient felt the most comfortable within the range where visible contractions were triggered. This treatment was applied for 15 minutes three times per week for four weeks (a total of 12 times). The concentric contraction of the elbow joints was performed with each patient sitting on a chair with his or her elbow joint flexed at 19 degrees and with his or her forearms and wrist joints in a neutral position. Concentric contractions were carried out to the extent that the patient could perform them. Concentric contractions were also applied for 15 minutes three times per week for four weeks (a total of 12 times), either during or after the TENS treatment.

Patients used a 10-cm visual analogue scale (VAS), selecting an integer from 1 (no pain) to 10 (unbearable pain), to evaluate the level of pain in their elbow joints. To measure the strength of muscles around the elbow joints, the subjects' paretic grip strength was measured using an electronic grip strength dynamometer. Each subject sat straight in an armchair, placed his or her forearm on the armrests, flexed the elbow joint at 90 degrees with the forearm and the elbow joint in a neutral position and the trunk and the arm positioned at an angle of 15 degrees from one another, and pulled the grip with all of his or her strength. The average value of three measurements was used as the measured value of grip strength. A pre-test was conducted before the first intervention, and a post-test was performed after the last intervention.

All statistical values were described as averages ± standard deviations, and statistical analyses were performed in the SPSS 18.0 software. Descriptive statistics were employed to examine the mean and the standard deviation of the dependent variable, and a paired t-test was used to assess changes in each group before and after the experiment. An independent t-test was carried out to compare differences between the groups. The significance level was set at $\alpha<0.05$.

## RESULTS

In this study, the VAS statistically significantly decreased in the post-test compared to the pre-test in both groups ($p<0.05$) (Table 1). However, no statistically significant difference in VAS was found between the two groups ($p>0.05$). Also, the subjects' grip strength significantly increased in the post-test compared to the pre-test in both groups ($p<0.05$) (Table 2). Regarding changes in grip strength, changes in the experimental group's grip strength were significantly greater than those in the control group ($p<0.05$).

Table 1. Comparison of VAS between the groups (mean ± SD)

| | Experimental group (n=15) | Control group (n=15) |
|---|---|---|
| Pre-test | 6.12 ± 1.56 | 6.04 ± 1.87 |
| Post-test | 4.31 ± 1.25* | 4.85 ± 1.32* |

*p<0.05, Unit=Score, *: within group, #: between group.

Table 2. Comparison of hand grip strength between the groups (mean ± SD)

| | Experimental group (n=15) | Control group (n=15) |
|---|---|---|
| Pre-test | 85.15 ± 11.34 | 84.19 ± 12.55 |
| Post-test# | 93.69 ± 13.87* | 89.27 ± 14.38* |

*p<0.05, Unit=Pound, *: within group, #: between group.

# DISCUSSION

This condition is frequently triggered by sports activities, although the cause of lateral epicondylitis is unidentifiable in many cases. Lateral epicondylitis is characterized by tenderness on the lateral epicondyle of the humerus and by pain occurring in the lateral part of the elbow joints[8]. In addition, lateral epicondylitis usually occurs during flexion of the elbow joints, extension of the wrist joints, or the gripping of objects. It may be accompanied by severe anxiety and depression, thereby complicating pain control as a result of lowered adhesion to treatment due to severity and long-term duration of pain[9].

Non-surgical methods to treat lateral epicondylitis include resting, electrical stimulation, restriction of joint movements, injection of drugs, extracorporeal shock wave therapy, and kinesitherapy; surgical operations may also be needed[10]. Non-invasive electrical stimulation therapy or kinesitherapy are several non-surgical methods with fewer side effects than invasive injections or surgical treatment and are therefore commonly used for rehabilitation treatment in the clinical setting[11].

Gripping is a delicate motion that occurs via the joint action of the flexors and the extensors of the wrists, not merely the action of the flexors of the hands. As grip strength increases, the extensor carpi ulnaris muscle is mobilized in addition to the already activated extensor carpi radialis brevis[12]. The extensor carpi radialis longus muscle and even the brachioradialis muscle can also be mobilized according to the posture during gripping and the degree of grip strength. Repetitive gripping leads to the excessive utilization of the extensors of the wrist joints, decreasing overall extension strength of the wrists and also triggering radiating pain from the arms to the wrists; such pain weakens grip strength[13].

Patients with lateral epicondylitis experience decreased grip strength as a result of pain. Grip strength is associated with decrease in bone density in women and may be used to predict early death rates, onset of a disability, post-operative complications, and decreased cognitive ability in elderly people[14]. This study examined the effects of active concentric contraction of the wrist flexors and extensors according to the utilized stimulation frequency of TENS on pain and grip strength in patients with lateral epicondylitis. In the results of this study, pain and grip strength significantly differed in the post-test compared to the pre-test in both the experimental group and the control group. Moreover, changes in grip strength were more statistically significant in the experimental group that performed concentric contractions in sync with a TENS cycle compared to the control group. In other words, to more efficiently increase muscle strength, the concurrent application of exercise methods and TENS of appropriate duration represents a better intervention than the separate application of each treatment.

Improving strength is thought to be caused by passive contraction stimulation by electrical stimulation and active contraction by concentric contraction at the same time. In other words, we thought that the reflex contraction at the level of spinal cord stimulation by TENS and the active contraction at the level of cerebral cortex stimulation by the concentric contraction are superimposed to improve the muscle strength.

The limitations of this study are that the number of patients was small and that the intervention period was short. In addition, only exercise methods employing concentric contraction were used, and the evaluation was not continuous. Further quantitative research on the simultaneous application of electrical stimulation therapy and kinesitherapy should be carried out in patients with different diseases on a continuous basis.

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