

# Effect of Transcutaneous Electrical Nerve Stimulation on Muscle Activity of Upper Trapezius in Subjects With Myofascial Pain Syndrome

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## 국문 요약

### 상부 승모근 근막 통증 환자에게 경피신경자극이 근 활성화도에 미치는 영향

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본 연구에서는 상부 승모근의 근막통증(myofascial pain syndrome; MPS)를 대상으로 이완상태에서 근 활성화도를 측정해보고, 통증을 감소시키는 데 주로 이용되는 경피신경자극 치료 후 근 활성화도에 어떠한 영향을 미치는지 알아보기 위해 실시하였다. 본 연구의 대상자는 근막 통증으로 진단을 받은 총 10명을 대상으로 실시하였다. 주관적 시각 척도(visual analogue scale; VAS)와 압통 역치 측정계(pressure threshold meter)를 이용하여 경피신경자극 전, 후 통증의 정도를 평가하였고, 표면 근전도를 이용하여 이완시 근 활성화도를 측정하였다. 치료 기구는 경피신경자극기(TENS: HAT-2000)를 이용하였다. 치료 전과 비교하여 VAS는 통증이 심한 쪽과 약한 쪽 모두에서 유의하게 감소하였으며( $p < .05$ ), 압통 역치는 통증이 심한 쪽과 약한 쪽 모두에서 유의한 차이가 없었고( $p > .05$ ), 근 활성화도는 통증이 심한 쪽에서 유의하게 감소하였다( $p < .05$ ).

핵심단어: 경피신경자극; 근막통증; 근활성도; 이완.

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## Introduction

MPS (Myofascial pain syndrome) is a common muscular pain syndrome resulting from an activation of the myofascial trigger points (MTrPs). MTrP has been defined as a hyperirritable spot within a taut band and a mass of the skeletal muscle fibers, which is painful on pressure stimulation and that can give rise to a characteristic referred pain, tenderness, tightness, local twitch response, autonomic phenomena (Travell and Simons, 1992). Moreover MPS has been known to be the most common disorder whoever must be afflicted with and be a major cause that gives rise to a musculoskeletal pain (Travell and Simons, 1992). Ju and Ok (1997) stated that poor posture, overuse of the muscle, lack of nutrition, metabolism disorder, stress cause MPS. However especially modern times to overuse computer at the work has made to increase it by gradually.

Assessing the activities in muscles through electromyography provides an insight into the patterns of activation or tension developed in the muscles, which may be of interest in and of itself, because sustained muscle activity is known to cause ischemic muscular pain (Cailliet, 1991). The static evaluation is used to assess the "tone" or the resting state of the muscle. To this extent, the static evaluation provides an objective measurement of chronically hyperactive muscles. In the more acute phase, these hyperactive muscles could be described as muscle spasm. Muscle spasms are similar to

chronically hyperactive muscles in alpha motor activity. However, unlike chronically hyperactive muscles, muscle spasms cannot be voluntarily released since they prevent loosening of the muscle involved (Stedman, 1990).

Simons (1998) quoted from the result of Kunze and Berlit that multiple locations of musculoskeletal pain are sometimes associated with advanced disease and marked muscular involvement. The advanced stage of sustained cocontraction that is associated with a flexed posture results from chronic spasm. This stage would be expected to become painful because of sustained contraction with muscles held in a shortened position.

Harms-Ringdahl and Ekholm (1986) studied EMG activity in the splenius, thoracic erector spine, and trapezius muscles during sustained extreme neck flexion. sEMG (surface electromyography) was low for all muscles except splenius muscle throughout the test. However activity of the splenius was not found to correlate with intensity of pain that developed during the test, EMG activity was greater at the end of the test than at the beginning, as was pain experienced by the subjects. There were no changes in posture to which sEMG increases could have been attributed. The authors suggested that the increase might have been due to the pain, "indicating that tonic reflex mechanism might have been elicited" (Sommerich et al., 2000).

According to Hsuen et al (1997), ENS (electrical nerve stimulation) is more effective for immediate release of myofascial

**Table 1.** General characteristics of the subjects

(N=10)

	Mean±SD	Range
Age (yrs)	36.3±11.0	22~55
Height (m)	161.1±6.9	153~175
Weight (kg)	58.5±7.0	50~75
Prevalence (month)	41.2±50.3	.25~160

trigger at pain (TrPs) than is EMS, and ENS has a better effect on immediate release of muscle tightness than EMS. However there haven't been many researches on the effects of ENS on muscle activity and pain in patient's MPS.

The upper Trapezius muscle has been focused in studies. This muscle is a prevalent site of pain, which is sometimes referred to as chronic trapezius myalgia or tension-neck syndrome (Ohlsson et al, 1995). Therefore the purpose of this study was to determine the effect of TENS on pain intensity, pain threshold, and EMG activity on upper Trapezius muscle in resting position.

## Methods

### Subjects

Subjects consisted of 10 patients who were receiving physical therapy as inpatients or outpatients at Won-ju Medical center, in Won-ju (Table 1). Inclusion criteria for subjects are as follows: 1) patients who were diagnosed with MPS by a medial doctor. 2) Patients who can understand and follow the investigator's instruction.

### Instruments and procedures

The sEMG signal was detected with an active parallel-bar electrode (bar size:1 mm by 10 mm, located 10 mm apart differential electrode (DelSys)<sup>1)</sup>). The electrodes were placed on the both upper trapezius muscle with the medial bar 20 mm lateral to the midpoint of the line between the C7 spinous process and the acromion (Jensen et al. 1993). Data were sampled by 512 Hz. After collection, the data were transferred to an personal computer for data reduction. The Acqknowledge 3.70<sup>2)</sup> program was employed to set up the required parameters and to store the EMG signal as computer files. The EMG signals were digitally band-pass filtered at 100~250 Hz and notch filtered at 60 Hz to reduce noise. The root mean square (RMS) value was calculated for epochs of 1/8 seconds (Hansson et al, 2000).

The RMS values were normalized to a reference voluntary electrical activity (RVE) obtained during an isometric submaximal reference voluntary contraction (RVC). During test contraction, the subject was standing, with arms abducted to 90° in the scapular plane and the elbow were held

1) Delsys Inc. Boston, MA, USA.

2) Biopac systems Inc. CA, USA.

straight, with the back of the hand facing upwards. 1 kg free weight was held in each hand for about 15 seconds during RVC test (Akesson et al, 1997).

Muscle tone was calculated from the RMS values. These values were recalculated by the formula

$$RMS_{Resting} = n\% RMS_{RVE} \dots \dots (1)$$

RMS<sub>Resting</sub> was measured for 60 seconds before and after TENS treatment. Pain intensity was scored on a 10 cm VAS (visual analogue scale), with 0 indicating no pain and 10, unbearable pain. An algometer (pressure threshold meter)<sup>3)</sup> was used to measure pressure pain bilaterally in the upper trapezius on each side. Pressure was given at a rate of 1kg/s and the subject was asked to report the first sensation of pain into the pain area by Travell and Simons (1983).

For application of TENS, commercially available TENS units (HAT-2000)<sup>4)</sup> were used. Frequency of TENS was automatically applied 3~20 Hz, and intensity was increased until a palpable motor contraction was not elicited. The duration of stimulation was fixed at 10 minutes.

VAS and Pain threshold were measured before and after TENS treatment. All measurements were performed at comfortable sitting position with hands on lap. EMG data were collected at the same position during relaxation, then RVC was measured

lastly, after treatment.

### Statistical analysis

Wilcoxon Singed ranks test was used to compare VAS, Pain threshold, and Muscle activity of before and after treatment. SPSS was used for statistical analysis with a significant level .05.

## Results

According to pain intensity measured by VAS, both upper trapezius muscles were divided into severe side (SS) and less severe side (LSS).

After TENS treatment, VAS scores were significantly lowered in both side (Figure 1). Pain threshold was increased between before and after treatment (Figure 2).

Muscle activity was reduced compared to before treatment in the SS (Table 2, 3).

## Discussion

Schnoz et al (2000) have shown that the activity of the trapezius muscle can be present in the tasks that do not necessarily require its activation. Apart from unsupressed co-activation or mechanism needed for head stabilization, factors such as visual load, concentration, and fatigue may be linked to an increased trapezius activity (Maeda, 1977), and to the development of tension neck syndrome (Ohara et al, 1982).

Under the assumption that the same motor unit (MU) are active over extended periods, the trapezius muscle activity could explain the development of pain in the

3) Pain Diagnosis and Thermography Inc.  
NY, USA.  
4) MEDITENS Co. Seoul, Korea.

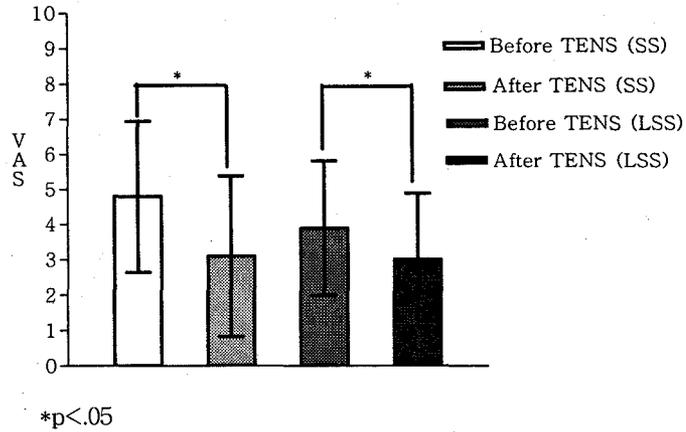


Fig 1. Comparison of VAS between Before and After TENS

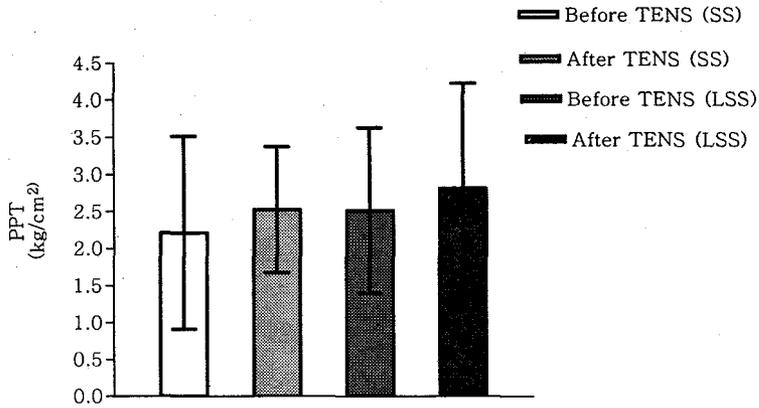


Fig 2. Comparison of PPT between before and after TENS

Table 2. Comparison of the RMS<sub>Resting</sub> values before and after TENS (unit: %RMS')

Pain intensity	Before TENS	After TENS
SS	8.4±6.9	6.7±3.7
LSS	5.9±3.6	5.4±3.5

Table 3. Wilcoxon Singed ranks test by RMS<sub>Resting</sub>

Pain intensity	Mean Rank		Z
	Before	After	
SS	7.0	2.0	-2.191*
LSS	5.5	5.5	-1.122

\*p<.05

neck region. However, according to Person (1974), the concept of MU substitution would offset the effects of fatigue. The Cinderella hypothesis (Hagg, 1991) contradicts this assumption and postulates the continuous activity of MU with low-threshold (type I) muscle fibers, which can lead to their overload.

Cram et al (1998) stated that chronic hyperactive muscle activity may have lost its nociceptive origin and is functionally defined as excessive muscle effort that is outside the patient's conscious awareness. Resting tone is an attribute that normally resides outside the general awareness of the patient. When we execute our conscious volition, we use primarily our alpha motor system for movement, with a secondary emphasis upon gamma motor activity for maintaining posture. The resting tone is the foundation for volitional movement. It is the basis for posture. 'Unnecessary' muscle tension is a confusing intermediate between muscle contraction that is beyond voluntary control (spasm) and viscoelastic tension that shows no EMG activity. This is unintentional muscle pain such as TrPs. This unwitting muscular contraction that is amenable to voluntary control is commonly identified as muscle tension (Rachlin, 1994).

Friedman and Nelson (1996) stated that to reduce muscle tension, another treatment, Cryotron, for alleviating hyperactivity at the shoulder-neck pain, was applied. Surface electromyographic activity of the upper trapezius was recorded before and after treatment with the Cryotron device. Averaged (left and

right sides) integrated electromyographic activity of the selected muscles was used. Following 15 minutes of the treatment with Cryotron device, nine out of 12 subjects demonstrated a reduction in the electromyographic activity of the selected muscles as compared with pre-treatment levels.

To prevent work-related musculoskeletal disorders in the shoulder, biofeedback techniques have been used to reduce trapezius muscle activity (Basmajian and Blumenstein, 1983; Parenmark et al, 1988). In cases where the muscle activity results from poor working postures, the feedback technique may contribute to better postures.

## Conclusion

In this study, the TENS affects VAS, pain threshold, and muscle activity on upper trapezius in patients with MPS.

Further study is needed for patients to find the long term effect of TENS on decreasing muscle activity on upper trapezius in patients with MPS.

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