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The Interferential current therapy (ICT) effects on muscle activity, muscle fatigue and pain of upper trapezius in persons with myofascial pain syndrome

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Abstract

The study was conducted to assess the effect of Interferential current therapy (ICT) in the subjects with myofascial pain syndrome (MPS) on upper trapezius. Twenty three subjects with MPS on upper trapezius was assigned randomly to ICT group (n=10) or placebo group (n=13). Duration of treatment was 4 weeks and treatment time was twenty minutes and frequency was three times a week. Effects were assessed pre- and post- treatment on muscle activation, muscle fatigue and Visual Analogue Scale (VAS). Paired t-test and independent t-test were performed to examine within group and between group differences. Significant decrease of muscle activity was noticed within ICT group after ICT application ($p<.05$), but not placebo group ($p>.05$). There was no significant difference in muscle fatigue between ICT group and placebo group, between before and after treatment within ICT group ($p>.05$). Significant reduction of VAS of ICT group was noticed in before and after treatment, in between groups ($p<.05$). These results demonstrated that ICT was positively effective on muscle activity and pain on upper trapezius. These findings show that ICT is effective treatment method for pain control and muscle relaxation in patients with MPS.

Key Words : ICT, Muscle fatigue, Myofascial pain syndrome, Muscle activity, VAS.

1 INTRODUCTION

The myofascial pain syndrome (MPS) indicate that chronic pain in musculoskeletal disorders generates in muscle and fascia (Hong, 2006). MPS is characterized by hypersensitivity by stimulation of trigger point which induced referred pain depending on trigger point area (Money, 2017). Also, MPS is well occurred in trapezius and levator scapulae muscle among muscle of the neck, shoulder, lumbar, buttocks (Chang, 2008). Especially, trigger point in upper portion of trapezius, locating superior scapula and center between vertebrae and shoulder, is most generated site (Lluch, 2013).

The massage, ultrasound, heat or cold, stretching, relaxation after isometric contraction and pharmacological interventions have been used to MPS (Alvarez and Rockwell, 2002). Although invasive pharmacological injection into trigger point has been applied to manage the pain control, this invasive management could cause many side effects such as vagus nerve syncope by needle or circulation arrest by body absorption of local anesthetic and generate hematoma in local site and pneumothorax in chest injection (Laskin and Block, 1986). Recently, interventions by non-invasive application effect to pain relive and muscle spasm by massage or transcutaneous electrical nerve stimulation (TENS) and ultrasound as electrical therapy (Espi-Lopez, 2016; Robinson, 1996).

Interferential current therapy (ICT) is noninvasive electrical therapeutic modality that don't have unpleasant feeling and burn injury because of low skin resistance. Also, it has effects to reduce pain, edema, and inflammation and promote tissue healing and relax muscles (Goats, 1990). For this reason, ICT is applied in musculoskeletal disorder, fracture, urinary incontinence with pain symptom (Goats, 1990; Coban, 2012). But, no study has determined that the application of ICT effects in pain control, fatigue, and overactive muscle following myofascial pain syndrome.

Thus, we investigated the long term of four weeks effects of ICT on muscle activity, and muscle fatigue using electromyography, and pain using VAS (Visual Analogue Scale) in upper trapezius MPS subjects.

2 MATERIALS AND METHODS

A. Participants

A total of 23 young adults in B University participated in this study, and received verbal descriptions of the study purpose and agree to participate in the study. This study was a randomized, single-blind, placebo-controlled. The participants were included in the study if they have over three in primary diagnosis and over one in secondary diagnosis.

Primary diagnosis

1. Pain in local site
2. Referred pain in lesion
3. Facilitation in coagulation of muscle
4. Pain in coagulated site and limitation of joint movement

Secondary diagnosis

1. Twitch response during compression of pain trigger point or needle insertion
2. Pain relieve in muscle stretching
3. Repeated pain during compression of pain trigger point

All participants were aligned randomly the experimental group or control group. The experimental group was applied with ICT intervention for 4 weeks, while the control group was applied without ICT current but electrode for placebo effect. The demographic characteristics of all subjects are shown average in 22.4 years, 166.4 cm, and 59.5kg in Table 1 (Lee, 2017).

TABLE I
GENERAL CHARACTERISTICS OF THE PARTICIPANTS

	Control group (n=13)	Experimental group (n=10)	Total (N=23)
Age (yrs)	21.8±1.8	23.3±0.7*	22.6±1.3
Height (cm)	167.9±8.6	164.4±6.5	166.2±7.6
Weight (kg)	60.6±8.5	58.3±7.4	59.5±8

*Mean ± Standard deviation.

B. Experimental procedure

This study was designed with two measurement time points before and after ICT treatment. The electrical stimulation of interferential current therapy device (COMBI 500; Gymna., Germany) was applied to subjects for 20 minutes in a single session using on three times per 1 week during 4 weeks in relaxed sitting on a chair with back. While, the electrodes were attached at the upper trapezius of ipsilateral side via four electrodes in a quadrant setting, and set minimum 3 Hz, maximum 25 Hz, 13mA. Placebo-group attached electrodes, but no electrical stimulation was applied.

For assessment of muscle activation and fatigue on upper trapezius was used surface electromyography device (Trigno Wireless EMG system, USA). All EMG signals were amplified and radio transmitted signal by Trigno sensor analyzed using EMG work 3.7 (Delsys Inc., USA). The sampling rate of EMG is 2000Hz and filtered range of 4 ∼450Hz.

Measurements of upper trapezius muscle activation

Upper trapezius muscle activation was measured in reference voluntary contraction (RVC) by surface EMG at pre- and pro- intervention for 4 weeks each group. The electrode was attached site in 7th spinous process of neck, center of acromion, and 2 cm beside the shoulder for measurement of upper trapezius activity, of which location was marked using pen for same electrode placement with interval of 4 weeks. The measured posture was sustained during seven seconds in shoulder abduction 90^0, elbow extension, and forearm pronation with holding 1kg weight. Only five seconds except one second of start and ending of muscle activation, and total three repetitive measurements are used into average value for normalization. The collected data on upper trapezius muscle activity during five seconds was processed into Root Mean Square (RMS).

Measurements of fatigue in upper trapezius muscle

Upper trapezius muscle fatigue was measured by electromyography during thirty seconds in the same position with RMS measurement at pre- and pro- intervention for 4 weeks each group (Moussavi, 1997). And the collected muscle activation were used for frequency spectrum analysis during thirty seconds. Median frequency (MDF) which represent frequency spectrum analysis was used as fatigue index in upper trapezius muscle. And then, it was averaged during twenty seconds except five seconds of start and ending and three times repeated measure. For preventing the effect of fatigue in upper trapezius muscle, the participants rested at least one minute per session.

Measurement of Visual Analogue Scale (VAS)

To compare pain intensity for application ICT, we used the 100 mm visual analog scale (VAS) with anchor words "no pain" at one end and "worst pain" at the other. VAS was measured at pre- and pro- intervention for 4 weeks each group.

C. Statistical analysis

Statistical analysis was analyzed using the SPSS (version 12.0). For muscle activation, muscle fatigue, and VAS analysis, paired t-test and independent t-test were performed to examine within-group and between-group differences, respectively. The significance lever for all analyzes was chosen at $\alpha = .05$.

3 RESULTS

A. Effects of ICT application on muscle activity

It was no significant difference between control (placebo) and ICT group ($p>.05$). However, in within-group of ICT treated group, it showed statistically significant decrease 5.51 mA before 22.2$\pm$6.8 mA and after 16.7$\pm$6.4 mA ($p<.05$) in Table 2.

B. Effects on muscle fatigue after ICT intervention

TABLE II

THE CHANGES OF THE MUSCLE ACTIVITY AFTER APPLICATION OF ICT

(Unit: mA)

	Control group		Experimental group		t
	Before	After	Before	After	
RMS	15.6±4.6[a]	20.4±8.6	22.2±6.8	16.7±6.4	-1.113
t	-1.727		3.230*		

[a]Mean±Standard deviation, *p<.05.

There was no significant difference in between control (placebo) and ICT group (p>.05), and in within ICT group (p>.05). After management of ICT, control and ICT group were 81.5±18.5 Hz and 75.3±8.5 Hz, respectively. The increase in fatigue in the placebo group was 6.7 Hz higher than 0.4 Hz in the ICT group in Table 3.

TABLE III

THE CHANGES OF THE MUSCLE FATIGUE AFTER APPLICATION OF ICT

(Unit : Hz)

	Control group		Experimental group		t
	Before	After	Before	After	
Muscle fatigue	74.8±9.4[a]	81.5±18.5	74.9±6.86	75.3±8.5	-.983
t	-1.862		-.143		

[a]Mean±Standard deviation

C. Effects on pain after ICT intervention

There was statistically significant different in between control and ICT group (p<.05). In within-group, VAS in placebo-group increased significantly from 6.9±1 to 7.4±.7 (p<.05), however, in ICT group decreased significantly with 2.6 difference from 7.6±0.8 to 5±0.8 (p<.05) in Table 4.

4 DISCUSSION

In this study, we demonstrated that ICT application was effective on muscle activity and fatigue using EMG, and pain using VAS. After ICT treatment, upper trapezius muscle activity decreased

TABLE IV

THE CHANGES OF VAS AFTER APPLICATION OF ICT

(Scale : point)

	Control group		Experimental group		t
	Before	After	Before	After	
VAS	6.9±1[a]	7.4±0.7	7.6±0.8	5±0.8	-7.806*
t	-2.208*		8.510*		

[a] Mean±Standard deviation, $p<.001$.

within ICT group and pain was reduced within ICT group and between ICT and control group.

MPS is clinically induced by increase of tension of tout band or fascia which is pathological disease of repeated twitch-pain-twitch response leading to chronic pain (Rubin, 1981). Also, the worker and students related musculoskeletal symptoms showed abnormal trapezius contraction because of seated position and working hard (Suh, 2015). For reducing these muscle tension, Friedman and Nelson applied therapy inhibiting hyper-mobility in shoulder-neck pain (Friedman and Nelson, 1996). In the other study, high-frequency TENS was effective to muscle stiffness by applying at bilateral tender points in the trapezius of fibromyalgia patients (Carbonario, 2013). Other study reports that TENS application in upper trapezius with myofascial trigger point pain improved range of motion in cervical movements (Rodrguez-Fernndez, 2011). In this study, ICT also might have a similarly beneficial effect on muscle relaxation due to reducing muscle activity within ICT group.

The many of workers and students have fatigue in their activity of daily living due to sustained and repeated activity that is not maintaining effectively muscle activation. The depleted chemical fuel of ATP and deficiency of blood flow generate the metabolic muscle fatigue for removal metabolites-accumulated in continuous contraction. In previous study related to electrical stimulation on fatigue, TENS contributed to local blood flow, tissue oxygenation, and sympathetic tone in small arteriole with improving fatigue by applying for 60 minutes (Suh, 2015; Wong and Jette, 1984). However, in this study, ICT might not effect on fatigue due to short time applied during fatigue measurement.

The electrical stimulation was effective to relive pain in case of arthritic pain, low back pain, and musculoskeletal pain (Robinson, 1996). Also, the pain was reduced by managements of the electrical stimulation applied on tender point of trapezius and supraspinatus and upper trapezius trigger points (Carbonario, 2013; Gemmell and Hilland, 2011). The electrical stimulation had influenced on inhibition of nociceptive transmission through non-nociceptive large diameter afferents and release of endogenous opioid (Melzack and Wall, 1965; Sluka, 1999). The ICT has been also commonly used in clinic for various type of pain management such as electrical stimulation and air-pump massage. The massage is well known to alleviate tenderness after exercise, musculoskeletal pain, and headache of muscle tension-type (Akazawa, 2016; Wamontree, 2015). Therefore, ICT might contribute to improvements in pain by neurological inhibition of electrical stimulation and massage.

The limitations of this study are small sample size, ICT application duration, and the number of ICT application. Also, further study will require a variety of measurement methods for change of muscle activity, muscle fatigue, and pain.

5 CONCLUSION

We investigated for four weeks the effects of ICT on muscle activity, and muscle fatigue using electromyography, and pain using VAS (Visual Analogue Scale) in upper trapezius MPS subjects.

In this study, we demonstrated that 4 weeks ICT application has effects on the muscle activation decrease and pain reduction of upper trapezius in MPS. ICT may play positive role in reducing the muscle spasm and pain of patients' MPS.

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