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Combination therapy using low versus medium frequencies in treating trigger points of upper fibers of trapizius

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Abstract

Background: A myofascial trigger point (MTrP) has been described as a hyperirritable spot located in a taut band of muscle; which is painful to palpation or compression and refers pain, tenderness, or an autonomic response to a remote area. Some investigators stated that when pressure is applied to aMTrP, a "jump sign" or "jump response" is elicited whereby the patient reacts with facial grimacing or by jumping away from the examiner. **Purpose:** the aim of this study was to compare between low frequency, high intensity burst-transcutaneous electrical nerve stimulation (TENS) CT and medium frequency, low intensity amplitude modulated frequency (AMF) interferential therapy (IFT) CT on upper trapezius active myofascial trigger points (MTrPs). **Design**: Single-blinded randomized controlled trial design was used. **Methodology:** Seventy participants with acute mechanical neck pain and more than two active MTrPs in upper trapezius were allocated randomly into three groups: The Burst-TENS-CT group (A), the AMF-CT group (B) or the sham CT control group(C). Group (A) consisted of 23 patients with mean age and height values of 34.39±5.92 years, and 163.73±11.69 cm respectively. Group (B) consisted of 25 patients with mean age, and height values of 34.88±5.67 years, and 167.92±10.22 cm respectively. Group (C) consisted of 22 patients with mean age and height values of 35.18±5.56 years and 167.5±13.83 cm respectively.

All groups received progressive pressure release (PPR) and passive stretch for the upper trapezius muscle, 3 sessions per week for 4 consecutive weeks. **Results:**

Demonstrated that CT significantly increased both PPT values as well as cervical lateral flexion ROM with a P<0.0001. However, among groups comparisonlow frequencyburst TENS-CT (4.73 ±0.59) yield a greater increase in PPT values and cervical lateral flexion ROM with a 547% increase than medium frequency AMF-CT (2.74 ±0.32) with a 290% increase.Primary measurement outcome included pressure pain threshold (PPT) using an electronic digital algometer. Secondary outcome included active cervical lateral flexion using a smart phone Clinometer application. Data was collected prior to the first treatment and at the end of the 4-week trial. **Conclusion:** Within the scope of our study, we conclude that both CT modalities were effective in increasing PPT and cervical lateral flexion, however, low frequency, high intensity burst-TENS CT produced significant improvements than medium frequency, low-intensity AMF-CT in the management of upper trapezius active MTrPs.

Keywords: combined therapy, interferential therapy, transcutaneous electrical nerve stimulation, myofascial trigger points and pressure pain threshold.

INTRODUCTION

Musculoskeletal pain is a major cause of morbidity in today's societies **(Millennium, 2003; Rickards, 2006; Toughet al., 2007; Yap, 2007).** About one-third of the patients with musculoskeletal pain meet the diagnostic criteria for myofascial pain syndrome **(Rickards, 2006).** A myofascial trigger point (MTrP) has been described as a hyperirritable spot located in a taut band of muscle; which is painful to palpation or compression and refers pain, tenderness, or an autonomic response to a remote area. Some investigators stated that when pressure is applied to aMTrP, a "jump sign" is elicited whereby the patient reacts with facial grimacing or by jumping away from the examiner **(Hantenet al., 2000).**

Cummings and White (2001) reported MTrPs as a significant primary source of pain. Myofascial trigger points were claimed to be the primary cause of pain in 74% of 96 patients with musculoskeletal pain in a medical center.

The upper trapezius (UT) plays an important role in the mobility and stability of neck. The UT muscle was found to be often affected by MTrPs**(Sciotti et al., 2001;Sarrafzadeh et al., 2012).** The common symptoms and pain patterns in subjects with MTrP in the UT muscle are taut and painful muscle, tension headache, neck pain, dizziness or vertigo, limited neck and shoulder range of motion**(Hanten et al., 2000; Rudin, 2003; Ferna´ndez-de-Las-Pen˜aset al., 2007; Lucas et al., 2009**).

In the physical therapy practice, therapeutic ultrasound (US) is used to treat soft tissue injuries, accelerate the wound's repair, and augment fracture healing. Therapeutic ultrasound can promote vascular permeability, promote muscle relaxation **(Srbely and Dickey, 2007),** thereby justifying its analgesic effects. **Srbely and Dickey (2007)**have shown a reduction of myofascial pain with the use of US.

TENS is considered the most frequently used electrotherapy for achieving pain relief (**Woolf and Thompson, 1994)**.Burst-TENS is characterized by high frequency pulses (approximately 100 pulses per second) delivered in a low frequency burst pattern (2-5 burst per second). Amplitude is intense enough to induce a forceful yet non-painful phasic muscle contraction (**Garrison and Foreman,1996)**. It produces extra-segmental analgesia by selectively activating small diameter afferent fibers; A-delta (Aδ) fibers arising from muscles (ergoreceptors). It stimulates the descending pain inhibitory pathways(**Woolf et al.,1980)**.

The interferential electric current is characterized by a medium frequency wave with low frequency modulated amplitude. It acts as TENS does and promotes analgesia by blocking pain potentials in the dorsal horn of the spinal cord (DHSC) **(Watson, 2008).** Furthermore, it prevents synaptic plastic rearrangement of the wide dynamic range (WDR) cells of the hyper sensitized cells, by reducing arborization of free-nerve terminations**(Offenbacherand Stucki, 2000)**.

The application of two therapeutic modalities; simultaneously and at the same site is reported with paucity in the literature and described as combination therapy **(Samosiuket al., 2011)**. This approach uses the combination of US and bipolar electrotherapeutical current in a single modality **(Almeida et al., 2003)**. The most commonly used combination therapy is US & TENS **(Mukkannavar,2008)**The combination of both resources (US and electrical current) is widely used in cases of musculoskeletal pain and is used respectively, however, a paucity of research have been conducted using these resources as a single modality **(Almeida et al., 2003).**

Due to the paucity of research conducted on combination therapy, there is a need to compare between combination therapy using TENS versus combination therapy using interferential current.

PARTICIPANTS AND METHODS

Participants

A single-blinded randomized controlled trial design was conducted to compare between the effect of medium (interferential current) and low frequency (TENS) combination therapy on the cervical range of motion (ROM) and pressure pain threshold (PPT) on upper fibers of trapezius trigger points.

Seventy subjects participated in this study with ages ranging from 25 to 45 years after approval of Ethical committee of the Faculty of Physical Therapy, Cairo University, and all participants provided written informed consent.

The participants were assigned simply and randomly in to three groups:

Group A: 23 subjects with upper fibers of trapezius active myofascialtrigger points receivedlow frequency Burst (TENS) combination therapy progressive pressure release and passive stretch to the upper trapezius; 3 times per week for 10 sessions

Group B: 25 subjects with upper fibers of trapezius active myofascial trigger points receivedmedium frequency (IFC) combination therapy, progressive pressure release and passive stretch to the upper trapezius; 3 times per week for 10 sessions

Group C: control group; 22 subjects with upper fibers of trapezius active myofascial trigger points received sham combination, progressive pressure release and passive stretch to the upper trapezius; 3 times per week for 10 sessions

Participants were included if their age ranged from 25 to 45 years, **Inclusion criteria** for participants who were presented bymechanical acute neck pain for less than 3 months and had at least two active MTrPs in the upper trapezius and decreased cervical ROM due to pain.**Exclusion criteria** for participants who had signs of cervical disc prolapse, radiculopathy, spondylolythesis, systemic disease migraine, and other neurological, orthopedic conditions.**(Mukkannavar, 2008),** pregnancy and pacemaker and onset of pain more than 3 months.

<u>Instrumentation:</u>

A) <u>Evaluative Instrumentation</u>

Assessment of pain: using pressure Algometer ;A simple hand held device used to measure trigger point tenderness level by determining the PPT using a pressure transducer probe that was placed on the trigger point and records the amount of pressure that causes pain **(Fischer, 1994).**

Assessment of cervical ROMwas measured using the smart phone application in the direction of side bending as they are often equipped with an accelerometer and magnetometer.They have the potential to measure and quantify range of motion; such as the cervical spine**. (Tousignant-Laflamme et al., 2013),** the tested smart phone application is valid and reliable to measure ROM of the cervical-spine in flexion, extension and lateral-flexion.**(Quek et al., 2014).**

B) <u>Treatment Instrumentation</u>

<u>Combination therapy device</u>

- Intelect Neo therapy system was used in this study; with model number 6001(Chattanooga DJO industries; made in USA).
- It is composed of a two-channel electrotherapy and US, and features a CT built in system. The selected US parameters consisted of 1 MHz pulsed mode with 50% duty cycle and set at an intensity of 1.2 W/cm^2 and 100Hz repetition rate.
- A 2 cm^2 crystal head with an effective radiating area of 4.0 cm^2 ±1.0 was used.
    - Burst-TENS CT parameters was set at high frequency pulses (100 pulses per second) that was delivered in a low frequency burst pattern (2 burst per second). An asymmetric biphasic waveform; with a phase duration 200 microseconds was used (24). The AMF-CT (IFT bipolar form) was set at a carrier frequency of 4,000 Hz, continuous pattern and a sweep beat frequency of 100-150 Hz **(Moretti et al., 2012;Sciotti et al., 2001).**

<u>Procedure:</u>

Subjects were assessed just before treatment and at the end treatment period. All procedures were explained to subjects prior to any measurements. Subjects underwent a screening process to establish the presence of MTrPs in the trapezius muscle.

➢Evaluative procedures

With the patient seated; the muscle was placed on moderate slack by bringing the ear slightly toward the shoulder on the same side. In a pincer grasp, the entire mass was lifted off then the muscle was firmly rolled between the fingers and thumb to palpate for a nodule and firm bands to locate the spot tenderness of MTrP. (**Simons et al., 1999**).

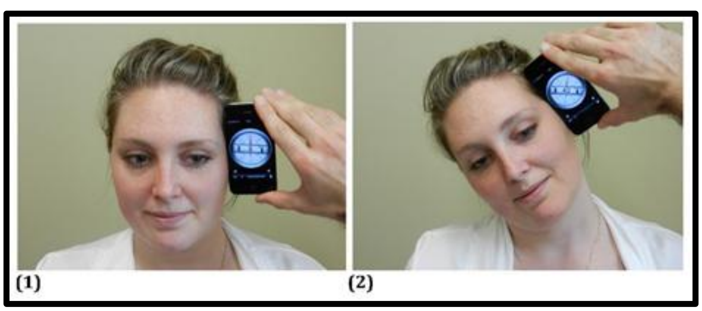
Myofascial trigger point tenderness assessment:

Myofascial trigger point tenderness measured by an electronic digital algometer by obtaining PPT value. With the patient in the same seated position and stretched up position; the transducer probe tip was put perpendicular on the MTrP. Required pressure exerted on the site of MTrP by pressing the transducer firmly downwards. Exerted pressure will be held and will be gradually increased until the subject indicated first sign of pain. The digital reading at this point will be the PPT value. For each assessment, the measurement was repeated three times and the mean of these measurements will be used in further calculations. **(Finocchietti et al., 2015).**

II) <u>Range of motion assessment</u>

For the purpose of this study, participants were asked to perform maximal (end-range) neck side bending. Each participant were asked to perform neck movement at his own pace without going too fast. **(Tousignant-Laflamme et al., 2013).**

Side flexion was measured with the smart phone on contralateral head side with level aligned with the eyes.



Side flexion ROM measurement

➢ Treatment Procedures

A) <u>Combination therapy</u>

The subject comfortably seated and the muscle was placed in a slightly stretched position; making it easier to find MTrPs. The dispersive negative electrode of channel two was placed distal to the active MTrPs;on the deltoid muscle **(Loharjun, 2013)**, while the ultrasound head acted as the positive electrode. After adjusting both electrical current and ultrasound parameters, the intensity raised up until the sensory threshold of the patient. Then circular stroking of ultrasound head over active MTrP1 and 2 of upper fibers of trapezius muscle was applied. For simultaneous electrical stimulation adjust amplitude as produce tingling for 10 minutes.

For the Control group that received sham combination therapy; the same therapeutic ultrasound machine and the electrode placementapplied as experimental group but turn-off electrical current during treatment period will be turned-off **(Loharjun, 2013)**

B) Progressive pressure technique:

Progressive pressure release uses the same concept of barrier-release technique to release the contraction knot in the muscle. **(Simons, 2004).**

The technique was performed as follows: using the thumbs or knuckles, steady pressure was applied, moving inward toward the center. Once tissue resistance felt, we waited until resistance dissipated, and then when a slow release or a "melting away" sensation of the tissue was felt, further steady pressure moving again inward toward the center. The muscle placed in a position to maximize stretch, but in a relaxed one. Pressure application varied in quantity guided by the patient's pain tolerance, where constant feedback provided by the patient. It was applied for at least 30 seconds and up to two (2) minutes at a time. The patient breathed deeply and slowly while we progressively increased the pressure. **(Travell and Simons, 1992).**

C) Passive stretch:

With the patient in a seated position; we stabilized the patient's head position with onehand and with the other hand we took up any slack in the muscle by gently pressing laterally and downward on the scapula. Release was augmented by having the patient coordinate downward eye motionand slow exhalation with relaxation. **(Simons et al., 1999)**

Outcome measures

The primary outcome measure was pain pressure threshold measured by electronic digital algometer and the secondary outcome measure was cervical ROM (side bending) measured by smart phone Clinometer application.

Data Collection and Statistical analysis

1- Descriptive statistics: One Way Analysis of Variance (ANOVA)
Mean, Std. Deviation, Range, Minimum, Maximum, and Variance.
2- Repeated Measures MANOVA: Comparison Mean between treatments within group.
3- Mixed design MANOVA: was used to compare the tested variables of interest at different tested groups and measuring periods. With the initial alpha level set at 0.05.

Descriptive statistics and One Way Analysis of Variance (ANOVA) for the mean age, weight, and height values for the three tested groups.

	Group A (N=23)	Group B (N=25)	Group C (N=22)	F-value	P-value	Level of significant
Age (years)	34.39±5.92	34.88±5.67	35.18±5.56	**0.11**	**0.896**	**N.S**
Body mass (kg)	77.47±19.93	78.64±17.99	88.59±19.09	**0.868**	**0.424**	**N.S**
Height (cm)	163.73±11.69	167.92±10.22	167.5±13.83	**2.33**	**0.105**	**N.S**

***Significant at alpha level <0.05**

The 3x2 mixed design Multivariate Analysis of Variance (MANOVA) for all dependent variables at different measuring periods between both groups.

Source of Variation	F-value	P-value
Groups	35.768	0.0001*
Measuring periods	1350.047	0.0001*
Interaction	54.587	0.0001*

***Significant at alpha level <0.05**.

Descriptive statistics and 3×2 mixed design MANOVA for MTrp1 at different measuring periods among different groups.

MTrp1	Group A (Mean ±SD)	Group B (Mean ±SD)	Group C (Mean ±SD)
Pre	0.72 ±0.18	0.75 ±0.164	0.71±0.168
Post	4.57 ±0.57	2.73 ±0.35	1.86 ±0.17
MD	-3.84	-1.98	-1.15
% of change	↑ 533%	↑ 264%	↑ 161%
Multiple pairwise comparisons between pre and post treatment values for MTrp1 at different groups			
Pre Vs. post	**Group A**	**Group B**	**Group C**

p-value	0.0001*	0.0001*	0.0001*
Multiple pairwise comparison tests (Post hoc tests) for the MTrp1 among different groups at different measuring periods			
	Group A Vs. group B	**Group A Vs. group C**	**Group B Vs. group C**
Pre	1.00	1.00	1.00
Post	0.0001*	0.0001*	0.0001*

***Significant at alpha level <0.05**

Descriptive statistics and 3×2 mixed design MANOVA for MTrp2 at different measuring periods among different groups.

MTrp2	**Group A (Mean ±SD)**	**Group B (Mean ±SD)**	**Group C (Mean ±SD)**
Pre	0.73 ±0.17	0.70 ±0.15	0.73±0.12
Post	4.73 ±0.59	2.74 ±0.32	1.87 ±0.13
MD	-4	-2.03	-1.13
% of change	↑ 547%	↑ 290%	↑ 154%
Multiple pairwise comparisons between pre and post treatment values for MTrp2 at different groups			
Pre Vs. post	**Group A**	**Group B**	**Group C**
p-value	0.0001*	0.0001*	0.0001*
Multiple pairwise comparison tests (Post hoc tests) for the MTrp2 among different groups at different measuring periods			
	Group A Vs. group B	**Group A Vs. group C**	**Group B Vs. group C**
Pre	1.00	1.00	1.00
Post	0.0001*	0.0001*	0.0001*

***Significant at alpha level <0.05**

Descriptive statistics and 3×2 mixed design MANOVA for ROM of right side bending at different measuring periods among different groups.

ROM of right side bending	**Group A (Mean ±SD)**	**Group B (Mean ±SD)**	**Group C (Mean ±SD)**
Pre	35.6±2.11	35.92±1.93	35.37±2.56
Post	52.86±1.86	47.08±1.49	42.55 ±1.19
MD	-17.26	-11.16	-7.18
% of change	↑ 48.48%	↑ 31.06%	↑ 20.29%
Multiple pairwise comparisons between pre and post treatment values for ROM of right side bending at different groups			
Pre Vs. post	**Group A**	**Group B**	**Group C**

p-value	0.0001*	0.0001*	0.0001*
Multiple pairwise comparison tests (Post hoc tests) for the ROM of right side bending among different groups at different measuring periods			
	Group A Vs. group B	**Group A Vs. group C**	**Group B Vs. group C**
Pre	1.00	1.00	1.00
Post	0.0001*	0.0001*	0.0001*

***Significant at alpha level <0.05**

Descriptive statistics and 3×2 mixed design MANOVA for ROM of left side bending at different measuring periods among different groups.

ROM of left side bending	Group A (Mean ±SD)	Group B (Mean ±SD)	Group C (Mean ±SD)
Pre	35.82 ±2.16	36.23 ±2.17	35.64±2.34
Post	53.49 ±1.87	46.99 ±1.39	42.15 ±1.63
MD	-17.67	-10.76	-6.51
% of change	↑ 49.32%	↑ 29.69%	↑ 18.26%
Multiple pairwise comparisons between pre and post treatment values for ROM of left side bending at different groups			
Pre Vs. post	**Group A**	**Group B**	**Group C**
p-value	0.0001*	0.0001*	0.0001*
Multiple pairwise comparison tests (Post hoc tests) for the ROM of left side bending among different groups at different measuring periods			
	Group A Vs. group B	**Group A Vs. group C**	**Group B Vs. group C**
Pre	1.00	1.00	1.00
Post	0.0001*	0.0001*	0.0001*

***Significant at alpha level <0.05**

DISCUSSION

The study was applied to compare between the effect of low frequency burst-TENS CT and medium frequency AMF-CT on active MTrPs on the cervical range of motion (ROM) and pressure pain threshold (PPT) on upper fibers of trapezius active MTrPs.

Patients were simply randomly divided into three groups , group (A) Burst-TENS C.T , group (B) AMF C.T and group (C) was a control group. Within the limitation of this study, there was a few studies concerning the scope of the current study to compare the present results within it.

This study was revealed that there were statistically significant difference in pain pressure threshold and cervical range of motion (side bending) between pre and post - treatment in the 3 groups. (group A versus B), (group A versus C), and (group B versus C) with (P=0.0001*) and this significant increase in favor of group (A) than other groups and in favor to group (B) than group (C). P-value level < (0.01).

The results of this study were in agreement with **Mukkannavar (2008)**, who found that CT with TENS resolved acute active MTrP pain & increased ROM efficiently when compared to ischaemic compression technique alone (**Mukkannavar ,2008**). CT with IFT was found to be an effective in reducing pain, improving sleep and quality of life in fibromyalgia patients **(Moretti et al., 2012; Almeida et al., 2003**).

Also The result of this study comes in accordance with the result stated by **(Avrahami et al., 2015);** who reported that Combined modulated ultrasound and electric field stimulation (CUSEFS) is an excellent adjunct modality and has a positive effect on stimulating wound healing in chronic ulcerations both in matters of chronicity and quality of the .

With methods similar to this study, **Shanahan et al. (2006)** reported in his experimental study using a crossover design with larger participant numbers. They found that TENS at a frequency of 100 Hz had a greater analgesic effect than pre-modulated IFC at a beat frequency of 100 Hz.

Ward et al. (2009) found that the effects of TENS and IFC at 50 Hz on the pain threshold was significantly increased and that there was no significant difference between TENS and IFC in a cold pain model. Also speculated that a short burst duration prevents or severely restricts multiple firing of sensory nerve fibers and instead produces one action potential per burst. The hypoalgesic effects are thus equivalent to TENS.

The findings of this study are in disagreement with (**Almeida et al., 2003)** who demonstrated that the interferential electric current is characterized by a medium frequency wave with low frequency modulated amplitude. IFT (4000 Hz; AMF-100 Hz; intensity in the tactile sensation threshold) It acts as TENS does **(Offenbacherand Stucki, 2000)** and promotes analgesia by blocking pain potentials in the dorsal horn of the spinal cord (DHSC) **(Goats, 1990).**

Solano et al.(2006) in a recent randomized study, compared 30 minutes of TENS with 30 minutes of IFC among 30 patients with acute low back pain. The TENS equipment was calibrated at a frequency of 100 Hz, with a pulse width of

150 ms, pulses of 2 Hz and four electrodes. The IFC was adjusted to a frequency modulation range of 5 Hz and spectrum of 10 Hz, with vectors. The pain reduction (mean difference) among the patients treated with IFC was 2.18 cm (31.5%) and it was 1.24 cm with TENS (18.4%). Despite the statistically meaningful results obtained, no meaningful differences were found between the groups. Both the results obtained by **Solano et al.(2006)** and the results by **FacciI et al. (2011)** the current study emphasize that there are no differences between TENS and IFC use for low back pain patients.

CONCLUSION

Within the scope of our study, we conclude that both CT modalities were effective in increasing PPT and cervical lateral flexion, however, low frequency, high intensity burst-TENS CT produced significant improvements than medium frequency, low-intensity AMF-CT in the management of upper trapezius active MTrPs.

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