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Comparison of Effectiveness of Transcutaneous Electrical Nerve Stimulation and Dry Needling on Pain, Disability, and Pressure Pain Threshold in Patients with Upper Trapezius Myofascial Pain Syndrome: Randomized Clinical Trial

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Original Article

Abstract

Introduction: Myofascial pain syndrome is one of the most common disorders of the musculoskeletal system with skeletal muscle origin. It is characterized by the presence of trigger points, which are very sensitive points in the muscle and are often found in the tight band of skeletal muscle; they are sensitive to stimulation (pressure or use of dry needles) and create a referral pain in an area far from that points. The prevalence of trigger points is higher in the postural muscles of the upper quarter, especially the trapezius muscle. The aim of this study was to compare the short-term effects of transcutaneous electrical nerve stimulation (TENS) with dry needling on pain, disability, and pressure pain threshold in subjects with trigger points in upper trapezius muscle.

Materials and Methods: In this clinical trial, 45 patients with upper trapezius muscle trigger points were randomly divided into three groups: TENS and stretching exercise (group A), dry needling and stretching exercise (group B), and stretching exercise alone (group C, control). The joint program between the three groups was to perform trapezius muscle stretching exercises at home for two weeks. In addition to stretching exercise training, group A was treated with TENS for ten sessions during two weeks (5 days a week). Group B, besides stretching exercise training, was treated with three sessions of dry needling for two weeks. Group C was the control group and was trained only in stretching exercises. The outcomes were pain intensity, disability, and pressure pain threshold that were measured using Visual Analog Scale (VAS), Neck Disability Index (NDI), and digital algometer. Paired t-test was used to compare before and after treatment in each group and one-way analysis of variance (ANOVA) test was used to compare mean changes between the three groups.

Results: After treatment, significant improvement was seen in pain intensity and NDI in all three groups ($P < 0.001$), but there was no significant difference in pressure pain threshold in any of the three groups before and after the intervention ($P > 0.05$). Moreover, there was no significant difference between the three groups in mean changes of pain, pressure pain threshold, and NDI scores after the intervention compared to before the intervention ($P > 0.05$).

Conclusion: Although the use of TENS and dry needling along with stretching exercises in subjects with upper trapezius muscle trigger points helps to reduce pain and disability, but it has no additional effect and only stretching exercise in these patients helps to reduce pain and disability to the same extent.

Keywords: Transcutaneous electrical nerve stimulation; Dry needling; Myofascial pain syndrome; Upper trapezius muscle; Trigger point

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Introduction

Myofascial pain syndrome is a common musculoskeletal disorder in skeletal muscles. It is characterized by sensory, motor, and autonomic symptoms caused by trigger points (1, 2). These trigger points are susceptible points within the muscle, often found in the tight bands of skeletal muscles. When stimulated, either through pressure or dry needling, these points can produce a referred pain in a distant area (1). Myofascial trigger points (MTPs) are the primary source of pain in 30-85% of musculoskeletal patients (3), and up to 85% of the general population has experienced this pain at least once in their lifetime (4). MTPs can affect individuals of any age group, but their prevalence is higher in middle-aged people, estimated at 65% in women and 37% in men (5).

There are two categories of MTPs: active and inactive. Active MTPs are characterized by spontaneous pain without touch, which may spread to other areas. However, inactive trigger points are typically not painful, and the pain is only caused by applying pressure to them (1, 6). According to Travell and Simons (1) and Rickards (7), the clinical features of trigger points include the presence of a hard band that contains a distinct and palpable nodule, a history of local tenderness, a referable pain pattern that can be attributed to trigger points and can reproduce a local reaction caused by touch called local twitch response (LTR), and a spontaneous reaction to pain due to mechanical pressure (Jump sign).

The development of MTPs and myofascial pain syndrome involves several underlying factors, including trauma, mechanical causes, aging, nerve root pressure, mental and emotional factors, and metabolic disorders. Repeated use of muscles and improper posture and ergonomics at work and in the living environment contribute to the development of MTPs and myofascial pain syndrome. Additionally, degenerative joint disorders, reduced muscle flexibility, hormonal problems, and lack of vitamins and minerals may be the contributing factors (8-10).

Muscles that undergo long-term eccentric contractions, particularly antigravity and postural muscles, are more prone to trigger points (7). Trigger points are more common in the postural muscles of the upper quarter of the body, especially the trapezius muscle (11). The trapezius muscle is crucial in the movement and stability of the neck and shoulder girdle, and the presence of active MTPs in the trapezius muscle can lead to neck and shoulder girdle dysfunction, in addition to local pain (12). Muscles can develop trigger points that have various effects, such as increased muscle tension, changes in the time and amount of muscle activation, muscle weakness, limitation of range of motion, fatigue, and autonomic changes (4). When these trigger points persist in the neck and shoulder area, they can cause headaches, neck pain, dizziness, etcetera that can negatively impact an individual's quality of life (QOL) and result in a significant financial burden on the health system (1, 3, 4). Therefore, it is crucial to diagnose and treat these trigger points, especially in the upper part of the trapezius muscle, as an essential part of a comprehensive neck physiotherapy program (13).

The treatment offered to patients with myofascial pain syndrome aims to reduce pain and disability. Various non-invasive and invasive methods have been used to treat this syndrome (11). Non-invasive techniques include educating patients (14) about the condition, managing underlying factors (14), using drug treatments such as analgesics, muscle relaxants, and antidepressants (15), and using surface and deep thermal techniques (14), electrotherapy, manual therapy methods, and exercise therapy (15, 16). Invasive treatments include local injection, dry needling, and acupuncture (12, 15, 16).

One widely used non-invasive method to reduce acute and chronic pain is transcutaneous electrical nerve stimulation (TENS) (13). This technique involves applying electrical stimulation to the skin for pain control, and effectively treats myofascial syndrome (8, 10, 15). TENS operates on the gate control theory of pain, an effective control mechanism. Another mechanism is the increase in the release of opioid substances (13, 18).

Clinical trials have shown that TENS can effectively reduce short-term pain, while increasing the range of motion and pressure pain threshold in people with trapezius muscle trigger points (22-19, 13, 2). Although there have been several studies on how TENS can reduce pain caused by myofascial pain syndrome of the trapezius muscle (22-19, 13, 2), the number of randomized clinical trials in this field is relatively small, and there are contradictions. Thus, further investigation in this regard is necessary.

Dry needling is another treatment method for MTPs, and it is a relatively low-risk, easy, and accessible method (23). In this method, the needle is inserted directly into the trigger point in the muscle without injecting any specific substance (12). Dry needling includes superficial dry needling (SDN) and deep dry needling (DDN) techniques (6). SDN has indirect effects, and C fibers inhibit pain, but DDN affects the muscle directly, leading to repeated depolarization of muscle fibers in the area (23).

Despite muscle burning after needling, due to stronger therapeutic effects, the DDN technique seems more suitable for pain with myofascial origin (23, 5). The dry needling technique effectively reduces symptoms through gate control and activation of the descending inhibitory system, shortening of muscle fibers, normalization of chemical changes at the site of pain, and secretion of analgesic indicators (24, 12, 3).

Several studies (25-30) have confirmed the effect of the dry needling technique in reducing myofascial pain. It has been suggested as a treatment method for minimizing MTP pain in the shoulder and neck areas (27). Clinical trials have shown that using dry needling in treating trigger points of the trapezius muscle significantly improves the intensity of pain and the pressure pain threshold (29, 28, 11, 3). According to the mentioned researches, the dry needling technique can be prescribed when the main goal is to reduce the pain at trapezius muscle trigger points. Although there are disagreements about the mechanism of action of dry needling in improving the symptoms of patients with myofascial pain syndrome, it seems effective in treating pain caused by myofascial pain syndrome.

Despite the various treatment methods available, it is important to find a method to treat MTPs in the minimum number of treatment sessions and minimum treatment session duration with at minimum cost. Based on the obtained information, many researchers have investigated the effect of TENS and dry needling separately. However, no study has been conducted to compare the two therapeutic methods of dry needling and TENS in treating myofascial pain syndrome of the trapezius muscle. The dry needling is an invasive treatment, while TENS is a non-invasive treatment. Some patients cannot benefit from dry needling due to its prohibition. Considering the difference in the duration and costs of these two methods, it seems necessary to compare the effects of these two methods on pain and level of disability of people with cervical myofascial pain syndrome. Perhaps, based on the comparison of these two methods, a decision can be made in choosing the appropriate treatment to improve pain and disability in these patients.

Therefore, the present study was performed to compare the short-term effect of TENS on the amount of pain, disability, and pressure pain threshold in people with trigger points of the upper trapezius muscle with that of dry needling.

Materials and Methods

This double-blind, randomized clinical trial (experimenter and analyst) with a parallel design was conducted in the spring, summer, and fall of 2021 at the third physiotherapy clinic in Shaaban, Isfahan province, Iran, on 45 patients.

The ethics committee of Isfahan University of Medical Sciences approved the research project with the code IR.MUI.RESEARCH.REC.1399.392. It was registered in Iran's clinical trial registration system with the code IRCT20200204046376N1. People suffering from myofascial pain in the neck were identified and invited to the study through the publication of advertisements in public and private medical centers, cyberspace, and city-level cultural centers and health centers of Isfahan University of Medical Sciences. The participants were selected through non-random sampling (convenience sampling). Then, information about the research objectives and procedures was provided to the participants, and the participants underwent a comprehensive clinical evaluation by a physiotherapist. If they had the necessary conditions and inclusion criteria, they were entered into the study after completing the consent form (including all information related to the research and its goals and benefits) through a medical history review and comprehensive evaluation and interview. The patient was given the right to withdraw from the study at any stage of the research. Moreover, the volunteers were assured that all their personal and medical information would remain confidential.

Based on relation 1, a sample size of at least 11 individuals was required in each group. In this relation, z1 represents a 99% confidence interval (2.58), while z2 represents a 90% confidence interval (1.28). Additionally, s1 and s2 are estimates for the standard deviation of the score. After the intervention, the pain intensity was reported as 1.17 and 0.92 in the TENS and dry needling groups, respectively. M1 and M2 represent the average pain intensity after the intervention in the TENS and dry needling groups, which were reported as 3.5 and 1.8, respectively (30). Considering the possibility of dropouts, each group consisted of 15 patients.

Relation 1: $$\frac{(z_1+z_2)^2(s_1^2+s_2^2)}{(m_1-m_2)^2}$$

The study participants included 60 individuals who attended the third physiotherapy clinic of Shaaban Flowerjan, Isfahan. They were given 72 hours to confirm their participation. Then, they had to fill out a consent form and demographic information

form and provided information such as contact details, age, gender, employment status, education level, weight, and height. After checking the inclusion and exclusion criteria, 45 patients (36 women and 9 men) were included in the study. The physiotherapist taught the patients the stretching exercise for the trapezius muscle (31) and determined the location of the trigger points through pincer palpation (32). A 10 x 10 cm paper with holes in the middle and 4 corners was used for marking to keep the location of the points fixed (33). If there was more than 1 painful point, the issue with the most pain was tested. Eligible subjects were randomly divided into 3 groups: A (TENS), B (dry needling), and C (control) without taking any painkillers.

The inclusion criteria for participants in this study are as follows: they must be between the ages of 18 and 50 years (22,11), be able to read and write (2), have trigger points in the upper trapezius muscle as evaluated by the Travell and Simons index (3), have non-specific neck pain with a score of at least 3 on the visual analog scale (VAS) and the origin of the trigger points should be in the upper trapezius muscle and may be referred to as the area between the shoulder blades and the head of the shoulders (34,12). The study exclusion criteria included presence of fibromyalgia syndrome diagnosed by a specialist doctor (35), presence of posture disorders such as kyphosis or severe scoliosis where the vertebrae of the spine are not in their normal alignment (36), congenital malformation in the neck area (33), use of anticoagulants or corticosteroids (35), use of painkillers within 48 hours prior to the beginning of the intervention (2), alcohol and drug use (36), communication and cognitive disorders (36), sensory impairment in the treated area (neck, shoulder, and shoulder) (2), symptoms of radiculopathy (3), receiving treatment for trapezius muscle trigger points within the last 3 months (22), degenerative problems of the neck vertebrae and shoulder joint (2), history of surgery in the neck or shoulder area (35), cases prohibiting the use of dry needling, such as fear of needles (5), local infection, pregnancy with the risk of miscarriage, menstruation, and serious medical problems (3), diagnosis of a neurological disorder by a specialist doctor (20), and presence of malignancy and systemic diseases (33).

After data collection, the participants' specifications and data under groups A, B, and C were delivered to a statistical analyst who performed the analysis without knowledge of the groupings. One-way ANOVA, chi-square test, and Kruskal-Wallis test were used to check the homogeneity of the demographic characteristics in the 3 groups, and the Shapiro-Wilk test was used to compare the distribution of pain scores, pressure pain threshold, and neck disability index before and after the intervention in each group. Since all 3 variables followed a normal distribution, the paired t-test was used to compare them before and after the intervention within each group, and one-way ANOVA was used to compare the variables between groups. Finally, the data were analyzed using SPSS software (version 20; IBM Corp., Armonk, NY, USA).

The study analyzed the 3 variables of pain, pressure pain threshold, and the neck disability index. The measurement tools used were VAS, a digital algometer, and the neck disability index questionnaire. The associate physiotherapist took the measurements before the beginning of the treatment and 2 weeks after the end of the treatment without knowing the treatment type received by the patient.

Pain intensity: Pain intensity was measured using the VAS scale (Figure 1), which ranges from 0 to 10. The patient rates their pain intensity on a 100 mm horizontal line, with 0 indicating no pain and 10 indicating the highest imaginable pain. The reliability and validity of this tool have been determined in previous studies (ICC = 0.97; CI = 0.96-0.98) (37, 38).

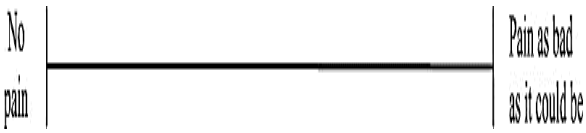

Figure 1. Visual Analogue Scale (VAS)

Pain threshold: The pain threshold of the patient was tested using a pressure algometer. The algometer used in this study was a digital model (FG-5020; Lutron Electronic, Taiwan), which measures pressure in kg/m^2. Before the measurement, the patient was given the necessary training to familiarize them with the concept of the pressure pain threshold. This training was provided at a point other than the examined points, specifically at the middle point of the deltoid muscle. The patient was asked to report to the examiner by saying "enough" as soon as the feeling of pressure changed to pain. Once the subject was fully aware, they were placed in a relaxed position in a chair, and the probe of the device was placed at an approximate 90° angle over the trigger point of the upper trapezius muscle. The pressure was then gradually increased at an approximate rate of 1 kg/cm^2 until the onset of the trigger point pain was reached, which was then recorded as the maximum

applied pressure. This test was repeated 3 times with a time interval of 30 seconds, and the average obtained was recorded as the participant's pain threshold score. The tool used in this test has been previously confirmed to be a valid and reliable research tool, with an ICC of 0.91 and CI of 0.82-0.97 (6, 39).

Neck Functional Disability Questionnaire: To assess the functional disability of the neck, the Neck Disability Index Questionnaire consisting of 10 sections was used. This questionnaire evaluates how neck pain affects a person's daily activities, including personal care, reading, headache, concentration, work, driving, sleeping, lifting, and recreation. Each item of the questionnaire is scored on a scale ranging from 0 to 5, with 0 indicating no impairment and 5 indicating the most significant disability. The total score of the questionnaire ranges from 0 to 50 and a score of 0-4, 5-14, 15-24, 25-34, and 35-50 represents no disability, low disability, moderate disability, severe disability, and complete disability, respectively (39, 40). This tool has been validated in studies on patients with neck pain. In the present study, the Persian version of the tool was used, and its repeatability and validity are acceptable in neck pain patients (ICC = 0.90-0.97; Cronbach's alpha = 0.88) (41).

Therapeutic intervention: Before grouping the participants, they were taught stretching exercises for the trapezius muscle. The exercises consisted of 3 movements: flex, contralateral side bend, and ipsilateral rot. Patients were instructed to do the exercises 3 times per day, 10 times each session and hold the stretching position for 15 seconds (13, 35). A physiotherapist provided practical training, and a brochure explaining how to perform the exercises was given to each participant. Patients were also given forms to mark every time they completed the exercises to ensure compliance. During the 2-week project, patients were contacted by phone to monitor their exercise regimen.

Group A was treated with TENS (burst-type asymmetrical rectangular biphasic pulse electrical current) for 10 sessions over 2 weeks. Each session lasted 20 minutes and was administered 5 days a week. The TENS frequency was 100 Hz, and the pulse duration was 250 microseconds. The intensity of the current was increased until the patient felt a strong flow, but no muscle contraction was observed. The current was applied using 2 electrodes, with the negative electrode placed on the trigger point and the positive electrode placed at the connection between the muscle and the acromion (2, 22). A Stimulator710 P Plus device was used for electrical stimulation.

Group B received 3 dry needling sessions over 2 weeks (28, 35). Before the technique was applied, the most sensitive active trigger point was detected, and its position on the skin was determined. A physiotherapist trained in this field used a needle with a diameter of 0.3 and a length of 30 mm. The needle was inserted into 2 points while the patient was lying on the stomach and the back, from both the front and back sides. The needle was moved back and forth 10 times in 10 seconds, with a frequency of 1 Hz vertically inside the muscle tissue (32, 42).

Group C was the control group, which only received upper trapezius muscle stretching exercises.

Results

Out of the initial group of 60 people who were asked to participate in the research project, 45 successfully met the inclusion criteria and completed the consent form. The remaining 15 people could not join the study due to certain conditions. Table 1 displays the demographic information of the participants. No significant difference was observed between the 3 groups in terms of their demographic characteristics, as revealed by the results of one-way ANOVA ($P < 0.05$).

The results of the chi-square test with the likelihood ratio showed that the frequency distribution of gender and occupation did not significantly differ between the 3 groups ($P < 0.05$). Based on the results of the Kruskal-Wallis test, no significant difference was observed between the 3 groups in terms of education level ($P < 0.05$) (Table 2).

The results of the Shapiro-Wilk test showed that the distribution of pain scores, disability, and pressure pain threshold before and after the intervention in all 3 groups followed a normal distribution. Therefore, paired t-test and one-way ANOVA were used to analyze the data.

Based on the paired t-test results, the mean scores of neck pain and disability in all 3 groups decreased significantly after the intervention ($P < 0.001$).

Table 1. Average refractive errors in the right and left eyes

Variable	TENS group (mean ± SD)	Dry-needling group (mean ± SD)	Control group (mean ± SD)	P
Age (years)	35.7 ± 7.2	34.1 ± 8.4	33.3 ± 6.9	0.69
Height (cm)	163.9 ± 4.6	166.7 ± 8.3	163.4 ± 7.1	0.37
Weight (kg)	67.7 ± 9.7	69.7 ± 9.6	64.8 ± 9.2	0.38
BMI (kg/m^2)	25.2 ± 3.8	25.1 ± 3.2	24.3 ± 3.8	0.77

TENS: Transcutaneous electrical nerve stimulation; SD: Standard deviation

Table 2. Frequency distribution of gender, occupation, and education level among the three groups

Variable		TENS group [n (%)]	Dry needling group [n (%)]	Control group [n (%)]	P
Gender	Female	13 (86.7)	10 (66.7)	13 (86.7)	0.30
	Male	2 (13.3)	5 (33.3)	2 (13.3)	
Occupation	Freelance	3 (20.0)	4 (26.7)	3 (20.0)	0.85
	Housewife	9 (60)	5 (33.3)	7 (46.7)	
	Employee	2 (13.3)	3 (20.0)	3 (20.0)	
	Student	1 (6.7)	3 (20.0)	2 (13.3)	
Education level	Pre-diploma	4 (26.7)	2 (13.3)	3 (20.0)	0.69
	Diploma and associate degree	7 (46.6)	8 (53.4)	6 (40.0)	
	Bachelor's and above	4 (26.7)	5 (33.3)	6 (40.0)	

TENS: Transcutaneous electrical nerve stimulation

However, there was no significant difference in the mean pressure pain threshold score in any of the 3 groups after the intervention compared to before the intervention ($P < 0.050$) (Table 3).

One-way ANOVA results showed no significant difference between the three groups in the average of any of the pain scores, pressure pain threshold, and neck disability before and after the intervention ($P < 0.05$) (Table 4).

According to the results of one-way ANOVA, the average changes in pain scores ($P = 0.99$), pressure pain threshold ($P = 0.71$), and neck disability ($P = 0.81$) after the intervention compared to before the intervention between the 3 groups showed no significant differences ($P < 0.05$) (Table 5).

Discussion

The present study was conducted to compare the effectiveness of TENS and dry needling on pain, disability, and pressure pain threshold in patients with trigger points of the upper trapezius muscle. The results revealed that adding TENS or dry needling to the standard exercise program did not have an additional effect in reducing pain and improving disability in patients with upper trapezius muscle trigger points.

The reduction in pain intensity after the treatment period (2 weeks) was 3.6, 3.7, and 3.7 in the TENS, dry needling, and control groups, respectively. This reduction was significant in all 3 groups compared to the baseline value ($P \geq 0.05$). However, the decline was not significant when comparing the TENS and dry-needling groups with the control group ($P < 0.05$).

Rayegani et al. conducted a study comparing 1 session of dry needling and 10 sessions of routine physiotherapy, where both groups also did stretching exercises (35). The results showed that both methods can equally reduce pain (35). This finding was also supported by Manafnezhad et al. (12), Hesari et al. (29), and Gerber et al. (28).

From a mechanical point of view, inserting a dry needle into trigger points creates mechanical tension in the contractile structure, reducing the overlap between actin and myosin and helping return sarcomeres to their resting length. From a neurophysiological point of view, dry needling stimulates the A-delta nerve receptor. It activates inhibitory mediator neurons, producing enkephalin in the spinal cords posterior horn, thus reducing pain (24). This mechanism activates the serotonergic and noradrenergic descending inhibitory system and blocks the pain message in the posterior horn of the spinal cord.

Table 3. Comparison of average pain scores, pressure pain threshold, and neck disability in each of the three groups before and after the intervention

Group	Score	Before intervention (mean ± SD)	After intervention (mean ± SD)	P-value
TENS	Pain (VAS)	7.8 ± 0.9	4.2 ± 2.3	< 0.001
	Pain pressure threshold	1.5 ± 0.6	1.8 ± 0.6	0.120
	Cervical Disability index	17.3 ± 5.2	10.3 ± 5.0	< 0.001
Occupation	Pain (VAS)	7.7 ± 2.1	4.0 ± 2.1	< 0.001
	Pain pressure threshold	1.6 ± 0.8	1.7 ± 0.7	0.200
	Cervical Disability index	15.1 ± 5.3	9.0 ± 3.9	< 0.001
Education level	Pain (VAS)	7.6 ± 1.0	3.9 ± 2.9	< 0.001
	Pain pressure threshold	1.4 ± 0.6	1.7 ± 0.7	0.130
	Cervical Disability index	13.8 ± 5.3	7.8 ± 5.9	< 0.001

SD: Standard deviation; VAS: Visual Analog Scale

Table 4. Comparison of mean pain scores, pressure pain threshold and neck disability before and after the intervention between the three groups

Score	Group	TENS (mean ± SD)	Dry needling (mean ± SD)	Control (mean ± SD)	P-value
Pain (VAS)	Before intervention	7.8 ± 0.9	7.7 ± 2.1	7.6 ± 1.0	0.92
	After intervention	4.2 ± 2.3	4.0 ± 2.1	3.9 ± 2.9	0.95
Pain pressure threshold	Before intervention	1.5 ± 0.6	1.6 ± 0.8	1.4 ± 0.6	0.84
	After intervention	1.8 ± 0.6	1.7 ± 0.7	1.7 ± 0.7	0.92
Cervical Disability index	Before intervention	17.3 ± 5.2	15.1 ± 5.3	13.8 ± 5.3	0.19
	After intervention	10.3 ± 5.0	9.0 ± 3.9	7.8 ± 5.9	0.39

TENS: Transcutaneous electrical nerve stimulation; SD: Standard deviation; VAS: Visual Analog Scale

From a chemical point of view, the level of chemicals such as bradykinin and substance P at the trigger points increases, and the pH of the environment decreases. Performing dry needling and creating its contractile response can directly return the level of these substances to a normal state and help reduce pain (24). Additionally, dry needling may affect microcirculation and increase skin and muscle blood flow at the target site (3). In a study by Dissanayaka et al., the effectiveness of TENS and interferential flow, alongside standard treatment, was compared in individuals with myofascial pain syndrome (2). The results showed that TENS significantly reduces pain (2), which is in line with the current study's findings. This outcome was also confirmed in the studies conducted by Azatcam et al. (13) and Farina et al. (21).

In another study, Sahin et al. compared the effects of 4 types of TENS in individuals with neck myofascial pain syndrome and concluded that solely using TENS does not improve pain and disability (33). Their research only used TENS treatment and did not include exercise therapy (33), which could be the primary reason for the difference in the results of their study compared to the current one. Moreover, in the research by Sahin et al., the individuals with neck myofascial pain did not exclusively have trapezius muscle trigger points (33), and the TENS method used was different from that used in the present study.

The mechanism of the TENS effect is based on the pain gate theory, which suggests that stimulating thick myelinated afferent fibers blocks pain transmission by non-myelinated fibers with a small diameter (43, 20). Additionally, TENS helps improve blood flow, increase oxygen supply, reduce painful substances, and decrease the release of acetylcholine (22). Using TENS also leads to a series of neurophysiological changes that help reduce pain (43, 20).

After the 2-week treatment period, the neck disability index scores were reduced by 0.7, 1.6, and 0.6 points in the TENS, dry needling, and control groups, respectively. All 3 groups showed significant improvement compared to the baseline value ($P \geq 0.05$). However, there was no significant difference between the TENS and dry-needling groups compared to the control group ($P < 0.05$).

Gerber et al. investigated the effect of 3 sessions of dry needling on patients with myofascial pain syndrome (28). They found that dry needling could effectively reduce the neck disability index (28), which is consistent with the findings of this study. Other studies have also confirmed these results. A separate study examining the effects of TENS and Kinesio taping in combination with exercise therapy found that TENS could effectively reduce the neck disability index (13).

The use of TENS and dry needling techniques can help reduce pain caused by neck pain. The Neck Disability Index (NDI) is a tool used to assess the impact of neck pain on daily activities, such as concentration, personal care, reading, working, lifting, sleeping, driving, and recreational activities. After pain reduction, an improvement is observed in the patient's performance and disability index.

Table 5. Comparison of mean changes in pain scores, Pain pressure threshold and Cervical disability before and after the intervention between the three groups

Score	TENS (mean ± SD)	Dry needling (mean ± SD)	Control (mean ± SD)	P-value
Pain (VAS)	-3.6 ± 2.3	-3.7 ± 2.5	7.6 ± 1.0 3.9 ± 2.9	0.99
Pain pressure threshold	0.3 ± 0.2	0.3 ± 0.1	1.4 ± 0.6 1.7 ± 0.7	0.71
Cervical Disability index	-7.0 ± 5.4	-6.0 ± 4.3	13.8 ± 5.3 7.8 ± 5.9	0.81

VAS: Visual Analog Scale; SD: Standard deviation

In the present study, the increase in the pressure pain threshold at the trigger points of the upper trapezius muscle in the TENS, dry needling, and control groups were reported as 0.3, 0.1, and 0.3, respectively, after the end of the treatment period (which lasted 2 weeks). However, this increase in the 3 groups was not significant compared to the baseline value ($P < 0.05$).

Previous studies have shown that dry needling can cause a significant increase in the pressure pain threshold. However, the present study showed that the use of dry needling did not result in a significant change in the pressure pain threshold. This contradiction in results may be due to several reasons:

a. The time to measure the pressure pain threshold was different. In the present study, the pressure pain threshold was measured 3 days after the last dry needling session, whereas in previous studies, this time ranged from immediately after dry needling to 1 week after the treatment.

b. Differences in the method of performing the dry needling technique, the number of sessions, and the interval between sessions can also be the causes of the differences in the results.

c. In some studies, the lack of blinding of the person who measures the pressure pain threshold and the possibility of bias can be another reason for the difference in the results.

d. Other differences between the studies can also account for inconsistent results. For instance, in the study by Rayegani et al., patients were advised to use ice and capsaicin ointment for 24 hours after dry needling (35), which can effectively reduce the pressure pain threshold.

Furthermore, it is essential to note that measuring the pressure pain threshold can potentially impact the obtained results.

The present study found that the TENS group did not experience a significant change in the pressure pain threshold. This finding is consistent with that of Farina et al. (21); they compared different methods of electrotherapy and stretching exercises in patients with upper trapezius muscle trigger points. The researchers concluded that TENS did not improve the pressure pain threshold after 1 week of treatment.

Another study investigated the effect of 10 minutes of Brest-type TENS on pressure pain threshold and neck range of motion in people with silent trigger points of the upper trapezius muscle. TENS treatment significantly improved pressure pain threshold compared to the placebo group (22). The reason for the contradiction between the findings and the results of the present study can be seen as the difference in the time of measuring the results and the type of trigger points investigated. In one study, the type of trigger points was off, and the pressure pain threshold was measured immediately after 10 minutes of using Brest TENS. However, active trigger points were used in the present study, and the results were measured 2 days after the last treatment session (22).

Azatcam et al. conducted a study to compare the effectiveness of TENS and Kinesio taping used in conjunction with exercise therapy (13). The results showed that all 3 groups significantly improved their pressure pain threshold. The differences in outcomes can be attributed to the differences in TENS current type, frequency, and wavelength (13).

When dry needling and exercise therapy, TENS, and exercise therapy alone were used to treat individuals with trigger points of the upper trapezius muscle, all three methods were found to be equally effective in reducing pain and disability. Additionally, stretching exercises alone effectively reduced pain and disability in individuals with upper trapezius muscle trigger points.

Stretching exercises recommended by Travell and Simons are practical for muscles with trigger points (1). They are the primary treatment method for myofascial pain syndrome. These exercises gradually reduce muscle stiffness and shorten to help restore the muscles' normal activity, thereby limiting pain. Stretching exercises also help deactivate trigger points and tight bands inside the muscles, allowing shortened muscles to return to their normal length and increase the range of motion (45, 44). A study compared the effectiveness of TENS, dry needling, and stretching exercises. It was found that stretching exercises significantly reduced pain intensity, disability index, and pressure pain threshold in people with trigger points of the upper trapezius muscle (13). Similarly, a study compared the effect of low-power laser and intramuscular stimulation, which showed that in the control group that received only stretching exercise, there was a significant decrease in pain intensity and disability (46).

However, in a study comparing two types of electrical stimulation in people with upper trapezius muscle trigger points, no improvement was observed in any variables (pressure pain threshold, pain, and disability) in the control group that did only stretching exercises (20). This discrepancy between the studies could be attributed to the way of teaching the exercises and monitoring their implementation.

Considering the lack of change in pressure pain threshold in all 3 groups, the cause of pain

reduction can be mostly related to the central mechanisms of pain reduction.

Limitations

The study was limited by the unavailability of suitable samples and the concurrent coronavirus pandemic.

Recommendations

It is suggested that future studies follow a similar approach to the present study, and examine the effects of pain management methods separately for both genders and different levels of pain intensity. Due to the lack of long-term follow-up on patients, the long-term effects of these methods were not investigated or compared. Therefore, it is recommended that these effects be explored in future researches.

Conclusion

The results of the present study indicate that there is no significant difference in the effectiveness of dry needling and TENS in reducing pain and disability in patients with trigger points in the upper trapezius muscle. However, neither method had any effect on improving the pressure pain threshold. Additionally, neither of these methods had any additional impact compared to stretching exercises. Therefore, it is not necessary to use TENS or dry needling if patients perform stretching exercises regularly and accurately. Muscle stretching exercises alone can help reduce pain and disability. It is important to note that the study did not include long-term follow-up, and the results were only observed after 2 weeks. Further research may be needed to examine any differences between the groups in the long run.

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Authors' Contribution

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Scientific and executive support of the study: Sayed Mohsen Mirbod
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Data collection: Parisa Mehri
Analysis and interpretation of data: Sayed Mohsen Mirbod, Fatemeh Bokaei, Parisa Mehri
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Specialized scientific evaluation of the manuscript: Sayed Mohsen Mirbod, Fatemeh Bokaei, Parisa Mehri
Confirmation of the final manuscript for submission to the journal website: Sayed Mohsen Mirbod, Fatemeh Bokaei, and Parisa Mehri
Maintaining the integrity of the study process from the beginning until publication, and responding to the referees' comments: Sayed Mohsen Mirbod, Fatemeh Bokaei, and Parisa Mehri

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Conflict of Interest

Authors do not have any conflicts of interest. Mr. Sayed Mohsen Mirbod received the project implementation budget from Isfahan University of Medical Sciences.

References

1. Travell J, Simons D. Myofascial pain and dysfunction, Vol. 1: The trigger point manual, the upper extremities. 2nd ed. Baltimore, MD: Williams and Wilkins; 1999. p. 1-93
2. Dissanayaka TD, Pallegama RW, Suraweera HJ, Johnson MI, Kariyawasam AP. Comparison of the effectiveness of transcutaneous electrical nerve stimulation and interferential therapy on the upper trapezius

in myofascial pain syndrome: A randomized controlled study. Am J Phys Med Rehabil 2016; 95(9): 663-72.
3. Ziaeifar M, Arab AM, Karimi N, Nourbakhsh MR. The effect of dry needling on pain, pressure pain threshold and disability in patients with a myofascial trigger point in the upper trapezius muscle. J Bodyw Mov Ther 2014; 18(2): 298-305.
4. Leon-Hernandez JV, Martin-Pintado-Zugasti A, Frutos LG, Alguacil-Diego IM, de la Llave-Rincon AI, Fernandez-Carnero J. Immediate and short-term effects of the combination of dry needling and percutaneous TENS on post-needling soreness in patients with chronic myofascial neck pain. Braz J Phys Ther 2016; 20(5): 422-31.
5. Myburgh C, Hartvigsen J, Aagaard P, Holsgaard-Larsen A. Skeletal muscle contractility, self-reported pain and tissue sensitivity in females with neck/shoulder pain and upper Trapezius myofascial trigger points- a randomized intervention study. Chiropr Man Therap 2012; 20(1): 36.
6. De Meulemeester KE, Castelein B, Coppieters I, Barbe T, Cools A, Cagnie B. Comparing trigger point dry needling and manual pressure technique for the management of myofascial neck/shoulder pain: A randomized clinical trial. J Manipulative Physiol Ther 2017; 40(1): 11-20.
7. Rickards LD. The effectiveness of non-invasive treatments for active myofascial trigger point pain: A systematic review of the literature. Int J Osteopath Mede 2006; 9(4): 120-36.
8. Yap EC. Myofascial pain--an overview. Ann Acad Med Singap 2007; 36(1): 43-8.
9. Yıldırım A, Akbaş A, Sürücü GD, Karabiber M, Gedik DE, Aktürk S. Effectiveness of mobilization practices for patients with neck pain due to myofascial pain syndrome: A randomized clinical trial. Turk J Phys Med Rehabil 2016; 62(4): 337-45.
10. Huguenin LK. Myofascial trigger points: the current evidence. Phys Ther Sport 2004; 5(1): 2-12.
11. Abbaszadeh-Amirdehi M, Ansari NN, Naghdi S, Olyaei G, Nourbakhsh MR. The neurophysiological effects of dry needling in patients with upper trapezius myofascial trigger points: study protocol of a controlled clinical trial. BMJ Open 2013; 3(5).
12. Manafnezhad J, Salahzadeh Z, Salimi M, Ghaderi F, Ghojazadeh M. The effects of shock wave and dry needling on active trigger points of upper trapezius muscle in patients with non-specific neck pain: A randomized clinical trial. J Back Musculoskelet Rehabil 2019; 32(5): 811-8.
13. Azatcam G, Atalay NS, Akkaya N, Sahin F, Aksoy S, Zincir O, et al. Comparison of effectiveness of Transcutaneous Electrical Nerve Stimulation and Kinesio Taping added to exercises in patients with myofascial pain syndrome. J Back Musculoskelet Rehabil 2017; 30(2): 291-8.
14. Auleciems LM. Myofascial pain syndrome: A multidisciplinary approach. Nurse Pract 1995; 20(4): 18, 21-8, passim.
15. Desai MJ, Saini V, Saini S. Myofascial pain syndrome: A treatment review. Pain Ther 2013; 2(1): 21-36.
16. Tough EA, White AR, Cummings TM, Richards SH, Campbell JL. Acupuncture and dry needling in the management of myofascial trigger point pain: A systematic review and meta-analysis of randomised controlled trials. Eur J Pain 2009; 13(1): 3-10.
17. Gemmell H, Hilland A. Immediate effect of electric point stimulation (TENS) in treating latent upper trapezius trigger points: A double blind randomised placebo-controlled trial. J Bodyw Mov Ther 2011; 15(3): 348-54.
18. Walsh DM, Howe TE, Johnson MI, Sluka KA. Transcutaneous electrical nerve stimulation for acute pain. Cochrane Database Syst Rev 2009; (2): CD006142.
19. Maayah M, Al-Jarrah M. Evaluation of transcutaneous electrical nerve stimulation as a treatment of neck pain due to musculoskeletal disorders. J Clin Med Res 2010; 2(3): 127-36.
20. Ardic F, Sarhus M, Topuz O. Comparison of two different techniques of electrotherapy on myofascial pain. J Back Musculoskelet Rehabil 2002; 16(1): 11-6.
21. Farina S, Casarotto M, Benelle M, Tinazzi M, Fiaschi A, Goldoni M, et al. A randomized controlled study on the effect of two different treatments (FREMS AND TENS) in myofascial pain syndrome. Eura Medicophys 2004; 40(4): 293-301.
22. Rodriguez-Fernandez AL, Garrido-Santofimia V, Gueita-Rodriguez J, Fernandez-de-Las-Penas C. Effects of burst-type transcutaneous electrical nerve stimulation on cervical range of motion and latent myofascial trigger point pain sensitivity. Arch Phys Med Rehabil 2011; 92(9): 1353-8.
23. Kalichman L, Vulfsons S. Dry needling in the management of musculoskeletal pain. J Am Board Fam Med 2010; 23(5): 640-6.

24. Dommerholt J. Dry needling in orthopedic physical therapy practice. Orthop Phys Ther Pract 2004; 16(3): 15-20.
25. Cummings TM, White AR. Needling therapies in the management of myofascial trigger point pain: A systematic review. Arch Phys Med Rehabil 2001; 82(7): 986-92.
26. Kietrys DM, Palombaro KM, Azzaretto E, Hubler R, Schaller B, Schlussel JM, et al. Effectiveness of dry needling for upper-quarter myofascial pain: A systematic review and meta-analysis. J Orthop Sports Phys Ther 2013; 43(9): 620-34.
27. Liu L, Huang QM, Liu QG, Ye G, Bo CZ, Chen MJ, et al. Effectiveness of dry needling for myofascial trigger points associated with neck and shoulder pain: A systematic review and meta-analysis. Arch Phys Med Rehabil 2015; 96(5): 944-55.
28. Gerber LH, Shah J, Rosenberger W, Armstrong K, Turo D, Otto P, et al. Dry Needling Alters Trigger points in the upper trapezius muscle and reduces pain in subjects with chronic myofascial pain. PMR 2015; 7(7): 711-8.
29. Hesari S, Attarbashi-Moghadam B, Shadmehr A. Comparison of dry needling and physical therapy in patients with trapezius myofascial pain syndrome. J Mod Rehabil 2016; 10(1): 43-7. 2023.
30. Dhanakotti S, Hemanani A, Makwana K, Koisa K. comparison of transcutaneous electrical nerve stimulation (TENS) and dry needling (DN) treatment on chornic low back pain participants: A randomized controlled study. Int J Physiother Res 2016; 4(6): 1749-56.
31. Amjad F, Shahid HA, Batool S, Ahmad A, Ahmed I. A comparison on efficacy of transcutaneous electrical nerve stimulation and therapeutic ultrasound in treatment of myofascial trigger points. Khyber Med Univ J 2016; 8(1): 3-6.
32. Dommerholt J, Mayoral O, Grobli C. Trigger point dry needling. Journal of Manual and Manipulative Therapy 2006; 14(4): 70E-87E.
33. Sahin N, Albayrak I, Ugurlu H. Effect of different transcutaneous electrical stimulation modalities on cervical myofascial pain syndrome. J Musculoskelet Pain 2011; 19(1): 18-23.
34. Blikstad A, Gemmell H. Immediate effect of activator trigger point therapy and myofascial band therapy on non-specific neck pain in patients with upper trapezius trigger points compared to sham ultrasound: A randomised controlled trial. Clinical Chiropractic 2008; 11(1): 23-9.
35. Rayegani SM, Bayat M, Bahrami MH, Elyaspour D, Azhar A, Valaei N. Comparison of dry needling and physical therapy modalities in treatment of myofascial pain of upper trapezius muscle. Research in Medicine 2010; 34(3): 157-63. [In Persian].
36. Tabatabaiee A, Ebrahimi I, Ahmadi A, Sarrafzadeh J. Comparison between the effect of pressure release and dry needling on the treatment of latent trigger point of upper trapezius muscle. Physical Treatment 2013; 3(3): 9-15. [In Persian].
37. Bijur PE, Silver W, Gallagher EJ. Reliability of the visual analog scale for measurement of acute pain. Acad Emerg Med 2001; 8(12): 1153-7.
38. Burckhardt CS, Jones KD. Adult measures of pain: The McGill Pain Questionnaire (MPQ), Rheumatoid Arthritis Pain Scale (RAPS), Short-Form McGill Pain Questionnaire (SF-MPQ), Verbal Descriptive Scale (VDS), Visual Analog Scale (VAS), and West Haven-Yale Multidisciplinary Pain Inventory (WHYMPI). Arthritis Rheum 2003; 49(S5): S96-S104.
39. Campa-Moran I, Rey-Gudin E, Fernandez-Carnero J, Paris-Alemany A, Gil-Martinez A, Lerma LS, et al. Comparison of dry needling versus orthopedic manual therapy in patients with myofascial chronic neck pain: A single-blind, randomized pilot study. Pain Res Treat 2015; 2015: 327307.
40. Cho YS, Park SJ, Jang SH, Choi YC, Lee JH, Kim JS. Effects of the combined treatment of extracorporeal shock wave therapy (ESWT) and stabilization exercises on pain and functions of patients with myofascial pain syndrome. J Phys Ther Sci 2012; 24(12): 1319-23.
41. Mousavi SJ, Parnianpour M, Montazeri A, Mehdian H, Karimi A, Abedi M, et al. Translation and validation study of the Iranian versions of the Neck Disability Index and the Neck Pain and Disability Scale. Spine (Phila Pa 1976) 2007; 32(26): E825-E831.
42. Hsieh YL, Kao MJ, Kuan TS, Chen SM, Chen JT, Hong CZ. Dry needling to a key myofascial trigger point may reduce the irritability of satellite MTrPs. Am J Phys Med Rehabil 2007; 86(5): 397-403.
43. Duncombe A., Hopp JF. Modalities of physical treatment. In: Schwab CD, editor. Physical medicine and rehabilitation: State of the art reviews. Philadelphia, PA: Hanley and Belfus; 1991. p. 493-519.

44. Borg-Stein J, Simons DG. Focused review: Myofascial pain. Arch Phys Med Rehabil 2002; 83(3 Suppl 1): S40-S49.
45. Simons DG. Myofascial pain syndromes: where are we? Where are we going? Arch Phys Med Rehabil 1988; 69(3 Pt 1): 207-12.
46. Sumen A, Sarsan A, Alkan H, Yildiz N, Ardic F. Efficacy of low level laser therapy and intramuscular electrical stimulation on myofascial pain syndrome. J Back Musculoskelet Rehabil 2015; 28(1): 153-8.