Transcutaneous Electrical Nerve Stimulation versus Dry Needling in Upper Trapezius Myofascial Trigger Points

Sara G. Soliman[1*], Neveen A. Abdel Raoof[2], Rania R. Mohamed[3]

[1]Department of Physical Therapy, General Zagazig Hospital, Al Shaqia, Egypt. .

[2]Professor of Physical Therapy, Basic Science Department, Faculty of Physical Therapy, Cairo University, Egypt.

[3]Assistant Professor of Physical Therapy, Basic Science Department, Faculty of Physical Therapy, Cairo University, Egypt.

*Corresponding author: Sara G. Soliman. Email address: jalalsarah31@gmail.com.

ABSTRACT

The study aimed to compare the effectiveness of transcutaneous electrical nerve stimulation (TENS) with dry needling (DN) in treating myofascial trigger points (MTrPs) in the upper trapezius muscle among individuals with non-specific chronic neck pain (NSCNP). Sixty participants aged 20-40 years with a BMI of 18-30 kg/m² were randomized into three groups: Group A received TENS with conventional physiotherapy, Group B received dry needling with conventional physiotherapy, and Group C received only conventional physiotherapy. Visual Analog Scale, Pressure Pain Algometry, Cervical Range of Motion device and The Neck Disability Index, were used to measure neck disability, cervical range of motion (ROM), pain intensity, and pressure pain threshold (PPT) at baseline and after four weeks of treatment**.**Results showed that Group A experienced a significant decrease in pain intensity and neck disability scores, along with an increase in cervical ROM and PPT, compared to Groups B and C. Group A demonstrated the most significant improvements ($p < 0.001$). The study concluded that adding electrophysical agents such as TENS to conventional PT may be more effective than dry needling combined with conventional PT or conventional PT alone in reducing pain, improving cervical ROM, and decreasing neck disability in treating upper trapezius MTrPs in NSCNP.

KEYWORDS: Dry Needling, Myofascial Trigger Points, Neck Disability Index, Non-Specific Neck Pain, Transcutaneous Electrical Nerve Stimulation, Upper Trapezius.

INTRODUCTION

The prevalence of non-specific chronic neck pain (NSCNP), which can occur with or without radiation and has an unclear pathological etiology, ranges from 5.9% to 38.7% of the overall population, making it a severe public health concern, which recurrent with percentile that ranged from 40% up to 50% with persistent symptoms after 6 to 12 months tend to be prolonged, thus often leads to severe disability, which steadily increased during the past two decades [1,2].

Myofascial Pain Syndrome (MPS) in the neck muscles, reduced function, restricted cervical mobility, and occupational stress are all factors. Because there is no "gold standard" evaluation, a diagnosis must be made based on clinical grounds, as long as there are no symptoms that point to a known pathological explanation for the patient's complaints [3].

Patients diagnosed with NSCNP who also exhibited motor dysfunction, autonomic abnormalities, and referral pain patterns were more likely to have Myofascial Trigger Points (MTrPs) in the upper trapezius (UT) [4,5]. Hypersensitive areas in skeletal muscles linked to a taut band are called trigger points (TrPs). When compressed, the area causes pain and radiates it in a manner specific to each muscle. MTrPs are hyperirritable, palpable nodules found along taut bands of muscle fibers[6].

Among the many symptoms that can result from activating the TrPsin UT is significant posterolateral neck pain and, more often than not, restricted as well as painful rotation of the neck to the opposite side. Trigger points located in the middle trapezius muscle are frequently associated with burning pain between the scapulae, pain over the acromion, and, in some instances, a referred autonomic reaction of pilomotor erection on the outside of the affected arm[7].

Some pharmacological treatments for non-specific neck pain (NSNP) involve non-steroidal anti-inflammatory drugs (NSAIDs), botulinum toxin injections, anticonvulsants, in addition to muscle relaxants [8]. Some examples of noninvasive treatments such as physiotherapy including heat, massage, stretches, TENS, mud baths, as well as magnetic field applications[9,10].

Among the invasive techniques are injection therapy, dry needling, along with intramuscular electrical stimulation. Electroacupuncture, which involves applying electrical stimulation to specific muscle areas using acupuncture needles like electrodes, is a more effective method of pain alleviation and functional enhancement compared to the more conventional transcutaneous nerve stimulation[11].

Traditional Transcutaneous Electrical Nerve Stimulation (TENS) using high rates as well as comfortable sensory intensities is a safe treatment that has been shown to be effective in reducing pain, restoring normal muscle length, and increasing range of motion (ROM) for deactivating MTrPs in NSCNP [12,13]. The use of TENS to alleviate UT MTrPs involves sending small electrical signals to the brain, which in turn trigger the body to produce endorphins[14].

The term "dry needling" (DN) refers to a non-pharmaceutical method of treating musculoskeletal conditions by penetrating the skin with very thin needles [15]. Using mechanical, neurophysiological, pharmacological, and microcirculation-based mechanisms, this invasive procedure treats MTrPs with the goal of improving pain and PPT in the cervical area in the short term. Improved pain intensity, PPT, and disability levels after NSCNP are outcomes of using DN on active MTrPs within the UT muscle[16].

Although there are many previous studies on the effect of TENS and DN on UTTrPs, there is no study comparing the therapeutic effect between them. So, this study has been conducted to compare between the impact of TENS and DN in treating activeMTrPsof UT in NSCNP patients.

MATERIALS AND METHODS

A) Study design

This study was a pre- and post-tests randomized controlled trial. The study took place from June 2023 to June 2024 within the Zagazig General Hospital Out-patient Physical Therapy Clinic. This study was appr oved by the Research Ethical Committee of the Faculty of Physical Therapy at Cairo University, Egypt (P.T. REC/012/003911) before it was started. To ensure the safety of its human subjects, the research followed the guidelines laid out in the Helsinki Declaration. The research protocol was registered on Clinicaltrial.gov with the identifier (NCT05585385).

B) Sample size calculation

Based on OSI data from a pilot study with 5 patients in each group, the sample size was calculated using the G*POWER statistical program (version 3.1.9.2; Franz Faul, Universität Kiel, Germany). With a power of 0.95 as well as an effect size of 0.458 (Partial Eta Square= 0.05), the researchers suggested a sample size of sixty individuals, with 20 from each group.

C) Randomization

Utilizing a random generator, sixty individuals were divided into three equivalent groups A, B, and C. An individual who wasn't involved with subject recruiting or treatment managed the allocation process. A different researcher used a computer list to construct the random allocation sequence, which was subsequently placed in opaque envelopes to keep the allocation concealed. Before the 1ST session, we opened the envelopes of all eligible individuals. Following randomization, no individuals dropped out of the study.

,

D) Participants

Sixty individuals were chosen from the Outpatient Clinic of Physical Therapy at Zagazig General Hospital; their physician had diagnosed them with active MTrPs of the UP in NSCNP. Their ages varied from twenty to forty, and their BMIs were between 18 and 30 kilograms per square meter. Inclusion criteria were patients who had MTrPs in the UT of NSCNP, a palpable taut band, a characteristic referred pain pattern in responding to compression upon tender points, as well as a local twitch reaction that was triggered by snapping palpation. The duration of symptoms had to be more than three months. Subjects were eliminated from the study if they had experienced cervical disc hernia, cervical osteoarthritis, radiculopathy or myelopathy, rheumatic or hormonal diseases or trigger point injection or physiotherapy in last 6 months, also kyphosis, scoliosis, forward head posture or cervicogenic headache, as well history of spine surgery, cardiovascular problems or any evidence of infection or inflammation in laboratory tests [17].

The participants were randomized into three equivalent groups: Group A had 20 individuals who was given TENS along with conventional physiotherapy (which included hot packs, isometric exercises, active ROM exercises, as well as stretching). Group B also had 20 individuals and was given DN plus conventional physiotherapy. Group C, the control group, had 20 individuals who only was given conventional physiotherapy. All groups received their treatments three sessions a week for four successive weeks.

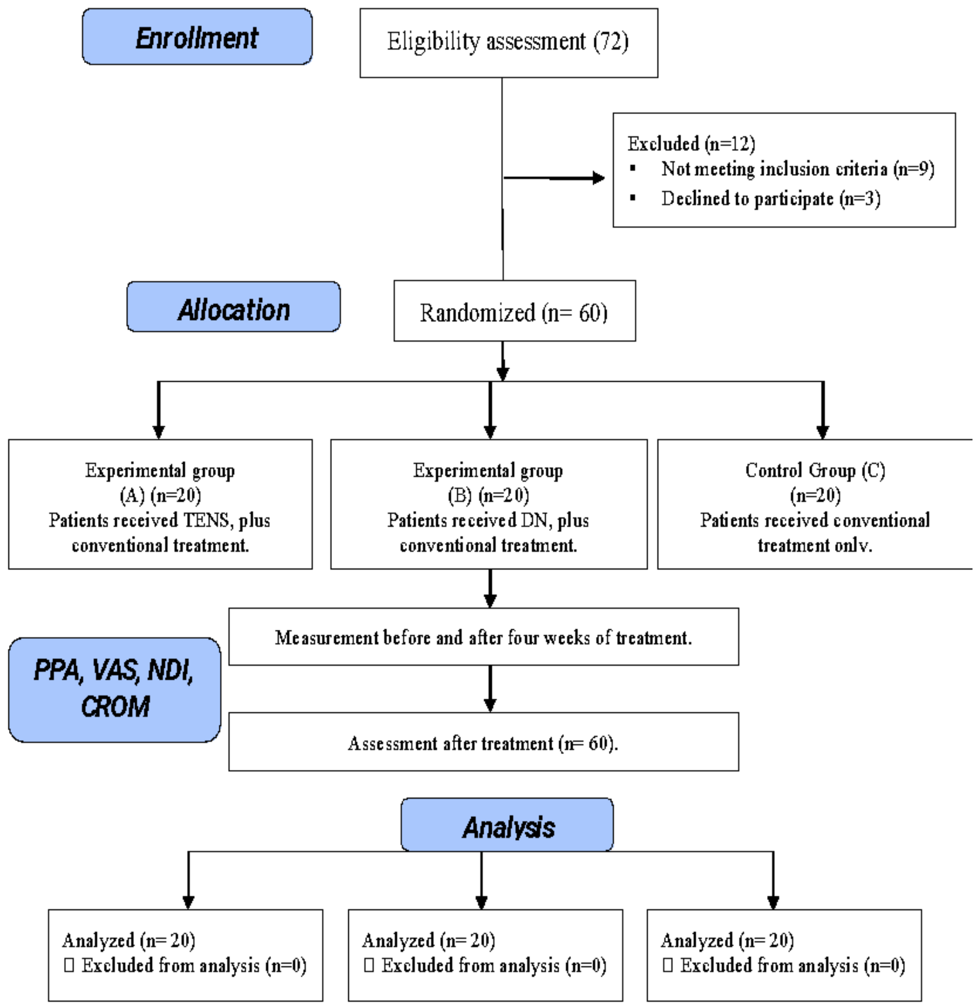

Figure (3-1): Flow chart of the study participants.

E) Instrumentation and Tools for Assessment

1. Visual Analogue Scale (VAS)

Its purpose was to measure the intensity of pain. A 10-centimeter-long horizontal line served as the basis of this self-reported pain assessment scale. The line has two extremes: no pain and most severe pain**[18].**

2. Pressure Algometer (PA)

The goal of this instrument is to identify MTrPs by measuring the maximum amount of pressure which can be applied before the sensation of pressure becomes painful. Testing for PPT can give a numerical assessment of the patient's tenderness because exceptionally low force levels will trigger pain in tender areas. With

ICCs ranging from 0.70 to 0.94 and Pearson (r) correlations of 0.99 for its maximum force reading compared to the force plate, the PA demonstrates great validity and reliability**[19,20].**

3. Cervical Range of Motion (CROM) Goniometer

It was employed to evaluate cervical ROM. Degrees were used to express the outcomes. This device demonstrates both validity and reliability, as evidenced by intra-rater intraclass correlation coefficients (ICCs) which vary from 0.84 to 0.96, and inter-rater ICCs ranging from 0.73 to 0.94 across all cervical ROM. Because it only requires a small amount of palpation to identify the landmarks and can assess cervical range in each direction without moving the inclinometer, it is easy to use with patients who are experiencing symptoms or none at all**[21].**

4. Neck Disability Index (NDI)

It is a tool for measuring self-reported impairment associated with neck pain. Both academics and therapists use it. The NDI's Arabic version was utilized in this study. When utilized by Arab patients, it provides valid and reliable data on the severity of neck pain. The format is two-factor and ten-item. Therefore, it is appropriate for use in research as well as clinical settings**[22].**

F) Instruments and Tools for Treatment

1. Transcutaneous Electrical Nerve Stimulation (TENS)

Enraf Endo-med 482 equipment manufactured by Enraf; Germany that offers conventional TENS in a continuous mode using a frequency of 100 Hz, a duration of 40 µs, a low amplitude, as well as an intensity that is painless for the patient, while simultaneously producing a slight tingling sensation without contraction within a level under the motor threshold**[23].**

2. Dry Needling (DN)

Trigger-points (TrPs) dry needling is an invasive tecnhnique involves inserting a small needle or acupuncture needle into the skin as well as muscle. The target is MTrPs, which are tender areas in the skeletal muscles linked to a sensitive nodule inside a taut band**[24].**

G) Procedures

1. Assessment Procedure

The VAS was used to measure the intensity of pain. The participants were asked to locate the exact point on the line where they felt the most pain. To measure

PPT and UT muscle tenderness, a pressure algometer (PA) was utilized. Since each patient exhibited active MTrPs, we requested them to identify the exact location of their pain. Pincer palpation was used to confirm the region, and afterwards it was marked. The MTrPs was covered with the transducer probe tip at an angle of 45 degrees. By strongly pressing the transducer downwards, the necessary pressure was applied to the MTrPs location. A digital display was provided with the real-time pressure reading in pounds per square inch from the site. Continuously increasing pressure was applied to the subject until the subject reported their first pain symptom and signaled "STOP." Right now, the PPT value was measured**[25].**

Cervical ROM was evaluated using CROM. The cervical ROM of rotations, side bending, extension, as well as flexion as measured by individual inclinometers. A frame resembling eyeglasses holds these inclinometers; a sagittal one measures flexion and extension, a frontal one measures side bending, and a transverse one measures rotation**[21].**

The NDI was used to evaluate the functional level of the neck. The maximum possible score is 50, with 5 being the score for each item. The section score is 0 for the 1st statement while 5 for the last statement if they are marked. After finishing all 10 parts, the patient's score can be converted to a percentage by multiplying it by 2. divide the patient's overall score by the overall number of sections finished, multiplied by 5, in the event that a section is missing**[26].**

2. Treatment Procedure

a. Transcutaneous Electrical Nerve Stimulation (TENS)

Two 40 mm and one 50 mm electrodes were used to apply TENS. The cathode electrode was positioned on the MTrP of the UT muscle, while the anode electrode was put on the site of acromial tendon insertion**[23].**

b. Dry Needling (DN)

The patient positioned in prone lying relaxed. After cleansing the skin with alcohol, which was then used to activate the muscle, palpate the taut band, and find the MTrPs, the muscle was held among the thumb, index as well as middle finger. Over the MTrPs, the solid filiform needle was inserted into its plastic guiding tube. The procedure for inserting the needle involved tapping the skin. The needle was entered at an angle to the skin, moving from the back to the front. We palpated the UT muscle to look for TrPs. TrPs were administered DN. The needle was inserted 10-15mm deep, depending on the muscle type [24]. The needle was vertically moved 3-5 mm without rotations following the 1st local twitch response was established until no additional twitch responses were produced. To induce a little twitch in the muscle surrounding the bundle, the needle was advanced and retracted through the tissue**[27].**

c. Traditional physical therapy treatment

1. Hot pack

Hot packs were applied on the patient's cervical, paraspinal, as well as upper thoracic regions (which involves the UT muscle with its MTrPs) for 20 minutes**[28].**

2. Isometric exercise

A- Isometric neck flexor exercise

Patient seated in relaxed position with good back support. Therapist stood behind. The therapist stabilized the patient's shoulder with one hand and the other hand was placed on forehead of the patient and applying maximum resistance. The therapist told the patient to flex their head as much as possible while the patient held for six seconds before releasing for six seconds of relaxation. Fifteen times, these steps were repeated.

B- Isometric neck extensor exercise

Patient seated in relaxed position with good back support. The therapist was positioned behind the patient. Using one hand to hold the patient's shoulder, the therapist applied maximum resistance while positioning his other hand behind the individual's head. The individual was told to extend their head as far as possible while the therapist applied maximum resistance, hold it for six seconds, and then to relax for six seconds. All of these steps were carried out fifteen times.

C- Isometric neck lateral flexor muscles exercise

Patient seated in relaxed position with good back support. Therapist was standing behind the patient. The therapist used one hand to support the individual's left shoulder while the other was put on the patient's opposite side of the head during right side bending. As the patient was brought into left lside bending, the therapist used one hand to support the patient's right shoulder while the other applied full resistance to the patient's opposite side of the head. Following the therapist's instructions, the patient was asked to bend their head as much as possible while holding the position for six seconds. After that, they were told to relax for six seconds. Fifteen times, these steps were repeated.

D- Isometric neck rotator exercise

The patient sits comfortably, with appropriate back support, in a relaxed position. The patient's therapist stood behind them. Using one hand, the therapist supported the patient's shoulder. With the other hand, they applied maximum resistance over the patient's chin. Attempting a full head rotation against the therapist's strongest resistance for six seconds followed by six seconds of relaxation was the patient's prescribed exercise. All of these steps were carried out fifteen times.

3. Active exercises

A- Active neck flexion and extension

There are two positions that include the cervical spine: flexion (chin to chest) as well as extension (looking upwards). To begin, bring your head forward slowly while bringing your chin in, and try to bring your chin towards your chest. After then, bring your head back to its neutral position by bending it forward as much as it will go, and then bring it forward again. Do this exercise five times. Those who experience hypertonic cervical paraspinals, commonly known as back pain, can greatly benefit from forward head flexion.

B- Lateral flexion exercise:

As much as you can, position your right ear such that it is touching your right shoulder. While you're stretching your neck, keep your head neutral. Before bringing your left ear to rest on top of your left shoulder, find a neutral position. Perform the process five times.

C- Side to side rotations:

To complete this move, tilt your head to the right to the furthest extent possible while bringing your chin to rest on your shoulders. Be careful not to lift your shoulders as you work your neck muscles. For three to five seconds, remain in this posture. Proceed to the left side of your neck as well as repeat the process five times.

4. Stretching techniques

A- Passive stretching for neck extensor muscles

The patient was seated in an erect and relaxed position. Standing behind the patient, the therapist placed one hand onto the occiput while the other was placed on the shoulder to provide stability. With the patient fully relaxed, the therapist gently flexed the head while maintaining the stretching posture for 30 seconds. Three repetitions were done.

B- Passive stretching of the neck lateral flexor muscles

While seated, the patient was able to relax and maintain appropriate back support. With one hand holding the shoulder of the individual while the other was resting on the temporal region of the head, the therapist was standing behind the patient. The therapist gently stretched the same side while bending the patient's head to the other side. Maintain the stretching position Stretch for 30 seconds, while the patient was completely relaxed. Three repetitions were done.

C- Passive stretching for scalene muscle

The patient was comfortably situated with a supportive back. Standing behind the patient, the therapist placed one hand across the occiput and the other was placed on the shoulder to provide stabilityand the therapist moved the patient's head in flexion with rotation. Maintain the stretching position for 30 seconds, while the patient was completely relaxed. Three repetitions were done

H) Statistical Analysis

Statistical analysis and comparison of the outcome measures were performed utilizing the statistical SPSS Package program version 25 for Windows (SPSS, Inc., Chicago, IL). The data was examined for existance of outliers, homogeneity of variance, as well as normality assumption. We utilized the Shapiro-Wilk test to ensure that the data was normal. The results demonstrated that the variables studied followed a normal distribution ($p<0.5$). With the exception of gender (counts), all outcomes were represented by means and standard deviations. The groups were compared using a two-way mixed-design MANOVA on the total effect of all outcomes. For each outcome, run a separate univariate ANOVA with Bonferroni correction if the MANOVA was statistically significant. This helped to avoid type I error. At a probability threshold of 0.05 ($P \leq 0.05$), all statistical analyses were significant.

RESULTS

1. Demographic characteristics of patients:

There were no substantial differences among groups A, B, and C in mean age (p > 0.05) (Table 1).

Table 1. Demographic characteristics of patients in all groups (A, B and C).

Characteristics	Group (A)	Group (B)	Group (C)	F-value	P-value	Level of significance
	$\overline{X}$ ± SD	$\overline{X}$ ± SD	$\overline{X}$ ± SD			
Age (years)	30.15 ± 7.28	31.2 ± 4.21	30.6 ± 4.76	2.01	0.14	NS
Weight (kg)	70.7 ± 12.88	71.18 ± 2.34	72.38 ± 6.97	0.62	0.54	NS
Height (cm)	159.85 ± 3.41	160.1 ± 3.19	164.45 ± 4.43	1.74	0.18	NS
BMI (kg/m^2)	27.48 ± 1.31	27.91 ± 1.06	26.57 ± 1.88	1.432	0.16	NS

$\overline{X}$: Mean. SD: Standard Deviation. f-value: ANOVA value. p-value: Probability value. NS: Non-Significant. kg: Kilogram. cm: Centimeter. Kg/m^2: kilogram per meter square.

2. Gender distribution

There were no substantial differences among the 3 groups (A, B, and C) (p> 0.05) (Table 2).

Table 2. The frequency distribution of gender in all groups (A, B and C).

Items	Group (A)	Group (B)	Group (C)	χ2-value	P-value	Level of significance
	Count / %	Count / %	Count / %			
Females	14 (70%)	15 (75%)	14 (70%)	0.62	0.73	NS
Males	6 (30%)	5 (25%)	6 (30%)			

%: Frequency. f-value: ANOVA value. p-value: Probability value

3. Measurements:

3.1. Before treatment among groups (A, B & C):

Comparison between the before treatment± SD values, non-substantial differences of all measurable variables were revealed between the three groups (p> 0.05) (Table 3).

3.2. Before and after treatment for groups (A, B and C):

Comparison among the before and after treatment $\overline{X}$ ± SD values, substantial differences of all measurable variables were revealed between the 3 groups (p< 0.05) (Table 3).

3.3. After treatment comparison between groups (A, B & C):

Comparison between the after treatment $\overline{X}$ ± SD values, substantial differences of all measurable variables were revealed among the 3 groups (p< 0.05) (Table 3).

Table 3. The measurement variables for the 3 groups (A, B and C)

Characteristics			**Group (A)** $\overline{X}$ **± SD**	**Group (B)** $\overline{X}$ **± SD**	**Group (C)** $\overline{X}$ **± SD**	**f-value**	**p-value**
VAS		Pre-treatment	83 ± 5.48	83.75 ± 5.35	81.5 ± 6.09	0.823	0.444^{NS}
		Post-treatment	30 ± 3.25	31 ± 3.84	35 ± 5.38	7.748	0.001^{S}
		MD	53	52.75	46.5		
		p-value	0.001^{S}	0.001^{S}	0.0001^{S}		
PPT		Pre-treatment	2.19 ± 0.44	2.19 ± 0.49	2.23 ± 0.49	0.033	0.968^{NS}
		Post-treatment	3.49 ± 0.25	3.19 ± 0.48	2.83 ± 0.37	15.335	0.0001^{S}
		MD	-1.23	-1	-0.6		
		p-value	0.001^{S}	0.001^{S}	0.001^{S}		
	Flexion	Pre-treatment	42.4	42.75	44.1	0.448	0.641^{NS}

CROM			± 5.58	± 5.91	± 6.46		
		Post-treatment	69.85 ± 3.47	66.3 ± 4.65	59.7 ± 4.96	27.323	0.001^{S}
		MD	-27.45	-23.55	-15.6		
		p-value	0.001^{S}	0.001^{S}	0.001^{S}		
	Extension	Pre-treatment	33.6 ± 3.68	31.6 ± 3.93	33.65 ± 4.49	1.672	0.197^{NS}
		Post-treatment	45.85 ± 3.39	43.05 ± 3.79	42.95 ± 3.62	4.172	0.02^{S}
		MD	-12.25	-11.45	-9.3		
		p-value	0.001^{S}	0.001^{S}	0.001^{S}		
	Right side bending	Pre-treatment	29.8 ± 5.15	29.4 ± 3.35	30.9 ± 2.73	0.802	0.454^{NS}
		Post-treatment	39.05 ± 3.39	40.85 ± 2.46	36.7 ± 2.87	10	0.001^{S}
		MD	-9.25	-11.45	-5.8		
		p-value	0.0001^{S}	0.0001^{S}	0.0001^{S}		
	Left side bending	Pre-treatment	33.35 ± 4.09	29.95 ± 2.42	31.2 ± 2.31	0.875	0.422^{NS}
		Post-treatment	40.15 ± 3.29	40.4 ± 2.26	36.45 ± 2.54	13.083	0.001^{S}
		MD	-6.8	-10.45	-5.24		
		p-value	0.001^{S}	0.001^{S}	0.001^{S}		
	Right rotation	Pre-treatment	50.05 ± 2.7	51.55 ± 3.1	50.85 ± 3.65	0.324	0.724^{NS}
		Post-treatment	65.45 ± 3.39	65.95 ± 2.96	58 ± 4.94	26.593	0.001^{S}
		MD	-15.4	-14.4	-7.15		
		p-value	0.001^{S}	0.001^{S}	0.001^{S}		

	Left rotation	Pre-treatment	51.35 ± 2.43	51.8 ± 2.78	51.05 ± 3.27	0.351	0.705NS
		Post-treatment	66.8 ± 2.71	67.55 ± 2.93	59.35 ± 4.53	411.017	0.0001S
		MD	-15.45	-15.75	-8.3		
		p-value	0.001S	0.001S	0.001S		
Arabic version of NDI		Pre-treatment	32.9 ± 3.63	32.75 ± 6.37	29.95 ± 6.34	1.764	0.181NS
		Post-treatment	20.4 ± 3.09	21.2 ± 3.71	21.6 ± 4.29	0.538	0.037S
		MD	12.5	11.55	8.35		
		p-value	0.001S	0.001S	0.001S		

$\overline{X}$: Mean. SD: Standard Deviation. f-value: ANOVA test value.
p-value: Probability value. NS: Non-Significant. S: Significant.

3.4. Before treatment among groups (A and B), groups (A and C) and groups (B and C):

When comparing the before treatment $\overline{X}$ ± SD values among groups (A & B), (A & C) as well as (B & C). There were no statistically significant differences among the two groups for any of the measured variables (p> 0.05)(Table 4).

Table 4. Before Multiple pairwise comparisons of VAS, PPT, CROM (flexion, extension, right and left side bending, also right and left rotation) and Arabic version of NDI between groups (A and B), groups (A and C) and groups (B and C)

Pairwise group effect	**Group (A) vs. Group (B)**		**Group (A) vs. Group (C)**		**Group (B) vs. Group (C)**	
	MD (95% CI)	**P-value**	**MD (95% CI)**	**P-value**	**MD (95% CI)**	**P-value**
VAS	-0.75 (-0.81, 0.7)	0.787 NS	-1.5 (-1.7, 2)	0.376 NS	-2.25 (-2.1, 2.8)	0.166 NS

PPT		-0.01 (-0.015, 0.02)	0.867 NS	-0.01 (-0.011, 0.06)	0.543 NS	-0.04 (-0.013, 0.07)	0.231 NS
CROM	**Flexion**	-0.35 (-0.45, 0.23)	0.67 NS	-1.7 (-1.23, 2.13)	0.532 NS	-1.35 (-1.86, 1.17)	0.217 NS
	Extension	-2 (-1.3, 2.17)	0.413 NS	-0.05 (-0.011, 0.09)	0.615 NS	-2.05 (-1.81, 2.37)	0.722 NS
	Right side bending	-0.4 (-0.1, 0.33)	0.336 NS	-1.1 (-0.9, 1.4)	0.823 NS	-1.5 (-1.3, 1.81)	0.545 NS
	Left side bending	-3.4 (-2.75, 3.63)	0.762 NS	-02.15 (-1.85, 2.53)	0.685 NS	-1.25 (-1.05, 1.43)	0.174 NS
	Right rotation	-1.5 (-1.09, 1.73)	0.586 NS	-0.8 (-0.53, 1.02)	0.195 NS	-0.7 (-0.45, 0.82)	0.478 NS
	Left rotation	-0.45 (-0.29, 0.63)	0.211 NS	-0.75 (-0.92, 0.61)	0.314 NS	-0.3 (-0.22, 0.42)	0.233 NS
Arabic version of NDI		-0.15 (-0.11, 0.17)	0.319 NS	-2.95 (-2.7, 3.1)	0.77 NS	-2.8 (-2.44, 3.08)	0.355 NS

$\overline{X}$: Mean. SD: Standard Deviation. P-value: Probability value. NS: Non-Significant.

3.3.5. After treatment between groups (A and B), groups (A and C) and groups (B and C):

When comparing the after treatment $\overline{X}$ ± SD values among groups (A & B), (A & C) as well as (B & C). All measurable variables showed significant differences among the 2 groups ($p< 0.05$) (Table 5).

Table 5. After Multiple pairwise comparisons of VAS, PPT, CROM (flexion, extension, right and left side bending, also right and left rotation) and Arabic version of NDI between groups (A and B), groups (A and C) and groups (B and C)

Pairwise group effect		Group (A) vs. Group (B)		Group (A) vs. Group (C)		Group (B) vs. Group (C)	
		MD (95% CI)	P-value	MD (95% CI)	P-value	MD (95% CI)	P-value
VAS		-1 (-0.5, 1.25)	0.01 S	-5 (-3.5, 6)	0.0001 S	-4 (-2.5, 4.5)	0.007 S
PPT		-0.39 (-0.22, 0.52)	0.001 S	-0.66 (-0.55, 0.73)	0.001 S	-0.36 (-0.25, 0.42)	0.006 S
CROM	Flexion	-3.55 (-2.35, 3.82)	0.007 S	-10.15 (-8.11, 12.01)	0.002 S	-6.6 (-5.56, 7.26)	0.017 S
	Extension	-2.8 (-1.78, 3.27)	0.003 S	-2.9 (-2.61, 3.33)	0.005 S	-0.1 (-0.76, 1.09)	0.012 S
	Right side bending	-1.8 (-143,	0.011 S	-2.35 (-1.91,	0.001 S	-4.15 (-3.73,	0.035 S

		2.22)		2.64)		4.41)	
	Left side bending	-0.25 (-0.17, 0.3)	0.001 S	-3.7 (-3.81, 4.13)	0.009 S	-3.95 (-2.8, 4.41)	0.004 S
	Right rotation	-0.5 (-0.33, 0.83)	0.001 S	-7.45 (-6.23, 7.82)	0.019 S	-7.95 (-6.85, 8.61)	0.008 S
	Left rotation	-0.75 (-0.59, 0.83)	0.001 S	-7.42 (-6.92, 7.63)	0.002 S	-8.2 (-7.22, 8.62)	0.003 S
Arabic version of NDI		-0.8 (-0.44, 0.95)	0.001 S	-1.2 (-0.85, 1.36)	0.0001 S	-0.4 (-0.25, 0.51)	0.001 S

$\overline{X}$: Mean. SD: Standard Deviation. P-value: Probability value. S: Significant.

DISCUSSION

The MANOVA used in this study to compare and detect If there was a significance between the three groups and pairwise comparison used to detect the significance between groups A and B), groups (A and C) and groups (B and C) post- treatment.

This study was done to compare the impact of TENS and DN on pain, PPT, cervical ROM and neck functional level on UT MTrPs in NSCNP patients. Sixty patients suffering from active UT MTrPs in NSCNP participated in this study, they were between the ages of 20 and 40, with a body mass index (BMI) of 18 to 30 kg/m2. They were divided into three equivalent groups at random; Group (A) (experimental) twenty participants received TENS, plus traditional physical therapy treatment, Group (B) (experimental) twenty participants received DN, plus traditional physiotherapy treatment and Group (C) (control) twenty participants was given traditional physiotherapy treatment only (hot pack, isometric exercises , active ROM and stretching exercises).

Three groups demonstrated significant improvements in all measured variables and post-test mean values for all assessed variables also revealed substantially significant in favor of group (A) compared between groups (A and B), in favor of group (A) compared between groups (A and C) and in favor of group (B) compared between groups (B and C) (P< 0.05).

The study's findings showed that a significant difference was observed in VAS at post-treatment among Group (A) and Group (B) (P=0.01), Group (A) and Group (C) (P=0.0001), and Group (B) and Group (C) (P=0.007), all with statistical significance (P<0.05).Accordingly, the experimental group (A) produced the highest VAS score, followed by the control group (B), and finally the experimental group (C). The post-treatment PPT levels were significantly different (P<0.05) in Group (A) compared to Group (B) (P=0.01), Group (A) compared to Group (C) (P=0.001), and Group (B) compared to Group (C) (P=0.006).Group (C) produced the lowest PPT value, which was followed by Group (A), which was the experimental group.

The results of the CROM goniometer, which measures flexion, extension, both left and right lateral flexion, in addition to right and left rotation, showed a significantly significant improvement in Group A compared to Group B and C after treatment (p= 0.001). Group (A) compared Group (B) (P=0.001), Group (A) versus Group (C) (P=0.0001), and Group (B) versus Group (C) (P=0.001) showed significant differences (P<0.05) in the NDI at after treatment. As a result, the experimental group (A) demonstrated significant enhancement in neck function as it linked to NDI, subsequently followed by the experimental group (B) and finally the control group (C).

This study's findings on the effects of TENS are in line with those of a 2011 study by Wessberg et al., which found that a regimen that utilized a neuromuscular theory of occlusion including TENS reduced pain in 21 patients (14 women and 7 men) with MPS symptoms at a rate significantly higher than in the current research. Results from the evaluation of the treatment suggest that 95% of patients exhibit improvement right after treatment and 86% exhibit improvement after one year of therapy[29].

The use of TENS has been suggested as a practical an alternative modality for the treatment of chronic pain, as demonstrated in a study conducted by Kruger et al. (2008). The study compared sham TENS at 8 sessions for 14 sucessive weeks using subthreshold TENS (frequency 35 Hz, pulse width 100 milliseconds, modulation 50%) in ten individuals with MPD. In contrast to TENS, time had a large significant impact (F = 4.80, P = 0.0003). Using subthreshold TENS did not improve the efficacy of conservative treatment in alleviating symptoms according to the utilized procedure. This study's findings are in agreement with those of the previous one, which found that different samples had different pain reduction rates due to differences in stimulation parameters utilized in TENS therapy as well as in the biological and social components influencing MPD[30].

Fifteen participants were randomly assigned to either the combination therapy (A) or ischemia compression (B) groups in a study by Mukkannavar (2015). For a week, both groups were treated every day. Participants in group A underwent a 10-minute combination therapy session, whereas those in group B underwent three or four cycles of 60-second progressive compression. Results were assessed using ROM and VAS. The study found that both groups experienced a significant decline in pain and an improvement in ROM, with a significance level of p<0.05. Group A noticed a more significant decline in pain and an improvement in ROM compared to group B[31].

The impact of combination therapy employing TENS in the treatment of active UT MPS was investigated in a single-blind randomized controlled experiment by Dissanayaka et al. (2016), which included 105 individuals with a UT MTrPs. Each of the three treatment programs—control, TENS, and Interferential Therapy Flow (ITF) was given eight times over the course of four weeks over regular intervals. The control regimen included a heated pack, active ROM exercises, myofascial release, as well as a home exercise program with posture recommendations. With regard to pain intensity as well as cervical ROM, the TENS group (n = 35) showed significant immediate as well as short-term improvements ($P < 0.05$) when compared to the ITF group (n = 35) as well as the control group (n = 35). The outcome measures were significantly better for the IFT group compared to the control group ($P < 0.05$). Combining TENS with conventional treatment facilitates recovery more effectively than IFT alone[32].

A study conducted by Jeon et al. (2012) examined the effects of extracorporeal shock wave treatment (ESWT) on MPS in the trapezius muscle. Thirty participants were randomly assigned to one of two groups: one group received ESWT (n=15), and the other group received TrPs injections in addition to TENS (n=15). For a duration of three weeks, an overall of 4,500 pulses were administered using ESWT at 1,500 pulse intervals per week, with TPI administered once a week an overall of three sessions and TENS administered five times a week a overall of three weeks. In this study, participants with trapezius muscle MPS reported less pain, higher PPT, and better cervical function after an increase in CROM. In individuals suffering from trapezius muscle MPS, the ESWT is just as useful as trigger point injections (TPI) and TENS in reducing pain and increasing cervical mobility[33].

These results are in agreement with those of Garcia-de-Miguel et al. (2020), who conducted their study on 44 To find out if TENS is better than DN for mechanical neck pain in the short term, participants were randomly assigned to either the TENS or DN groups. All of the following were assessed: level of disability, ROM, pain, as well as side-bending strength. According to their findings, mechanical stress upon the nervous system may be higher during cervical flexion compared to cervical extension. Disability (mean difference, 3.27; 95% CI, 0.27-6.27) and PPT (mean difference, 0.88-1.35; $p < 0.01$) were both improved more significantly in the TENS group. For ROM, the results were mixed. There appears to be a short-term benefit to TENS in terms of PPT and disability[34].

In addition, a study conducted by Dusunceli et al. (2009) randomly assigned sixty patients suffering from neck pain to one of three groups. One group received physical therapy treatments such as TENS, continuous ultrasound, as well as infrared irradiation. The second group received the same treatments plus isometric and stretching exercises. The third group received the same treatments plus exercises to stabilize the neck. After participating in a supervised group exercise for three weeks, the activities were continued at home as part of a training program. They discovered that when used in conjunction with other active treatments, including neck stability exercises, TENS is beneficial in reducing cervical pain and increasing neck mobility[35].

A study was conducted by Gibson et al. (2017) to compare the analgesic impact of TENS with that of placebo (sham) TENS, with that of traditional treatment, with no treatment, and with that of traditional treatment plus TENS compared to traditional treatment alone in the management of adult neuropathic pain. Patients suffering from chronic trapezius discomfort reported both short-term and long-term improvements in their condition after using TENS[36].

This study's findings on the effects of TENS coupled with infrared irradiation (IRIS) on sixty-six patients suffering from chronic neck pain were in agreement with those of Chiu et al. (2005). The study continued by showing that following six weeks of treatment with acupuncture points as well as neck exercises, patients' isometric neck muscle strength significantly improved. Additionally, patients in the TENS and exercise group experienced better and clinically significant improvements in disability, isometric neck muscle strength, along with pain-related disability. after 6 months, all of the treatment groups had preserved their improvements[37].

Another study applied by Sah,(2023),84 patients with acute UT MPSwere participated in the study to compare the impacts of traditional physiotherapy, Kinesiotaping, and ESWT.They were randomly assigned into three treatment groups: traditional physical therapy, Kinesiotaping, and ESWT. They demonstrated that TENS + home exercise program was found to be superior when compared to Interferential Therapy Flow (ITF) + home exercise program and Hot pack + home exercise program (control group) in acute UT MPS patients[38].

The efficacy of DN on active MTrPs in the upper, middle, as well as lower trapezius muscles was evaluated in a study by Cerezo-Tellez et al. (2016b). 44 office workers suffering from neck pain along with active MTrPs in the trapezius muscle were included in the trial, and after five sessions over three weeks, the subjects in the DN group received DN of all trapezius MTrPs as well as passive stretching. Just a passive trapezius muscle stretch was administered to the control group. They provided evidence to support the claim that DN combined with passive stretching appears to be more effective at reducing pain VAS in office workers with neck pain than passive stretching alone[39].

The study conducted by Gerber et al. (2015) involved 56 individuals who were selected from a campus-wide volunteer pool who had active MTrPs and had experienced neck or shoulder girdle pain for more than three months. Only 52 people, 23 men and 33 women, completed the research. According to the findings of this study, there is a strong correlation between a change in trigger point status as well as a statistically and clinically significant decrease in pain, as assessed by VAS and PPT. Mood, function, as well as disability level are all positively correlated with pain alleviation in UT MTrPs, these results were agreed with the results of the current study[40].

Martin-Sacristan et al. (2022) reported that 65 patients suffering from chronic neck pain were divided into three groups: those who received DN at a non-MTrPs site, those who received DN at an active MTrPs site, and those who received DN at a latent MTrPs site. The purpose of the study was to compare the effects of DN on pain as well as cervical functional restrictions at different sites. The results found that regardless of whether DN was used to treat TrPs, latent TrPs, or areas without TrPs, both mechanical hyperalgesia measured by PPT and pain intensity VAS were improved equally in all points that were treated[41].

In addition, Naghikhani et al. (2020) conducted a study to identify the impacts of DN on individuals who have musculoskeletal complaints caused by active MTrPs within the shoulder girdle muscles. A total of twenty subjects, each experiencing pain in the shoulders, upper extremities, head, and neck, were included in the study, which lasted two weeks and consisted of five sessions, with a single session held every other day. The results demonstrated significant improvements in the VAS as well as PPT outcomes compared to the pretreatment values. Considering that DN may be a useful therapeutic treatment for MTrPs within the shoulder girdle muscles[42].

Espejo-Antunez et al.,(2017)Fifteen studies were involvedin this systematic reviewto examine the efficacy of DN in MPS treatmentand the main outcome measures were the CROM, pain, depression, Quality of Life (QoL) as well as disability. Results showed that DN improved QoL, enhanced ROM, and reduced pain in comparison with sham or no intervention groups[43].

In an additional study, 14 patients suffering from bilateral shoulder pain as well as active MTrPs in the infraspinatus muscles bilaterally were examined to determine whether the PRP of the secondary MTrPs changed following DN of a primary MTrs. The researchers were led by Hsieh et al. (2007). A MTrP in the infraspinatus muscle on one side was needled dry, while the other side served as a control. Data showed that DN is superior to other methods for reducing pain and enhancing CROM. This is to explain how DN could potentially damage the hypertone muscle fibers' structural integrity—TrPs. Muscle relaxation is a side effect of CROM (flexion, extension, right and left lateral flexion, along with right and left rotation), that can be induced by an inserted needle by applying a specific stretch to the muscle fibers. This, in turn, may enhance CROM[44].

In addition, Shah and Gilliams (2008) review the biochemical basis of musculoskeletal pain by evaluating muscular pain thoughts in the context of MPS and by summarizing microdialysis findings. According to the study, DN immediately corrects the elevated levels of bradykinin, substance P, along with other substances in TrPs by inducing a local twitch response [45]. In addition, the precise mechanisms of DN activity are identified by Cagnie et al. (2013). Researchers discovered that inserting needles into muscles enhanced blood flow to the affected area, suggesting that DN may affect circulation [46].

Fifty patients suffering from MTrPs in the neck were included in a study by Anjana et al. (2023) that compared the effects of DN with TENS on the severity of neck pain and CROM. For Group A, the treatment was DN, while for Group B, it was TENS. Prior to therapy and again on days 14 and 28, participants were measured for outcomes using VAS, NDI, and CROM. When it comes to myofascial neck pain, they discovered that DN and TENS are equally effective ways to enhance pain, NDI, and cervical ROM. Both treatments are well-tolerated and well-complied with by patients[47].

In line with our present study, which also revealed enhancement of disability with similar outcomes observed in both groups, Leon-Hernandez et al. (2016) showed that TENS + DN as well as DN alone had comparable effects on enhancement in degree of neck disability at 3 days-follow-up. For myofascial chronic neck pain patients, applying TENS following DN treatment is more beneficial than DN alone in reducing short-term soreness and alleviating the severity of pain at a short term. On the other hand, the NDI group may have seen more improvement than the DN group because of post-needling soreness or higher dosages[48].

Garcia-de-Miguel et al. (2020) shown that NDI improved TENS more than DN did. According to the author, this could have been because the subjects in the TENS group had less pain during active motions, leading to a lower feeling of neck impairment. This would have resulted from a reduction in muscle mechano-sensitivity[34].

According to the effect of traditional physical therapy treatment, Javaid et al., (2016) 48 patients with UT MTrPs participated in the study to determine the effects of interventions in form of traditional Physiotherapy with or without strain counterstrain were recorded on NDI, VAS and CROM goniometer with treatment groups A and B which involved 24 patients each.In patients with UT MTrPs, they found that conventional physical treatment was more beneficial than traditional physiotherapy alone in lowering pain, functional impairment, and enhancing ROM at the cervical area. These findings reinforce the increasing amount of evidence that strain counter strain can be an effective tool in the treatment of MTrPs[49].

Kannan (2012) reports that a study including 50 patients with MTrPs examined the efficacy of conventional physiotherapy, laser, as well as ischemia compression in alleviating pain and enhancing cervical ROM. The results showed that MTrPs are well managed with typical physical therapy, which reduces impairment caused by musculoskeletal disease among UT MTrPs patients[50].

Contrary to Diaz-Pulido et al. (2021), this study compared the effectiveness of TENS with manual therapy (MT) for improving active mobility as well as endurance in patients suffering from mechanical neck disorders who were experiencing either subacute or chronic pain in their cervical spines. The participants were randomly assigned to receive ten 30-minute sessions of either MT or TENS in a multi-center trial conducted through 12 primary care physical therapy units located in the Madrid community. The results showed that the TENS group did not show any significant enhancement. On the other hand, MT outperformed TENS in improving mobility and endurance both immediately following the intervention as well as during the 6-month follow-up in the sagittal plane. Among the three measures, only MT produced statistically significant enhancements in cervical movement along with endurance [51].

In addition, Nordermar and Thorner (2001) used a randomized design to treat 30 patients suffering from acute neck pain with either a neck collar, TENS, or MT. All groups showed fast recovery, however the TENS group restored cervical mobility at a much faster rate[52].

This study's findings are at disagreement with those of De Meulemeester et al. (2017), who examined the efficacy of DN and myofascial pain release (MP) in the management of myofascial neck as well as shoulder pain within 42 female office workers. The participants were randomly assigned to one of two groups and each group received four treatments. Both methods had both immediate and delayed benefits, but when it came to relieving myofascial pain in the neck and shoulders, DN was no better than MPR[53].

By contrast, Gam et al. (2008) examined the efficacy of ultrasonic, massage, as well as exercise treatment for 58 individuals suffering from MTrPs of the shoulder and neck. When they treated MTrPs in the shoulder and neck with conventional physiotherapy, they discovered no improvement. Results from this study support the idea that treatment modalities can improve CROM and decrease pain perception[54].

The limitation of the study

First: It is necessary to conduct additional studies to determine the long-term effects of TENS as well as DN on UT MTrPs in NSCNP patients, as this study only assessed the effects after 4 weeks. Secondly, future research should use a larger sample size because the current one was too small.

Conclusion

According to the results and scope of this research, we concluded that TENS with traditional physical therapy showed superiority than DN with traditional physical therapy program in improving pain intensity level, PPT, neck functional level as well as CROM in UT MTrPs in NSCNP patients rather than traditional physical therapy alone.

Acknowledgements

The authors are grateful to all children for their participation in this study.

Informed consent

Informed consent has been obtained from all individuals included in this study.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

Funding

No external funding supported this research.

References

1. O'Riordan C., Clifford A., Van De Ven P. and Nelson J., (2014):Chronic neck pain and exercise interventions: Frequency, intensity, time, and type principle. Arch. Phys. Med. Rehabil.; 95 (2): 770 – 783.
2. Gross A. R., Paquin J. P., Dupont G., Blanchette S., Lalonde P., Cristie T., Graham N., Kay T. M., Burnie S. J. and Gelley G., (2016): Exercises for mechanical neck disorders: A Cochrane review update. Man. Ther.; 24 (1): 25 – 45.
3. Jahre H., Grotle M., Smedbraten K., Dunn K. M. and Oiestad B. E., (2020): Risk factors for non specific neck pain in young adults: A systematic review. BMC

Musculoskelet. Disord.; 21(1): 366 – 373.

4. Cerezo-Tellez E., Torres-Lacomba M., Fuentes-Gallardo I., Perez-Munoz M., Mayoral-Del Moral O., Lluch-Girbes E., Prieto-Valiente L. and Falla D., (2016): Effectiveness of dry needling for chronic nonspecific neck pain: a randomized, single-blinded, clinical trial. Pain; 157 (3): 1905 – 1917.
5. Frenandez-de-Las-Penas C. and Nijs J., (2019): Trigger point dry needling for the treatment of myofascial pain syndrome: current prospectives within a pain neuroscience paradigm. J. Pain Res.; 12: 1899 – 1911.
6. Shah P., Thaker N., Heimur J., Aredo JAM, Sikdar S. and Gerber L., (2015): Myofascial trigger point then and now: a historical and scientific perspective.PM R J.; 7(1): 746 – 761.
7. Alahmari K. A., (2017): Normal cervical spine range of motion using digital inclinometer in male asymptomatic subjects of Aseer. Saudi J Sports Med; 17(1):40-44.
8. Desai M. J., Saini V. and Saini S., (2013): Myofascial pain syndrome: A treatment review. Pain Ther.; 2 (1):1: 21 – 36.
9. Pratsel H. G., Eigner U. M., Weinert D. and Limbach B., (1992): The analgesic efficacy of sulfur mud baths in treating rheumatic diseases of the soft tissues. A study using the double-blind control method. Vopr. Kurortol. Fizioter. Lech. Fiz. Kult.; 3: 37 – 41.
10. Vallbona C., Hazlewood C. F. and Jurida G., (1997): Response of pain to static magnetic fields in postpolio patients: A double-blind pilot study. Arch. Phys. Med. Rehabil.; 78 (11): 1200 – 1203.
11. Ghoname E. S. A., White P. F., Ahmed H. E., Hamza M. A., Craig W. F. and Noe C. E., (1999): Percutaneous electrical nerve stimulation: an alternative to TENS in the management of sciatica. PAIN.; 83 (2): 193 – 199.
12. Hou C. R., Tsai L. C., Cheng K. F., Chung K. C. and Hong C. Z., (2002): Immediate effects of various physical therapeutic modalities on cervical myofascial pain and trigger point sensitivity. Arch. Phys. Med. Rehab.; 83 (10): 1406 – 1414.
13. Dommerholt J., Chou LW., Finnegan M. and Hooks T., (2018): A critical

overview of the current myofascial pain literature- April 2018. J.Bodyw. Mov. Ther.; 22(2): 402 – 410.

14. Iaroshevskyi O. A., Morozova O., Logvinenko A. V. and Lypynska Y. V., (2019): Non pharmacological treatment of chronic neck-shoulder myofascial pain in patients with forward head posture. Wiad. Lek.; 72 (1): 84 – 88.
15. Gattie E., Cleland J. A. and Snodgrass S., (2017): The effectiveness of trigger points dry needling for musculoskeletal conditions by physical therapists: A systematic review and meta-analysis. J. Ortho. Sports Phys. Ther,; 47 (2): 133 – 149.
16. Dunning J., Butts R., Young I., Mourad F., Galante V., Bliton P., Tanner M. and Fernández De-Las-Peñas C., (2018): Periosteal electrical dry needling as an adjunct to exercise and manual therapy for knee osteoarthritis. Clin. J. Pain; 34 (2): 1149 – 1158.
17. Aridici R., Yetisgin A., Boyaci A., Tutoglu A., Bozdogan E., Dokumaci D. S., Kilicaslan N. and Boyaci N., (2016): Comparison of the efficacy of dry needling and high-power pain threshold ultrasound therapy with clinical status and sono-elastography in myofascial pain syndrome. Am. J. Phys. Med. Rehabil.; 95 (10): 149 – 158.
18. Gulick D. T. (2018): Instrument-assisted soft tissue mobilization increases myofascial trigger point pain threshold. J. Bodyw. Mov. Ther.; 22 (2): 341 – 345.
19. Hoving J., Koes B. and de Vet H., (2002): Manual therapy, physical therapy, or continued care by a general practitioner for patients with neck pain: A randomized, controlled trial. Ann. Inter. Med.; 136:713 – 722.
20. Hussain S., Ahmad A., Amjad F. and Shafi T., (2016): Effectiveness of Natural Apophyseal Glides versus Grade I and II Maitland Mobilization in Non Specific Neck Pain. Ann. King Edw. Med. Univ. Lah. Pakis.; 22(1):23 – 29.
21. Hakkinen A., Ylinen J., Rinta-Keturi M., Talvitie U., Kautiainen H. and Rissanen A., (2004): Decreased neck muscle strength is highly associated with pain in cervical dystonia patients treated with botulinum toxin injections. Arch. Phys. Med. Rehabil.; 85 (10): 1684 – 1688.
22. Hammer W., (2008): The effect of

mechanical load on degenerated soft tissue. J. Bodyw. Mov. Ther.; 12 (3): 246 – 256.

23. Young J. D., Spence A. J., Power G. and Behm D. G., (2018):The Addition of Transcutaneous Electrical Nerve Stimulation with Roller Massage Alone or in Combination Did Not Increase Pain Tolerance or Range of Motion. J. Sports Sci. Med.; 17 (4): 525 – 532.
24. Abbaszadeh-Amirdehi M., Ansari N., Naghdi S., Olyaei G. and Nourbakhsh M. R., (2017a): Neurophysiological and clinical effects of dry needling in patients with upper trapezius myofascial trigger points. J. Bodyw. Mov. Ther.; 21 (1): 48 – 52.
25. Ismail M., (2008): The Effect of Neck Endurance Training as a Component of an Exercise Program for Chronic Non-specific Neck Pain. Bull. Fac. Ph. Th. Cairo Univ. 13 (1): 309 – 315.
26. Imai K., Ikoma K., Chen Q., Zhao C., An K. N. and Gay R.E., (2015): Biomechanical and histological effects of augmented soft tissue mobilization therapy on Achilles tendinopathy in a rabbit model. J. Manip. Physiological Ther.; 38 (2): 112–118.
27. Abbaszadeh-Amirdehi M., Ansari N. N., Naghdi S., Olyaei G. and Nourbakhsh M. R., (2017b): Therapeutic effects of dry needling in patients with upper trapezius myofascial trigger points. Acupunct. Med.; 35(2):85 – 92.
28. Galasso A., Urits I., An D., Nguyen D., Borchart M., Yazdi C., Manchikanti L., Kaye R. J., Kaye A. D., Mancuso K. and Viswanath O., (2020): A comprehensive review of the treatment and management of myofascial pain syndrome. Cur. Pain Headache Rep.; 24 (43): 234 – 238.
29. Wessberg G. A., Carroll W. L., Dinham R. and Wolford L. M., (2011): Transcutaneous electrical stimulation as an adjunct in the management of myofascial pain-dysfunction syndrome. J. Prosthet. Dent.; 45 (3): 307 – 314.
30. Kruger L. R., Van der Linden W. J. and Cleaton-Jones P. E., (2008): Transcutaneous electrical nerve stimulation in the treatment of myofascial pain dysfunction. S. Afr. J. Surg.; 36 (1): 35 – 38.
31. Mukkannavar P. B., (2015): Effect of

Combination Therapy [Tens & Ultrasound] and Ischemic Compression in the Treatment of Active Myofascial Trigger Points. J. Exerc. Sci. Physiother.; 8 (2): 95 – 106.

32. Dissanayaka T. D., Pallegama R. W., Suraweera H. J., Johnson M. I. and Kariyawasam A. P., (2016): 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.; 95 (9): 663 – 672.
33. Jeon J. H., Jung Y. J., Lee J. Y., Choi J. S., Mun J. H., Park W. Y., Seo C. H. and Jang K. U., (2012): The effect of extracorporeal shock wave therapy on myofascial pain syndrome. Ann. Rehabil. Med.; 36 (5): 665 – 674.
34. Garcia-de-Miguel S., Pecos-Martin D., Larroca-Sanz T., Sanz-de-Vicente B., Garcia-Montes L., Fernandez-Matias R. and Gallego-Izquierdo T., (2020): Short-term effects of PENS versus dry needling in subjects with unilateral mechanical neck pain and active myofascial trigger points in levator scapulae muscle: a randomized controlled trial. J. Clin. Med.; 9 (6): 1665 – 1675.
35. Dusunceli Y., Ozturk C., Atamaz F., Hepguler S. and Durmaz B., (2009): Efficacy of neck stabilization exercises for neck pain: A randomized controlled study. J. Rehabil. Med.; 41 (8): 626 – 631.
36. Gibson W., Wand B. M. and O'Connell N. E., (2017): Transcutaneous electrical nerve stimulation (TENS) for neuropathic pain in adults. Cochrane Database Syst. Rev.; 9 (9): CD011976.
37. Chiu T. T., Hui-Chan C. W. and Cheing G., (2005): A randomized clinical trial of TENS and exercise for patients with chronic neck pain. Clin. Rehabil.; 19 (8): 850 – 860.
38. Sah V., (2023): Comparative Effects of Conventional Physical Therapy, Kinesio Taping and Extracorporeal Shock Wave Therapy in Acute Upper Trapezius Myofascial Pain Syndrome. East. J. Med.; 28 (1): 107 – 114.
39. Cerezo-Tellez E., Lacomba M. T., Fuentes-Gallardo I., Del Moral O. M., Rodrigo-Medina B. and Ortega C. G., (2016b): Dry needling of the trapezius muscle in office workers with neck pain: A randomized clinical trial. J.

Man. Manip. Ther.; 24 (4): 223 – 232.

40. Gerber L. H., Shah J., Rosenberger W., Armstrong K., Turo D., Otto P., Heimur J., Thaker N. and Sikdar S., (2015): Dry Needling Alters Trigger Points in the Upper Trapezius Muscle and Reduces Pain in Subjects With Chronic Myofascial Pain. PM R; 7 (7): 711 – 718.
41. Martin-Sacristan L., Calvo-Lobo C., Pecos-Martín D., Fernández-Carnero J. and Alonso-Pérez J. L., (2022): Dry needling in active or latent trigger point in patients with neck pain: A randomized clinical trial. Sci. Rep.; 12 (1): 3188 – 3199.
42. Naghikhani M., Nasrabadi H. T., Soleimanirad J., Joghataei M. T. and Arablu A. M., (2020): The Effectiveness of Dry Needling on Subjects With Multiple Myofascial Trigger Points in Shoulder Girdle Muscles. Cres. J. Med. Biolog. Sci.; 7 (2): 285 – 290.
43. Espejo-Antunez L., Tejeda J. F., Albornoz-Cabello M., Rodriguez-Mansilla J., De la Cruz-Torres B., Ribeiro F. and Silva A. G., (2017): Dry needling in the management of myofascial trigger points: A systematic review of randomized controlled trials. Complement. Ther. Med.; 33 (2): 46 – 57.
44. Hsieh Y. L., Kao M. J., Kuan T. S., Chen S. M., Chen J. T. and Hong C. Z., (2007): Dry needling to a key myofascial trigger point may reduce the irritability of satellite MTrPs. Am. J. Phys. Med. Rehabil.; 86 (5): 397 – 403.
45. Shah J. P. and Gilliams E. A., (2008): Uncovering the biochemical milieu of myofascial trigger points using in vivo microdialysis: an application of muscle pain concepts to myofascial pain syndrome. J. Bodyw. Mov. Ther., 12 (4): 371 – 384.
46. Cagnie B., Dewitte V., Barbe T., Timmermans F., Delrue N. and Meeus M., (2013): Physiologic effects of dry needling. Curr. Pain Headache Rep.; 17 (8): 348 – 354.
47. Anjana G., Gupta A. K., Kumar D., Mishra S., Yadav G., Roy M. S. and Prajapti L., (2023): Efficacy of Dry Needling Versus Transcutaneous Electrical Nerve Stimulation in Patients With Neck Pain Due to Myofascial Trigger Points: A Randomized Controlled Trial. Cureus;

15 (3): e36473.

48. Leon-Hernandez J. V., Martín-Pintado-Zugasti A., Frutos L. G., Alguacil-Diego I. M., De la Llave-Rincón A. I. and Fernandez-Carnero J., (2016): 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. Phy. Ther.; 20 (2): 422 – 431.
49. Javaid H. M., Ahmad A., Ajmad F., Liaqat S. and Tahir S., (2016): Effects of Conventional Physical Therapy with or without Strain Counterstrain in Patients with Trigger Points of Upper Trapezius; a Randomized Controlled Clinical Trial. ANNALS; 22 (3): 191 – 196.
50. Kannan P., (2012): Management of Myofascial Pain of Upper Trapezius: A Three Group Comparison Study. Glob. J. Health Sci.; 4 (5): 46 – 52.
51. Diaz-Pulido B., Pérez-Martín Y., Pecos-Martín D., Rodríguez-Costa I., Pérez-Muñoz M., Calvo-Fuente V., Ortiz-Jiménez M. F. and Asúnsolo-Del Barco A., (2021): Efficacy of Manual Therapy and Transcutaneous Electrical Nerve Stimulation in Cervical Mobility and Endurance in Subacute and Chronic Neck Pain: A Randomized Clinical Trial. J. Clin. Med.; 10 (15): 3245 – 3254.
52. Nordemar R. and Thorner C., (2001): Treatment of acute cervical pain-a comparative group study. Pain; 10 (1): 93 – 101.
53. De Meulemeester K. E., Castelein B., Coppieters L., Barbe T., Cools A. and Cagnie B., (2017): 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.; 4 (1): 11 – 20.
54. Gam A. N., Warming S., Larsen L. H., Jensen B., Høydalsmo O., Allon I., Andersen B., Gøtzsche N. E., Petersen M. and Mathiesen B., (2008): Treatment of myofascial trigger-points with ultrasound combined with massage and exercise: A randomised controlled trial. Pain; 77 (1): 73 – 79.