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Effects Of Dry Needling and Dry Needling Combined with Electrical Stimulation on Pain and Function in Patients with Subacute Musculoskeletal Neck Pain Following Myofascial Trigger Points

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Abstract

Study design: Double Blinded RCT. Objectives: Study the effects of dry needling (DN) and dry needling combined with electrical stimulation(EDN) on pain and function in patients with subacute neck pain following myofascial trigger points in upper quadrant muscles. Method: Thirty patient will be randomly allocated into two groups one receives DN +hot pack and group two receive EDN + hot pack. Each protocol of intervention consists of 6 sessions for 3 weeks (2 sessions per week) and checking VAS and ROM and NDI and FCE before and after treatment. Result: Thirty patients were including in the study, 17 men and 13 women, VAS for pain at rest and at movement showed improvement in both group DN and EDN with an improvement advantage for the EDN group (p=0.000). And also for FCE we showed improvement and correlation in both group DN and EDN with an improvement advantage for the EDN group (p=0.000). and second outcome measure NDI we showed also improvement in both group DN and EDN with an improvement advantage for the EDN group(p=0.000). And for ROM of cervical also we showed improvement in both group DN and EDN and no significant different between two group the (P=0.000). Conclusion: The combination of dry needling, Electrical stimulation, and conventional therapy can be effective protocol for relieving pain, improving disability, function, at the patients with subacute neck pain following myofascial trigger points in upper quadrant muscles. The Application of dry needling, Electrical stimulation, and conventional therapy has no additional effects compare to dry needling therapy on improving identified ROM measures in these patients.

Keyword

Neck Pain, dry needling, electrical stimulation, myofascial trigger point, upper quadrant muscles.

One of the most disregarded causes of acute or chronic musculoskeletal pain is myofascial trigger points (MTrPs) (1). Trigger points have a high rank among the most prevalent musculoskeletal pain disorders (2). There is ample proof that muscle pain frequently represents a primary dysfunction and it is not always related to other diagnoses (3). Numerous different nociceptors are found in muscles, and they can be turned on and off mechanically and chemically (4).

A solid filament needle is inserted into a myofascial trigger point (MTrPs) during trigger point dry

needling (TrPs-DN), as an invasive procedure used by physiotherapists. The benefits of dry needling are more thoroughly documented (5), and include a prompt decrease in local, referral and general pain (5, 6) (7), restoration of muscle activation patterns and range of motion (5, 7), and a return to normal situation of nearby chemical environment of active myofascial trigger points (8). Dry needling can lessen both peripheral and central sensitization claims (6). Neck pain has also been linked to active trigger points (9) . Electrical acupuncture also can cause analgesic effects through neuronal mechanisms linked to central nervous system (CNS) and peripheral nervous system (PNS), involving numerous brain regions and various neurotransmitters and modulators (10, 11).
are painful to palpate and cause referral pain(12). Active myofascial trigger point produces local or referred spontaneous pain that can be elicited by stimulation. Latent myofascial trigger points produce local or referral pain only when it is stimulated, but it is not spontaneously(13, 14). More recent studies indicate myofascial trigger points are responsible for as much as 85% of musculoskeletal pain(15). The researchers have identified myofascial trigger points with every musculoskeletal pain, including radiculopathies, joint dysfunction, disc pathology, tendonitis, craniomandibular dysfunction, migraines, tension-type headaches, carpal tunnel syndrome, whiplash-associated spinal dysfunction, and pelvic pain and other neurologic syndromes(16).

Dry Needling Treatment

Dry needling (DN) is an invasive (some researchers believe that is minimally invasive) treatment in which a fine needle or acupuncture needle is inserted into the skin and/or muscle. It is applied in myofascial trigger points which are hyperirritable spots in skeletal muscles and are associated with a hypersensitive palpable nodule in a taut band(17). Trigger point dry needling can be carried out at the superficial or deep tissue level (17). The mechanical effects of the needle may lead to improvement in the fiber structure, localized tissue stiffness, and local circulation of biochemical situation associated with the trigger point (18). The changes of local blood flow and induction of local twitch responses through dry needling may improve ischemia, hypoxia, and presence of analgesic substances, such as calcitonin gene-related peptide (18, 19).
A systematic review study was published in 2017, focused on randomized controlled
trials, aimed to examine effectiveness of dry needling in treatment of myofascial trigger points, and also to explore the impact of specific aspects of technique on its effectiveness. The results suggested that dry needling was effective in short-term for pain relief, increasing range of motion, and improving quality of life when compared to no intervention/sham or placebo group (20)
Another study published in 2020 was a systematic review aimed to evaluate the effects of combining dry needling with other physical therapy interventions versus the application of other interventions or dry needling alone, applied over trigger points (TrPs) associated with neck pain. There were low-to-moderate evidences suggested positive effects of combination of dry needling with other interventions for improving pain intensity, pain-related disability, pressure pain thresholds, and cervical range of motion in people with neck pain associated with trigger points for short-term period (21).

Electrical Dry Needling

Electrical dry needling (EDN) is a method of applying at least two needles that are inserted as electrodes for passing an electric current to the tissue. One of the main advantages of using electrical dry needling in medicine-based practice or (therapy by needles in skin) is its ability to set and manage stimulation characteristics including frequency and strength without extra motion. Mechanical hypoalgesia was found immediately after treatment in the Intramuscular electrical stimulation through dry needling group, but not in the dry needling group, with the differences between-group being statistically significant in favor of the Intramuscular electrical stimulation through dry needling group in pressure pain threshold. By delivering electrical stimulation flows only in one way directly into the target muscle, treatment can be focused on the myofascial trigger point, and impedance by more shallow tissue can be avoided (22). In addition to brain chemical and (related to nerves and movement) changes, dry needling intramuscular electrical stimulation can be a good possible approach to improve pain, Pain pressure threshold, blood flow, disability, and ROM (23, 24)

Materials and Methods

This study double blind was conducted at The department of rehabilitation in Imam Hassan Hospital Karbala Governorate, Iraq. Between April and June of the year 2023.the data analyser was blinded from the participant's allocation. The study protocol was approved by the Ethical committee of Tehran University of Medical Sciences (IR, TUMS.FNM.REC.1402.025) and

registered in Iranian registry of clinical trials IRCT20230604058307N1

Moreover, a specific informed written consent was signed by all patients prior to intervention

Table 1: Demographic and Baseline Characteristics.

Variable	DN+ Hot pack	EDN+HOT Pack
Age	±31.07	± 35.00
gender	± 1.53	± 1.33
Pain intensity at rest	5.067	5.027
Pain intensity during movement	5.927	6.007
Neck flexion	40.867	43.673
Neck extension	40.066	47.160
Neck lefit lateral flextion	33.513	35.057
Neck right latreral flextion	32.893	32.158
Neck left rotation	49.267	47.487
Neck right rotation	50.200	48.420
FCE neck Repetitive side reaching test	74.973	104.000
FCE Repetitive overhead reaching test	56.400	63.133
FCE static overhead work test	50.967	47.520
FCE overhead lift test	46.113	45.005
NDI	20.185	21.667

DN (Dry needling). EDN (Electrical dry needling). FCE (functional capacity evaluation).NDI(Nick disability index)

Study Subjects

Thirty patients were selected by means of convenience non-probability sampling method We do allocation concealment by recruited for the study based on their voluntary participation like (figure-1).

The inclusion criteria were both gender age 25 to 45 years, differentially diagnosed with unilateral neck pain following myofascial trigger point in upper quadrant muscles(25), Neck pain rated between (30-70) mm base on VAS score during activity and rest, Patients presenting unilateral sub-acute trigger point signs and symptoms form (22-84) days (25). The presence of 5 to 10 identified trigger points in the upper quadrant muscles. (26)

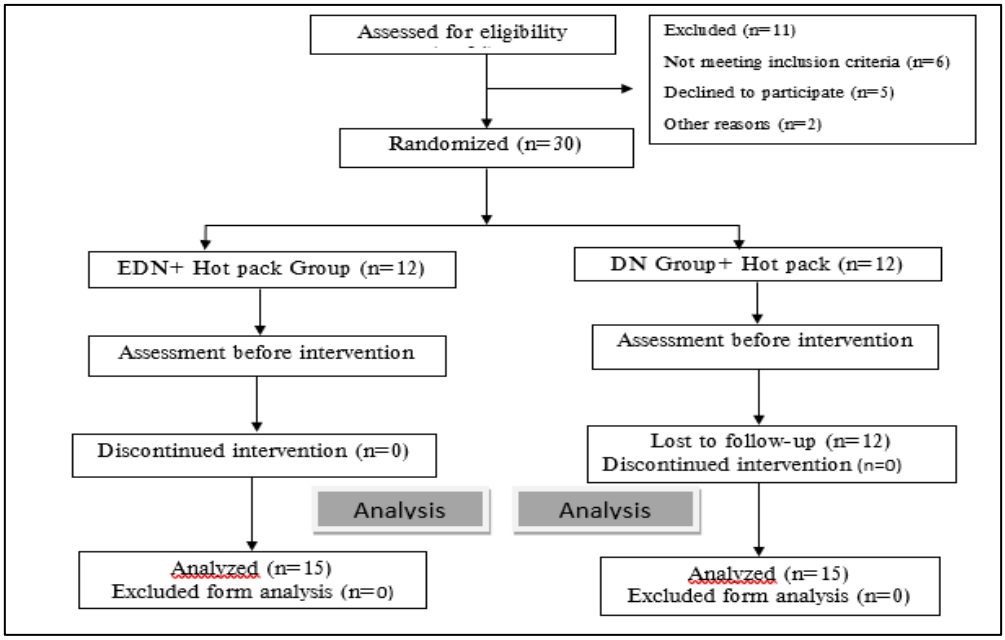

Figure 1: study design flowchart for intervention groups

Primary Criteria

If a patient met at least two of the five signs and symptoms criteria, they would be considered as a potential candidate for this study. Regional pain complaint.

Pain complaints or altered sensation in the expected distribution of referred pain from a

trigger point in the upper quadrant muscle.
Taut band palpable in an accessible muscle.
Exquisite spot tenderness at 1 point along the length of the taut band.
Some degrees (20 to 60 degrees) of a restricted ROM in rotation and lateral flexion (27).

Secondary Criteria

If a patient passed the initial selection stage, they must also meet at least one of the three additional criteria to be included in the study. reproduction of clinical pain complaint or altered sensation when pressure is applied to the tender spot
Local twitch response triggered by palpation or needle insertion at the tender spot.
Pain relief experienced when the muscle is elongated (stretched) or when the tender spot is injected (27).
All patient with a systemic disorder or a history of migraines. Patient who received medication or physiotherapy treatment specifically targeting trigger point within the 3 weeks preceding the study, pregnant women, patient who experienced trauma to the neck area within past six month, or who has skin inflammation. or open wounds, and who refused to continue the study were also excluded(28).

Outcome Measures

Visual analogue scale

Pain intensity at rest and during activity was evaluated by visual analogue scale (VAS). It was performed by using a 10-cm VAS with endpoints marked as 'no pain' and 'worst pain imaginable', The VAS score was determined by measuring in millimetres from the left-hand end of the line to the point that the patient marks higher score indicated greater pain intensity. The following cut points on the pain by VAS have been recommended; No pain (0−4 mm), mild pain (5-44 mm), moderate pain (45−74 mm), and severe pain (75−100 mm). It's important to mention that normative values are not available in this method of measurement. The VAS takes < 1 minute to complete. It is a valid and reliable method of measurement to evaluate musculoskeletal pain intensity(29).

Range of Motion of the Neck

The ROM of the neck were assessed to examine mobility of the neck and its quality of movement by a Bubble Inclinometer,
The validity and reliability of the measuring tools were reported in different studies: and measuring Range of motion of all neck movement, including flexion-extension, lateral flexion, and lateral rotation
(30)

Functional Capacity

The Functional Capacity Evaluation (FCE) is used to assess the functional capacity of patient's neck. It is designed to assess a person's physical capacity for carrying out tasks that are related to their line of work. The FCEs are used in work rehabilitation programs, to determine a person's level of disability, to make recommendations regarding a return to work, and in medico-legal situations. The FCE reveals a patient's actual performance in a setting for standardized evaluation (31). Six tests make up the FCE for neck pain (Neck-FCE): lifting the waist to the overhead position (LOH), carrying objects with both hands, working overhead (OHW), bending and reaching overhead (BOR), and repeatedly reaching to the side (left and right).
The participants received a brief tutorial on how to complete each test. First, the assessor was conducted a single demonstration of each test. Then, the participants were instructed to give the tests with their best efforts. Using weights of 2.5 and 5 kg, the weights lifted were gradually increased based on a participant's performance. Testers used observational criteria to gauge physical effort levels. A participant could stop the test for any number of reasons, including pain. The observer assessed test safety based on biomechanical criteria. If unsafe, criteria included heart rate not exceeding age-related maximum (220 - age) or reaching predetermined time limit. (32).
The FCE is considered as a safe under specific condition that takes into account the patient's tolerance capacity (32). The following tests of the FCE were specifically used to assess the functions of the neck:
These test is

Repetitive side reaching test, Repetitive overhead reaching test. Static overhead work test. Overhead lift test:

Neck Disability

Disability can be measured using the Neck Disability Index, and there are some studies that have examined the reliability of the NDI (23) However, most of these articles were conducted in physical therapy departments or focused on patients with whiplash-related disorders or problems (24). The NDI is the most commonly

used outcome measure for assessing disability of the patients with neck pain (33).It has sufficient support and usefulness to maintain its current status as the most widely used self-reported measure of neck pain (30). The NDI contains 10 questions, each representing one item described in his six options, the items being pain severity, personal care, lifting, headache, reading and work, concentration, driving, sleep, and rest. The questions are rated on a 6-point scale from 0 (no impairment) to 5 (complete impairment). Numerical responses for each item are summed to give a score from 0 to 50. Some raters specifically choose to give a score of 100% as (Success Plan/Method of Achieving Goals) to answer unanswered questions.

The participants were given a standardized NDI form, with questions to fill in before, and after (means to help bad situations) (31). The Arabic version of the NDI is used in this study. It has been two factors with 10-point structure and is a reliable and valid (Responsive or Responsive/Rapid Response) tool that can be used for testing/evaluation neck pain in patients who speaks Arabic. Therefore, it can be recommended for medical and research purposes. It becomes easier for Arabic patients to read and understand it without the need for a translator, thus avoiding translation bias. The patients with difficulty in self-managing the NDI questionnaire were assisted by the person (who cared for them) or someone unaware of the purpose of the tool (check the building for details)(34).

Study procedure

After being selected according to the inclusion and exclusion criteria, all participants signed an informed written consent form voluntarily before starting any intervention. All participants were assessed and treated in the same clinic. They were randomly allocated into either one of these two groups:

1: Electrical stimulation combined with dry needling + Hot therapy

2: Dry needling + Hot therapy

All participants were lying in prone position and did receive standard medical care, including 7 minutes of superficial heat (hot pack) before and after applying dry needling. The period between hot pack and dry needling was about 3 min. Each protocol of intervention consisted of 6 sessions for 3 weeks (2 sessions per week). Participants were instructed not to undergo any additional treatments during the research period. They were also advised to maintain their routine daily activities without engaging in any extra activities such as sewing, typing, etc.

All participants were lying in prone position and did receive standard medical care, including 7 minutes of superficial heat (hot pack) before and after applying dry needling. The period between hot pack and dry needling was about 3 min. Each protocol of intervention consisted of 6 sessions for 3 weeks (2 sessions per week). Participants were instructed not to undergo any additional treatments during the research period. They were also advised to maintain their routine daily activities without engaging in any extra activities such as sewing, typing, etc.

The interventions were implemented using the following methods:

Group-1: The patient was lying in prone position. After the therapist identified the trigger points, one of two sizes of sterilized disposable stainless steel needles were applied including 0.25 mm Ч 30 mm or 0.30 mm Ч 40 mm in the area of Upper quadrant muscle like in (figure -3). The size of the needle was chosen based on the patient's physical constitution (i.e., muscle size and/or connective tissue thickness). The needle was inserted until it reached the active or latent MTrPs or taut band causing the local twitch responses and let it inside the muscle for ten mint (35).

Group -2: The patient was lying in prone position. After the therapist identified the trigger points, he inserted the needle as it was combined with electrical stimulation (electrical dry needling application). The applied electrical stimulation was transcutaneous electrical nerve stimulation – (TENS). The stimulation frequency was about 2 Hz, with an intensity of 12 mA, and a pulse width 0.2 ms (36). The applied waveforms were biphasic square waves that mostly use for these patients like (figure -2). We used these measurements because they were reported to be effective characteristics in electrical dry needling. (44, 45, 46) They were applied through one of two sizes of sterilized disposable stainless steel needles: 0.25 mm Ч 30 mm or 0.30 mm Ч 40 mm. The size of the needle was similar to group one (35) (36, 37)

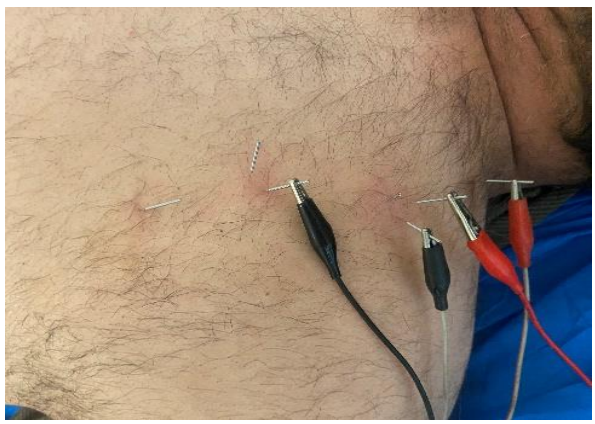

Figure (2) Electrical stimulation through dry needling

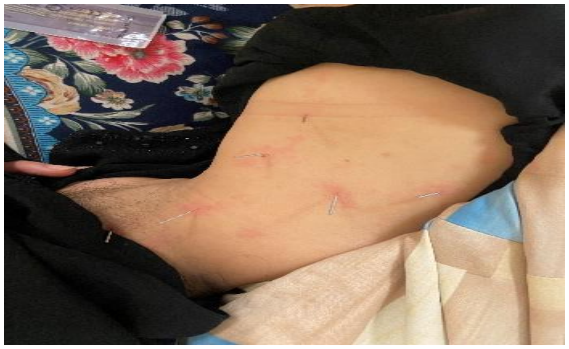

Figure (3) Dry needling in myofascial trigger point.

Statistical analysis

The sample size was measured using the "G-power" 3.1.9.4 version by taking into consideration the mean and standard deviation (SD) of previously published data (Hsieh et al.2007) The mean±SD for DN group were (2.8±1.1), and the mean±SD for control group were (6.8±1.00). The values referred to pain scores immediately post treatment (38). The participants were allocated for each group were 15

Data Analysis

The SPSS version 23 was used for data analysis. The descriptive analysis was reported base on the mean and standard deviations of the demographic variables of the participants. The normality of the data was analyzed using the Shapiro-Wilk test, and appropriate statistical tests were applied based on normal distribution. Independent t-tests were applied to compare demographic variables between the two groups and also compared dependent variables at baseline. The t-test analysis was used in case of normal distribution to compare the results between the groups. Progress within each group was evaluated using paired t-tests. The level of significance was considered as $p<0.05$ with confidence interval of 95%.

Results

Thirty patients were including in the study, 17 men and 13 women, the primary outcome measure, VAS for pain at rest and at movement showed improvement in both group DN and EDN with an improvement advantage for the EDN group over the DN group depending on Cohen s d value. And

Table (2). Visual analogue scales (cm) at rest and movement in the two groups.

Group		Pain at Rest Pre Treatment	Pain at Rest Post Treatment	Cohen s d test value	Pain at Movement Pre Treatment	Pain at Movement Post Treatment	Cohen s d test value
DN	Mean	5.067	3.353	3.9	5.927	4.260	1.7
	Standard division	.729	916		736	978	
EDN	Mean	5.027	1.417	4.6	6.007	2.257.	3.2
	Standard division	.814	.439		727	.819	

Table (3). The mean of ROMs of cervical flexion and extension (degrees) before and after improvement in two groups

Group		Cervical Flexion Range of Motion Pre Treatment	Cervical Flexion Range of Motion Post Treatment	Cohen s d test value	Cervical Extension Range of Motion Pre Treatment	Cervical Extension Range of Motion Post Treatment	Cohen s d test value
DN	Mean	40.867	45.213	3.3	43.673	48.067	3.9
	Standard division	3.015	3.008		4.252	4.591	
EDN	Mean	40.066	49.099	4.09	40.787	47.160	1.9
	Standard division	4.501	4.754		4.656	6.025	

for ROM of cervical also we showed improvement in both group DN and EDN with an improvement advantage for the EDN group over the DN group in ROM flexion right lateral flexion left rotation Except Extension left lateral flexion and right rotation the advantage improvement for DN group, the difference was not so much in the improvement depending on Cohen s d value. And also for FCE we showed improvement and correlation in both group DN and EDN with an improvement advantage for the EDN group over the DN group for all test, and second outcome measure NDI we showed also improvement in both group DN and EDN with an improvement advantage for the EDN group over the DN group depending on Cohen s d value.

Pain

Pain at rest before and after intervention for both groups in table(2); the mean and t value and Cohens d, in the DN group was (mean =1.713, t value= 15.347, Cohen s d=3.9) and for the EDN group was (mean= 3.609, t value=18.007 Cohen s d= 4.6). Since to the Effect size by Cohen s d value result we could consider that the EDN application had more effects on pain at rest compared than the DN alone.

Pain at movement before and after intervention for both groups in table (2); the mean and t value and Cohens d, in the DN group was (mean= 1.667, t= 6,928, Cohen d=1.7) and for the EDN group was (mean= 3.750, t value=12.539, Cohen s d=3.2). Since to the and Cohen s d value result we could consider that the EDN application had more effects on pain at rest compared than the DN alone.

Range of Motion of Cervical Spine (ROM)

Cervical flexion ROM pre and post treatment between two groups in table (3); the mean and t value and Cohens d, in the DN group was (mean= -4.347 t=-12.880, Cohen s d=3.3) and for the EDN group was (mean=-9.033 t=-15.837, Cohen s d=4.09). Since to the and Cohen s d value result we could consider that the EDN application had more effects on. Cervical flexion ROM compared to the DN alone.

Cervical extension ROM pre and post treatment between two groups in table (3); the mean and t value and Cohens d, in the DN group was (mean=-4.393, t= -3.773, Cohen s d=3.9) and for the EDN group was (mean=-6.373 t= -7.647, Cohen s d=1.9). Since to the and Cohen s d value result we could consider that the DN application had more effects on. Cervical extension ROM compared to the EDN alone.

Table (4). The mean of ROMs of cervical left and right lateral flexion (degrees) pre- and post-treatment in the two groups.

Group		Cervical Left Lateral Flexion Range of Motion Pre Treatment	Cervical Left Lateral Flexion Range of Motion Post Treatment	Cohen s d test value	Cervical Right Lateral Flexion Range of Motion Pre Treatment	Cervical Right Lateral Flexion Range of Motion Post Treatment	Cohen s d test value
DN	Mean	33.513	36.907	4.09	32.893	36.573	3.8
	Standard division	3.478	3.261		4.123	3.769	
EDN	Mean	35.057	43.007	3.9	32.158	41.147	4.9
	Standard division	4.121	3.140		3.0415	2.288	

Table (5). The ROMs of cervical left and right rotation (degrees) pre and post treatment in the two groups.

Group		Cervical Left Rotation Range of Motion Pre treatment	Cervical Left Rotation Range of Motion Post Treatment	Cohen s d test value	Cervical Right Rotation Range of Motion Pre treatment	Cervical Right rotation range of motion post treatment	Cohen s d test value
DN	Mean	49.267	55.467	4.5	50.200	56.493	7.4
	Standard division	4.234	4.486		5.480	5.545	
EDN	Mean	47.487	60.237	7.4	48.420	61.422	5.8
	Standard division	3.576	3.514		5.344	3.736	

Cervical left lateral flexion ROM pre and post treatment between two groups in table (4); the mean and t value and Cohens d, in the DN group was (Mean=-3.393 t= -15.863, Cohen s d=4.09) and for the EDN group was (-7.950, t=-15.295, Cohen s d=3.9). Since to the and Cohen s d value result we could consider that the DN application had more effects on. Lateral flexion ROM compared to the EDN alone.

Cervical right lateral flexion ROM pre and post treatment between two groups in table (4); the mean and t value and Cohens d, in the DN group was (Mean=-3.680, t= -14.962, Cohen s d=3.8) and for the EDN group was (mean=-8.992, t=-19.046, Cohen s d=4.9). Since to the and Cohen s d value result we could consider that the EDN application had more effects on cervical right lateral flexion ROM compared to the DN alone.

Cervical left rotation ROM pre and post treatment between two groups in table (5); the mean and t value and Cohens d , in the DN group was (mean=-6.200, t= 17.486, Cohen s d=4.5) and for the EDN group was (mean=-12.751, t= -28.867, Cohen s d=7.4). Since to the and Cohen s d value

result we could consider that the EDN application had more effects on cervical left rotation ROM compared to the DN alone.

Cervical right rotation ROM pre and post treatment between two groups in table(5); the mean and t value and Cohens d, for the DN group was (mean= -6.293, t= -28.920, Cohen s d=7.4) and for the EDN group was (mean=-13.002, t =-22.528, Cohen s d=5.8 Since to the and Cohen s d value result we could consider that the DN application had more effects on cervical right rotation ROM compared to the EDN alone.

Function Capacity Evaluation (FCE)

Functional capacity of the neck repetitive side reaching test pre and post treatment for both groups in table (6); the mean and t value and Cohens d , in the DN group was (mean =9.387, t=11.736, Cohen s d=3.03) and for the EDN group was (mean=45.800 t=24.164, Cohen s d=6.2). Since to the and Cohen s d value result we could consider that the EDN application had more effects on the FCE of the neck repetitive side reaching test compared to the DN alone.

Functional capacity of the neck repetitive overhead reaching test pre and post treatment for both groups in table (6); the mean and t value and Cohens d, in the DN group was (mean=5.688, t= 6.142, Cohen s d=1.66) and for the EDN group was (mean=12.380, t=10.775, Cohen s d=2.7). Since to the and Cohen s d value result we could consider that the EDN application had more effects on FCE of neck repetitive overhead reaching test compared to the DN alone.

Table (6). The mean of Functional capacity of neck evaluation (FCE) (time) of Repetitive side reaching test and Repetitive overhead reaching test pre- and post-treatment in the two groups.

Group		Functional capacity of the neck Repetitive side reaching test pre treatment	Functional capacity of the neck Repetitive side reaching test post treatment	Cohen s d test value	Functional capacity of the neck repetitive overhead reaching test pre treatment	Functional capacity of the neck repetitive overhead reaching test post treatment	Cohen s d test value
DN	Mean	74.973	65.587	3,03	50.160	45.160	1.66
	Standard division	9.390	7.618		12.283	10.354	
EDN	Mean	104.000	58.200	6.2	63.133	50.753	2.7
	Standard division	8.992	6.062		6.278	5.907	

Table (7). The mean of Functional capacity of neck static overhead work test and overhead lift test pre and post treatment in the two groups.

Group		Functional capacity of the neck static overhead work test pre treatment	Functional capacity of the neck static overhead work test post treatment	Cohen s d test value	Functional capacity of the neck overhead lift test pre treatment	Functional capacity of the neck overhead lift test post treatment	Cohen s d test value
DN	Mean	50.967	45.267	1.60	46.113	39.540	2.4
	Standard division	12.393	11.0354		7.241	6.142	
EDN	Mean	47.520	35.767	2.1	45.005	32.457	3.7
	Standard division	6.933	7.457		6.567	4.963	

Table (8). The mean of Neck disability index (NDI) pre- and post-treatment in the two groups.

Group		The Neck Disability Index Pain intensity Pre Treatment	The Neck Disability Index Pain intensity Post Treatment	Cohen s d test value
DN	Mean	20.185	12.570	3.1
	Standard division	1.898	1.276	
EDN	Mean	21.667	9.731	3.9
	Standard division	3.155	1.518	

Functional capacity of the neck static overhead work test pre and post treatment for both groups table (7); the mean and t value and Cohens d, for the DN group was (mean=5.700, t= 6.210, Cohen s d=1.60) and for the EDN group was (mean=11.753, t= 8.152, Cohen s d=2.1). Since to the and Cohen s d value result we could consider that the EDN application had more effects on FCE of neck static overhead work test compared to the DN alone.

Functional capacity of the neck overhead lift test pre and post treatment for both groups table (7);

the mean and t value and Cohens d, for the DN group was (mean=6.573, t=9.527,, Cohen s d=2.4) and for the EDN group was (mean=12.547, t=14.612, Cohen s d=3.7). Since to the and Cohen s d value result we could consider that the EDN application had more effects on FCE of neck static overhead work test compared to the DN alone.

Neck Disability (NDI)

Pain intensity in Neck Disability Index pre and post treatment for both groups in table (8); the mean and t value and Cohens d, in the DN group was (Mean=7.615, t= 12,373, Cohen s d=3.1) and for EDN group was (mean=11.936, t=15.29, Cohen s d=3.9). Since to the and Cohen s d value result we could consider that the EDN application had more effects on Pain intensity in Neck Disability Index compared to the DN alone.

Discussion

Based on our literature review, this study might be initial clinical study to compare effects of dry needling (DN) and electrical stimulation through dry needling (EDN) for treatment of the patients with subacute neck pain following myofascial trigger points in upper quadrant muscles. The researchers of this study evaluated changes in each group of intervention and compared the variables between the groups. In discussion chapter, the study results will be interpreted considering similarities and differences with the results of former researchers. The results of the study showed that both DN and EDN application could be beneficial to reduce pain level (by VAS), improve range of motion (by bubble inclinometer), and improve functional capacity (by four Tests, Repetitive side reaching test, Repetitive overhead reaching test, Static overhead work test, Overhead lift test). and improve neck disability (by NDI). The improvement would be higher for the patients who were under the EDN application.Numerous studies on the effectiveness of thermotherapeutic treatments for cervical neck pain have been published. They suggest that increased blood flow, decreased tissue injury, decreased muscle spasm, and increased connective tissue elasticity may all contribute to the effectiveness of topical thermotherapy applications. the analgesic effects brought on by thermotherapy's rise in -endorphin levels(39, 40). The intervention were 6 sessions for a period of three weeks (two sessions per week), as explained in materials and methods. Our study showed statistically significant difference on the pain intensity (VAS) improvement between the EDN and DN groups (P<0.0001).

Pain by Visual Analogue Scale

The results of this study were different with the results of some published studies. Ilbuldu and colleagues (2004) (41) did not find any significant difference on myofascial pain in trapezius muscles following dry needling application compared to placebo groups immediately post-treatment and also after six months. The failure of pain reduction in this study might be because of type of needling as they used just one size of 0.25mm Ч 25mm needle that this size might be not reach to some trigger points are deep and far from the surface of the skin, Therefore, due to the depth of the muscles. The locations of trigger points in this study were also different among the patients and the researchers did not report exact sites of the points. Paracetamol as analgesic was prescribed to the patients during the study when the patients had pain and it could be affect the results as well. Another concern of this study was different numbers for intervention sessions that might also affect the results.

Two RCTs (Hong et al., 1994 and Ilbuldu et al., 2004) (41, 42) reported comparison of dry needling versus lidocaine on the MTrPs in neck area. The researchers evaluated the patients immediately after treatment and the results did not show any difference between two groups of interventions on pain of the MTrPs in neck area. Their results might be because the researchers did provide the treatment approaches just on one active MTrP for each patients. This approach could be very limited option for the patients who had and suffered pain following multiple MTrPs. In addition, size of needle on these studies might be too small to be effective on the MTrPs since they applied just one needle of 0.25mm Ч 25mm.

There were also three relevant studies that recruited elderly patients with chronic neck or low back pain (Itoh et al., 2004, 2006, 2007) (43-45). The cause of pain was not clear in these three studies. The patients with different history of injury, such as whiplash or sustained postural strain, might show different reaction on treatment approaches. Beyond, sample sizes were too small that lead to increase probability of type II error, the likelihood of study producing false negative result. On the other hand, treatment interventions in these studies were varied considerably based on needle placement, depth of insertion, treatment time and overall number of treatment sessions. Since the possible mechanism of action following needling and the other different interventions are different, it is not possible to compare these results with the present study and

identify optimal intervention.

Maryam Ziaeifar and colleagues (2013) studied effects of dry needling on pain, pressure pain threshold and disability in patients with myofascial trigger point in upper trapezius muscle. Pain alleviation was the main objective in this study and the DN application could improve pain intensity, PPT, and DASH scores in the patients. The researchers prescribed their approaches for the patients with the TrP in upper trapezius muscles. Another group of researchers reported effectiveness of the DN on lower Trapezius in the patients with mechanical neck pain (Pecos-Martın et al., 2015),. If MTrP-DN was applied for the active trigger point in lower trapezius at the patients with mechanical idiopathic neck pain, the results would be better improvement on pain, PPT, and Neck Pain Questionnaire (NPQ) scores compared to the MTrP-DN that was applied out of trigger points (46). Brennan and colleagues (2021) did not find differences in improvement of pain existed between the DN group and DN with intramuscular electrical stimulation groups. The results of these researchers was in conflict with the present study. The Brennan and colleagues did not represent overall population and they did not consider blinding for their study. Majority of the patients in this study were under treatment in sitting position, rather than lying, while evidences suggested that this technique might be better to use in sitting position lead to a vasovagal response. They also work just in one part of one muscle which was upper part of trapezius muscle and generalized their results. (47)

The results by Couto and colleagues (2014) highlighted greater efficacy of multiple deep intramuscular stimulation therapy over the placebo-sham and lidocaine injection trigger point. They indicated both active treatments could be more effective compared to placebo-sham for myofascial pain syndrome associated with limitations in normal activities. Their findings of this study were in direction with our results (48). Leon-Hernandez and colleagues (2016) also reported that adding percutaneous TENS to the DN could significantly reduce cervical discomfort compared to the DN alone at the patients with, the findings of this investigation were also in direction with the results of present study. (22) .

Mechanism of EDN in pain control

its analgesic effects via neuronal mechanisms associated with both the peripheral nervous system (PNS) and central nervous system (CNS), involving many brain regions as well as different neurotransmitters and modulators(49)

Range of Motion of Cervical Spine

The results of our study showed that cervical range of motions for all movements following EDN application were better compared than the patients after DN application. There was just one exception in extension movement that the improvement ratio between two groups was similar with tendency in favour the EDN group over the DN group.

The results of our study were in conflict with the results of some former researchers (Leyn Hernбndez et al., 2016). Application of percutaneous electrical nerve stimulation (PENS) after DN could not significantly increase cervical range of motion (CROM), when compared to the DN group alone. The failure of substantial increase in the CROM might be because of lack of blinding in this study since both the patients and therapist were not blinded in this study. The short period of intervention (just three days), and treatment over just on upper trapezius muscle might be the other reasons for different results. As it is clear, more than one muscle control range of motions of the neck (not just upper Trapezius). The treatment approaches of just one muscle, as it was applied at the patients of this study, could not be effective to see real effects of intervention on neck range of motions (22).

Garcia-de-Miguel and colleagues (2020) also reported inconsistencies regarding range of motions between the patients following percutaneous electrical nerve stimulation (PENS) and DN application. The failure of this study was on the CROM evaluation and lack of blinding for the patients and therapists. The DN application in both groups of this study were followed by compression force that might affect the study outcomes and concealed real differences between groups. Cervical side-bending is also under the action by group of muscles not just by levator Scapulae(50), and it is not possible to isolate and evaluate contraction of just levator Scapulae to measure side bending strength. Another reason that could restrict the results of this study was efficiency of the PENS compared with the DN. There were two needles that were utilized in the PENS group and just one needle that was applied in the DN group.(51) This process might be another reason for the different results.

Lee Chen and colleagues (2008) studied effects of needle electrical intramuscular stimulation on cervical and shoulder joint ROM, cervical lateral flexion and rotation, shoulder flexion, extension and adduction at the patients with myofascial trigger points (MTrPs), and It causes an increase in the flow of blood circulation in the neck area, The ROMs were evaluated before and after interventions accomplishment. All ROM measures had good immediate responses to the treatment and findings showed that results were in direction with the results of the present study (52). Ga and colleagues (2007) also found that the DN

application on trigger points with and without para spinal muscles (intramuscular stimulation) (IMS) could significantly improve of all cervical ROMs. The results were in favor of the results of the present study (53). Changes in range of motion could be related to mechanical effects induced by MTrP DN, for example, disruption of contraction knots (MTrP), localized stretch of contracted cytoskeletal structures, and decreased actin and myosin filament overlap, may be responsible for changes in range of motion. TrP DN may reduce muscular stiffness because taut bands with MTrPs are more rigid than the surrounding muscle tissue.(54, 55).

Neck Disability

The results of our study showed more significant improvement in the NDI score for the EDN group compared than the DN group.

The results of the present study were in conflict with a published trial (Leyn-Hernбndez-2016) that reported neck disability decreased significantly from baseline after application of both DN and also combination of DN and PENS. However, there was no significant difference between the groups (22). Besides, the NDI evaluation in this study was demonstrated satisfactory responsiveness for patient In clinical practice, it must be considered that the NDI changes of 10 points can be clinically meaningful for the patients with mechanical neck pain representing both with and without symptoms(56). The NDI changes in this study was less than 10. The failure of clinical difference in terms of the NDI between two groups in this study might be because of short period of interventions (just three days) that might not be enough to provide clinical improvement. Besides, the researchers performed the interventions just in upper trapezius muscle that might be not enough to provide a clinical improvement for bigger area.

Brennan and colleagues (2021) did not find any differences in disability improvement between the DN and DN with intramuscular electrical stimulation interventions at the patients having at least one palpable active trigger point located in one or both upper trapezius muscles. The results of this study was in conflict with the results of the present study. There were no blinding in Brennan study and majority of the patients were sitting at the time of interventions, rather than lying that suggested by former researchers (47). This position could provide vasovagal response and might alter the patients' outcomes. The researchers also worked just in one part of Trapezius muscle (upper part), that might affect the study results as well. We discovered a ceiling effect with the NDI, because baseline NDI of the patients who were selected for the study were less than 5 and this score could not be considered to defect the differences. It was also reported as measurement properties of the neck disability index in a systematic review was published on 2009 (56).

Garcia-de-Miguel and colleagues (2020) applied percutaneous electrical nerve stimulation with DN in one group and compared it with the DN application for the patients with unilateral mechanical neck pain and active myofascial trigger points in levator scapulae muscle. They reported greater improvements in Mechanosensitivity and disability for group PENS with DN compared than group DN , and the findings of this investigation agreed with our results (51). Some study showed that although people with chronic neck pain reported higher pain intensity and fear of movement, pain intensity and kinesiophobia degree did not associate to their physical activity levels. It can be speculated that high kinesiophobia degrees cause low physical activity level(57).

it can be stated that there is accumulating support for the fear-avoidance model. As predicted from the vast literature on fear and anxiety, pain-related fear is associated with catastrophic interpretations of pain, hypervigilance, increased escape and avoidance behaviours, as well as with intensified pain intensity and functional disability(58). Most people are afraid of using needles and when using them as a treatment method, their fear is released and they show different movement abilities.

Conclusion

The combination of dry needling, electrical stimulation, and hot pack presents a promising protocol for alleviating pain, enhancing disability, and improving function in patients experiencing subacute neck pain due to myofascial trigger points in upper quadrant muscles. However, the application of dry needling, electrical stimulation, and hot pack does not demonstrate any supplementary effects compared to dry needling alone in enhancing identified ROMs among these patients. Subsequent investigations are necessary to investigate deeper into the distinctive features of effective EDN and DN applications for individuals with subacute neck pain stemming from myofascial trigger points in upper quadrant muscles.

Ethical Considerations

Compliance with Ethical Guidelines

The research project was ethically approved by Tehran University of Medical Sciences

(#IR.TUMS.FNM.REC.1401.181). All steps of the assessments and interventions, and purpose of the study were explained to the patients before any interventions. The patients voluntarily read and signed the informed consent form. All collected data were kept confidential and available just for the researchers. In this study, therapeutic interventions did not have adverse effects on musculoskeletal system and also identified side effects for the participants. All patients were free to withdraw at any stage of the study and for any reason, even without a specific reason.

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Authors' Contributions

Conceptualization and study design: SBT, BAM, HZ; Data collection, writing initial draft: NT; Analysis and interpretation of data: All authors; Drafting of the manuscript: All authors; Critical revision of the manuscript for important intellectual content: SBT, BAM, HZ; Supervision: SBT.

Conflict of Interest

The authors declared that there was no conflict of interest in this study.

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