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Is adding dry needling to a standard care protocol beneficial in patients with chronic neck pain? A randomized placebo-controlled trial

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DECLARATION OF CONFLICTING INTERESTS

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Highlights

- Chronic neck pain patients present trigger points in superficial neck muscles.
- The addition of dry needling to a standard protocol does not provide better benefits.
- Only cervical range of motion improved after dry needling.

CRediT authorship contribution statement

Ricardo Medrano-de-la-Fuente: Writing – review & editing, Writing – original draft, Resources, Methodology, Investigation, Formal analysis, Conceptualization. Ignacio Hernando-Garijo: Writing – review & editing, Resources, Methodology, Investigation. María Teresa Mingo-G´ omez: Writing – review & editing, Supervision, Resources, Methodology, Conceptualization. Sandra Jim´ enez-del-Barrio: Writing – review & editing, Writing – original draft, Supervision, Software, Resources, Methodology, Formal analysis, Conceptualization. H´ ector Hern´andez-L´ azaro: Resources, Methodology. Luis Ceballos-Laita: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Conceptualization.

ABSTRACT

Purpose: To evaluate the short-term effects of adding a dry needling therapy to a standard care protocol based on education, exercise and electrotherapy, compared to a sham procedure and to a standard care protocol in isolation in patients with chronic neck pain.

Material and methods: A randomized placebo-controlled trial was performed. The participants in the dry needling group received a standard care protocol based on patient education, therapeutic exercise and electrotherapy, as well as two sessions of dry needling in the upper trapezius, levator scapulae, and/or sternocleidomastoid muscles. The participants in the sham dry needling group received the same standard care protocol and two sessions of sham dry needling. The participants in the control group received the same standard care protocol. The outcomes measured were pain intensity, pressure pain threshold, neck disability, range of movement, activation of deep cervical flexor muscles, kinesiophobia, pain catastrophizing, anxiety, and depression.

Results: No significant group by time interactions were found for any of the outcome variables except for lower cervical spine range of movement ($F=3.79$; $p=0.030$).

Conclusion: The addition of two sessions of dry needling in the superficial neck muscles to a standard protocol did not yield superior results compared to either the standard care alone or the standard care plus sham dry needling in patients with chronic neck pain in any outcome except for cervical range of movement.

Keywords: chronic pain; neck pain; dry needling; primary health care; myofascial pain syndromes.

INTRODUCTION

It is estimated that neck pain is the fourth cause of disability in the United States (1), with an annual prevalence of 37.2% (2). The neck pain episodes that remain for 3 or more months are classified as chronic neck pain (CNP). Around 50% of the cases may experience pain one year after the onset (3).

It is well known that patients with CNP may present a lack of deep cervical flexor motor control (4), decreased pressure pain threshold (PPT) (5) and disability (6). In addition, these symptoms are closely linked to psychological distress (7–9).

Currently, the clinical guidelines recommend a combination of education, exercise and electrotherapy for the treatment of CNP (10,11). The implementation of these strategies has proven effective in diminishing both pain intensity and disability (12–16), and they constitute the established standard care protocol in the rehabilitation departments of primary care settings in Spain (17). However, the etiology of CNP is still unclear (18) and some authors suggest that the continuous pain may be related to the presence of myofascial trigger points (MTrP) (19,20). In fact, several systematic reviews have demonstrated the presence of MTrPs in patients with CNP (21,22).

MTrPs are hyperirritable nodules in a taut band of skeletal muscle fibers (23) and are classified as active or latent (24). Active MTrPs can cause both local and referred spontaneous pain (25). The local and referred pain described for different neck muscles such as the upper trapezius, levator scapulae or sternocleidomastoid muscles (20) are similar to the pain areas described by patients with CNP.

Dry needling (DN) is an invasive technique based on the introduction of a filiform needle into the MTrP (26). The current literature suggests that DN reduces musculoskeletal pain in the upper quarter of the body (27–30). Previous studies performed in CNP population showed that DN provides positive effects in several outcome variables such as pain intensity, hyperalgesia, and disability among others. However, most of the studies compared DN in isolation to a conservative manual technique, a sham technique or no intervention (31–33). Therefore, the aim of this randomized controlled trial was to evaluate the short-term effects of adding a DN therapy to the standard care protocol used in primary care settings of Spain compared to a sham procedure and to a standard care protocol in isolation in patients with CNP.

METHODS

Study design

A double-blind randomized placebo-controlled trial was conducted between February 2020 and May 2021. This study was approved by the Clinical Research Ethics Committee of Aragón (C.P. - C.I. PI18/356) and registered at www.clinicaltrials.gov (NCT04060004) in August 2019. The clinical trial was carried out according to the Consolidated Standards of Reporting Trials (CONSORT) guidelines (34). Patients provided written and informed consent to participate in the study.

Participants

Fifty patients (mean age 45.98 ± 14.46 years; 88% females) diagnosed with CNP by medical doctors were referred to the physiotherapy primary care service. The inclusion criteria were CNP for ≥3 months, aged between 18 to 70 years, and at least one active MTrP in the upper trapezius muscle, levator scapulae muscle or sternocleidomastoid muscle. Active MTrPs were identified using manual palpation. Manual palpation is the current criterion standard (24) and has shown excellent reliability in neck muscles (35). The presence of MTrP was confirmed based on the criteria developed by Travell and Simons (20): 1) presence of a palpable taut band, 2) local pain upon pressure applied to the nodule of the taut band, 3) reproduction of the patients' pain by palpation and 4) painful limitation of the amplitude mobility during stretch. The exclusion criteria were history of neck trauma; cervical radiculopathy; acute neck pain; previous surgery in the neck or shoulder area; history of diagnosed primary headache, deformity, infection, or malignancy; previous physiotherapy treatment in the last three months; previous experience of the DN technique; DN contraindications such as local infection, bleeding disorders, immune suppression, or significant fear to needles; and inability to understand the instructions.

The sample size was calculated using the Minitab 13.0 program, conceptualized as a superiority study. The sample size was calculated for the primary outcome, pain intensity. 15 patients per group were estimated assuming a standard deviation of 0.7 previously reported in a pilot study (36) and a between mean difference of 2.1 points considered as the minimum detectable change (MDC) in the VAS (37), at a two-tailed t-test accepting a 5% alpha error rate and desiring 95% power and expecting at least a 15% dropout rate.

Randomization and blinding

Participants were randomly allocated to the DN group, sham DN group or control group. The allocation was performed by an independent researcher, who was not involved in the study, using a random number generation (Research Randomizer, version 4.0). The examiners and the patients in the DN and sham DN groups were blinded to the assigned group.

Interventions

The same therapist performed all the interventions and remained blinded to the data recorded in the measurements made by the examiner.

Standard care protocol

All the patients received a treatment consisting of patient education, exercise, and electrotherapy based on transcutaneous electrical nerve stimulation (TENS) and therapeutic ultrasound (US). The standard care protocol included five sessions per week for two weeks (ten sessions as a whole).

In the first session, the therapist provided individualized patient education. Patients were guided to adopt an active approach, steering clear of prolonged postures, and were imparted insights into workplace ergonomics alongside self-care strategies (38).

Therapeutic exercise included active movements of the neck and shoulder regions (39). The exercises were neck flexion, neck extension, left and right neck rotation, left and right neck lateral flexion, shoulder rotations and shoulder shrug. Patients were instructed to perform 1 set of 10 repetitions of each exercise, twice a day.

Electrotherapy consisted of ten sessions of TENS and therapeutic US. An Enraf-Nonius device TENS 911 was used for the TENS treatment. The frequency was 80 Hz and 150 μ for 15 minutes. One electrode was placed on the lateral part of the upper trapezius muscle and another one was placed 5 cm proximal (40). The intensity varied across patients depending on their tolerance. An Enraf – Nonius device Sonopuls 490®, with a 5 cm^2 effective radiation area transducer was used for the therapeutic US treatment. The frequency was 1 MHz with an intensity of 1 W/cm^2 (41). It was applied bilaterally into the upper trapezius muscle area for 5 minutes.

DN group

The patients included in this group received the standard care protocol, and two sessions of DN were added. One DN session per week was performed (2^{nd} and 7^{th} day of the

intervention) following the findings described by Domingo et al. (42). DN was performed with single-use stainless needles (0.25 x 0.40 mm), using the fast-in-fast-out technique described by Hong et al. (43,44). The MTrP was stimulated until local twitch responses were elicited. Once the local twitch responses stopped, the therapist applied pressure with a cotton ball to prevent bleeding. A maximum of three active MTrPs, which reproduced the symptoms experimented by the patients, were addressed in each session.

Sham DN group

The patients included in this group received the standard care protocol, and two sessions of sham DN were added to the standard care protocol. The sham DN sessions were performed once per week (2^{nd} and 7^{th} day of the intervention). A maximum of three active MTrPs, which reproduced the symptoms experimented by the patients, were addressed each session. The sham DN technique was performed using the sparrow pecking technique described by Tough et al. (45). The needle was placed on the MTrP area and was pressed up and down without penetrating the skin, causing a pricking feeling.

Data collection

Sociodemographic and clinical variables were registered at baseline for descriptive purposes, and consisted of sex, age, height, weight and body mass index, patient expectation, and presence of MTrP on the upper trapezius, sternocleidomastoid and levator scapulae muscles. The primary outcome was pain intensity and the secondary outcomes were PPT, neck disability, range of motion (ROM), activation of deep cervical flexor muscles, kinesiophobia, pain catastrophizing, anxiety, and depression. The outcomes were measured by a blind examiner at baseline and 24 hours after the intervention.

Pain intensity was recorded using a 100-mm Visual Analogic Scale (VAS) in which 0 mm represented no symptoms and 100 mm represented the most intense pain imaginable. It is considered as a valid instrument to detect changes in pain intensity (46). This scale has shown an ICC of 0.67 (47). The MDC was established in 2.1 points (37).

PPTs were measured on the upper trapezius, sternocleidomastoid and levator scapulae muscles using a pressure analogic algometer (Wagner Instruments, Post Office Box 1217, Greenwich, CT 06836-1217, USA). The pressure was gradually increased by 1 kg/second. Patients were asked to say “now” when they felt pain; at that moment pressure stopped. Measurements were made 3 times and the mean of all the trials was recorded as

the final result (48). The assessment of PPT in the cervical spine has shown an ICC of 0.96 and a MDC of 47.2 KPa (49).

Cervical disability was measured using the Neck Disability Index. It is a validated questionnaire consisting of 10 questions scored from 0 to 5 (50). Scores below 4 indicate no disability; between 5 and 14 points, average disability; between 15 and 24 points, moderate disability; between 25 and 34 points, severe disability; and scores higher than 35 points indicate complete disability (51). This assessment tool has shown an ICC of 0.97. The MDC for NDI has been stated in 5 points (52).

The assessment of lower cervical spine flexion-extension ROM was performed using the CROM device (CROM®, Performance Attainment Associates). Participants moved three times in each direction and the mean of the three trials was used for statistical purposes (53). This protocol has shown an ICC ranging from 0.73 to 0.95 for flexion and from 0.80 to 0.97 for extension with a MDC of 9.6º for flexion and 7º for extension (54).

The activation of the deep cervical flexor muscles was measured with the craniocervical flexion test (CCFT) (55), using a pressure biofeedback unit (Stabilizer; Chattanooga Group, South Pacific). The patients were placed in supine position, resting their heads on the biofeedback unit with an initial pressure of 20 mmHg. In this position, patients were asked to perform a craniocervical flexion without using compensatory strategies or activating the superficial cervical musculature, such as the sternocleidomastoid muscle. Patients had to hold the contraction for 10 seconds at five possible levels: 22, 24, 26, 28 and 30 mmHg. The examiner was able to palpate the superficial musculature to verify that patients did not activate it during the execution of the test. The CCFT has shown an ICC ranging from 0.69 to 0.81 (56). The MDC has been stated between 2.94 to 3.99 mmHg (57).

Kinesiophobia was assessed using the TSK-11 scale. It consists of 11 questions scored from 1 to 4, where 1 means totally disagree and 4 means totally agree. The score ranges from 11 to 44 with higher scores indicating higher kinesiophobia. High scores indicate fear of pain, movement and injury. This questionnaire has shown to have an ICC of 0.81 and a MDC of 5.6 points (58).

Anxiety and depression were assessed using the Hospital Anxiety and Depression Scale, which comprises 14 questions divided into two subscales: anxiety and depression. Each

question is scored from 0 to 3 points, resulting in a total score of 21 (59). The reliability showed an ICC ranging from 0.76 to 0.82 (60) and a MDC of 4.9 (61).

Pain catastrophism was evaluated using the Pain Catastrophizing Scale, which comprises 13 questions assessing rumination, magnification, and hopelessness. Each question is rated on a scale from 0 to 4, resulting in a total score of 52. This scale has been demonstrated to possess an ICC value of 0.84 (62) and a MDC of 12.8 (63).

Patient expectations were measured before the treatment. The patients had to choose one of the two following options: “The treatment proposed in this study: I think it will be beneficial to relieve my neck pain or I think it will not be beneficial to relieve my neck pain”.

The sham DN blinding was measured at the end of the intervention. The DN group and the sham DN group had to answer the following question: “to which group do you think you belonged in the clinical trial? Placebo DN group, Real DN group or don´t know, no answer”.

Statistical analysis

The statistical analysis was performed using SPSS, version 27.0 for MAC. A p-value less than 0.05 was considered statistically significant. The normal distribution of the variables registered were analyzed using the Shapiro-Wilk test. Baseline sociodemographic and clinical variables were compared between the three groups using a one-way analysis of variance (ANOVA) or Kruskal-Wallis test for continuous data according to the normally distributed data or non-normally distributed data, respectively. Chi-square test or Fisher exact test were used for categorical data.

The linear mixed-model with repeated-measures analysis was used to investigate the differences in outcomes in terms of time (baseline and postintervention) and group (DN group, sham DN group, and control group). Change scores compared with baseline for post-intervention were calculated. A p-value <0.05 was considered statistically significant.

RESULTS

87 patients were referred and screened for eligibility. 37 patients were excluded. Finally, 50 patients fulfilled all the eligibility criteria, agreed to participate, signed the informed consent, and were randomly allocated into the DN group (n=17), the sham DN group

(n=16), or the control group (n=17). The study flowchart is shown in Figure 1. Sociodemographic data were similar for all the variables between groups at baseline (Table 1). Concerning expectations at baseline, all the participants (n=50; 100%) showed positive expectations regarding the treatment proposed in the study.

The physical examination allowed to locate the active MTrPs in the neck muscles in the right and left neck muscles, which are shown in the Table 2. The mean number of active MTrPs identified was (5.35 ± 2.55) in the DN group, (5.12 ± 2.50) in the sham DN group, and (5.06 ± 1.71) in the control group. No statistical differences were found between the DN group and sham DN group in the muscles punctured (x^2 = 16.98; p= 0.200).

After the intervention, no significant group by time interactions were found for any of the outcome variables assessed except for lower cervical spine ROM (F= 3.79; p = 0.030). The baseline and postintervention mean values as well as the group by time interactions and between-groups change scores are shown in Table 3.

Regarding blinding, there were no statistically significant differences between the DN group and the sham DN group (p=0.103). The number of patients in the DN group who correctly identified the intervention were 17 (100%), and the number of patients who correctly identified the technique in the sham DN group were 3 (18.75%). 13 patients in the sham DN group (81.25%) reported having received the DN technique.

There were no statistically significant differences in session attendance (p=0.400). Out of ten sessions, the mean session attendance in the DN group was 9.59, 9.12 in the sham DN group, and 9.29 in the control group.

DISCUSSION

The objective of the present study was to investigate whether adding two sessions of DN to a standard care protocol in patients with CNP would be more effective than a sham DN plus a standard care protocol or the standard care protocol in isolation.

In this randomized controlled trial, two sessions of DN targeting active MTrPs in the upper trapezius, levator scapulae, and/or sternocleidomastoid muscles were added to the standard care protocol, which included patient education, therapeutic exercise, and electrotherapy. The results achieved showed that DN plus standard care produce no more benefits than the standard care in isolation or combined with sham DN, except for lower cervical spine ROM.

The results shown in this study are in agreement with recent studies that demonstrated that DN along with another intervention does not provide additional benefits when compared to the isolated intervention (64,65), or when compared to the intervention combined with sham DN (66,67) in pain (65–67), disability (64–67), PPT (66) or pain catastrophizing (64) in patients with neck pain. Young et al. (66) and Gattie et al. (67) implemented an intervention incorporating manual therapy and exercise, supplemented with either DN or sham DN, depending on the assigned group. Young et al. (66) utilized thrust manipulation on the middle and the upper thoracic spine, while Gattie et al. (67) focused on manual therapy to improve joint mobility of the cervical and thoracic spines. In terms of exercise intervention, participants in the study of Young et al. followed a program involving cervical rotation and cervical retraction (66). Gattie et al. incorporated exercises aimed at enhancing the performance of the deep neck flexor and scapular musculature (67). In both studies (66,67) the researchers performed DN on the neck muscles during two (66) or three (67) sessions. However, none of these studies (64–67) incorporated electrotherapy as a component of the treatment, and none assigned the participants into three groups as we did in our study.

The results of this study may be attributed to the fact that all participants received an intervention protocol consisting of patient education, exercise, and electrotherapy over a two-week period. Consequently, the analgesic effects of these interventions may have overshadowed the potential analgesic effects of DN (68).

The results regarding the activation of the deep cervical flexor muscles suggest that treatments based on a soft tissue approach, such as the use of TENS, therapeutic US or DN, do not produce positive effects on motor control, as none of the three groups reached the MDC (57). Therefore, this could indicate the need to add specific training of the deep flexor cervical musculature in the management of patients with CNP. Previous studies showed that the specific training of this musculature causes improvements in the CCFT, pain intensity, and disability (69,70).

Furthermore, none of the participants in any of the groups reached the MDC for kinesiophobia, anxiety and depression, and catastrophizing (58,61,63). Regarding this, pain neuroscience education based on pain neurophysiology could potentially enhance the results concerning these variables. Furthermore, implementing the education over the course of two weeks might yield more effective results.

On the other hand, DN has shown immediate ROM improvements in other joints such as the hip (71), shoulder (72) or lumbopelvic region (73), as well as an immediate enhancement of muscular extensibility (74). In our study, DN was found to enhance the ROM for flexion – extension. Similarly, Young et al. (66) noted an improvement in cervical rotation after two sessions of DN targeting neck muscles.

Concerning participants' assistance, it is important to note that there were no significant differences between groups. Therefore, the results were not influenced by this aspect. There were no significant differences between the DN group and sham DN group regarding the blinding. This suggests that results have not been determined by patients' beliefs regarding the allocation to the DN or sham DN groups.

Finally, several limitations need to be considered. First, only short-term effects were assessed. Second, the patients included in the study had to have at least one active MTrP on the superficial neck musculature, so the results cannot be extrapolated to patients with other neck pain disorders. Third, only the upper trapezius muscle, levator scapulae and sternocleidomastoid muscles were assessed, so other neck muscles were excluded from the DN treatment. Fourth, exercise was not monitored. Therefore, it is possible that patients did not perform them regularly. Future studies should investigate the medium- and long-term effects of DN therapy combined with a standard care protocol based on patient education, therapeutic exercise and electrotherapy. It would also be interesting to analyze the effects of a treatment based on DN and strength exercise in CNP patients.

CONCLUSIONS

The addition of two sessions of DN in the superficial neck muscles to a standard protocol based on education, exercise, and electrotherapy, did not lead to higher improvements in pain, disability, PPT, activation of deep cervical flexor muscles, kinesiophobia, pain catastrophizing, anxiety and depression when compared to a standard care or a standard care plus sham DN in patients with CNP. Only lower cervical ROM presented significant improvements in favor to the DN group.

AUTHOR CONTRIBUTIONS

Conceptualization, S.J.-d.-B., R.M.-d.-l.-F., M.T.M.-G., and L.C.-L.; methodology, R.M.-d.-l.-F., I.H.-G., L.C.-L., S.J.-d.-B., M.T.M.-G and H.H.-L.; software L.C.-L., and S.J.-d.-B.; formal analysis, R.M.-d.-l.-F., S.J.-d.-B. and L.C.-L.; investigation, R.M.-d.-l.-F ., I.H.-G., and L.C.-L.; resources, I.H.-G., R.M.-d.-l.-F., L.C.-L., S.J.-d.-B., M.T.M.-

G. and H.H.-L; writing, R.M.-d.-l.-F., L.C.-L., and S.J.-d.-B.,.; writing—review and editing, R.M.-d.-l.-F., I.H.-G., L.C.-L., S.J.-d.-B., M.T.M.-G., and H.H.-L.; visualization and supervision, L.C.-L., M.T.M.-G, and S.J.-d.-B.; project administration, R.M.-d.-l.-F. All authors have read and agreed to the published version of the manuscript.

DECLARATION OF CONFLICTING INTERESTS

The author(s) declared no potential conflicts of interest.

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Table1. Sociodemographic characteristics at baseline.

Characteristics	DN group (n = 17)	Sham DN group (n = 16)	Control group (n = 17)	Significance
Sex (male/female)	2/15	1/15	3/14	X^2= 1.01 p= 0.602[a]
Age (years)	42.12 (16.04)	50.44 (14.02)	45.65 (12.77)	H= 2.34 p= 0.310[b]
Height (cm)	162.47 (8.99)	163.50 (5.37)	164.82 (7.42)	H= 1.02 p= 0.601[b]
Weight (kg)	62.24 (11.36)	67.69 (12.58)	68.42 (13.95)	F= 1.20 p= 0.310[c]
BMI (Kg/cm^2)	23.59 (3.85)	25.19 (3.85)	25.03 (4.70)	F= 0.75 p= 0.476[c]

DN: Dry Needling; BMI: Body Mass Index; [a]Chi - Square test; [b]Kruskal - Wallis test; [c]ANOVA test.

Table 2. Number of active MTrPs identified by manual palpation at baseline.

Muscle	DN group	Sham DN group	Control group
Upper Trapezius MTrP 1	23	18	21
Upper Trapezius MTrP 2	21	24	22
Sternocleidomastoid MTrP	9	9	8
Levator Scapulae proximal MTrP	16	15	13
Levator Scapulae distal MTrP	22	16	22

DN: Dry Needling; MTrP: Myofascial Trigger Point. Values are expressed as frequencies.

Table 3. Primary and secondary outcomes at baseline and postintervention as well as between groups interactions and change scores.

Outcome group		DN group	Sham DN group	Control group	Group by time interaction p-value	Between groups change score
VAS (0– 100mm)	Baseline Mean (± SD)	4.63 (1.99)	4.70 (2.04)	5.22 (1.72)	F= 1.68 p= 0.196	-1.06 (-2.57, 0,44)*
	Postintervention Mean (± SD)	1.59 (1.13)	2.72 (1.87)	3.32 (2.21)		-1.14 (-2.56, 0.27)**
						-0.08 (-1.43, 1.27)***
PPT Upper Trapezius MTrP1 (kg/cm^2)	Baseline Mean (± SD)	2.24 (1.11)	2.38 (0.55)	2.38 (0.53)	F= 0.36 p= 0.699	0.09 (-0.37, 0.55)*
	Postintervention Mean (± SD)	2.93 (0.98)	2.98 (0.88)	2.74 (0.69)		0.33 (0.01, 0.65)**
						-0.24 (-0.28, 0.76)***
PPT Upper Trapezius MTrP2 (kg/cm^2)	Baseline Mean (± SD)	2.27 (0.94)	2.53 (0.59)	2.44 (0.56)	F= 0.41 p= 0.666	0.05 (-0.58, 0.70)*
	Postintervention Mean (± SD)	2.79 (0.79)	2.99 (0.81)	2.75 (0.83)		0.20 (-0.26, 0.67)**
						0.14 (-0.49,0.79)***
PPT Sternocleidomastoid MTrP (kg/cm^2)	Baseline Mean (± SD)	1.40 (0.31)	1.51 (0.36)	1.56 (0.37)	F= 0.02 p= 0.983	0.08 (-0.14, 0.31)*
	Postintervention Mean (± SD)	1.63 (0.51)	1.65 (0.45)	1.62 (0.32)		0.16 (-0.07, 0.40)**
						0.07 (-0.18, 0.34)***
PPT Levator Scapulae proximal MTrP (kg/cm^2)	Baseline Mean (± SD)	2.23 (0.63)	2.68 (1.03)	2.52 (0.61)	F= 0.01 p= 0.990	0.41 (-0.22, 1.04)*
	Postintervention Mean (± SD)	2.68 (0.97)	2.72 (0.76)	2.69 (0.85)		0.28 (-0.35, 0.91)**
						-0.12 (-0.83, 0.57)***

PPT Levator Scapulae distal MTrP (kg/cm^2)	Baseline Mean (± SD)	3.12 (1.41)	3.47 (1.03)	3.66 (0.93)	F= 0.47 p= 0.630	-0.01 (-0.75, 0.74)*
	Postintervention Mean (± SD)	3.70 (1.27)	4.06 (1.17)	4.05 (1.19)		0.19 (-0.44, 0.63)**
						0.20 (-0.62, 1.02)***
NDI (0 – 50 pts)	Baseline Mean (± SD)	10.89 (4.54)	11.75 (4.10)	13.04 (5.13)	F= 1.17 p= 0.317	-1.96 (-5.34, 1.41)*
	Postintervention Mean (± SD)	5.39 (3.28)	8.21 (6.78)	9.69 (5.02)		-2.15 (-4.60, 0.29)**
						-0.18 (-3.85, 3.47)***
ROM	Baseline Mean (± SD)	107.03 (15.99)	100.26 (18.72)	109.44 (20.38)	F= 3.79 p= 0.030	5.39 (-2.56, 13.36)*
	Postintervention Mean (± SD)	112.42 (14.74)	100.26 (17.73)	103.36 (15.84)		11.47 (3.26, 19.68)**
						6.07 (-3.42, 15.56) ***
CCFT (22 – 30 mmHg)	Baseline Mean (± SD)	24.00 (2.55)	23.75 (2.52)	24.47 (2.29)	F= 0.06 p= 0.942	-0.37 (-2.15, 1.40)*
	Postintervention Mean (± SD)	24.00 (3.08)	24.13 (3.05)	24.35 (2.94)		0.11 (-2.18, 2.41)**
						0.49 (-1.47, 2.45)***
Kinesiophobia (0– 44 pts)	Baseline Mean (± SD)	22.06 (7.21)	24.63 (7.30)	19.82 (4.79)	F= 1.75 p= 0.184	-0.75 (-6.01, 4.51)*
	Postintervention Mean (± SD)	19.12 (4.11)	22.44 (8.27)	19.06 (4.60)		-2.17 (-5.73, 1.38)**
						-1.42 (-5.98, 3.13)***
HADS	Baseline Mean (± SD)	9.35 (5.07)	12.38 (4.74)	9.24 (5.26)	F= 1.15 p= 0.323	2.04 (-0.78, 4.86)*
	Postintervention Mean (± SD)	8.71 (4.55)	9.69 (4.33)	7.94 (5.58)		0.64 (-1.94, 3.24)**
						-1.38 (-4.28, 1.49)***

Pain catastrophizing	Baseline Mean (± SD)	13.71 (6.71)	17.12 (13.70)	12.24 (7.51)	F= 0.18 p= 0.830	-1.50 (-6.79,3.79)*
	Postintervention Mean (± SD)	8.71 (5.96)	13.63 (13.06)	8.29 (7.23)		-1.05 (-5.83, 3.71)**
						0.44 (-4.88, 5.77)***

*: DN group Vs Sham DN group; **: DN group VS Control group; ***: Control group Vs Sham DN group; DN: dry needling; NDI: neck disability index; PPT: pressure pain threshold; CCFT: craniocervical flexion test; VAS: visual analogue scale.

Figure 1: Flowchart diagram.