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Analysis and comparison of pain pressure threshold and active cervical range of motion after superficial and deep dry needling techniques of the upper trapezius muscle

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Abstract

Objectives: To evaluate the changes in pain pressure threshold (PPT) and active cervical range of motion (ACROM) after the application of superficial dry needling (DN) or deep DN in myofascial trigger point (MTrP) 1 of the upper trapezius versus a simulated DN technique in the gastrocnemius muscle (control group).

Design: Double-blind, randomized controlled trial with 7-day follow-up.

Participants: Asymptomatic volunteers (n = 180; 76 men, 104 women) with a latent MTrP 1 in the upper trapezius were randomly divided into three groups: G1, receiving superficial DN in the upper trapezius; G2, receiving deep DN in the upper trapezius; and G3, control group, receiving simulated DN technique in the gastrocnemius muscle.

Main outcome measures: While sitting in a chair, each subject underwent measurements of PPT and ACROM (ipsilateral and contralateral side flexion and rotation, flexion and extension) preintervention, (immediately) postintervention, and at 24 h, 72 h and 7 days.

Results: Superficial and deep DN produced an increase in PPT at 7 days with respect to preintervention levels. Furthermore, superficial and deep DN produced a decrease in cervical flexion at 24 h and an increase in ipsilateral rotation until 72 h, increasing to 7 days in the case of deep DN. On the contrary, superficial DN produced an increase in ipsilateral and contralateral side flexion after intervention, unlike deep DN that produced a decrease at 24 h. Furthermore, superficial DN produced an increase in contralateral rotation at 24 h and deep DN decreased extension at 72 h.

Conclusion: A single intervention of superficial or deep DN did not produce statistically significant changes in PPT or goniometry measurements.

Trial registration number: NCT03719352 (ClinicalTrials.gov)

Keywords

myofascial trigger point, needles, pain pressure threshold, range of motion, rehabilitation

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Introduction

Myofascial pain syndrome is defined as a set of signs and symptoms of myofascial trigger points (MTrPs) in the skeletal muscles. This syndrome causes referred pain, restriction of mobility, fatigue and/or muscle weakness,[1,2] as well as muscle spasms in the pain area and alteration of motor activation patterns.[3,4]

MTrPs are defined as "hyperirritable nodules of focal pressure pain that are in a palpable tense band of skeletal muscle."[5] Other authors claim they have been detected in 50% of the asymptomatic population, being more frequent in women than in men.[5,6] MTrPs can be classified as active or latent. MTrPs produce muscle weakness and spontaneous pain at a distance—that is, far from the location of the MTrPs. Latent MTrPs can also cause motor and mechanical alterations, with the difference that they have not been stimulated manually.[5,7]

To eliminate MTrPs, we usually use two types of treatments that are classified into two groups: conservative physiotherapy and invasive physiotherapy.

Invasive physiotherapy includes a set of techniques that apply the stimulus of a needle[8] that traverses the patient's skin and that inactivates and/or eliminates MTrPs.[9] Among these invasive techniques are dry needling (DN), which can be subclassified according to the depth of needle insertion as deep DN[10] or superficial DN.[11]

Deep DN is one in which the needle penetrates the muscle until it passes through the MTrP.[5,12] In 1979, Lewit described the results of his study[13] showing that the DN technique is more effective if it achieves local twitch responses (LTRs) than if it does not. This led Hong to design the technique that seems to be the most effective, called the "fast in, fast-out technique,"[14–16] incorporating the idea of speed as used in the classical techniques described by Travell and Rinzler in 1952,[17] in which speed was applied both when entering (to promote the LTRs) and when leaving (to avoid the contraction and local spasm that occurs with the needle inside the taut band). The fast entry and exit are repeated until the LTRs are extinguished, and exit refers to the withdrawal of the needle back into the subcutaneous tissue, that is, outside of the muscle but not outside of the skin.[5,14,18] The depth of needling is 2–3.5 cm, depending on the thickness of the subcutaneous tissue layer of the subject.

Superficial DN consists of inserting a needle into the skin to a depth of 1 cm, without reaching the muscle, such that the needle remains in the subcutaneous tissue overlying the MTrP. Effects are believed to be mediated by encephalinergic inhibitory interneurons located on the edges of laminae I and II of the dorsal horn of the cord, and indirectly through the descending inhibitory serotoninergic system. In addition, the needle activates fuzzy inhibitory controls of nociception by acting on the autonomic nervous system and modulating activity in the MTrPs. It also stimulates Aβ nerve fibers by exciting the cells of the gelatinous substance, which are located at the apex of the posterior horn along the entire spinal cord, inhibiting the transmission of pain to the upper centers.[19–26]

With all these premises, the aim of the present study was to analyze the pain pressure threshold (PPT), active cervical range of motion (ACROM), and ipsilateral and contralateral rotation, flexion and extension, after the application of superficial or deep DN at MTrPs 1 of the upper trapezius.

Methods

General design

The study was a randomized clinical trial, performed in a sample of asymptomatic university students, to evaluate the validity and effectiveness of two physiotherapy treatments against a control group. In addition, it was double blind, since neither the evaluator nor the subject was aware of the group to which the subject belonged. There was also no interrelation between the evaluator and the auditor, adding strength to the design. This clinical trial followed the CONSORT (Consolidated Standards of Reporting Trials) extension for pragmatic clinical trials.[27]

Study participants

The participants were 180 asymptomatic undergraduates belonging to the CEU Cardenal Herrera University of Elche headquarters. Subjects were included in our study if they presented latent MTrPs 1 in the upper trapezius. The inclusion criteria were (1) presence of latent MTrPs 1 in upper trapezius; (2) acceptance of participation in the study (with signed informed consent); (3) age between 18 and 55 years; and (4) lack of any exclusion criteria.

Participants were excluded if they: (1) did not present latent MTrPs 1 in the upper trapezius; (2) had contraindications to the technique of DN; (3) had used analgesics 24 h before participation in the study; or (4) knew the study techniques.

Ethical aspects

This study was approved by the Research and Ethics Committee of CEU Cardenal Herrera University (CEI15/006). All subjects signed informed consent and read the general study information before their inclusion. Furthermore, this clinical trial was registered at ClinicalTrials.gov (ref. NCT03719352) on 25 October 2018.

Procedure of DN

Superficial DN was based on the needling method described by Fischer[28,29] and deep DN was based on the needling method described by Hong.[12,14,18] MTrP DN was performed with a solid needle (0.25 mm × 40 mm, Agupunt, Barcelona,

Spain). The MTrP was held with the thumb, and index and middle fingers. The needle was introduced in the direction of the MTrP between the index and the middle fingers, perforating it repeatedly in the case of the group that underwent the deep DN. It is generally believed that at least two to three LTRs are enough to obtain a positive outcome, at least in patients with neck pain. In the group that underwent superficial DN, the needle was introduced into the subcutaneous tissue, and three needle rotations were performed, with 3 min between them. After both techniques, the needle was removed, and compression was applied with a cotton swab for 1 min to prevent bleeding. The control group (G3) underwent simulated DN using the plastic guide tube of the needle. This technique is similar to a sham needle procedure that uses a "Dong Band" placebo needle, which is similar to the Streitberger needle.[30] Stimulation was performed for 1 min and followed by local compression of 1-min duration. We only performed one needle insertion in the intervention groups.

Outcome measures

The procedure of PPT measurement recommended by Fischer was applied in this study.[28,29] Algometry is the most frequently used method of measuring PPT.[31,32]

First of all, we explained the procedure to each subject clearly. We used an algometer to quantify PPT. The algometer (Commander TH, JTECH, Medical Industries) was perfectly calibrated. To locate the MTrPs 1, the palpation technique was used, grasping the belly of the muscle between the thumb and the 2nd and 3rd fingers. The evaluator pressed the fibers with a forward and backward movement to find the taut bands. Once found longitudinally, the nodule and the point of greatest sensitivity to pressure were located, and the MTrPs 1 were marked with a dermal marker. Those subjects in whom MTrPs 1 could not be precisely located were excluded from the study. After having marked the MTrPs 1, the evaluator performed algometry at that site. The pressure of compression was increased gradually at a speed of ± 1 kg/s. We stopped the compression when the subject verbalized "PAIN" as soon as any increase in pain sensitivity or discomfort occurred. Three measurements were taken on each side at intervals of 30–60 s and the average of the three obtained measurements was calculated. After 5 min, the algometric measurement was repeated to statistically calculate the error of the device in our study. PPT was expressed in kg/cm^2.

Goniometry is the most frequently used and widespread way to measure and explore joint balance.[33,34] The apparatus used was a cervical range of motion goniometer (Performance Attainment Associates©, Lindstrom MN, USA). The patient sat on a stool, with their back straight and feet resting on the floor, and performed a movement of ipsilateral and contralateral rotation and side flexion on both sides, flexing and extending the neck, and focusing their gaze on a line placed on the wall. The subject was instructed not to make compensatory movements with the trunk and shoulders. Goniometry has been shown to be a reliable method of measuring the range of cervical mobility and superior to other measurement methods.

Furthermore, to evaluate the reliability of the algometer and goniometer used in this study, two algometric and two goniometric measurements were made before the intervention, at an interval of 5 min. In addition, an analysis of concordance between the two measurements was made for all the subjects included in the study by calculating the intraclass correlation coefficient (ICC) with 95% confidence interval,[35] which revealed that the measurement of extension was the most reliable with an ICC of 0.909 (rating of "very good"). The other measures (PPT, flexion, rotation and side flexion) had ICCs of 0.895, 0.795, 0.848 and 0.868, respectively (rating "good").

Study protocol

Before the needling intervention, two algometric and two goniometric measurements were performed to calculate the statistical error of the device in the measurements. Then, subjects were randomly divided into three groups, as follows, by a computerized randomization program (Research Randomizer (version 4.0); available at http://www.randomizer.org): G1, superficial DN; G2, deep DN; and G3, control group receiving simulated DN in the gastrocnemius muscle. ACROM was assessed immediately postintervention, and 24 h (POST24h), 72 h (POST72h) and 7 days (POST7d) after the intervention.

Sample size

The sample size for our study was determined using G*Power software (version 3.1.8; available at: http://www.gpower.hhu.de). A pilot study with 30 subjects (10 per group) who met the inclusion criteria was previously conducted. An equal number of subjects were randomly assigned to one of the three intervention groups. Treatments were applied to each group, evaluating algometry and goniometry preintervention, postintervention and POST24h, 72 POST72h and POST7d after the intervention, yielding an estimate of the means, standard deviations (SDs) and correlations factor between repeated measures. According to the data from the pilot study, the appropriate sample size (α 0.05, power 80%), assuming a repeated-measures analysis of variance (ANOVA) design of a factor with three levels, was estimated at 180 individuals (60 per group) randomly distributed across the three groups as mentioned above.

Statistical analysis

To verify the correct randomization of the subjects to the intervention groups, a baseline homogeneity analysis of the

preintervention response variables with the different explanatory variables was performed. The statistical program used was the Statistical Package for the Social Sciences (SPSS) version 20 (SPSS Inc., Chicago, IL, USA). For the qualitative variables, double-entry tables were calculated. For the quantitative variables, mean values and SD were calculated and an ANOVA procedure was applied. We also evaluated the preintervention response variables in the three intervention groups, to verify their homogeneity and correct masking of the evaluator, applying an analysis of covariance with repeated-measures procedures. Multiple comparisons of Bonferroni in the algometric measurements of ipsilateral side flexion, ipsilateral rotation and flexion over time were analyzed. For all analyses, statistical significance was set at $p < 0.05$.

Results

Characteristics of enrolled participants

A total of 188 subjects were enrolled in the study. Eight were excluded for not meeting the inclusion criteria. Of the 180 people who were part of this study, 76 were men (42%) with an average age of 24.3 ± 6.1 years (mean ± SD) and 104 women (58%) with an average age of 22.1 ± 5.5 years. Regarding the variable "work," 135 subjects (75%) aged 21.1 ± 4.1 years were not working; the remaining 45 subjects (25%) aged 28.6 ± 6.4 years were working. Of those who performed sports, 100 subjects (56%) reported performing for 1–5 h a week and 36 (20%) more than 5 h. The remaining 44 (24%) declared that they did not perform any type of sports activity. The average age of the individuals was 23.0 ± 5.9 years for those who did not carry out any sports activity, 23.2 ± 6.1 years for those who performed for 1–5 h per week, and 22.8 ± 5.0 years for those who performed for more than 5 h per week. Regarding the variable "sleep hours," 37 subjects (21%) with an average age of 26.9 ± 7.6 years reported sleeping less than 6 h. The remaining 143 individuals (79%) slept more than 6 h and had an average age of 22.1 ± 4.9 years. Figure 1 shows the process of recruitment and dropouts.

ANOVA and effects of covariates on response variables

No statistically significant differences were found in the response variables between intervention groups by ANOVA (Supplemental Table 1). There were no significant effects of any covariates on the response variables ($p > 0.05$, Supplemental Table 2).

Algometric and goniometric measurements by intervention group over time

After performing repeated-measures analysis of covariance (ANCOVA) on the algometric and goniometric measurements by intervention group over time (Table 1), we found some coincidences and differences between groups.

With respect to algometry, it can be seen that immediately after the POSTINT intervention there seemed to be a slight increase in the mean PPT, which dropped sharply in the POST24h, gradually increasing in the POST72h and in the POST7d (Figure 2).

Regarding ipsilateral and contralateral side flexion, decreased movement was observed in the deep DN group after 24 h. However, superficial DN increased the movement after intervention and deep DN increased the movement from the postintervention until 7 days (1.9°). There were no changes in the control group (Figure 3).

Ipsilateral rotation in the superficial DN and control groups increased progressively until 72 h after the intervention, decreasing slightly after 7 days. In the deep DN group, increases were noted at 24 h and at 7 days, decreasing slightly at 72 h.

Regarding contralateral rotation, the movement increased in the superficial DN group at 24 h after the intervention, while no changes occurred in the deep DN group or control groups.

For flexion, superficial DN and deep DN produced a decrease at 24 h after the intervention, with no changes occurring in the control group.

For extension, superficial DN did not produce any changes but deep DN decreased the movement after 72 h.

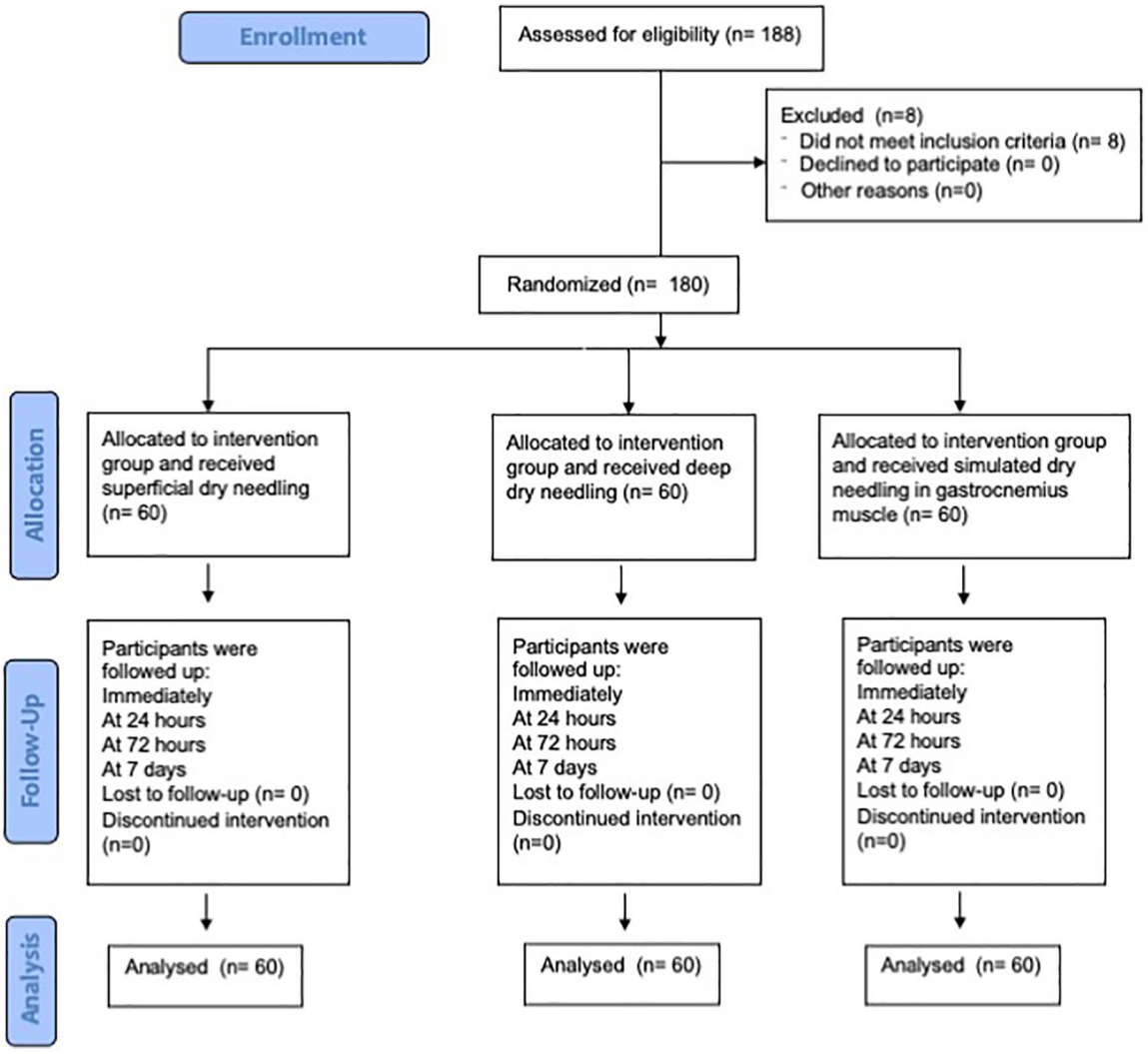
Multivariate contrasts of the response variables over time

When performing a multivariate contrast of the response variables over time (Table 2), we observed statistically significant differences between the mean values of algometry ($p < 0.001$), ipsilateral side flexion ($p = 0.014$), ipsilateral rotation ($p = 0.002$) and flexion ($p < 0.001$) over time, without taking into account the intervention group allocations. However, there were no statistically significant differences between the mean values of these variables over time when taking into account the intervention groups. Therefore, interventions did not appear to produce different effects on these variables. For the variables of contralateral side flexion, contralateral rotation and extension, there were no statistically significant differences.

Multiple comparisons of Bonferroni in algometric and goniometric measurements of ipsilateral side flexion, ipsilateral rotation and flexion over time

According to our algometric measures, there were no differences between interventions but, together, there was a statistically significant decrease in PPT at 24 h (POST24h) ($p = 0.006$) and at 7 days (POST7d) ($p < 0.001$) after the intervention (Supplemental Table 3).

Figure 1. CONSORT flow chart for the study.



We did not obtain statistically significant differences in ipsilateral side flexion preintervention versus postintervention. However, there were statistically significant differences between preintervention and POST24h ($p = 0.011$), and between postintervention and POST24h ($p = 0.005$), producing a significant decrease in the mean ipsilateral side flexion. At POST24h the mean ipsilateral side flexion returned to preintervention levels. There were no statistically significant differences in ipsilateral rotation preintervention versus postintervention, but there were differences between preintervention and POST24h ($p = 0.016$), POST72h ($p = 0.045$) and POST7d ($p = 0.028$). Therefore, the average ipsilateral rotation increased over time. There were statistically significant differences in flexion between POST24h and the rest of the measurements. The intervention groups did not produce significantly different changes among themselves in terms of mean flexion but, taken together, there was a significant decrease in flexion at POST24h, subsequently returning to preintervention levels.

Discussion

Pain pressure threshold

The observed increase after 7 days, which was more pronounced in G1 and G2 than in the control group, could be due to the fact that the stimulus caused by the presence of a needle in the tissue, may restore local circulation in the area of the intervention, helping to clean up the algogenic substances and end the nociceptive stimulus that is responsible for causing pain to pressure.[36,37]

Our results are similar to those found by Mejuto-Vázquez et al.[38] who determined the effects of a single intervention with deep DN in the MTrPs 1 of the upper

Table 1. Goniometric measurements by intervention group over time (analysis of covariance with repeated measures).

Algometry	G1 Superficial dry needling (n = 60)			G2 Deep dry needling (n = 60)			G3 Control group (n = 60)		
	$\bar{X}$	SD	95% CI	$\bar{X}$	SD	95% CI	$\bar{X}$	SD	95% CI
PREINT	4.12	1.61	3.71–4.54	4.22	1.49	3.84–4.61	4.14	1.65	3.71–4.57
POSTINT	4.22	1.35	3.87–4.57	4.37	1.65	3.95–4.80	4.08	1.55	3.68–4.48
POST24h	3.87	1.2	3.56–4.18	3.88	1.66	3.45–4.31	3.87	1.48	3.49–4.25
POST72h	4.23	1.44	3.86–4.60	4.43	1.76	3.97–4.88	4.1	1.54	3.71–4.50
POST7d	4.77	1.74	4.32–5.22	4.65	1.75	4.20–5.11	4.26	1.63	3.84–4.68
Ipsilateral side flexion									
PREINT	48.9	10.8	46.1–51.7	46.1	9.7	43.6–48.6	46.3	11.1	43.5–49.2
POSTINT	49.8	10.2	47.2–52.5	45.4	8.2	43.3–47.6	46.2	10.3	43.5–48.8
POST24h	47.3	9.6	44.9–49.8	43.6	7	41.7–45.4	45.2	9.6	42.7–47.7
POST72h	48.2	8.6	46.0–50.4	45.5	9.9	42.9–48.0	45.9	9.7	43.4–48.4
POST7d	48	9.4	45.6–50.5	47	9	44.7–49.3	45.7	9.6	43.2–48.2
Contralateral side flexion									
PREINT	50.9	9.6	48.3–53.1	49.1	9.3	47.0–51.8	48.6	9.4	46.2–50.9
POSTINT	51.8	7.7	49.3–53.7	47.6	7.6	45.7–50.1	48.6	9.8	46.5–50.8
POST24h	49.7	8.8	47.2–51.7	46.8	7	44.8–49.2	48	10.2	45.8–50.2
POST72h	50.3	9.7	47.6–52.6	48.8	9.1	46.5–51.4	49.2	9.7	46.8–51.6
POST7d	50.5	10.6	47.8–52.9	48.7	8.8	46.3–51.4	49.2	9.9	46.7–51.7
Ipsilateral rotation									
PREINT	67.6	10.7	65.0–70.2	65.8	10.3	63.2–68.4	67.5	9.4	64.9–70.1
POSTINT	68.8	10.8	66.2–71.5	66	9.9	63.3–68.6	68.3	10.2	65.7–70.9
POST24h	71.3	10	68.9–73.8	66.8	10.2	64.4–69.3	69.4	8.6	67.0–71.9
POST72h	71.9	10.1	69.3–74.5	65.7	10.9	63.1–68.4	70.1	9.8	67.5–72.7
POST7d	71.1	9.8	68.4–73.8	67	11.7	64.4–69.7	69.4	9.7	66.7–72.0
Contralateral rotation									
PREINT	68.7	11.8	65.7–71.8	67.7	11.3	64.8–70.6	69.9	9	67.5–72.2
POSTINT	66.9	10.8	64.1–69.7	67.7	10.4	65.0–70.4	68.6	9.3	66.2–71.0
POST24h	70.2	10.5	67.5–72.9	68.2	11.7	65.2–71.2	69.9	10	67.3–72.4
POST72h	69.4	11.1	66.5–72.2	67.9	10.3	65.2–70.6	70.6	8.3	68.5–72.8
POST7d	68.9	10.3	66.3–71.6	67.1	10.5	64.4–69.8	70.4	8	68.3–72.4
Flexion									
PREINT	58.8	10.5	56.1–61.5	59.8	10.8	57.0–62.6	55.9	8.9	53.6–58.2
POSTINT	59.6	9.5	57.1–62.0	59.4	10.4	56.7–62.0	57.5	10.8	54.7–60.3
POST24h	55.5	9.6	53.0–57.9	55.5	10.3	52.9–58.2	55.1	10.5	52.4–57.9
POST72h	59.3	9.9	56.7–61.9	58.3	9.5	55.9–60.8	56	9.4	53.5–58.4
POST7d	59.6	9.9	57.0–62.1	56.8	8.8	54.5–59.0	55.8	9.6	53.3–58.2

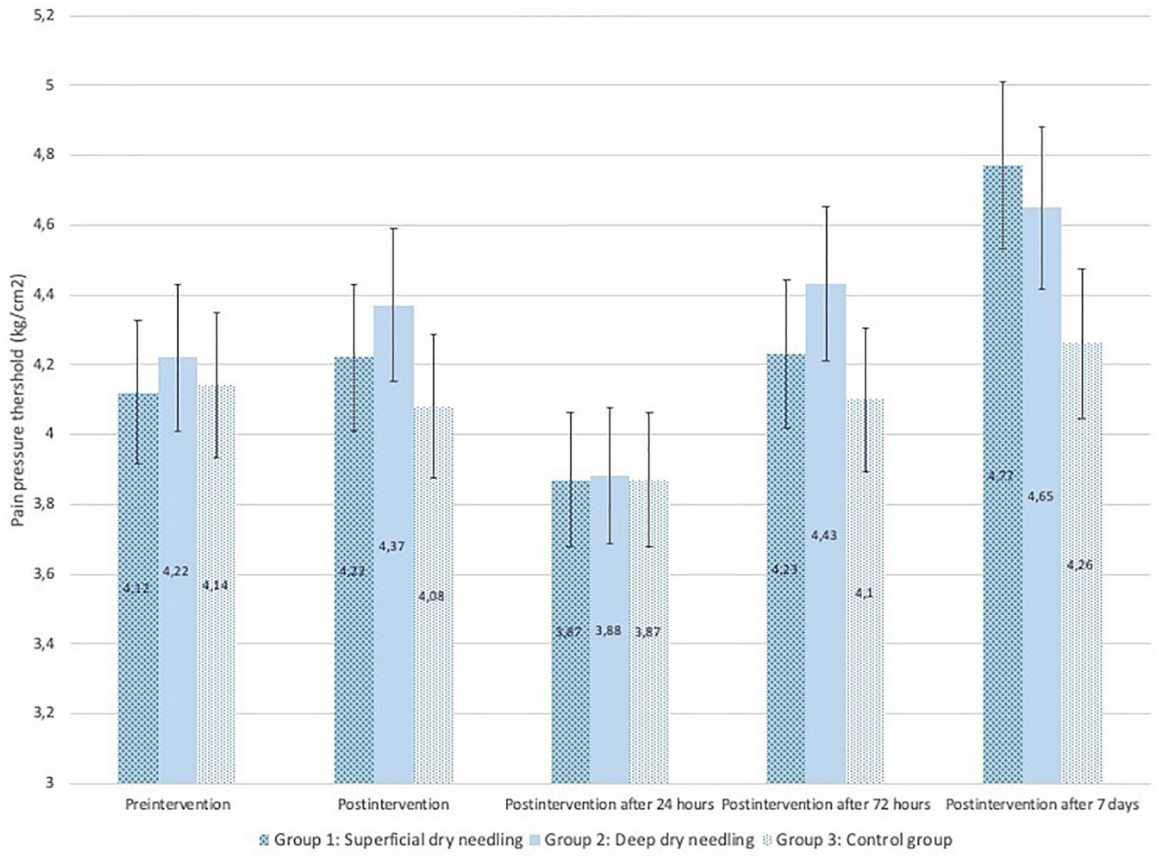
(Continued)

Table 1. (Continued)

Algometry	G1 Superficial dry needling (n = 60)			G2 Deep dry needling (n = 60)			G3 Control group (n = 60)		
	$\bar{X}$	SD	95% CI	$\bar{X}$	SD	95% CI	$\bar{X}$	SD	95% CI
Extension									
PREINT	71.6	13.4	68.2–75.1	70.4	13.1	67.0–73.8	73.3	11.6	70.2–76.3
POSTINT	71.6	12.7	68.4–74.9	69.5	12.2	66.4–72.7	72.1	10.9	69.3–75.0
POST24h	71.3	13.4	67.8–74.8	69	12.4	65.7–72.2	72.2	11.8	69.1–75.2
POST72h	71.1	12.9	67.7–74.4	67.2	12.7	63.9–70.5	71.8	11.8	68.8–74.9
POST7d	71.4	14	67.8–75.0	70	12.4	66.8–73.2	70.9	12.4	67.7–74.1

$\bar{X}$: mean; SD: standard deviation; CI: confidence interval.

Figure 2. Algometry pain pressure threshold (kg/cm^2) over time by intervention group.



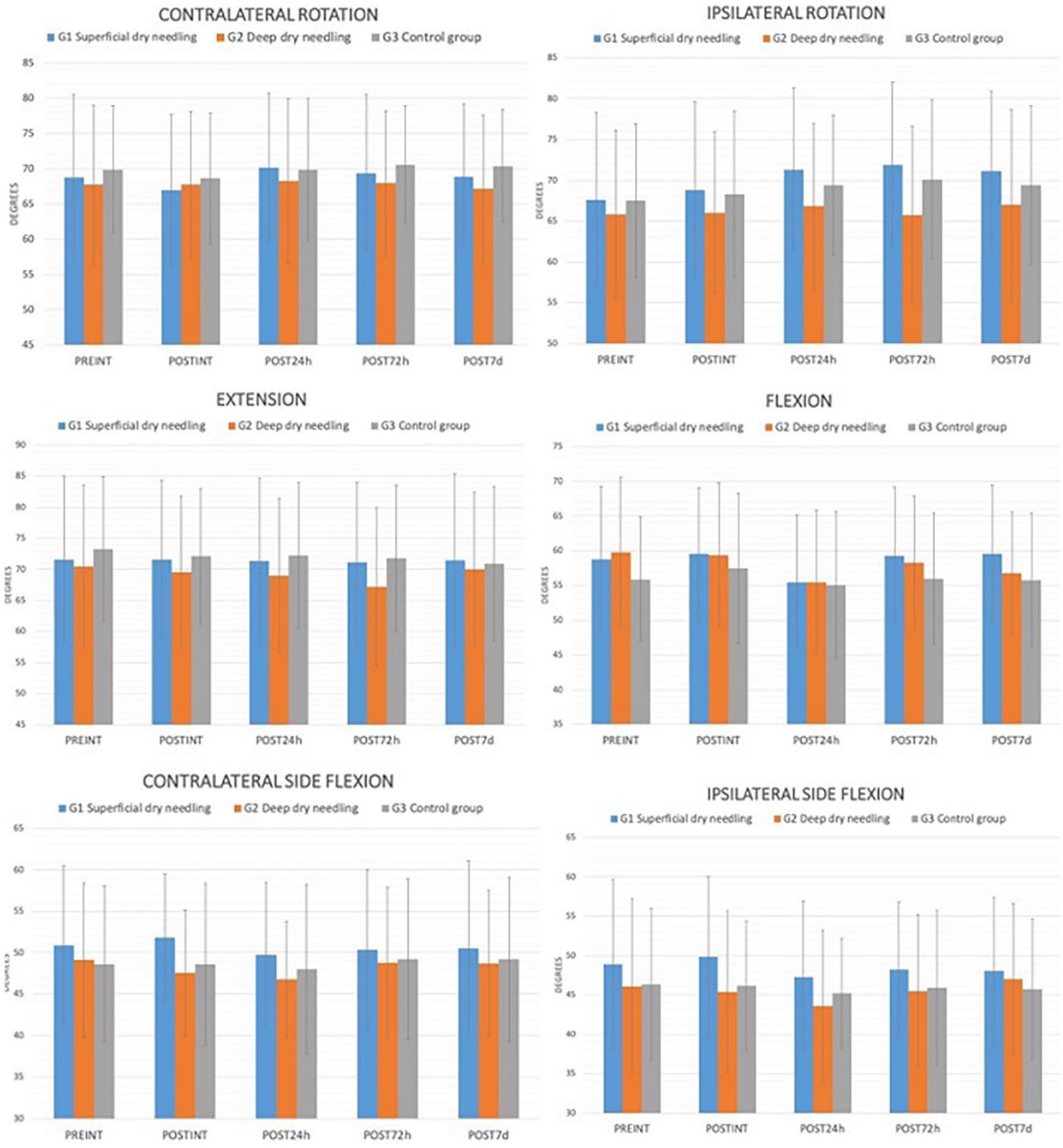
trapezius, finding significant results in terms of decreased pain sensitivity 7 days after the intervention.

Other studies[39,40] have shown that the application of DN in the MTrPs of the upper trapezius cause a significant decrease in substance P and calcitonin gene-related peptide (CGRP). In addition, the stimulation of A-δ fibers could activate noradrenergic inhibitory systems that are related to pain neuromodulation.[41]

In addition, post-puncture pain is one of the most common adverse effects associated with needle treatment,[20,42] and more specifically with DN treatment.[5,42]

The evolution in the response of the tissue to the stimulation that occurs with needling in the subjects may be related to the usual characteristics of these invasive techniques and the subsequent post-puncture pain that extends in some occasions up to 48 h after carrying out DN techniques.[43]

Figure 3. Goniometry (ipsilateral and contralateral side flexion and rotation, flexion and extension) over time by intervention group.



Our data agree with a previous study,[15] in which 100% of patients treated with DN suffered pain after the intervention. In addition, in another study[44] conducted in asymptomatic subjects using the technique of "rapid entry and exit" described by Hong[12,14,18] in latent MTrPs, post-puncture pain was reported in most subjects at 24 h, but disappeared completely at 72 h. Another study carried out by Martín-Pintado et al.[43,45] also described results similar to those obtained in this study, with 100% rates of post-puncture pain. On the contrary, there are other studies[42,46] that have observed that, once DN was applied, post-puncture pain occurred in 52.5% and 54.6% of cases, respectively.

In our study, all the subjects indicated that they had never experienced needle treatment, so they were unaware of the sensation that could be caused by the techniques used. Given that there were no differences between the two interventions (G1 and G2) and the control group (G3), and that the control group behaved similarly to the two intervention groups, with sharply decreased average algometry at POST24h, we think that the neutral treatment applied to the control group may have influenced the algometry in some way. Martín-Pintado-Zugasti et al.,[47] in a study in which they analyzed the psychological factors related to post-puncture pain, observed that anxiety around the DN

Table 2. Multivariate contrasts of the goniometric measurements over time.

Algometry	F	DF	p value
Time	20.5	3.4	<0.001*
Time vs. Group	1.7	6.8	0.116
Ipsilateral side flexion			
Time	3.3	3.6	0.014*
Time vs. Group	1.1	7.2	0.363
Contralateral side flexion			
Time	2.2	3.7	0.074
Time vs. Group	0.9	7.5	0.519
Ipsilateral rotation			
Time	4.3	3.8	0.002*
Time vs. Group	0.9	7.7	0.481
Contralateral rotation			
Time	1.9	3.7	0.105
Time vs. Group	0.6	7.4	0.726
Flexion			
Time	8.7	3.7	<0.001*
Time vs. Group	1.6	7.4	0.128
Extension			
Time	1.8	3.6	0.125
Time vs. Group	0.9	7.3	0.516

F: Snedecor's F distribution; DF: degree of freedom.
*$p < 0.05$.

treatment itself caused post-puncture pain to increase after the intervention until 24 h. All these findings could explain the decrease in PPT that we detected at 24 h in the control group (G3).

Ipsilateral side flexion

Comparing the preintervention and POST7d data, we observed that the ACROM increased in ipsilateral side flexion. These data are similar to the results of Llamas-Ramos et al.[48] and Mejuto-Vázquez et al.,[38] who obtained an increase of the ACROM in ipsilateral side flexion of 6.2° and 15.5°, respectively, after 7 days in their studies.

Contralateral side flexion

Our data obtained in the superficial DN group are similar to the results of the study by Mejuto-Vázquez et al.,[38] who observed an increase after a deep DN intervention from 39.4° ± 15.1° in preintervention to 51.6° ± 9.3° postintervention. However, these results are different from the results obtained in our study with deep DN, showing a decrease after the intervention. Similarly, these researchers measured an increase of 0.6° in contralateral side flexion postintervention until 7 days after the intervention. We obtained similar values in the deep DN group.

Ipsilateral rotation

Our postintervention results resemble the study conducted by Llamas-Ramos et al.,[48] in which they obtained an increase in ipsilateral rotation after treatment with deep DN, going from 63.5° ± 5.9° to 75.0° ± 3.8° postintervention. It should be noted that, in their study, values decreased slightly to 71.5° ± 2.3° a week after the intervention with respect to the postintervention value, which contrasts with our data showing a considerable increase in the deep DN group. It is necessary to highlight that the subjects of the study by Llamas-Ramos et al.[48] were symptomatic, whereas in our study they were asymptomatic.

However, our results are similar to the results of the study conducted by Mejuto-Vázquez et al.,[38] in which ipsilateral rotation increased from 55.5° ± 24.1° preintervention to 66.6° ± 15.6° postintervention and to 72.7° ± 14.1° postintervention until 7 days.[AQ: 1] In this case, the treated patients were symptomatic.

Contralateral rotation

Our data differ from the study by Mejuto-Vázquez et al.,[38] in which ACROM for contralateral rotation increased 9.5° postintervention and 15.6° after 7 days of intervention. If we analyze their postintervention data (58.8° ± 23.5°) and our preintervention data (68.7° ± 11.3°), we find that our ACROM for contralateral rotation was much higher in preintervention. We consider that this difference is likely due to the fact that the subjects in the study by Mejuto-Vázquez et al.[38] were symptomatic and ours were asymptomatic. Something similar happened with the study carried out by Llamas-Ramos et al.,[48] in which they detected an increase 6.3° in ACROM for contralateral rotation postintervention, which decreased 2.8° with respect to the postintervention data after 7 days of the intervention. These results are similar to our results in the deep DN group, in which active range of motion decreased until 7 days after the intervention.

Flexion

Our values differ from the study conducted by Llamas-Ramos et al.,[48] who obtained an increase of ACROM for flexion of 9.0° postintervention and 7.6° within the 7 days of the intervention in comparison with the data obtained preintervention. Something similar was detected by Mejuto-Vázquez et al.[38] who observed an increase in ACROM for flexion of 10.0° postintervention and 9.4° to 7 days after the intervention, in comparison with the data obtained preintervention.

Extension

Our results differ from other studies[38,48] that have measured ACROM of the neck, after the intervention with both DN methods and with other techniques of conservative physiotherapy in the upper trapezius muscle. Furthermore, our results differ from the study conducted by Mejuto-Vázquez et al.,[38] in which they achieved an increase of 15° in the ACROM for extension after the deep DN technique in the upper trapezius going from 65.0° ± 16.2° as a preintervention average to 80.5° ± 8.4° a week after performing the technique. It must be clarified that, in their study, the data were measured with the same therapist and that only 17 subjects were involved (9 of them in the intervention group and the remaining 8 in the control group), which means that the sample size may have been a limitation in this study.

Limitations of the study

A limitation of our study is having delayed the measurement from 72 h until 1 week and not having performed more interventions. Future studies should clarify the number of interventions that need to be performed and the evolution until the week of intervention. In this way, its influence on the variables analyzed could be determined.

We also believe that treating a single MTrP of a single muscle (in this case the upper trapezius) may limit the increase in ACROM, since several muscles participate in each cervical movement. Future research should apply these techniques to different MTrPs of the upper trapezius and/or in more MTrPs of the cervical muscles and analyze the different response variables explained in this study.

Conclusion

Even though deep and superficial DN did not produce statistically significant different effects in terms of PPT and goniometric measurements, both techniques produced a clear improvement in PPT at 7 days with respect to preintervention compared to the control group and a decrease in flexion at 24 h after the intervention. Furthermore, ipsilateral rotation of the dominant side increased at 24 h in the superficial DN group and until 7 days in the deep DN group. However, superficial DN increased ipsilateral rotation at 24 h after intervention, while no such effects were seen in the deep DN group. In addition, deep DN produced a decrease in extension at 72 h, while no changes were seen in the superficial DN group. There was an increase postintervention in ipsilateral and contralateral side flexion after superficial DN and a decrease after deep DN.

Authors' note

This study was performed at the Cardenal Herrera CEU University. The study protocol was approved by the Research and Ethics Committee of CEU Cardenal Herrera University (CEI15/006). The authors certify that they have no affiliations with or financial involvement in any organization or entity with a direct financial interest in the subject matter or material discussed in the article.

Contributors

All authors contributed to the study concept and design. SMN, MTPG and MIRO contributed to the acquisition of data. The analysis and the interpretation of data was done by MTPG, SdRM, MIRO and JMBR. The final approval of the manuscript was done by SMN and MTPG. SMN, SdRM and MIRO contributed to acquisition of funding. SMN, MTPG, SdRM and JMBR provide facilities and the equipment. Furthermore, SdRM, MIRO and JMBR provide the subjects. All the authors contributed to the writing, review and editing of manuscript. In addition, all of them revised the text for intellectual content, and read and approved the final version of the manuscript accepted for publication.

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Ethical approval

The study protocol was approved by Research and Ethics Committee of CEU Cardenal Herrera University Number: CEI15/006.

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Supplemental material

Supplemental material for this article is available online.

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