MARÍA J. MEJUTO-VÁZQUEZ, PT[1] • JAIME SALOM-MORENO, PT, PhD[1-3] • RICARDO ORTEGA-SANTIAGO, PT, PhD[1-3]
SEBASTIÁN TRUYOLS-DOMÍNGUEZ, PT, PhD[4] • CÉSAR FERNÁNDEZ-DE-LAS-PEÑAS, PT, PhD[1-3]

Short-Term Changes in Neck Pain, Widespread Pressure Pain Sensitivity, and Cervical Range of Motion After the Application of Trigger Point Dry Needling in Patients With Acute Mechanical Neck Pain: A Randomized Clinical Trial

STUDY DESIGN: Randomized clinical trial.

OBJECTIVES: To determine the effects of trigger point dry needling (TrPDN) on neck pain, widespread pressure pain sensitivity, and cervical range of motion in patients with acute mechanical neck pain and active trigger points in the upper trapezius muscle.

BACKGROUND: TrPDN seems to be effective for decreasing pain in individuals with upper-quadrant pain syndromes. Potential effects of TrPDN for decreasing pain and sensitization in individuals with acute mechanical neck pain are needed.

METHODS: Seventeen patients (53% female) were randomly assigned to 1 of 2 groups: a single session of TrPDN or no intervention (waiting list). Pressure pain thresholds over the C5-6 zygapophyseal joint, second metacarpal, and tibialis anterior muscle; neck pain intensity; and cervical spine range-of-motion data were collected at baseline (pretreatment) and 10 minutes and 1 week after the intervention by an assessor blinded to the treatment allocation of the patient. Mixed-model analyses of variance were used to examine the effects of treatment on each outcome variable.

RESULTS: Patients treated with 1 session of TrPDN experienced greater decreases in neck pain, greater increases in pressure pain threshold, and higher increases in cervical range of motion than those who did not receive an intervention at both 10 minutes and 1 week after the intervention ($P<.01$ for all comparisons). Between-group effect sizes were medium to large immediately after the TrPDN session (standardized mean score differences greater than 0.56) and large at the 1-week follow-up (standardized mean score differences greater than 1.34).

CONCLUSION: The results of the current randomized clinical trial suggest that a single session of TrPDN may decrease neck pain intensity and widespread pressure pain sensitivity, and also increase active cervical range of motion, in patients with acute mechanical neck pain. Changes in pain, pressure pain threshold, and cervical range of motion surpassed their respective minimal detectable change values, supporting clinically relevant treatment effects.

LEVEL OF EVIDENCE: Therapy, level 1b–. *J Orthop Sports Phys Ther 2014;44(4):252-260. Epub 25 February 2014. doi:10.2519/jospt.2014.5108*

KEY WORDS: *cervical, spine, upper trapezius*

SUPPLEMENTAL VIDEO ONLINE

Mechanical neck pain has a lifetime and point prevalence almost as high as low back pain[31] and results in substantial disability and economic burden for society.[29] The authors of a recent study[16] found that the prevalence of mechanical neck pain has decreased in the last few years in Spain, potentially attributed to a better understanding and management of the condition. Physical therapy is usually the first management option for individuals with insidious-onset mechanical neck pain.[7] Various therapeutic approaches, including spinal joint manipulation,[11] exercises,[26] and soft tissue techniques,[28] are

[1]Department of Physical Therapy, Occupational Therapy, Physical Medicine and Rehabilitation, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain. [2]Esthesiology Laboratory, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain. [3]Cátedra de Investigación y Docencia en Fisioterapia: Terapia Manual y Punción Seca, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain. [4]Department of Physical Therapy, Universidad Camilo José Cela, Madrid, Spain. The protocol for this study was approved by the Institutional Ethics Committee of Universidad Rey Juan Carlos. 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 materials discussed in the article. Address correspondence to Dr César Fernández-de-las-Peñas, Facultad de Ciencias de la Salud, Universidad Rey Juan Carlos, Avenida de Atenas s/n 28922 Alcorcón, Madrid, Spain. E-mail: cesarfdlp@yahoo.es; cesar.fernandez@urjc.es

typically used for treatment of mechanical neck pain; however, further studies are needed, particularly of interventions directed at the soft tissues, for which there is limited evidence.

The relevance of soft tissue interventions is related to the hypothesis that muscle trigger points (TrPs) may be involved in pain processes in patients with mechanical neck pain. TrPs are defined as hypersensitive regions in taut bands of a skeletal muscle that are painful on stimulation (ie, palpation) and elicit referred pain.[40] TrPs are clinically classified as active or latent. Active TrPs, both spontaneously and when palpated, elicit referred pain, reproducing the patient's symptoms. Latent TrPs, when palpated, elicit a referred pain that does not reproduce the patient's symptoms. Shah et al[39] found higher levels of algogenic substances and chemical mediators, such as bradykinin, serotonin, or substance P, in active TrPs as compared to latent TrPs and muscle regions without TrPs.

An intervention targeting TrPs as part of a multimodal treatment approach may help to reduce symptoms in individuals with mechanical neck pain.[35,46] TrP dry needling (TrPDN) is one proposed treatment method[15] that has been shown to reduce TrP-associated pain.[38,43] A recent meta-analysis concluded that there is grade A (high-level) evidence to support the use of TrPDN in patients with upper-quarter myofascial pain, particularly chronic neck and shoulder pain.[27] However, additional well-designed studies are needed to further examine treatment effectiveness.

The mechanisms as to how TrPDN exerts its effect are not fully understood, and both mechanical and neurophysiological theories have been proposed.[14] Proposed mechanical effects include disruption of the contraction knots, localized stretch of contracted cytoskeletal structures, and reduction of the overlap between actin and myosin filaments. Potential neurophysiological effects include a decrease in metabolic mediators, an increase in microcirculation, a reduction in peripheral nociceptive inputs, and activation of descending inhibitory central pain systems.[4,9]

A few studies have indicated that referred pain elicited by active TrPs in the upper trapezius, levator scapulae, and sternocleidomastoid muscles may contribute to symptoms in individuals with mechanical neck pain, with the upper trapezius being the most commonly involved muscle.[17,33] The presence of algogenic substances and chemical mediators within active TrPs has been shown to be related to sensitization mechanisms found with mechanical neck pain.[24]

To our knowledge, no previous study has investigated the clinical and neurophysiological effects of TrPDN in patients with acute mechanical neck pain. Potentially, TrPDN could help to reduce nociceptive inputs in the acute stage of injury, and therefore help to prevent the development of central sensitization and lead to faster recovery. The purpose of this randomized clinical trial was to determine the effects of TrPDN on pain and widespread pressure pain sensitivity in individuals with acute mechanical neck pain and active TrPs in the upper trapezius muscle. We hypothesized that patients who received a single session of TrPDN would have greater improvement in pain, pressure pain sensitivity, and cervical range of motion than patients who did not receive any intervention (natural course of the disease).

METHODS

Participants

A randomized controlled clinical trial was conducted. Consecutive patients with acute mechanical, idiopathic, unilateral neck pain were referred by their physician to a private physical therapy clinic from June 2012 to March 2013 and screened for eligibility criteria. In the current study, mechanical neck pain was defined as neck-shoulder pain with symptoms provoked by neck posture, neck movement, or palpation of the cervical musculature. To be considered acute, neck pain needed to be less than 7 days in duration. Patients were screened for any sign of vertebrobasilar insufficiency (nystagmus, gait disturbances, or Horner syndrome)[8] and for upper cervical spine ligamentous instability, using the Sharp-Purser, alar ligament stress, and transverse ligament tests. Further, patients were required to exhibit active TrPs in the upper trapezius muscle that reproduced their neck pain.

The following criteria were required for a patient to have active TrPs[40]: the presence of a palpable taut band in the upper trapezius muscle, the presence of a hypersensitive spot in the taut band, a palpable or visible local twitch on snapping palpation, and a reproduction of referred pain elicited by palpation of the sensitive spot. These criteria have good interexaminer reliability (κ = 0.84-0.88) when applied by experienced clinicians.[20] Although a previous review[30] found that reliability was based on determining the presence or absence of a TrP without distinction between its active or latent status, a recent study[34] reported that identification of clinically relevant TrPs in the upper trapezius muscle is reproducible when performed by experienced clinicians.

TrPs were considered active when the referred pain elicited by palpation reproduced the neck pain symptoms and the patients recognized the pain as a familiar experience.[40] Participants were examined for the presence of active TrPs in the upper trapezius muscle by a clinician with more than 8 years of experience in the assessment and treatment of TrPs.

Patients were excluded if they exhibited any of the following: history of a whiplash injury, previous cervical surgery, cervical radiculopathy or myelopathy, diagnosis of fibromyalgia syndrome,[48] any physical therapy intervention in the previous 12 months, fear of needles, any sign of vertebrobasilar insufficiency[8] or upper cervical spine ligamentous instability, or any contraindication for dry needling (eg, anticoagulant medications or the presence of psychiatric symptoms). The study protocol was approved by the Institutional Ethics Committee of the Universidad

Rey Juan Carlos (Spain), and all patients signed an informed consent form prior to participation in the study.

Primary Outcomes: Self-Reported Neck Pain and Pressure Pain Thresholds

The primary outcomes of the study were pain and pressure pain thresholds (PPTs). Participants rated the intensity of their neck pain at rest on an 11-point numeric pain rating scale, where 0 was no pain and 10 maximum pain.[25] Cleland et al[10] reported that the minimal detectable change (MDC) and minimal clinically important difference (MCID) for the numeric pain rating scale were 1.3 and 2.1 points, respectively, in patients with mechanical neck pain.

PPT, defined as the amount of pressure applied at which the pressure sensation first changes to pain,[45] was assessed bilaterally with an electronic algometer (Somedic AB, Hörby, Sweden) over the C5-6 zygapophyseal joint, the second metacarpal, and the tibialis anterior muscle. Patients were instructed to press a switch when the sensation changed from pressure to pain. The mean of 3 trials was calculated and used for the analysis. Thirty seconds was provided between each trial. It has recently been reported that PPT measurements conducted over the cervical spine exhibit excellent intrarater reliability (intraclass correlation coefficient [ICC] = 0.94-0.97) and good to excellent interrater reliability (ICC = 0.79-0.90) when performed on individuals with acute neck pain.[47] The MDC for PPT over the cervical spine and tibialis anterior muscle in patients with acute neck pain has been reported to be 47.2 kPa and 97.9 kPa, respectively.[47]

Cervical Range of Motion

The secondary outcome measure was active cervical range of motion assessed with the CROM device (Performance Attainment Associates, Lindstrom, MN), following previously published guidelines.[12,13] Measurements were made separately for each direction and in a standard sequence: flexion, extension, right lateral flexion, left lateral flexion, right rotation, and left rotation. Two measurements for each movement were recorded, and the mean was used in the analysis. Fletcher and Bandy[18] reported an intratester reliability ranging from 0.87 to 0.96, with a standard error of measurement between 2.3° and 4.1°, for these measurements. They also reported that changes between 5° and 10° are needed to determine a real change in cervical spine mobility (MDC) in individuals with neck pain.[18]

Trigger Point Dry Needling

The upper trapezius, which is the most commonly affected muscle in patients with neck pain,[17,33] was the only muscle to be treated with TrPDN. The intervention was provided by a clinician who had more than 5 years of experience in the management of TrPs using this technique. Patients in the experimental group received a single session of TrPDN with disposable, 0.3 × 30-mm stainless-steel needles (Novasan, SA, Madrid, Spain), which were inserted through the skin over the TrP. In this study, the "fast-in and fast-out" technique described by Hong[21] was applied. After locating an active TrP in the upper trapezius using pincer palpation, the overlying skin was cleaned with alcohol and the needle was subsequently inserted, penetrating the skin and muscle tissues to a depth of approximately 10 to 15 mm into the TrP (**FIGURE 1**). Once inserted into the TrP, the needle was moved into multiple directions until the first local twitch response was obtained. It has been suggested that multiple local twitch responses should be elicited during TrPDN for successful treatment.[21] Once the first local twitch response was obtained, the needling was performed in an up-and-down fashion, performing 2- to 3-mm vertical motions with no rotations (fast-in and fast-out technique), at approximately 1 Hz for 25 to 30 seconds, with the aim of eliciting local twitch responses. In such a manner, the needle was inserted multiple times into the TrP without removing it from the skin (**VIDEO,** available online).

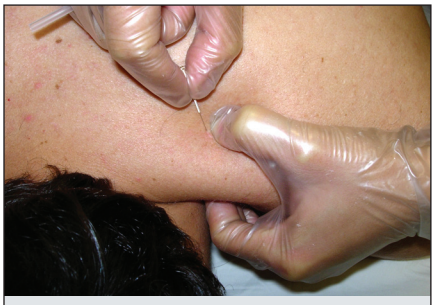

FIGURE 1. Trigger point dry needling applied over active trigger points in the upper trapezius muscle of a patient with acute mechanical neck pain. With the patient in prone, the needle was inserted into the skin over the trigger point until the first local twitch response was obtained, and moved up and down (2- to 3-mm vertical motions with no rotations) at approximately 1 Hz for 25 to 30 seconds (**VIDEO,** available online).

Control Group

Patients in the control group did not receive any intervention, so that the natural course of the condition could be determined. These patients were asked to continue their normal activities without exacerbating their symptoms and to refrain from taking any medication or seeking additional treatments during the study period.

Adverse Events

Patients were asked to report any adverse event that they experienced after the needling intervention and during the 1-week follow-up. In this study, an adverse event was defined as sequelae of medium-term duration of any symptom perceived as distressing and unacceptable to the patient and requiring further treatment.[5] Adverse events were self-reported by the patient, and information was collected by a clinician not involved in the study. Because TrPDN sometimes induces post-treatment soreness, patients were advised to report any increase in their symptoms after the intervention.

Randomization

Following the baseline examination, patients were randomly assigned to receive either TrPDN (experimental group) or no intervention (natural history of the disease), using a computer-generated table

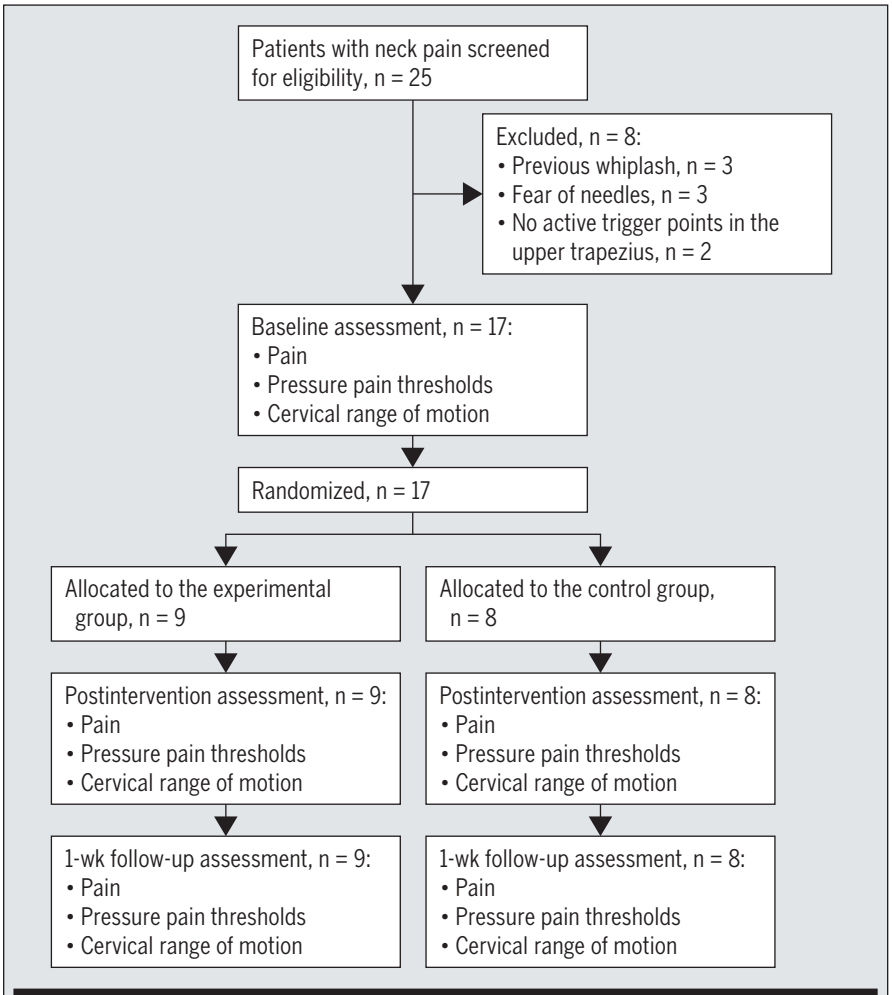

FIGURE 2. Flow diagram of patients throughout the course of the study.

of randomized numbers created prior to the start of data collection by a researcher not involved in the recruitment or treatment of patients. The randomized group assignments on sequentially numbered index cards were placed in sealed, opaque envelopes. A second therapist, blinded to baseline examination findings, opened the envelope and proceeded with treatment according to the group assignment. Outcome measures were assessed before, 10 minutes after, and 1 week after the intervention by a second assessor blinded to the treatment group allocation.

Statistical Analysis

Data were analyzed with SPSS Version 18.0 (SPSS Inc, Chicago, IL). Means, standard deviations, and 95% confidence intervals (CIs) were calculated for each variable. The Kolmogorov-Smirnov test showed normal distribution of quantitative data. Because participants received the intervention only for the upper trapezius muscle on the symptomatic side, sides were classified as ipsilateral or contralateral to the treated side. For pain and cervical range of motion in flexion and extension outcome data, separate 3-by-2, mixed-model analyses of variance (ANOVAs), with time (baseline, 10 minutes after, 1 week after) as the within-subject factor and group (TrPDN, control) as the between-subject factor, were used. For PPT data and cervical-range-of-motion data for lateral flexion and rotation, a separate 3-by-2-by-2, mixed-model ANOVA, with time (baseline, 10 minutes after, 1 week after) and side (ipsilateral, contralateral to the treated side) as within-subject factors and group (TrPDN, control) as the between-subject factor, was used. The hypothesis of interest was the group-by-time interaction, with a Bonferroni-corrected alpha of .017. To enable comparison of effect sizes, standardized mean score differences (SMDs) were calculated by dividing mean differences between experimental and control groups by the pooled standard deviation.

RESULTS

Twenty-five consecutive patients with neck pain were screened for eligibility criteria. Seventeen patients (mean ± SD age, 25 ± 4 years; 53% female) satisfied the eligibility criteria, agreed to participate, and were randomized to either the TrPDN (n = 9) or control (n = 8) group. The reasons for ineligibility are listed in a flow diagram of patient recruitment and retention (**FIGURE 2**). Baseline features between the 2 groups were similar for all variables (**TABLE 1**).

The 3-by-2, mixed-model ANOVA revealed a significant group-by-time interaction ($F = 15.547$, $P<.001$) for neck pain, in which patients treated with TrPDN experienced a greater reduction in neck pain than those in the control group, both 10 minutes after treatment as well as 1 week after the intervention (**TABLE 2**). Between-group differences in change scores were large at both follow-up periods (SMD, 2.05 and 3.11, respectively).

The 3-by-2-by-2 ANOVA revealed significant group-by-time interactions for PPT for all tested locations: C5-6 (group by time: $F = 12.302$, $P<.001$; side by time: $F = 0.545$, $P = .466$; group by side: $F = 0.710$, $P = .443$; group by time by side: $F = 0.546$, $P = .465$), second metacarpal (group by time: $F = 7.563$, $P = .010$; side by time: $F = 0.234$, $P = .632$; group by side: $F = 0.238$, $P = .789$; group by time by side: $F = 0.072$, $P = .790$), and tibialis anterior (group by time: $F = 7.604$, $P = .009$; side by time: $F = 0.530$, $P = .472$; group by side: $F = 0.707$, $P = .497$; group

TABLE 1 Baseline Demographics for Both Groups*

	Control Group (n = 8)	Experimental Group (n = 9)
Gender (male/female), n	4/4	4/5
Age, y	24 ± 7	25 ± 4
Neck pain duration, d	3.4 ± 0.7	3.1 ± 0.8
Pain intensity (0-10)	5.3 ± 2.0	5.7 ± 1.8
Pressure pain thresholds, kPa		
C5-6 joint, treated side	285.1 ± 102.4	224.8 ± 100.3
C5-6 joint, nontreated side	244.6 ± 109.5	220.8 ± 80.9
Second metacarpal, treated side	305.5 ± 108.7	259.5 ± 89.5
Second metacarpal, nontreated side	280.6 ± 97.2	293.2 ± 112.1
Tibialis anterior, treated side	554.0 ± 277.6	565.1 ± 243.7
Tibialis anterior, nontreated side	519.0 ± 230.9	573.2 ± 253.9
Cervical range of motion, deg		
Flexion	51.2 ± 9.9	58.3 ± 12.2
Extension	61.8 ± 13.6	65.0 ± 16.2
Lateral flexion toward treated side	38.7 ± 12.7	36.1 ± 13.4
Lateral flexion away from treated side	36.2 ± 11.5	39.4 ± 15.1
Rotation toward treated side	58.1 ± 15.1	55.5 ± 24.1
Rotation away from treated side	59.3 ± 18.2	58.8 ± 23.5

**Values are mean ± SD except for gender.*

TABLE 2 Neck Pain Intensity Outcome Data

	Pretreatment	Posttreatment	1 wk Posttreatment
Experimental (trigger point dry needling)*	5.7 ± 1.8	3.8 ± 1.9	2.0 ± 1.7
Control (wait and see)*	5.3 ± 2.0	5.5 ± 2.1	4.6 ± 2.1
Within-group change score from pretreatment†			
Experimental (trigger point dry needling)		−1.9 (−3.1, −0.7)‡	−3.7 (−5.3, −2.2)‡
Control (wait and see)		0.2 (−0.3, 0.8)	−0.7 (−1.4, −0.1)
Between-group difference in change score†		2.1 (1.0, 3.2)‡	3.0 (2.1, 3.9)‡

**Values are mean ± SD on a 0-to-10 scale.*
†Values are mean (95% confidence interval).
‡Statistically significant (P<.01).

by time by side: F = 0.005, *P* = .942). PPTs increased significantly bilaterally in patients treated with 1 session of TrPDN compared to those who did not receive treatment at both follow-ups (**TABLE 3**). Between-group differences in change scores ranged from medium to large 10 minutes after the intervention (0.56 less than SMD less than 2.10) and were large (2.23 less than SMD less than 3.01) 1 week after the intervention.

The 3-by-2-by-2, mixed-model ANOVA indicated significant group-by-time interactions for cervical lateral flexion (group by time: F = 9.031, *P* = .004; side by time: F = 0.012, *P* = .913; group by side: F = 0.422, *P* = .658; group by time by side: F = 0.551, *P* = .464) and rotation (group by time: F = 7.674, *P* = .009; side by time: F = 0.023, *P* = .881; group by side: F = 0.005, *P* = .985; group by time by side: F = 0.013, *P* = .91). Similarly, the 3-by-2 ANOVA revealed significant group-by-time interactions for cervical flexion (F = 7.797, *P* = .008) and extension (F = 7.294, *P* = .010) range of motion, with patients treated for a single session of TrPDN experiencing greater increases in cervical range of motion in all directions compared to those who did not receive treatment, both 10 minutes and 1 week after the intervention (**TABLE 4**). Between-group differences in change scores were large at both follow-up periods (1.34 less than SMD less than 2.92).

Although their neck pain decreased, 8 of 9 patients (88%) assigned to the TrPDN group experienced upper trapezius muscle soreness after the treatment but did not experience an increase in pain. TrPDN posttreatment soreness resolved spontaneously within 24 to 36 hours.

DISCUSSION

The results of this randomized clinical study suggest that a single session of TrPDN decreased neck pain intensity and widespread pressure pain sensitivity in individuals with acute mechanical neck pain. In addition, TrPDN also increased cervical range of motion. Between-group mean difference effect sizes were large (SMD greater than 0.8) for almost all outcomes, suggesting clinically relevant change after TrPDN.

The patients treated with a single session of TrPDN experienced statistically significant improvement in neck pain, as measured by the numeric pain rating scale, at 10 minutes and 1 week after the intervention. Clinically, when interpreted based on the previously published MCID of 2.1 for this population,[10] both the point estimate and the lower bound of the 95% CI at 1 week posttreatment were greater than the MCID, providing strong confidence in the clinical significance of the results (**TABLE 2**). Similarly, the point estimate and the lower bound of the 95% CI for the between-group difference in change scores at 1 week postintervention were at least as large as those of the MCID, also suggesting clinically significant greater benefit of TrPDN over a wait-and-see approach to treatment in

the short term (1 week) in this population (**TABLE 2**). However, it should be noted that, although the between-group mean differences and within-group mean differences in pain outcomes for the TrPDN group were also statistically significant when measured 10 minutes after the intervention, the clinical significance of these differences is not as clear, given the inclusion of the MCID within the 95% CIs for these comparisons (**TABLE 2**).

We also observed that TrPDN reduced widespread pressure pain sensitivity in patients with acute mechanical neck pain, as reflected by the increase in PPTs over both the symptomatic (neck) and nonsymptomatic (second metacarpal and tibialis anterior muscle) areas. In addition, the between-group differences in change scores for PPTs at 1 week postintervention were all larger than the MDC values of 47.2 kPa for the cervical spine and 97.9 kPa for the tibialis anterior muscle previously published by Walton et al[47] for this population. However, it is noted that the lower bound of the 95% CI for between-group difference in change scores does not always surpass the MDC. Other authors established that differences ranging from 20% to 25% are required to indicate a real change in PPT.[37] Changes in PPTs at 1 week after the intervention in our experimental group were greater than 25% of preintervention scores for all locations, supporting a clinically significant effect of TrPDN for reducing widespread mechanical pain sensitivity.

Our results are in agreement with the conclusion of a recent meta-analysis[27] and findings of randomized clinical trials[21,23,42,44] that demonstrate that TrPDN reduces intensity of chronic neck pain. Our results suggest that TrPDN may provide a similar benefit, at in the least short term, in patients with acute mechanical neck pain, potentially resulting in a faster recovery. However, further studies with longer follow-up periods are required for more conclusive results.

The observed combined reduction in pain intensity and widespread pressure pain sensitivity after TrPDN suggests a

TABLE 3 Pressure Pain Threshold Outcome Data

Variables/Groups	Pretreatment	Posttreatment	1 wk Posttreatment
PPT C5-6 joint, treated side*			
Experimental (TrPDN)	224.8 ± 100.3	294.0 ± 69.6	353.7 ± 92.3
Control (wait and see)	285.1 ± 102.4	282.0 ± 109.5	296.1 ± 89.7
PPT C5-6 joint, nontreated side*			
Experimental (TrPDN)	220.8 ± 80.9	298.7 ± 64.5	349.7 ± 116.1
Control (wait and see)	244.6 ± 109.5	239.6 ± 105.5	296.6 ± 74.7
PPT second metacarpal, treated side*			
Experimental (TrPDN)	259.5 ± 89.5	310.8 ± 72.9	395.6 ± 232.5
Control (wait and see)	305.5 ± 108.7	287.4 ± 108.4	304.1 ± 99.8
PPT second metacarpal, nontreated side*			
Experimental (TrPDN)	293.2 ± 112.1	330.1 ± 81.9	388.6 ± 176.1
Control (wait and see)	280.6 ± 97.2	282.2 ± 113.5	278.6 ± 90.6
PPT tibialis anterior, treated side*			
Experimental (TrPDN)	565.1 ± 243.7	568.0 ± 234.0	701.4 ± 373.7
Control (wait and see)	554.0 ± 277.6	517.7 ± 252.1	572.1 ± 239.2
PPT tibialis anterior, nontreated side*			
Experimental (TrPDN)	573.2 ± 253.9	597.7 ± 275.0	662.1 ± 284.0
Control (wait and see)	519.0 ± 230.9	498.6 ± 221.0	479.0 ± 148.2
Within-group change score from pretreatment†			
PPT C5-6 joint, treated side			
Experimental (TrPDN)		69.2 (36.4, 101.9)‡	128.9 (74.5, 183.3)‡
Control (wait and see)		−3.1 (−36.5, 30.3)	11.0 (−37.0, 59.0)
PPT C5-6 joint, treated side			
Experimental (TrPDN)		77.9 (51.8, 103.9)‡	128.9 (56.7, 201.0)‡
Control (wait and see)		−5.0 (−28.3, 18.3)	52.0 (23.1, 80.9)
PPT second metacarpal, treated side			
Experimental (TrPDN)		51.3 (7.5, 95.0)‡	136.1 (74.2, 198.0)‡
Control (wait and see)		−18.1 (−60.6, 24.4)	−1.4 (−66.6, 65.2)
PPT second metacarpal, nontreated side			
Experimental (TrPDN)		36.9 (5.6, 68.2)‡	95.4 (19.1, 171.7)‡
Control (wait and see)		1.4 (−30.1, 31.5)	−2.0 (−24.1, 22.2)
PPT tibialis anterior, treated side			
Experimental (TrPDN)		2.9 (−43.5, 46.4)‡	136.3 (97.8, 175.1)‡
Control (wait and see)		−36.3 (−95.0, −22.4)	18.1 (−47.4, 65.6)
PPT tibialis anterior, nontreated side			
Experimental (TrPDN)		24.5 (−23.7, 42.8)‡	88.9 (52.1, 125.7)‡
Control (wait and see)		−20.4 (−46.2, 5.4)	−40.0 (−93.1, 13.0)
Between-group difference in change score†			
PPT C5-6 joint, treated side		72.3 (29.3, 115.3)‡	117.9 (50.7, 185.1)‡
PPT C5-6 joint, nontreated side		82.9 (50.5, 115.2)‡	76.9 (20.6, 133.1)‡
PPT second metacarpal, treated side		69.4 (13.2, 125.5)‡	137.5 (70.0, 205.0)‡
PPT second metacarpal, nontreated side		35.5 (9.4, 61.6)‡	97.4 (57.1, 137.7)‡
PPT tibialis anterior, treated side		39.2 (27.1, 51.4)	118.2 (81.4, 156.1)‡
PPT tibialis anterior, nontreated side		44.9 (7.4, 82.4)	128.9 (90.0, 167.8)‡

Abbreviations: PPT, pressure pain threshold; TrPDN, trigger point dry needling.
**Values are mean ± SD kPa.*
†Values are mean (95% confidence interval).
‡Statistically significant (P<.01).

TABLE 4 Cervical-Range-of-Motion Outcome Data

Variables/Groups	Pretreatment	Posttreatment	1 wk Posttreatment
Cervical flexion*			
Experimental (TrPDN)	58.3 ± 12.2	68.3 ± 13.4	67.7 ± 5.0
Control (wait and see)	51.2 ± 9.9	46.2 ± 9.5	50.6 ± 7.7
Cervical extension*			
Experimental (TrPDN)	65.0 ± 16.2	78.8 ± 12.6	80.5 ± 8.4
Control (wait and see)	61.8 ± 13.6	58.1 ± 16.0	60.2 ± 16.3
Cervical lateral flexion toward treated side*			
Experimental (TrPDN)	36.1 ± 13.4	48.3 ± 6.6	51.6 ± 4.3
Control (wait and see)	38.7 ± 12.7	38.1 ± 10.0	41.2 ± 10.3
Cervical lateral flexion away from treated side*			
Experimental (TrPDN)	39.4 ± 15.1	51.6 ± 9.3	52.2 ± 6.6
Control (wait and see)	36.2 ± 11.5	37.5 ± 12.8	42.5 ± 8.5
Cervical rotation toward treated side*			
Experimental (TrPDN)	55.5 ± 24.1	66.6 ± 15.6	72.7 ± 14.1
Control (wait and see)	58.1 ± 15.1	53.7 ± 15.0	57.5 ± 7.0
Cervical rotation away from treated side*			
Experimental (TrPDN)	58.8 ± 23.5	68.3 ± 15.4	74.4 ± 8.0
Control (wait and see)	59.3 ± 18.2	55.1 ± 18.2	58.7 ± 7.9
Within-group change score from pretreatment†			
Cervical flexion			
Experimental (TrPDN)		10.0 (2.3, 17.6)‡	9.4 (2.9, 15.8)‡
Control (wait and see)		−5.0 (−12.4, −2.4)	0.6 (−8.5, 7.2)
Cervical extension			
Experimental (TrPDN)		13.8 (4.1, 23.6)‡	15.5 (4.1, 26.9)‡
Control (wait and see)		−3.7 (−10.3, −2.8)	−1.6 (−9.5, 7.0)
Cervical lateral flexion toward treated side			
Experimental (TrPDN)		12.2 (5.0, 19.4)‡	15.5 (3.4, 27.6)‡
Control (wait and see)		−0.6 (−5.3, 4.0)	2.5 (0.9, 4.2)
Cervical lateral flexion away from treated side			
Experimental (TrPDN)		12.2 (5.4, 19.0)‡	12.8 (6.4, 20.2)‡
Control (wait and see)		1.3 (−3.6, 6.1)	6.3 (0.5, 12.1)
Cervical rotation toward treated side			
Experimental (TrPDN)		11.1 (3.4, 18.7)‡	17.2 (6.6, 27.8)‡
Control (wait and see)		−4.4 (−11.9, 3.1)	−0.6 (−10.7, 9.4)
Cervical rotation away from treated side			
Experimental (TrPDN)		9.4 (−0.8, 19.6)‡	15.5 (−3.5, 34.6)‡
Control (wait and see)		−4.2 (−10.0, 1.5)	−0.6 (−13.0, 11.7)
Between-group difference in change score†			
Cervical flexion		15.0 (6.1, 23.9)‡	10.0 (5.1, 14.9)‡
Cervical extension		17.5 (6.5, 28.6)‡	17.1 (5.5, 28.8)‡
Cervical lateral flexion toward treated side		12.8 (6.5, 18.9)‡	13.0 (5.1, 20.9)‡
Cervical lateral flexion away from treated side		10.9 (5.4, 16.4)‡	6.5 (3.1, 9.8)
Cervical rotation toward treated side		15.5 (5.6, 25.3)‡	17.8 (5.2, 30.4)‡
Cervical rotation away from treated side		13.7 (5.4, 22.0)‡	16.1 (7.2, 25.0)‡

Abbreviation: TrPDN, trigger point dry needling.
**Values are mean ± SD deg.*
†Values are mean (95% confidence interval).
‡Statistically significant (P<.01).

hypoalgesic effect of the intervention. The mechanisms by which TrPDN reduces pain and central sensitization remain speculative, and segmental and central mechanisms have been proposed.[4,9,14,15] It has been suggested that the mechanical stimulus due to the insertion of the needle stimulates sensitized muscle nociceptors, decreases metabolic mediators,[22,39] and increases local microcirculation.[3] The potential decrease in chemical mediators could be related to the observation of immediate decreases in pain and tenderness after TrPDN.

The increases in PPT over the cervical spine are consistent with the concept that TrPDN induces a segmental antinociceptive effect, in agreement with the findings of a previous study.[41] But the increase in PPTs at distant locations (tibialis anterior muscle and second metacarpal) also suggests that central antinociceptive effects occur through activation of the descending inhibitory pain mechanisms.[4,9] In their previous work, Niddam et al[36] found that the effects of TrPDN combined with electrical stimulation were mediated by supraspinal pain-control mechanisms related to antinociception and regulation of pain, particularly the periaqueductal gray matter. This is consistent with the most widely accepted theory that physical therapy interventions, including TrPDN, stimulate descending inhibitory pain mechanisms, particularly the periaqueductal gray matter.[1] It is plausible that TrPDN provides a counterirritant effect by removing a constant nociceptive source, resulting in inhibition of neuroplastic changes associated with central sensitization at the dorsal horn.[4,9,14,22] Therefore, it is possible that a single application of TrPDN can reduce nociception and pain from active TrPs, preventing the development of future widespread pressure pain hyperalgesia in patients with acute mechanical neck pain.

In the current study, a single treatment session of TrPDN also led to statistically significant and likely clinically important increases in cervical range of motion (**TABLE 4**), with the mean differences in chang-

es between groups being generally larger than those previously observed after cervical spine manipulation (ranging from 1.6° to 5.7°)[2,32]; however, those previous studies included individuals with chronic neck pain. Changes in range of motion could be related to mechanical effects induced by TrPDN, for example, disruption of contraction knots (TrP), localized stretch of contracted cytoskeletal structures, and reduction of overlap between actin and myosin filaments.[4,9,14] Because taut bands with TrPs have greater stiffness than the surrounding muscle tissue,[6] it is possible that TrPDN decreases muscle stiffness.

The results of the present study should be interpreted with regard to potential study limitations. First, the study sample consisted of younger patients who had a first episode of acute neck pain; therefore, some of the improvement seen in the TrPDN group could have been partially due to the natural history of the condition. Though the inclusion of a control group may help to account for this, a possible placebo effect cannot be ruled out without a group that received a sham intervention.[19] Of interest is the conclusion of a recent systematic review[27] that TrPDN is superior to sham needling for decreasing pain in upper-quadrant syndromes. A second limitation is that the outcomes were only collected in the short term, which precludes inference beyond the duration of the study in terms of continued improvement or differences between groups. Finally, all patients were treated by the same clinician and only 1 treatment session was provided, thus the results cannot be generalized to interventions involving multiple treatment sessions. Future studies should include multiple treatment sessions, a greater number of clinicians, and longer follow-ups. Despite the small sample size of the present study, statistically significant and clinically relevant results were observed, suggesting that a greater sample size would not alter the direction of the results. However, future studies may also benefit from greater sample size to increase the generalizability of the results.

CONCLUSION

The results of this randomized clinical trial suggest that a single treatment session with TrPDN decreases pain intensity and widespread pressure pain sensitivity and increases cervical range of motion in the short term (1 week posttreatment) in individuals with acute mechanical neck pain. Compared to a control group that did not receive any intervention, between-group differences in effect sizes were large for almost all outcomes, suggesting a clinically important treatment effect for TrPDN. Additional large-scale clinical trials with a longer-term follow-up are needed. ◉

KEY POINTS

FINDINGS: A single treatment session of TrPDN reduces pain intensity and widespread pressure pain sensitivity and increases cervical range of motion in patients with acute mechanical neck pain.

IMPLICATIONS: The improvements in the acute stage may help to prevent the development of central sensitization and promote faster recovery.

CAUTION: Generalizability of the current results should be interpreted with caution, as all patients were treated by the same therapist. Large-scale multicenter clinical trials with longer follow-ups are needed to further confirm these results.

REFERENCES

1. Bialosky JE, Bishop MD, Price DD, Robinson ME, George SZ. The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model. *Man Ther*. 2009;14:531-538. http://dx.doi.org/10.1016/j.math.2008.09.001
2. Bronfort G, Evans R, Nelson B, Aker PD, Goldsmith CH, Vernon H. A randomized clinical trial of exercise and spinal manipulation for patients with chronic neck pain. *Spine (Phila Pa 1976)*. 2001;26:788-797; discussion 798-799.
3. Cagnie B, Barbe T, De Ridder E, Van Oosterwijck J, Cools A, Danneels L. The influence of dry needling of the trapezius muscle on muscle blood flow and oxygenation. *J Manipulative Physiol Ther*. 2012;35:685-691. http://dx.doi.org/10.1016/j.jmpt.2012.10.005
4. Cagnie B, Dewitte V, Barbe T, Timmermans F, Delrue N, Meeus M. Physiologic effects of dry needling. *Curr Pain Headache Rep*. 2013;17:348. http://dx.doi.org/10.1007/s11916-013-0348-5
5. Carlesso LC, MacDermid JC, Santaguida LP. Standardization of adverse event terminology and reporting in orthopaedic physical therapy: application to the cervical spine. *J Orthop Sports Phys Ther*. 2010;40:455-463. http://dx.doi.org/10.2519/jospt.2010.3229
6. Chen Q, Bensamoun S, Basford JR, Thompson JM, An KN. Identification and quantification of myofascial taut bands with magnetic resonance elastography. *Arch Phys Med Rehabil*. 2007;88:1658-1661. http://dx.doi.org/10.1016/j.apmr.2007.07.020
7. Childs JD, Cleland JA, Elliott JM, et al. Neck pain: clinical practice guidelines linked to the International Classification of Functioning, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther*. 2008;38:A1-A34. http://dx.doi.org/10.2519/jospt.2008.0303
8. Childs JD, Flynn TW, Fritz JM, et al. Screening for vertebrobasilar insufficiency in patients with neck pain: manual therapy decision-making in the presence of uncertainty. *J Orthop Sports Phys Ther*. 2005;35:300-306. http://dx.doi.org/10.2519/jospt.2005.35.5.300
9. Chou LW, Kao MJ, Lin JG. Probable mechanisms of needling therapies for myofascial pain control. *Evid Based Complement Alternat Med*. 2012;2012:705327. http://dx.doi.org/10.1155/2012/705327
10. Cleland JA, Childs JD, Whitman JM. Psychometric properties of the Neck Disability Index and numeric pain rating scale in patients with mechanical neck pain. *Arch Phys Med Rehabil*. 2008;89:69-74. http://dx.doi.org/10.1016/j.apmr.2007.08.126
11. Cross KM, Kuenze C, Grindstaff TL, Hertel J. Thoracic spine thrust manipulation improves pain, range of motion, and self-reported function in patients with mechanical neck pain: a systematic review. *J Orthop Sports Phys Ther*. 2011;41:633-642. http://dx.doi.org/10.2519/jospt.2011.3670
12. De-la-Llave-Rincón AI, Fernández-de-las-Peñas C, Laguarta-Val S, Ortega-Santiago R, Palacios-Ceña D, Martínez-Perez A. Women with carpal tunnel syndrome show restricted cervical range of motion. *J Orthop Sports Phys Ther*. 2011;41:305-310. http://dx.doi.org/10.2519/jospt.2011.3536
13. De-la-Llave-Rincón AI, Fernández-de-las-Peñas C, Palacios-Ceña D, Cleland JA. Increased forward head posture and restricted cervical range of motion in patients with carpal tunnel syndrome. *J Orthop Sports Phys Ther*. 2009;39:658-664. http://dx.doi.org/10.2519/jospt.2009.3058
14. Dommerholt J. Dry needling – peripheral and central considerations. *J Man Manip Ther*. 2011;19:223-227. http://dx.doi.org/10.1179/106698111X13129729552065

15. Dommerholt J, Fernández-de-las-Peñas C, eds. *Trigger Point Dry Needling: An Evidenced and Clinical-Based Approach*. Edinburgh, UK: Churchill Livingstone/Elsevier; 2013.
16. Fernández-de-las-Peñas C, Alonso-Blanco C, Hernández-Barrera V, Palacios-Ceña D, Jiménez-García R, Carrasco-Garrido P. Has the prevalence of neck pain and low back pain changed over the last 5 years? A population-based national study in Spain. *Spine J*. 2013;13:1069-1076. http://dx.doi.org/10.1016/j.spinee.2013.02.064
17. Fernández-de-las-Peñas C, Alonso-Blanco C, Miangolarra JC. Myofascial trigger points in subjects presenting with mechanical neck pain: a blinded, controlled study. *Man Ther*. 2007;12:29-33. http://dx.doi.org/10.1016/j.math.2006.02.002
18. Fletcher JP, Bandy WD. Intrarater reliability of CROM measurement of cervical spine active range of motion in persons with and without neck pain. *J Orthop Sports Phys Ther*. 2008;38:640-645. http://dx.doi.org/10.2519/jospt.2008.2680
19. George SZ, Robinson ME. Dynamic nature of the placebo response. *J Orthop Sports Phys Ther*. 2010;40:452-454. http://dx.doi.org/10.2519/jospt.2010.0107
20. Gerwin RD, Shannon S, Hong CZ, Hubbard D, Gevirtz R. Interrater reliability in myofascial trigger point examination. *Pain*. 1997;69:65-73.
21. Hong CZ. Lidocaine injection versus dry needling to myofascial trigger point. The importance of the local twitch response. *Am J Phys Med Rehabil*. 1994;73:256-263.
22. Hsieh YL, Yang SA, Yang CC, Chou LW. Dry needling at myofascial trigger spots of rabbit skeletal muscles modulates the biochemicals associated with pain, inflammation, and hypoxia. *Evid Based Complement Alternat Med*. 2012;2012:342165. http://dx.doi.org/10.1155/2012/342165
23. Itoh K, Katsumi Y, Hirota S, Kitakoji H. Randomised trial of trigger point acupuncture compared with other acupuncture for treatment of chronic neck pain. *Complement Ther Med*. 2007;15:172-179. http://dx.doi.org/10.1016/j.ctim.2006.05.003
24. Javanshir K, Ortega-Santiago R, Mohseni-Bandpei MA, Miangolarra-Page JC, Fernández-de-las-Peñas C. Exploration of somatosensory impairments in subjects with mechanical idiopathic neck pain: a preliminary study. *J Manipulative Physiol Ther*. 2010;33:493-499. http://dx.doi.org/10.1016/j.jmpt.2010.08.022
25. Jensen MP, Turner JA, Romano JM, Fisher LD. Comparative reliability and validity of chronic pain intensity measures. *Pain*. 1999;83:157-162.
26. Kay TM, Gross A, Goldsmith CH, et al. Exercises for mechanical neck disorders. *Cochrane Database Syst Rev*. 2012;8:CD004250. http://dx.doi.org/10.1002/14651858.CD004250.pub4
27. Kietrys DM, Palombaro KM, Azzaretto E, et al. Effectiveness of dry needling for upper-quarter myofascial pain: a systematic review and meta-analysis. *J Orthop Sports Phys Ther*. 2013;43:620-634. http://dx.doi.org/10.2519/jospt.2013.4668
28. Kong LJ, Zhan HS, Cheng YW, Yuan WA, Chen B, Fang M. Massage therapy for neck and shoulder pain: a systematic review and meta-analysis. *Evid Based Complement Alternat Med*. 2013;2013:613279. http://dx.doi.org/10.1155/2013/613279
29. Korthals-de Bos IB, Hoving JL, van Tulder MW, et al. Cost effectiveness of physiotherapy, manual therapy, and general practitioner care for neck pain: economic evaluation alongside a randomised controlled trial. *BMJ*. 2003;326:911. http://dx.doi.org/10.1136/bmj.326.7395.911
30. Lucas N, Macaskill P, Irwig L, Moran R, Bogduk N. Reliability of physical examination for diagnosis of myofascial trigger points: a systematic review of the literature. *Clin J Pain*. 2009;25:80-89. http://dx.doi.org/10.1097/AJP.0b013e31817e13b6
31. Martin BI, Deyo RA, Mirza SK, et al. Expenditures and health status among adults with back and neck problems. *JAMA*. 2008;299:656-664. http://dx.doi.org/10.1001/jama.299.6.656
32. Martínez-Segura R, De-la-Llave-Rincón AI, Ortega-Santiago R, Cleland JA, Fernández-de-las-Peñas C. Immediate changes in widespread pressure pain sensitivity, neck pain, and cervical range of motion after cervical or thoracic thrust manipulation in patients with bilateral chronic mechanical neck pain: a randomized clinical trial. *J Orthop Sports Phys Ther*. 2012;42:806-814. http://dx.doi.org/10.2519/jospt.2012.4151
33. Muñoz-Muñoz S, Muñoz-García MT, Alburquerque-Sendín F, Arroyo-Morales M, Fernández-de-las-Peñas C. Myofascial trigger points, pain, disability, and sleep quality in individuals with mechanical neck pain. *J Manipulative Physiol Ther*. 2012;35:608-613. http://dx.doi.org/10.1016/j.jmpt.2012.09.003
34. Myburgh C, Lauridsen HH, Larsen AH, Hartvigsen J. Standardized manual palpation of myofascial trigger points in relation to neck/shoulder pain; the influence of clinical experience on inter-examiner reproducibility. *Man Ther*. 2011;16:136-140. http://dx.doi.org/10.1016/j.math.2010.08.002
35. Nagrale AV, Glynn P, Joshi A, Ramteke G. The efficacy of an integrated neuromuscular inhibition technique on upper trapezius trigger points in subjects with non-specific neck pain: a randomized controlled trial. *J Man Manip Ther*. 2010;18:37-43. http://dx.doi.org/10.1179/106698110X12595770849605
36. Niddam DM, Chan RC, Lee SH, Yeh TC, Hsieh JC. Central modulation of pain evoked from myofascial trigger point. *Clin J Pain*. 2007;23:440-448. http://dx.doi.org/10.1097/AJP.0b013e318058accb
37. Prushansky T, Dvir Z, Defrin-Assa R. Reproducibility indices applied to cervical pressure pain threshold measurements in healthy subjects. *Clin J Pain*. 2004;20:341-347.
38. Scott NA, Guo B, Barton PM, Gerwin RD. Trigger point injections for chronic non-malignant musculoskeletal pain: a systematic review. *Pain Med*. 2009;10:54-69. http://dx.doi.org/10.1111/j.1526-4637.2008.00526.x
39. Shah JP, Phillips TM, Danoff JV, Gerber LH. An in vivo microanalytical technique for measuring the local biochemical milieu of human skeletal muscle. *J Appl Physiol (1985)*. 2005;99:1977-1984. http://dx.doi.org/10.1152/japplphysiol.00419.2005
40. Simons DG, Travell JG, Simons LS. *Travell & Simons' Myofascial Pain and Dysfunction: The Trigger Point Manual Volume 1: Upper Half of Body*. 2nd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 1998.
41. Srbely JZ, Dickey JP, Lee D, Lowerison M. Dry needle stimulation of myofascial trigger points evokes segmental anti-nociceptive effects. *J Rehabil Med*. 2010;42:463-468. http://dx.doi.org/10.2340/16501977-0535
42. Tekin L, Akarsu S, Durmuş O, Çakar E, Dinçer U, Kiralp MZ. The effect of dry needling in the treatment of myofascial pain syndrome: a randomized double-blinded placebo-controlled trial. *Clin Rheumatol*. 2013;32:309-315. http://dx.doi.org/10.1007/s10067-012-2112-3
43. Tough EA, White AR. Effectiveness of acupuncture/dry needling for myofascial trigger point pain. *Phys Ther Rev*. 2011;16:147-154. http://dx.doi.org/10.1179/1743288X11Y.0000000007
44. Tsai CT, Hsieh LF, Kuan TS, Kao MJ, Chou LW, Hong CZ. Remote effects of dry needling on the irritability of the myofascial trigger point in the upper trapezius muscle. *Am J Phys Med Rehabil*. 2010;89:133-140. http://dx.doi.org/10.1097/PHM.0b013e3181a5b1bc
45. Vanderweeën L, Oostendorp RA, Vaes P, Duquet W. Pressure algometry in manual therapy. *Man Ther*. 1996;1:258-265. http://dx.doi.org/10.1054/math.1996.0276
46. Vernon H, Schneider M. Chiropractic management of myofascial trigger points and myofascial pain syndrome: a systematic review of the literature. *J Manipulative Physiol Ther*. 2009;32:14-24. http://dx.doi.org/10.1016/j.jmpt.2008.06.012
47. Walton DM, MacDermid JC, Nielson W, Teasell RW, Chiasson M, Brown L. Reliability, standard error, and minimum detectable change of clinical pressure pain threshold testing in people with and without acute neck pain. *J Orthop Sports Phys Ther*. 2011;41:644-650. http://dx.doi.org/10.2519/jospt.2011.3666
48. Wolfe F, Smythe HA, Yunus MB, et al. The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. Report of the Multicenter Criteria Committee. *Arthritis Rheum*. 1990;33:160-172.