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Original Research

Effects of Low-Load Exercise on Postneedling-Induced Pain After Dry Needling of Active Trigger Point in Individuals With Subacromial Pain Syndrome

Jaime Salom-Moreno, PT, PhD, Laura Jiménez-Gómez, PT, Victoria Gómez-Ahufinger, PT, María Palacios-Ceña, PT, MSc, José L. Arias-Buría, PT, PhD, Shane L. Koppenhaver, PT, PhD, César Fernández-de-las-Peñas, PT, PhD, DMSc

Abstract

Background: The application of dry needling usually is associated with postneedling-induced pain. A postneedling intervention reduce this adverse event is needed.
Objective: To determine the effectiveness of low-load exercise on reducing postneedling-induced pain after dry needling of active trigger points (TrPs) in the infraspinatus muscle in subacromial pain syndrome.
Design: A 72-hour follow-up, single-blind randomized controlled trial.
Setting: Urban hospitals.
Participants: Individuals with subacromial pain syndrome (n = 90, 52% female, mean age: 35 ± 13 years) with active TrPs in the infraspinatus muscle.
Interventions: All individuals received dry needling into the infraspinatus active TrP. Then, they were divided randomly into an experimental group, which received a single bout of low-load exercise of shoulder muscles; a placebo group, which received inactive ultrasound for 10 minutes; and a control group, which did not receive any intervention.
Outcome Measures: Numerical Pain Rating Scale (0-10 point) was administered postneedling, immediately postintervention (2 minutes), and 24, 48, and 72 hours after needling. Shoulder pain (Numerical Pain Rating Scale, 0-10) and disability (Disabilities of the Arm, Shoulder and Hand; Shoulder Pain and Disability Index) were assessed before and 72 hour after needling.
Results: The 5 × 3 analysis of covariance showed that the exercise group demonstrated a larger decrease in postneedling-induced pain immediately after ($P = .001$), 24 hours ($P = .001$), and 48 hours after ($P = .006$) than placebo or control groups. No differences were found at 72 hours ($P = .03$). Similar improvements in shoulder pain ($P < .001$) and related disability (Disabilities of the Arm, Shoulder and Hand: $P < .001$; Shoulder Pain and Disability Index: $P < .001$) were observed 72 hours after needling, irrespective of the treatment group.
Conclusions: Low-load exercise was effective for reducing postneedling-induced pain on active TrPs in the infraspinatus muscle 24 and 48 hours after needling. The application of a postneedling intervention did not influence short-term pain and disability changes.
Level of Evidence: To be determined.

Introduction

Trigger points (TrPs) are defined as hypersensitive tender spots within taut bands of skeletal muscles that are painful on mechanical stimulation, elicit a referred pain, and generate motor dysfunction and an autonomic response [1]. Active TrPs are those provoking spontaneous symptoms and the elicited referred pain reproduces the symptom experienced by the patient [1]. It has been reported that active TrPs reproduce the symptoms experienced by individuals experiencing mechanical neck pain [2], lateral epicondylitis [3],

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whiplash [4], tension-type headache [5,6], fibromyalgia [7,8], temporomandibular pain [9], or shoulder pain [10,11].

Several therapeutic approaches are proposed for the management of myofascial pain including the growing trend of TrP dry needling (TrP-DN) [12]. TrP-DN is defined as a "skilled intervention using a thin filiform needle to penetrate the skin that stimulates TrPs, muscles, and connective tissue for the management of musculoskeletal disorders" [13]. Recent meta-analyses suggest that TrP-DN may be effective for the management of neck and shoulder pain [14,15]. Significant adverse effects associated with the use of TrP-DN are rare, but some mild adverse events such as pain during and after needling, bleeding, or bruising are fairly common [16]. Postneedling-induced pain or soreness is reported as one of the most common side effects of TrP-DN and is thought to be a consequence of neuromuscular damage generated by the repetitive needling insertions into the muscle [17]. The presence of postneedling soreness has been associated with a possible reluctance to receive further needling therapy by individuals with myofascial pain, generating patient dissatisfaction and reduced treatment adherence [18]. In fact, the American Physical Therapy Association recommends warning patients about the presence of soreness after TrP-DN [19]. Therefore, it is relevant to determine whether clinicians are able to reduce postneedling-induced pain by postintervention strategies.

There are few studies that have investigated therapeutic strategies to decrease postneedling-induced pain. Two recent studies demonstrated that the application of ethyl chloride spray and stretching [20] and ischemic compression [21] after TrP-DN exhibited short-term effects (between 6 and 24 hours) for reducing postneedling soreness on latent TrPs in the upper trapezius. Although promising, these studies included asymptomatic subjects with latent TrPs, which does not represent clinical practice, and also applied passive modalities for reducing postneedling soreness.

It is possible that active exercise may be more functional, time efficient, and empowering to patients than passive treatments after TrP-DN. A recent study has reported that low-load eccentric exercise provided protection against damage [22]. It is possible that the application of low-load exercise after TrP-DN helps to decrease postneedling soreness by protecting against muscle damage. To the best of our knowledge, no previous study has determined the effectiveness of any intervention on postneedling soreness in symptomatic individuals exhibiting active TrPs.

Therefore, our aim was to determine the effectiveness of low-load eccentric exercise on reducing induced pain after dry needling of active TrPs in the infraspinatus muscle in subacromial pain syndrome. We hypothesized that subjects receiving low-load exercise as TrP-DN postintervention would exhibit greater reduction of postneedling-induced pain and greater improvements in pain and disability than those receiving detuned (inactive) ultrasound or no intervention.

Methods

Study Design

A randomized, parallel-group, controlled trial was conducted to compare the effects on postneedling soreness of low-load eccentric exercise (experimental), detuned ultrasound (placebo), and no intervention (control) in subacromial pain syndrome. The study was approved by the Institutional Review Board of Universidad Rey Juan Carlos (URJC 20072015341531/2014). The trial was registered (ClinicalTrials.gov: NCT02558686).

Participants

Consecutive subjects with a diagnosis of subacromial pain syndrome from different regional hospitals in Madrid, Spain, were screened for eligibility criteria. Subacromial pain syndrome was defined when individuals fulfilled the following: (1) unilateral shoulder pain complaints persisting from at least 6 months; (2) pain intensity >3 points on an 11-point Numerical Pain Rating Scale (NPRS); (3) a positive painful arc test during abduction (+likelihood ratio [LR] 3.7, 95% confidence interval [CI] 1.9-7.0) [23]; and (4) at least 2 positive tests from the following: Hawkins-Kennedy test (+LR 1.70, 95% CI 1.29-2.26), Neer sign (+LR 1.86, 95% CI 1.49-2.31), empty can test (specificity 0.62), drop arm test (specificity 0.92), or lift-off test (specificity 0.97) [24].

In addition, subjects exhibited at least one active TrP in the infraspinatus muscle reproducing their shoulder symptoms. A diagnosis of TrP was performed following the criteria described by Simons et al [1]: (1) presence of a hypersensitive spot in a palpable taut band in the infraspinatus muscle; (2) local twitch response elicited by snapping palpation of the taut band; and (3) referred pain in response to compression. To be considered active, the elicited pain by the TrP should reproduce any symptom experienced by the subject and the subject should recognize the pain as familiar. These criteria, when applied by trained assessors, have exhibited a moderate interexaminer reliability (k: 0.65-0.88) [25].

The infraspinatus muscle was selected for the following reasons: (1) it is the muscle most frequently affected by TrPs in individuals with shoulder pain [10,11]; (2) the referred pain elicited by its TrPs spreads to the shoulder area [1], mimicking symptoms experienced by individuals with subacromial pain

syndrome [10,11]; (3) it is superficial and accessible to manual palpation and treatment; (4) it has shown the highest agreement about the presence or absence of TrPs (70%-80%) in relation to other rotator cuff muscles [26]; and (5) because it is a posterior muscle, differentiation of postneedling-induced pain from the shoulder symptoms would be easier for the participants because they usually report symptoms in the anterior and lateral parts of the shoulder region.

Participants were excluded if they exhibited any of the following: (1) bilateral shoulder pain; (2) fear of needles; (3) coagulation disorders; (4) history of shoulder fractures and/or dislocation; (5) cervical radiculopathy; (6) previous intervention with steroid injections in the shoulder; (7) fibromyalgia syndrome; (8) previous history of shoulder or neck surgery; (9) any therapeutic intervention for the shoulder area the previous year. All participants signed an informed consent before their inclusion in the study.

Randomization and Masking

Subjects were assigned randomly to receive one intervention. Concealed allocation was done with a computer-generated randomized table of numbers created by an external statistician. Individual and sequentially numbered index cards with the random assignment were prepared, folded, and placed in sealed opaque envelopes. A second researcher opened the envelope and proceeded with subject allocation. All outcomes were assessed by another investigator who was blinded to group assignment.

Dry Needling Procedure

All participants received TrP-DN to an active TrP in the infraspinatus muscle by a physical therapist with 10 years of experience with this procedure. TrP diagnosis and TrP-DN was applied by the same clinician in all participants. Because the infraspinatus muscle can exhibit multiple active TrPs [27], a clinical/pragmatic approach was applied. If multiple active TrPs were found, the clinician selected the most painful to receive TrP-DN. Once the TrP was located, the skin was cleaned with alcohol. Participants received TrP-DN with disposable stainless-steel needles of 0.32 × 40 mm (Novasan, Madrid, Spain) that were inserted into the skin over the TrP and advanced into the muscle by use of the fast-in and fast-out technique described by Hong [28] until a local twitch response was obtained. The depth of the needle typically ranged from 10 to 15 mm. depending on the muscle thickness (Figure 1). Once the first local twitch response was obtained, the needle was moved up and down (3- to 5-mm vertical motions, no rotations) until no more local twitch responses were elicited [28]. On removal of the needle, the area was compressed firmly with a cotton bud for approximately 1 minute.

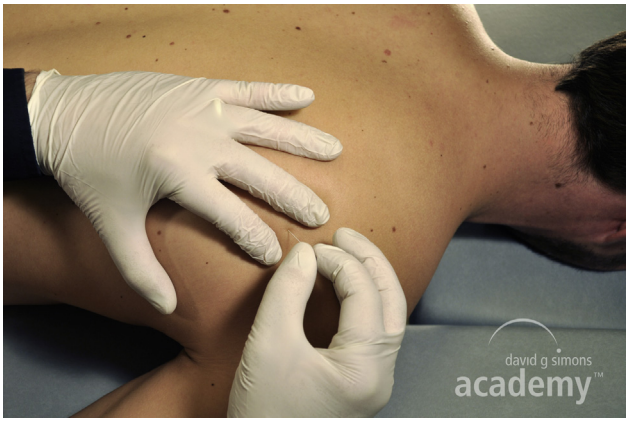

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Figure 1. Dry needling on active trigger points in the infraspinatus muscle. Copyright David G. Simons Academy, Switzerland, with permission.

Postneedling Interventions

Participants assigned to the experimental group received a session of low-load exercise of the shoulder musculature that focused on the infraspinatus muscle with the patient supine. One set of 12 repetitions was conducted. Each repetition included a self-paced concentric phase, followed by a very slow and controlled eccentric phase lasting about 5 seconds (Figure 2). A medium-resistance TheraBand (TheraBand, Akron, OH) was used for conducting low-load pain-free contraction. Individuals assigned to the placebo group received 10 minutes of detuned (inactive) ultrasound on the area receiving the TrP-DN on the infraspinatus muscle. Finally, those assigned to the control group did not receive any intervention and they were asked to rest on the table for 10 minutes.

Outcome Measures

The primary outcome included the intensity of postneedling-induced pain with an 11-point NPRS (0: no pain; 10: maximum pain) [29]. It was defined as

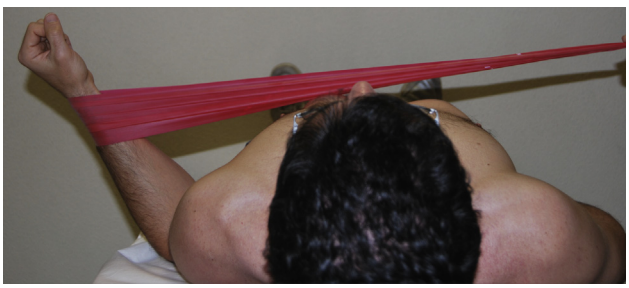

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Figure 2. Exercise of the shoulder musculature focusing on the infraspinatus muscle.

tenderness and/or pain perceived around the TrP receiving the dry needling procedure. Postneedling-induced pain was assessed before the postneedling intervention (baseline), 2 minutes (immediately post-needling), and 24, 48, and 72 hours after the post-needling intervention by an assessor blinded to the subject's allocation.

Secondary outcomes included shoulder pain and disability and were assessed before TrP-DN and 72 hours after the intervention. A separate 11-point NPRS (0-10) was used to assess the patients' current level of shoulder pain. Mintken et al [30] reported that the minimal clinically important difference (MCID) for the NPRS in individuals with shoulder pain is 1.1 points. Participants were asked to differentiate between their shoulder pain and TrP-DN—induced pain.

Shoulder-related disability was assessed with the most commonly used questionnaires [31]: the Disabilities of the Arm, Shoulder and Hand (DASH) and Shoulder Pain and Disability Index (SPADI). The DASH is a 30-item questionnaire assessing (1) degree of difficulty the preceding week in performing physical activities because of upper extremity problems (21 items); (2) severity of each symptom, activity-related pain, tingling, weakness, and stiffness (5 items); and (3) the effect of shoulder pain on social activities, work, and sleep and its psychological impact (4 items) [32]. Each item is answered on a 5-points scale ranging from 1 (no difficulty to perform, no symptoms, or no impact) to 5 (unable to do, severe symptoms, or high impact). Responses are summed to form a raw score that is converted to a 0 to 100 score, in which a greater score reflects greater disability. The Spanish version of the DASH has shown high internal consistency (Cronbach α: 0.96) and excellent test-retest reliability (r: 0.96) [33]. It recently has been reported that the MCID for the DASH is 10.81 points [34].

The SPADI is a 13-items shoulder function index assessing pain and disability related to shoulder dysfunction [35]. Each item is scored by a NPRS ranging from 0 (no pain/no difficulty) to 10 (worst pain imaginable/so difficult it required help). The total score ranges from 0 to 100 points, in which a greater score indicates greater disability. The Spanish version of the SPADI has exhibited high internal consistency (Cronbach α: 0.916) and excellent test-retest reliability (intraclass correlation coefficient: 0.91) [36]. It has been reported recently that MCID for the SPADI ranges from 8 to 13 points [37].

Sample Size Determination

The sample size was calculated with Ene 3.0 software (Autonomic University of Barcelona, Barcelona, Spain). The calculations were based on detecting differences of 1.1 points (the MCID) [30] in the primary outcome (postneedling-induced pain) at follow-up, assuming a standard deviation (SD) of 1.35, a 2-tailed test, an alpha level (α) of .05, and a desired power (β) of 80%. The estimated desired sample size was calculated to be 25 individuals per group. Allowing for a 20% dropout rate, we recruited 30 subjects per group.

Statistical Analysis

Statistical analysis was performed using SPSS software, version 21.0 (Chicago, IL). Mean, SD, and 95% CI for each variable were calculated. The Kolmogorov-Smirnov test showed that all quantitative data showed a normal distribution ($P > .05$). Baseline data were compared among groups with one-way analysis of variance tests for continuous data and χ^2 tests of independence for categorical data. For the main outcome measure, a 5 $\times$ 3 mixed-model analysis of covariance (ANCOVA) with time (baseline and 2 minutes, 24 hours, 48 hours, and 72 hours after intervention) as the within-subjects factor, group (experimental, placebo, control) as the between-subjects factor, and gender as the covariate was used to determine the effect of each intervention on postneedling-induced pain. A 2 $\times$ 3 mixed model ANCOVA with time (before and 72 hours after TrP-DN) as the within-subjects factor, group (experimental, placebo, control) as the between-subjects factor, and gender as the covariate was used to determine the effects of TrP-DN on pain and disability. Gender was used as covariate because previous research suggests that women experience more postneedling soreness than men [38]. For each ANCOVA, the hypothesis of interest was the group $\times$ time interaction. Post hoc analyses were conducted with the Bonferroni test using a corrected alpha of .017 (3 independent-samples). Consistent with the intention to treat principle, all data were analyzed to the group that the participant was assigned.

Results

A total of 125 patients with shoulder pain were screened for eligibility criteria. Ninety patients (mean $\pm$ SD age: 35 $\pm$ 13 years; 52% female) satisfied the eligibility criteria, agreed to participate, and were randomized into experimental (n = 30), placebo (n = 30), or control (n = 30) group. The reasons for ineligibility are found in Figure 3. Baseline data among the groups were similar for all variables (Table 1).

Postneedling-Induced Pain

The 5 $\times$ 3 mixed-model ANCOVA revealed a significant group $\times$ time interaction ($P < .001$), with no effect of gender ($P = .54$), for changes in postneedling-induced

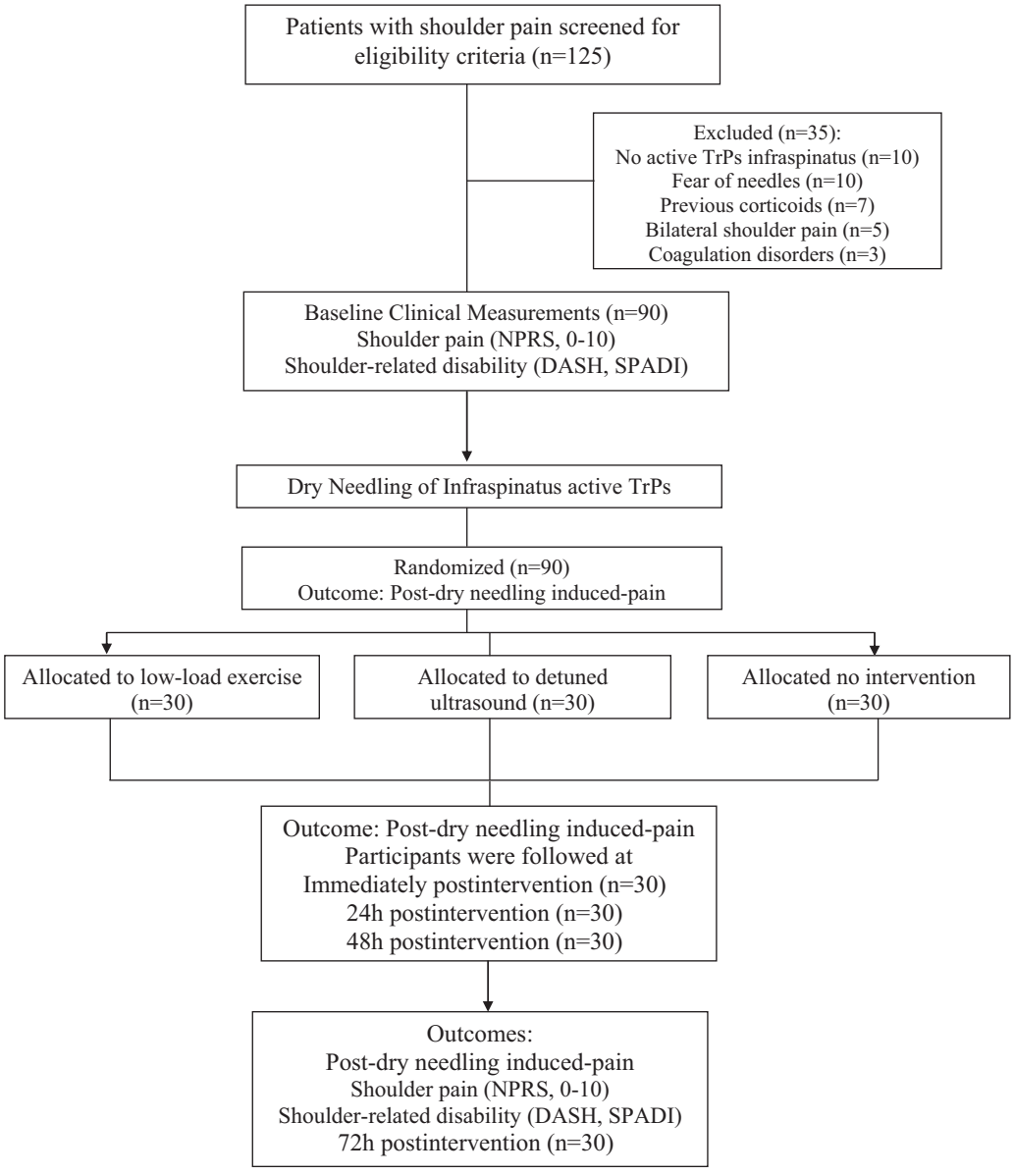

Figure 3. Flow diagram of patients throughout the course of the study. DASH, Disabilities of the Arm, Shoulder and Hand; NPRS, Numeric Pain Rating Scale; SPADI, Shoulder Pain and Disability Index; TrPs, trigger points.

pain. Post hoc analysis showed that the exercise group exhibited a greater decrease in postneedling-induced pain immediately after ($P = .001$), 24 hours after ($P = .001$), and 48 hours after ($P = .006$) than did the placebo or control groups (Figure 4). No significant differences were observed at 72 hours ($P = .03$). Table 2 provides the course of postneedling-induced pain in all groups.

Table 1
Baseline demographics and clinical data for the 3 groups*

	Eccentric Exercise (Experimental)	Detuned Ultrasound (Placebo)	No Intervention (Control)	F and *P* Values
Gender, male/female	14/16	12/18	17/13	$\chi^2 = 1.692$; $P = .429$
Age, y	35 ± 11	37 ± 14	34 ± 13	$F = 0.379$; $P = .686$
Duration of symptoms, mo	11.7 ± 3.7	11.0 ± 2.4	12.1 ± 2.8	$F = 0.363$; $P = .696$
Shoulder pain, 0-10†	6.7 ± 1.8	7.4 ± 1.6	7.0 ± 1.7	$F = 1.152$; $P = .321$
DASH, 0-100	32.4 ± 16.4	29.3 ± 20.1	34.2 ± 21.2	$F = 0.515$; $P = .599$
SPADI, 0-100	38.1 ± 20.4	37.6 ± 22.5	41.8 ± 19.9	$F = 0.369$; $P = .693$

DASH = Disabilities of the Arm, Shoulder and Hand; SPADI = Shoulder Pain and Disability Index.
* Data are mean ± SD except for gender.
† Measured with a 11-point numerical pain rate scale (0, no pain; 10, worst pain imaginable).

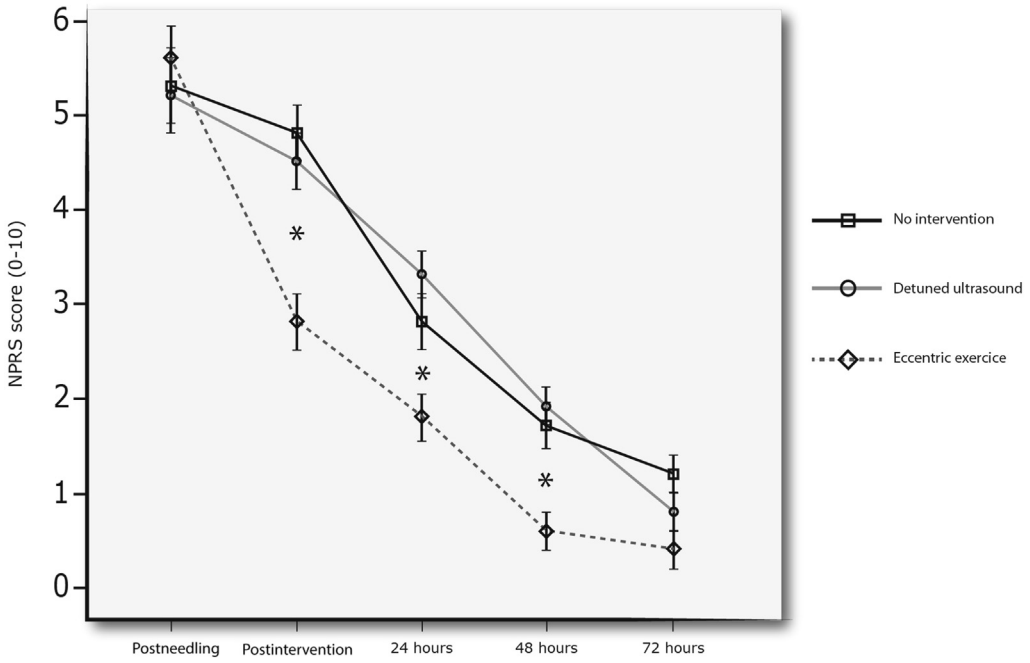

Figure 4. Course of post-dry needling—induced pain on an NPRS during the study. *Statistically significant differences between the exercise group and both placebo (detuned ultrasound) and control (no intervention) groups ($P < .01$). NPRS, Numerical Pain Rating Scale.

Shoulder Pain and Related Disability

The 2 × 3 mixed model ANCOVA did not reveal any statistically significant group × time interaction for shoulder pain ($P = .48$), DASH ($P = .75$), or SPADI ($P = .98$). However, there were main effects for time, with all groups reporting similar improvements in shoulder pain ($P < .001$), DASH ($P < .001$), and SPADI ($P < .001$) after TrP-DN. Gender did not influence the main effect for any outcome (pain: $P = .55$; DASH: $P = .84$; SPADI: $P = .72$). Table 3 provides baseline and 72-hour postintervention data as well as within-group differences with their 95% CI for shoulder pain and related disability.

Discussion

We found that application of 1 set of 12 repetitions of low-load contractions was more effective for reducing postneedling-induced pain from active TrPs in the infraspinatus muscle immediately after, 24 hours, and 48 hours after TrP-DN in subacromial pain syndrome than was placebo or control interventions. No differences were found in postneedling-induced pain 72 hours after TrP-DN between interventions. Likewise, there were no differences in pain or disability outcomes between the different interventions; rather, these outcomes improved to a similar degree regardless of the treatment group. Finally, gender did not influence the outcomes.

This is the first study investigating the effects of low-load exercise as a postneedling intervention in active TrPs. Previous studies investigating post-dry needling interventions were conducted on asymptomatic subjects exhibiting latent muscle TrPs [20,21]. Similar to previous studies, postneedling soreness was present in 100% of the individuals who received TrP-DN in our study. In contrast with previous studies, postneedling-induced pain did not completely disappear 72 hours after the needling procedure, although pain levels were relatively small. This can be related to the fact that previous studies investigated latent TrPs in asymptomatic people [20,21], whereas in our study we included symptomatic subjects with active muscle TrPs. Combing clinical experience and available scientific data, it seems that postneedling soreness tends to disappear 72 hours after the application of TrP-DN, without any

Table 2
Changes in post-dry needling—induced pain by group*

Group	Baseline	2 min After†	24 h After†	48 h After†	72 h After
Eccentric exercise	5.6 ± 1.5 (5.0-6.2)	2.8 ± 1.3 (2.1-3.6)	1.8 ± 1.2 (1.3-2.3)	0.6 ± 1.2 (0.1-1.2)	0.4 ± 0.9 (0.0-0.8)
Detuned ultrasound	5.2 ± 1.5 (4.5-5.8)	4.5 ± 2.1 (3.7-5.2)	3.3 ± 1.4 (2.7-3.8)	1.9 ± 2.0 (1.3-2.5)	0.8 ± 1.0 (0.4-1.2)
No intervention	5.3 ± 2.1 (4.5-5.8)	4.8 ± 2.4 (4.1-5.5)	2.8 ± 1.8 (2.3-3.4)	1.7 ± 1.7 (1.1-2.3)	1.2 ± 1.3 (0.8-1.6)

* Data are mean ± SD (95% confidence interval).
† Significant differences between the eccentric exercise and detuned ultrasound/no intervention groups (analysis of covariance; $P < .01$).

Table 3
Preintervention, postintervention, and within-group change scores for shoulder pain and related disability*

	Eccentric Exercise (Experimental)		Detuned Ultrasound (Placebo)		No Intervention (Control)	
	Baseline	72 h Postintervention	Baseline	72 h Postintervention	Prebaseline	72 h Postintervention
Shoulder pain (0-10)†	6.7 ± 1.8	3.2 ± 2.4	7.4 ± 1.6	3.7 ± 2.6	7.0 ± 1.7	4.0 ± 2.2
Within-group change scores	3.5 (2.7-4.4)		3.7 (2.5-4.8)		3.0 (2.3-3.6)	
Shoulder related-disability						
DASH (0-100)	32.4 ± 16.4	11.4 ± 8.6	29.3 ± 20.1	11.2 ± 7.0	34.2 ± 21.2	14.1 ± 11.6
Within-group change scores	21.0 (15.8-26.2)		18.1 (11.8-24.2)		20.1 (13.9-26.4)	
SPADI (0-100)	38.1 ± 20.4	11.0 ± 8.3	37.6 ± 22.5	11.2 ± 8.6	41.8 ± 19.9	15.5 ± 12.1
Within-group change scores	27.1 (19.7-34.3)		26.4 (19.7-33.2)		26.3 (20.5-32.3)	

DASH = Disabilities of the Arm, Shoulder and Hand; SPADI = Shoulder Pain and Disability Index.
* Data are means ± SD for preintervention and immediate postintervention and as means (95% confidence interval) for within-group change scores.
† Measured with a 11-point numerical pain rate scale (0, no pain; 10, worst pain imaginable).

postneedling intervention. Nevertheless, short-term reduction of postneedling-induced pain may be important for the patient's perception of recovery because those individuals experiencing strong postneedling soreness may refuse to receive further needling treatment [39].

We observed that individuals receiving low-load exercise after TrP-DN exhibited a larger decrease in postneedling-induced pain than those receiving detuned ultrasound or those who did not receive any intervention. Between-group change scores surpassed the MCID for the main outcome [30] in favor of the exercise group immediately after, 24 hours, and 48 hours after; however, clinical relevance of the observed changes should be considered with caution, because the lower bound of the 95% CI for between-groups change scores was equal to the MCID in some patients. In fact, the greatest postneedling pain reduction after exercise was observed immediately after the intervention (2.8, 95% CI 2.1-3.5), surpassing the MCID of 1.1 points to be considered as a clinically significant change in patients with shoulder pain [30]. It is interesting to note that the reduction in post-dry needling—induced pain observed after exercise in our study was similar to those previously observed with the application of spray and stretch or ischemic compression in latent TrPs in the upper trapezius muscle [20,21]. We do not know the effects of these last 2 techniques on postneedling soreness in active TrPs.

In addition, there were no differences between women and men in the reduction of postneedling-induced pain after either intervention. A recent study found that women reported significantly greater intensity of postneedling soreness than men immediately after needling, 5 minutes after, and 12 hours after needling of latent TrPs in the upper trapezius; however, this study did not investigate gender differences on the response to any intervention after the needling procedure [38]. Our study suggests that no differences exist in the response to interventions applied for decreasing postneedling-induced pain between women and men with active TrPs. Further studies are required to determine whether other gender differences exist.

Finally, we also observed that, regardless of the postneedling intervention received, all groups experienced similar short-term improvements in shoulder pain and disability 72 hours after TrP-DN in the infraspinatus muscle. Within-groups change scores and their 95% CI surpassed the MCID for pain [30] and related-disability [34,37]. This suggests a potential clinical finding because the decreases in postneedling-induced pain were associated with improvement in shoulder pain and disability. Therefore, it is possible that TrP-DN maybe effective for the management of individuals with subacromial pain syndrome; however, the lack of a control group not receiving TrP-DN does not permit us to determine the effectiveness of the intervention. Future randomized clinical trials investigating the effectiveness of TrP-DN in the shoulder musculature should clarify this hypothesis.

The results of the current study should be considered according to some limitations. First, only one active TrP received the needling intervention; therefore, we do not know whether the same results would be obtained if a greater number of active TrPs in the same muscle or different muscles receive the needling intervention. Second, multicenter studies would help to better generalization of the results. Third, patients were not blinded to the postneedling intervention because it is difficult to perform a sham exercise. Finally, we did not consider the role of psychological variables, eg, depression, anxiety, mood, or somatization.

Conclusions

This study found that application of a low-load exercise was effective for reducing postneedling-induced pain on active TrPs in the infraspinatus muscle immediately after, 24 hours, and 48 hours, but not 72 hours, after the intervention in people with subacromial pain syndrome. No gender differences were observed. The

application of any intervention after TrP-DN did not influence short-term shoulder pain and related-disability outcomes.

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Disclosure

J.S.-M. Department of Physical Therapy, Occupational Therapy, Rehabilitation and Physical Medicine and Cátedra de Investigación y Docencia en Fisioterapia, Terapia Manual y Punción Seca, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain
Disclosure: nothing to disclose

L.J.-G. Department of Physical Therapy, Occupational Therapy, Rehabilitation and Physical Medicine, Universidad Rey Juan Carlos, Alcorcón, Spain
Disclosure: nothing to disclose

V.G.-A. Department of Physical Therapy, Occupational Therapy, Rehabilitation and Physical Medicine, Universidad Rey Juan Carlos, Alcorcón, Spain
Disclosure: nothing to disclose

M.P.-C. Department of Physical Therapy, Occupational Therapy, Rehabilitation and Physical Medicine and Cátedra de Investigación y Docencia en Fisioterapia, Terapia Manual y Punción Seca, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain
Disclosure: nothing to disclose

J.L.A.-B. Cátedra de Investigación y Docencia en Fisioterapia, Terapia Manual y Punción Seca, Universidad Rey Juan Carlos, Alcorcón, Madrid; Department of Physical Therapy, Universidad Francisco de Vitoria, Madrid, Spain
Disclosure: nothing to disclose

S.L.K. U.S. Army-Baylor University Doctoral Program in Physical Therapy, San Antonio, TX
Disclosure: nothing to disclose

C.F.-d.-l.-P. Department of Physical Therapy, Occupational Therapy, Rehabilitation and Physical Medicine and Cátedra de Investigación y Docencia en Fisioterapia, Terapia Manual y Punción Seca, Facultad de Ciencias de la Salud, Universidad Rey Juan Carlos, Avenida de Atenas s/n, 28922 Alcorcón, Madrid, Spain. Address correspondence to: C.F.d.l.P.; e-mail: cesar.fernandez@urjc.es
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