



ORIGINAL SCIENTIFIC ARTICLE

ACUTE EFFECTS OF DRY NEEDLING ON LOWER LIMB MUSCLE STRENGTH IN CROSSFIT ATHLETES WITH LATENT TRIGGER POINTS: A RANDOMIZED TRIPLE-BLINDED PILOT CLINICAL TRIAL

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Abstract

Study purpose. The purpose of this study was to evaluate the acute effect of deep dry needling (DP) on lower-limb muscle strength-related variables in CrossTraining recreational athletes with latent trigger point (TrP).

Materials and methods. A total of 19 healthy CrossFit®-trained males (27.8 [4.7] years; 79.8 [10.4] kg; 1.76 [0.07] cm) with myofascial TrP in quadriceps, gluteus or gastrocnemius muscles completed this repeated-measures triple-blind pilot clinical trial. Participants were randomly allocated into either experimental (EG, n = 10) or Sham (SG, n = 9) groups. After allocation, the assessment of lower-limb muscle power (squat jump [SJ] and countermovement jump [CMJ]) and maximal isometric hip abduction and quadriceps strength were measured at baseline and after 48 hours of the intervention.

Results. The results are expressed as Δ (SD) [95% CI]; unbiased Cohen's d [d_{unb} , 95% CI]). DN has been shown to reduce the presence of muscle TrP. The maximal isometric hip abduction strength had a moderate-to-high significant increase in the EG (left: 21.5 (16.9) [9.42, 33.57]; 0.55 [0.19, 0.99], right: 20.3 (16.2) [8.70, 31.89]; 0.74 [0.25, 1.35]); however, the Sham group only showed significant improvement in the left hip abductor muscles 15.77 (15.37) [3.96, 27.59]; 0.57 [0.11, 1.12]) with no significant changes in the right side.

Conclusions. The acute reduction of myofascial TrP was observed with the application of DN but had no significant effect on maximal isometric strength or jump height compared to the Sham group. Results of this pilot clinical trial can be used to commission future research.

Keywords: dry needling, muscle strength, trigger point, trigger area.

Introduction

CrossTraining is a high-intensity functional training modality, which has had a fast growth worldwide with CrossFit® as the most popular registered trademark (with presence in 142 countries and more than 10,000 affiliates) (Claudino et al., 2018). This discipline is characterized by the execution of high-intensity interval training (HIIT) with external loads or the body mass itself, so that physical performance depends largely on the ability to generate

muscle strength (Claudino et al., 2018). Although no direct data have been reported on the prevalence of myofascial pain syndrome in CrossTraining, de Almeida et al. (2019) suggested that this modality might evoke in myofascial pain syndrome which is associated to CrossFit®-related spinal injuries (de Almeida, Carvalho, & Ribeiro Neto, 2019). This makes sense considering the moderate prevalence of this condition in Spinal Disorders (Chiarotto, Clijsen, Fernandez-de-Las-Penas, & Barbero, 2016) and in neck and shoulder-related disorders (Ribeiro et al., 2018).

Myofascial pain syndrome is characterized by symptoms and signs generated by trigger points (TrP) in the body including muscle pain (referred pain), decreased range of mo-

tion, uncoordinated movements (changes in motor patterns), muscle fatigue, delayed muscle relaxation and recovery, and spasms (de las Peñas, 2013). TrP are discrete, focal, hyperirritable spots located in a taut band of skeletal muscle that may be spontaneously painful (i.e., active) or only painful with compression (Shah et al., 2015). The prevalence of myofascial pain syndrome, and TrP, is high among physically active individuals and athletes (Fett, Trompeter, & Platen, 2019; Hidalgo-Lozano et al., 2013; Noormohammadpour, Farahbakhsh, Farahbakhsh, Rostami, & Kordi, 2018; Skootsky, Jaeger, & Oye, 1989) with significant differences of the anatomical distribution according to the sport discipline (Park et al., 2010). This has been associated to changes in muscle status including alterations on intracellular Ca²⁺ levels, reactive oxygen species production, and decline in force production (Jafri, 2014).

Evidence of low to moderate quality suggests that dry needling (DN) can be an effective strategy for eliminating myofascial TrP (Mayoral del Moral, 2005). In fact, having latent TrP has been shown to generate strength losses while their treatment and elimination have shown an increase in strength levels (Calvo-Lobo, Pacheco-da-Costa, & Hita-Herranz, 2017; Cubukcu, Alimoglu, Samanci, & Gurbuz, 2007; Lisinski & Huber, 2017). Notwithstanding, evidence is not clear in this regard (Espejo-Antúnez et al., 2017) and more high-quality clinical studies are needed (Gattie, Cleland, & Snodgrass, 2017). Some authors have even suggested that this practice may be detrimental to strength because of the pain it causes (Prado, 2017). So far, most of the studies have been carried out on upper limbs and there is a need for further work with athletic population. Therefore, the aim of this study was to evaluate the acute effects of DN versus placebo (sham) on lower-limb muscle strength in CrossFitters with latent TrP.

Materials and methods

Trial design

This was a double-arm triple-blind (participants, the evaluator, and the data analyzer) and repeated-measures randomized pilot study in trained men. All outcome variables were assessed before and 48 hours after the DN intervention. This study is reported according to the Consolidated Standards of Reporting Trials (CONSORT) extension to pilot and feasibility trials (Eldridge et al., 2016).

Participants

Healthy Colombian male CrossFitters attending to the physical fitness center 'Soy Hakuna' (Envigado, Antioquia), with latent TrP in gluteal, quadriceps and gastrocnemius muscles (diagnosed by palpation) were potentially eligible to participate in this clinical trial. Participants were recruited on a voluntary basis, and all signed an informed consent form to be randomly assigned to either the experimental (EG: dry needling) or placebo (Sham) groups. In the consent, detailed information was given about the aim of the study, the measurements to be made, the conditions (comfortable clothing and features of the anthropometric assessment), and the approximate duration of the evaluation. All procedures were conducted in accordance with the ethical guidelines of the Declaration of Helsinki. Compliance with the stipulations of the Ministry of Social Protection in Resolution 8430 of

1993 was guaranteed and the study protocol was approved by the Institutional Review Board at Universidad de Antioquia (Act N°059, September 12th, 2019).

The inclusion criteria were as follows: a) to have at least ≥1 year experience in CrossTraining; b) to reside in Medellín or its metropolitan area (including Envigado); c) to have agreed to participate in the study by signing the informed consent form; d) to have a Colombian health system affiliation; e) to have latent TrP in quadriceps, gluteal and gastrocnemius muscles. Additionally, the following were considered as exclusion criteria: a) consumption of psychoactive substances; b) suffering from acute or chronic injuries; c) use of performance and image-enhancing drugs; d) consumption of drugs; e) diagnosed with chronic diseases (e.g., diabetes, hypertension); f) excessive alcohol consumption; g) surgery or operation during the same month of the interventions; h) non-attendance to the baseline assessment.

Dry Needling Intervention

A DN intervention was performed by a physiotherapist expert in this technique. After finding the latent TrP in each quadriceps, gluteus and gastrocnemius, the subjects in both groups underwent a DN or Sham session. Following previously published procedures (Tasoglu, Sahin Onat, Boluk, Tasoglu, & Ozgirgin, 2017), the patient's anatomical location was cleaned with alcohol for asepsis and with 0.40 x 0.25 mm needles a direct deep DN puncture was performed on the latent TrP (EG). This technique has been shown to be effective for the improvement in acute pain in myofascial pain syndrome patients (Yehoshua, Rimon, Mizrahi Reuveni, Peleg, & Adler, 2022), however, this is the case with placebo or sham, but the evidence is of low to moderate quality. A similar procedure was performed on the Sham group subjects but without inserting the needle into the skin after the guide was placed. The intervention took 15 minutes with each athlete and was performed in May 2020.

Outcomes

Dependent variables were strength-related variables: i) lower-limb muscle power through countermovement and squat jump tests; and ii) maximal isometric hip abduction and quadriceps strength. All variables were measured after a 5-min warm up that consisted of four rounds of 30 seconds plank, 10 elbow flexion-extensions, prone cubitus, 10 deep squats with the hands behind the head.

Myofascial trigger points

The physiotherapist performed the evaluation of latent TrP in the quadriceps, gluteal and gastrocnemius muscles using flat palpation or pincer grip techniques according to the diagnostic criteria (the presence of a taut band, the presence of a tender spot during palpation, and the reproduction of referred pain during compression) previously published (Rozenfeld, Strinkovsky, Finestone, & Kalichman, 2021). As a clinical criterion, a participant's improvement was determined when at least three latent TrP decreased after the intervention. Rozenfeld et al. reported that the palpation of myofascial TrP is a moderately reliable diagnostic tool in the hip and thigh muscles and can be used

in clinical research (Rozenfeld, Finestone, Moran, Damri, & Kalichman, 2017).

Lower-limb muscle power

Squat jump (SJ) and countermovement jump (CMJ) tests were performed. The assessment protocol was carried out after the 3-min warm-up described previously. Participants performed two attempts for each jump test with a 1-min rest interval between attempts following laboratory procedures reported in previous articles published by our research group (Bonilla et al., 2021; Vargas-Molina et al., 2022). The tests were performed on a jump mat DIN-A2 Chronojump (Boscosystem®, Spain). This device has been previously reported to be reliable and valid for measuring vertical jump height (Pueo, Penichet-Tomas, & Jimenez-Olmedo, 2020). The highest jump of the two attempts (in centimeters) was used for statistical analysis using the manufacturer open-source software <https://chronojump.org/es/programa/>.

Maximal isometric muscle strength

A strain-gauge force sensor kit (Chronojump, Boscosystem®, Spain) was used to measure muscle strength. The characteristics of the force sensor include a maximal capacity of 500 kg, output impedance $350 \pm 3 \Omega$, insulation resistance of $>2000 \text{ M}\Omega$ and input impedance of $365 \pm 5 \Omega$. Three minutes after the athlete performed the jump tests, the maximal isometric hip abduction strength was measured with the subject side lying (Figure 1). For the evaluation of maximal isometric quadriceps strength, the subject was seated in position for a 90° knee extension (Figure 2).

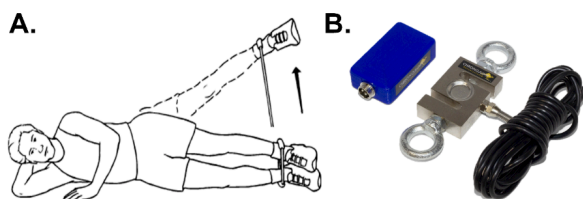


Fig. 1. Assessment of the maximal isometric hip abduction strength. A. Participants were instructed to raise top leg keeping knee straight while were side lying with a band around ankles. Source: Taken from Iris Hattiesburg Clinic at shorturl.at/aoPW8 (Accessed on 5 February 2023) under copyright and owned by VHI Healthcare. B. The band was attached to a force sensor able to record the maximal isometric strength in real time. Source: Taken from Chronojump Bosco System® at <https://chronojump.org/product/force-sensor-kit-able-to-add-accessories/> (Accessed on 5 February 2023)

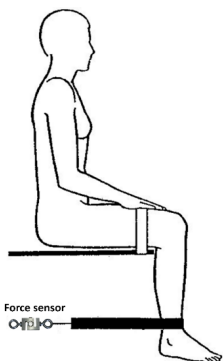


Fig. 2. Assessment of the maximal isometric quadriceps strength. Taken and modified from Stoll, Huber, Seifert, Michel, and Stucki (2000)

The following were taken into account to consider a valid measurement: a) the gauge straps had a standard distance, so that the length did not vary in either the pretest or posttest; b) in knee extension, the free leg did not touch the floor; c) in knee extension, the entire back was supported on the backrest; d) the test was performed with each limb; e) in both tests, dorsiflexion was allowed while performing the movement; and f) the participant started by applying a small force and then increased to the greatest amount of force possible. Data were collected in Newton using the free software provided by the manufacturer.

Sample size

Due to the lack of similar studies, a sample size of 10 patients in each group was considered suitable for this pilot study. Therefore, non-probability sampling (convenience sampling) was implemented. After the call to participate in this study, 20 subjects were suitable for eligibility from the available population (i.e., Cross-trained men attending the fitness and strength conditioning center 'Soy Hakuna' located in Envigado, Colombia).

Randomization

The subjects were randomly assigned to the EG and Sham groups using the permuted block technique within the Epidat statistical software (the evaluator did not have access to this information). This randomization was intended to ensure the balance of the groups from the beginning of the investigation. After group assignment, all participants were contacted and notified of the group to which each one had been assigned.

Blinding

This was a triple blind study. In the evaluation protocols, the examiners that performed pre- and post-test measurements did not know which group the participants belonged to while the researcher in charge of the interventions did not have access to the evaluations; therefore, the investigator in charge of analyzing the data was blinded. The participants were also blinded, as none of them knew to which group they belonged (groups were named as A and B) so that all participants thought they were performing the same intervention. In the end, there were three blind processes: i) participants, ii) evaluators, iii) researcher who analyzed the data.

Bias

Valid and reliable instruments were used to control for reporting bias. Moreover, all participants were subjected to the same measurement protocol and the evaluators were trained for these measurements. To control confounding variables, such as diet, sleep and motivation, the following recommendations were made: a) subjects should follow their normal diet; b) subjects should sleep at least seven hours a day during the days of the study; c) they should not perform strength training.

Statistical Analysis

The descriptive statistics are expressed as mean and standard deviation (SD). A fourfold contingency table was used

to represent the set of improvement counts of the latent TrP in relation to DN versus Sham using the online free software OpenEpi (www.openepi.com). Based on current recommendations to improve data analysis practices (Martin & Teste, 2022), we implemented an estimation approach following analytical procedures reported in previous articles published by the DBSS Research Division (Bonilla, Kreider et al., 2021; Bonilla, Méndez et al., 2021). Thus, to determine statistical significance, we examined the 95% CIs for the difference between the mean change scores ($\Delta = \text{post} - \text{pre}$). If the 95% CI excludes zero, the difference will attain significance at the $p < 0.05$ level. Effect size was calculated as unbiased Cohen's d (dunb), considering a result of ≤ 0.2 as a small, 0.5 as a moderate, ≥ 0.8 as a large effect, and ≥ 1.30 as a very large effect (Rosenthal, 1996). Estimation plots were generated to display the repeated measures data across two time points (at baseline and after eight weeks). A difference-in-differences (Diff-in-Diff) analysis was performed to compare changes in the outcome variables between the groups (Cumming, 2013).

Results

A total of 20 participants were potentially eligible; however, one man of the Sham group did not show up for the baseline assessment session and was, therefore, excluded

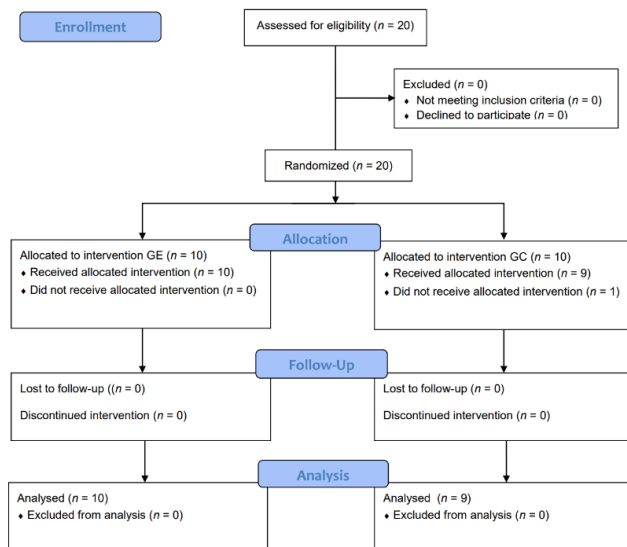


Fig. 3. CONSORT flow diagram

Table 2. Test-retest reliability

	ICC	LL	UL	Mean	CV (%)	SWC	SWC (%)
CMJ	0.99	0.97	0.99	41.10	2.61	2.97	7.22
SJ	0.95	0.89	0.98	37.20	1.03	1.06	2.85
MVC Hip-L	0.87	0.76	0.94	140.30	0.15	0.59	0.42
MVC Hip-R	0.88	0.96	0.99	145.20	0.89	3.59	2.47
MVC Knee-L	0.94	0.87	0.97	407.30	0.06	0.64	0.16
MVC Knee-R	0.98	0.79	0.95	401.40	0.05	0.56	0.14

CMJ: countermovement jump; ICC: intraclass correlation coefficient; LL: lower limit; MVC Hip-L: maximum voluntary contract in left hip abduction; MVC Hip-R: maximum voluntary contract in right hip abduction; MVC Knee-L: maximum voluntary contract in left knee extension; MVC Knee-R: maximum voluntary contract in right knee extension; SJ: Squat jump; SWE: smallest worthwhile change; UL: upper limit

Table 1. Descriptive information of participants at baseline

	EG (n = 10)	Sham (n = 9)	p
BM, kg	78.4 (6.54) [70, 92]	81.2 (6.74) [69, 91]	0.420
Stature, cm	176 (7.06) [165, 190]	177 (5.78) [165, 186]	0.647
BMI, kg/m ²	25.4 (1.35) [23.3, 28.4]	25.9 (1.17) [24.1, 28.1]	0.421
SJ, cm	37.3 (4.41) [31.9, 44.4]	36.1 (4.81) [28.1, 44.4]	0.606
CMJ, cm	41.1 (3.91) [33.9, 47.2]	41.4 (4.92) [36.5, 51.1]	0.864
MVC Hip-L, N	148 (31) [102, 196]	135 (24.7) [98, 171]	0.318
MVC Hip-R, N	154 (26.1) [120, 192]	139 (24.9) [101, 174]	0.235
MVC Knee-L, N	406 (83.6) [312, 539]	412 (83) [279, 579]	0.892
MVC Knee-R, N	387 (90.3) [253, 520]	435 (77.5) [309, 560]	0.234

Data is presented as mean (standard deviation) [95% confidence interval]. BM: body mass in kg; BMI: body mass index; CMJ: countermovement jump; LL: lower limit; MVC Hip-L: maximum voluntary contract in left hip abduction; MVC Hip-R: maximum voluntary contract in right hip abduction; MVC Knee-L: maximum voluntary contract in left knee extension; MVC Knee-R: maximum voluntary contract in right knee extension; N: newtons; SJ: Squat jump. A two-tailed p value for testing the null hypothesis of no difference between the two group means is reported

from the study. The rest of the participants attended and complied with the intervention without attrition (Figure 3).

Table 1 presents a descriptive analysis of the sample of participants at baseline without significant differences between EG and Sham groups while Table 2 shows the reliability of the tests that were performed.

The results of all variables are expressed as Δ (SD) [95% CI]; dunb [95% CI] and presented in Table 3. After post-test assessments, there were no significant differences in SJ, CMJ and the maximal isometric quadriceps (right and left) strength compared to baseline measures in any group. The maximal isometric hip abduction strength had a moderate-to-high significant increase in the EG (left: 21.5 (16.88) [9.42, 33.57]; 0.55 [0.19, 0.99], right: 20.3 (16.2) [8.70, 31.89]; 0.74 [0.25, 1.35]); however, the Sham group only showed statistically significant improvement in the left hip abductor muscles (15.77 (15.37) [3.96, 27.59]; 0.57 [0.11, 1.12]) with no changes on the right side (5.45 (14.51) [-5.70, 16.61]; 0.18 [-0.17, 0.57]).

Table 3. Pre- and post-intervention data on the study variables

Variable	Group	Pretest	Posttest	Δ	d_{unb}
		Mean (SD)	Mean (SD)	Mean(SD) [95% CI]	δ [95% CI]
SJ (cm)	EG	37.25 (4.40)	37.48 (3.12)	0.23 (3.27) [-2.10, 2.57]	0.05 [-0.47, 0.59]
	Sham	36.13 (4.81)	36.48 (4.32)	0.35 (5.40) [-3.80, 4.50]	0.06 [-0.69, 0.84]
CMJ (cm)	EG	41.08 (3.90)	41.20 (4.17)	0.12 (2.13) [-1.39, 1.64]	0.02 [-0.29, 0.35]
	Sham	41.43 (4.91)	39.60 (4.85)	-1.82(4.67) [-5.42,1.76]	-0.33 [-1.01, 0.28]
MVC Hip-L	EG	148.2 (30.965)	169.7 (39.79)	21.5 (16.88) [9.42, 33.57] *	0.55 [0.19, 0.99]
	Sham	134.89 (24.68)	150.67 (25.30)	15.77 (15.37) [3.96, 27.59] *	0.57 [0.11, 1.12]
MVC Hip-R	EG	153.8 (26.12)	174.1 (23.58)	20.3 (16.20) [8.70, 31.89] *	0.74 [0.25, 1.35]
	Sham	139.33 (24.89)	144.79 (27.58)	5.45 (14.51) [-5.70, 16.61]	0.18 [-0.17, 0.57]
MVC Knee-L	EG	406.3 (83.58)	454.7 (116.39)	48.4 (85.80) [-12.98, 109.78]	0.43 [-0.10, 1.03]
	Sham	411.56 (83.03)	462.89 (101.6)	51.33 (91.89) [-19.30, 121.97]	0.49 [-0.16, 1.23]
MVC Knee-R	EG	386.7 (90.25)	398.4 (110.2)	11.7 (84.02) [-48.40, 71.70]	0.10 [-0.40, 0.63]
	Sham	434.67 (77.54)	443.33 (69.03)	8.66 (73.19) [-47.59, 64.92]	0.10 [-0.53, 0.76]

Data is presented as mean and standard deviation (SD). Δ : post-test – pre-test; d_{unb} , unbiased Cohen's d; CI, confidence interval; CMJ: countermovement jump; EG: experimental group; MVC Hip-L: maximum voluntary contract in left hip abduction; MVC Hip-R: maximum voluntary contract in right hip abduction; MVC Knee-L: maximum voluntary contract in left knee extension; MVC Knee-R: maximum voluntary contract in right knee extension; SJ: Squat jump. * Statistically significant change ($p < 0.05$)

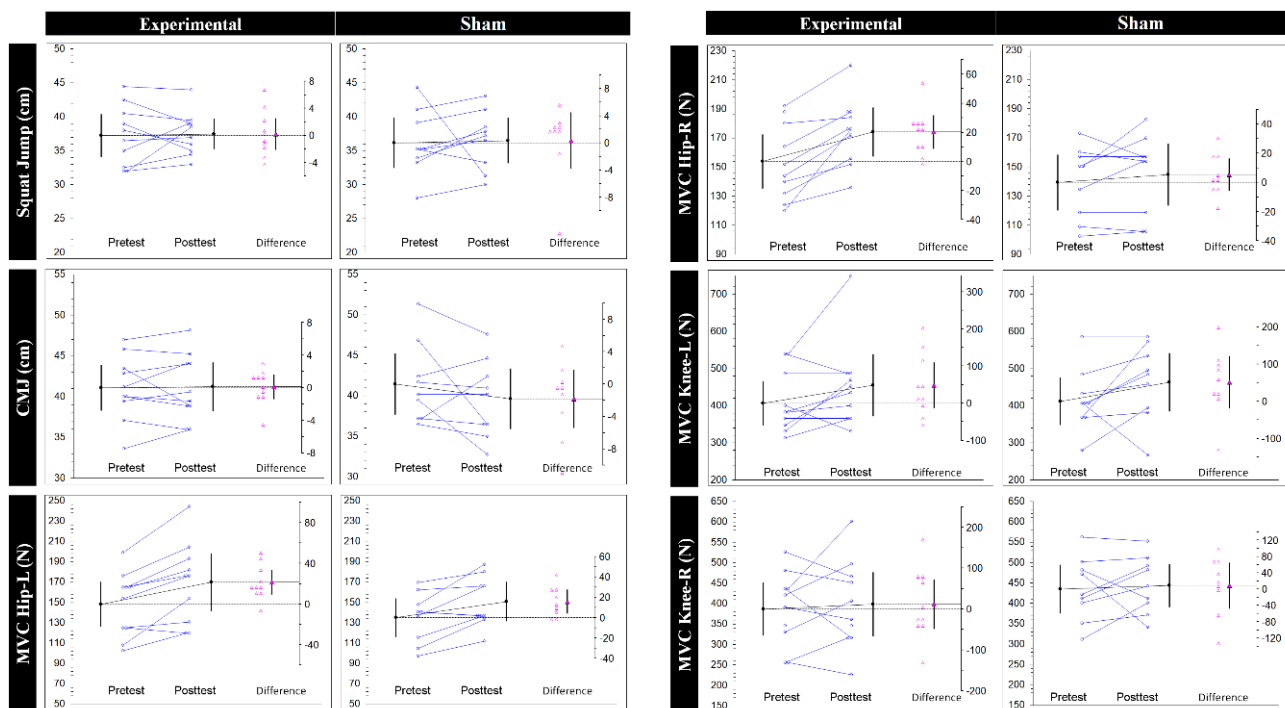


Fig. 4. Estimation plots showing pre- and post-intervention values on analyzed variables. Paired data from Experimental (left) and Sham (right) groups are shown as small circles joined by blue lines. The differences between the initial (pre) and final (post) means are plotted on a floating difference axis whose zero is aligned with the pre-test mean. The filled pink triangle marks the difference on that axis and the 95% CI on that difference is displayed. The differences are shown as open triangles on the difference axis. CMJ: countermovement jump; MVC Hip-L: maximum voluntary contract in left hip abduction; MVC Hip-R: maximum voluntary contract in right hip abduction; MVC Knee-L: maximum voluntary contract in left knee extension; MVC Knee-R: maximum voluntary contract in right knee extension; SJ: Squat jump

Figure 4 shows the Gardner Altman estimation plots of the variables that showed a significant pre-post difference in each group.

Although the analysis of the fourfold (2x2) contingency table with cases of success (pain improvement counts) showed a statistically significant association ($p < 0.05$)

Table 4. Statistical results of the fourfold (2x2) contingency table

	Dry needling	Sham	Total	
Success	9	1	10	
No success	1	8	9	
Total	10	9	19	
Risk-based* Estimates with confidence intervals at 95%				
Point Estimates		Confidence Intervals		
Type	Result	Lower	Upper	Type
Estimated risk in the exposed	90.0 %	57.41	100.0	Taylor series
Estimated risk in the nonexposed	11.11 %	0.0	45.67	Taylor series
Overall risk	52.63 %	31.7	72.67	Taylor series
Risk ratio	8.1	1.262	51.99	Taylor series
Risk difference	78.89 %	51.19	106.6	Taylor series
Etiologic Fraction in the Population	78.89 %	42.86	100	
Etiologic Fraction in the Exposed	87.65 %	20.75	98.08	
Odds-Based Estimates and Confidence Limits				
Point Estimates		Confidence Limits		
Type	Value	Lower, Upper		Type
CMLE Odds Ratio*	45.82	3.733, 1746 ¹		Mid-P Exact
		2.824, 3528 ¹		Fisher Exact
Odds Ratio	72	3.842, 1349 ¹		Taylor series
Etiologic fraction in pop.(EFp OR)	88.75%	67.67, 100		
Etiologic fraction in exposed(EFe OR)	98.61%	73.97, 99.93		

*Conditional maximum likelihood estimate of Odds Ratio. (P)indicates a one-tail P-value for Protective or negative association; otherwise, one-tailed exact P-values are for a positive association. ^o ¹ 95% confidence limits testing exclusion of 0 or 1, as indicated

between DR and the elimination of TrP (Table 4), there were no significant differences between the EG and Sham groups with regards to the change in selected strength variables. The results of this Diff-in-Diff analysis (DID [95% CI], p value) is reported in Table 5, Figure 5.

Table 5. Difference-in-differences analysis

Variable	Mean ($\Delta_2 - \Delta_1$)	DID	95% CI	p
SJ	0.35-0.23	0.11	-5.42, 5.65	0.96
CMJ	-1.82-0.12	-1.95	-7.84, 3.93	0.50
MVC Hip-L	15.77-21.5	-5.72	-46.79, 35.34	0.77
MVC Hip-R	5.45-20.3	14.84	-48.58, 18.89	0.37
MVC Knee-L	51.33-48.4	2.93	-125.7, 131.55	0.96
MVC Knee-R	8.66-11.7	-3.03	-120.5, 114.39	0.96

Difference of differences (DID) for EG (Δ_1) and Sham (Δ_2) groups. The p value is two-tailed for testing the null hypothesis of no difference between the two group means with statistical significance when $p < 0.05$.

Discussion

Considering that strength is a determining capacity for different sports modalities, including CrossTraining® (Dexheimer et al., 2019), this study aimed to evaluate for the

first time the acute effects of a DN intervention on lower-limb muscle power and maximal isometric hip abduction and quadriceps strength in trained CrossFitters with Latent TrP. Our main findings showed reduction of latent TrP in the quadriceps, gluteus, and gastrocnemius muscles when DN was performed, and DN was not observed to have any effect on lower-limb muscle power or maximal isometric quadriceps strength.

Similar to previous reports (Gattie et al., 2017), the DN intervention was able to clinically reduce the number of TrP; in fact, our results showed that a participant was 8.1 times more likely to decrease latent TrP when DN was performed than when it was not (table 4). These findings are in agreement with literature since DN has shown to be effective to reduce pain (Kamali, Sinaei, & Morovati, 2019; Khan, Ahmad, Ahmed, Sadiq, & Asim, 2021) and to possibly generate positive changes at the neuromuscular level (Ceballos-Laita et al., 2021; Perez-Bellmunt et al., 2021). It should be noted that potential improvements have also been described in hip or knee osteoarthritis (Jimenez-Del-Barrio et al., 2022), plantar heel pain or plantar fasciitis (Llurda-Almuzara et al., 2021) and post-stroke patients (Fernandez-de-Las-Penas et al., 2021).

The precise mechanisms that cause TrP in skeletal muscle, as well as the effects that NP has on them, are not fully understood. However, it is suggested that that TrP may arise due to a combination of several factors, including alterations in the excitation-contraction coupling mechanism of

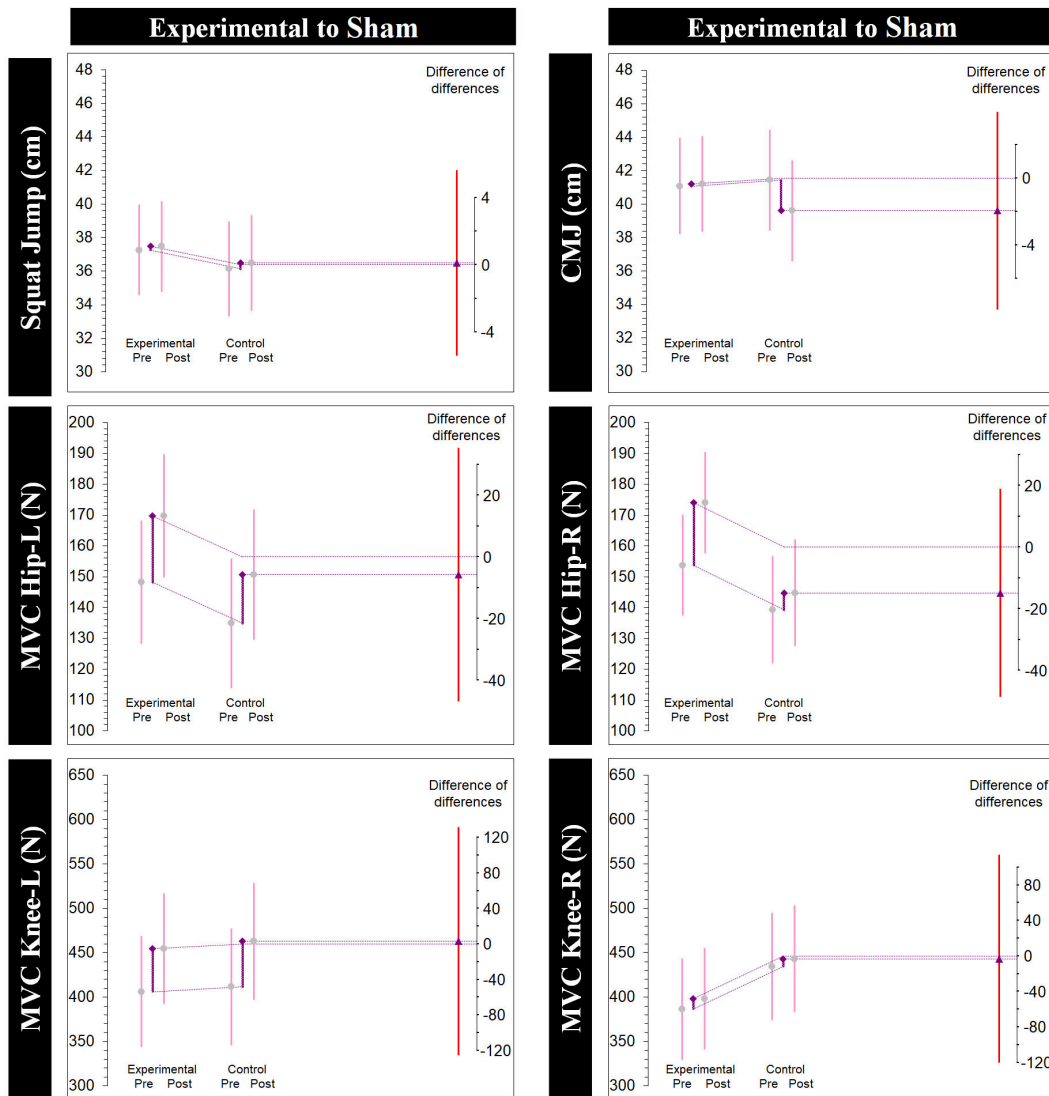


Fig. 5. Difference-in-difference estimation plots for all variables. This graphic shows the difference ($\Delta = \text{post-test} - \text{pre-test}$) of the differences, which is the calculation of the group means: Experimental ($\Delta 1$) and Sham ($\Delta 2$) groups on selected variables. The effect chosen for examination is displayed as the triangle, with its 95% CI, against a floating different axis. CMJ: countermovement jump; MVC Hip-L: maximum voluntary contract in left hip abduction; MVC Hip-R: maximum voluntary contract in right hip abduction; MVC Knee-L: maximum voluntary contract in left knee extension; MVC Knee-R: maximum voluntary contract in right knee extension; SJ: Squat jump

muscle fibers, elevated intracellular calcium concentrations, changes in intramyocellular pH, and inflammation (Perreault et al., 2022; Zhang et al., 2020). In this regard, Shah et al. (Shah, Phillips, Danoff, & Gerber, 2005) found through an *in vivo* microanalytical technique that levels of inflammatory mediators, such as tumor necrosis factor, bradykinin, substance P, interleukin-1, and norepinephrine, were significantly higher in active myofascial TrP compared with latent or absent myofascial TrP. In this context, DN may decrease the levels of some of these inflammatory molecules. For instance, Hsieh et al. (Hsieh, Yang, Liu, Chou, & Hong, 2014) showed that DN induced a reduction in substance P levels in rabbit muscles. These present results unveil plausible mechanisms of action of DN on TrP yet warrant further investigation in human trials. CrossTrainer-type

HIT can potentially serve as a suitable study model, given its considerable levels of workload demand.

On the other hand, our results showed that the elimination of TrP through a single session of DN did not significantly affect lower-limb muscle power (i.e., SJ or CMJ) or the maximal isometric quadriceps strength in CrossFitters. Interestingly, significant increases on maximal isometric hip strength for each limb (+13.1% right; +14.5% left) were only found in the EG with no differences when compared to the Sham group which improved solely the left-limb hip strength. Of note, Haser et al. (Haser et al., 2017) showed that elite soccer players who received a DN and water pressure massage intervention for 4 weeks had a significant effect on knee muscle strength (flexion and extension) and hip flexion range of motion compared to placebo (an

inactive laser device with water pressure massage) and the control group (no intervention).

Consistent with our results, Prado et al. (Prado, 2017) reported no benefits and even found a reduction in jump height after acute DN in apparently healthy men, likely due to changes in electromyographic activity that resulted in a negative impact on muscle strength. Likewise, a recent systematic review and meta-analysis (Mansfield et al., 2019), which included studies involving a diverse range of populations (e.g., different age ranges, healthy, injured, with and without surgery), who manifested TrP and received some form of dry-needling therapy, based on evidence of moderate to very low quality, that there is no discernible effect of DN on force production. However, since there have been few studies evaluating the effects of DN in athletic populations, more controlled clinical trials in this population are needed to establish the effects of DN on muscle strength and its possible mediating mechanisms.

It is important to note that although the results did not show a significant increase in muscle strength after DN, latent myofascial TrP were eliminated. This is relevant because several studies have shown that the presence of myofascial TrP may be related to a decrease in muscle strength. For example, Cubukcu et al. (Cubukcu et al., 2007) reported that the isokinetic and isometric strength levels of the knee flexors and extensors were lower in groups of women with fibromyalgia syndrome and chronic myofascial pain syndrome (who had the presence of TrP), compared to the control group. Similarly, it has been evidenced that older adults with myofascial TrP in the shoulder had lower levels of grip strength (Calvo-Lobo et al., 2017). In studies of patients with different cervical conditions, it was observed that the presence of myofascial pain decreased trapezius strength (Lisinski & Huber, 2017). Moreover, in healthy adults of both sexes, muscle strength for flexion and scaption was lower in subjects with TrP compared to healthy subjects (Celik & Yeldan, 2011). Nevertheless, other authors have concluded that the presence of latent myofascial TrP may not affect the upper-limb strength, at least in apparently healthy non-athletic women (Doraisamy & Anshul, 2011). Although these studies have a different focus than ours, such as the type of population, co-morbidities, and musculoskeletal disorders, they emphasize the negative relationship between myofascial TrP and decreased strength. However, the causal relationship between TrP and loss of strength, or whether strength is immediately restored by the reduction of TrP, is still unclear. In this sense, based on the mechanisms of TrP, it can be hypothesized that the elimination of TrP should increase force production because the muscle would be in a better physiological state for force generation (e.g., for excitation-contraction response, intracellular calcium management, and reduced inflammation).

Limitations

The limitations of this study were: a) the small sample size as a pilot clinical trial; b) the non-measurement of strength before having TrP; c) the diagnosis was performed by palpation and not a more objective one such as electromyography; d) only one DN intervention session was performed; and e) the study was conducted with a single post-test measurement.

Future directions

Considering the need to obtain a higher level of quality of evidence for the effects of DN on TrP and force production-related outcomes, more randomized clinical trials in athletic populations are required, incorporating a more robust assessment of TrP and muscle strength over the medium to long term. To achieve this, we propose a more sensitive assessment of myofascial TrP, using techniques such as electromyography, histochemical analysis, and/or micro-analytical methods. Additionally, since muscle strength is influenced by various variables, it should be evaluated considering aspects such as interaction with other factors (e.g., type of training, fatigue, fitness level), changes over time, and their impact on performance and health. This would not only enable us to analyze the efficacy of DN on TrP, but also determine whether these changes are directly or indirectly associated with force production.

Conclusions

Our results show that the application of DN has acute effects on the reduction of myofascial TrP in the quadriceps, gluteus, or gastrocnemius of recreational CrossFit athletes. However, we did not find any significant effects on maximal isometric strength during knee extension and hip abduction, nor on strength during CMJ and SJ jumps compared to the Sham group. Further controlled clinical trials are needed to evaluate the efficacy of DN on TrP and its relationship with muscle strength outcomes.

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Institutional Review Board Statement

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the University of Antioquia on 12 September 2019, act number 059.

Data Availability Statement

All data is available upon request.

Conflicts of Interest

The authors declare no conflicts of interest. All authors are responsible for the content of this article.

References

Claudino, J. G., Gabbett, T. J., Bourgeois, F., Souza, H. d. S., Miranda, R. C., Mezêncio, B., . . . Hernandez, A. J. (2018).

- CrossFit overview: systematic review and meta-analysis. *Sports medicine-open*, 4(1), 1-14.
- de Almeida, R. L., Carvalho, V. G., & Ribeiro Neto, F. (2019). In Response to: Impact of CrossFit-Related Spinal Injuries. *Clin J Sport Med*, 29(6), e87. <https://doi.org/10.1097/JSM.0000000000000583>
- Chiarotto, A., Clijsen, R., Fernandez-de-Las-Penas, C., & Barbero, M. (2016). Prevalence of Myofascial Trigger Points in Spinal Disorders: A Systematic Review and Meta-Analysis. *Archives of Physical Medicine and Rehabilitation*, 97(2), 316-337. <https://doi.org/10.1016/j.apmr.2015.09.021>
- Ribeiro, D. C., Belgrave, A., Naden, A., Fang, H., Matthews, P., & Parshottam, S. (2018). The prevalence of myofascial trigger points in neck and shoulder-related disorders: a systematic review of the literature. *BMC Musculoskeletal Disorders*, 19(1), 252. <https://doi.org/10.1186/s12891-018-2157-9>
- de las Peñas, C. F. (2013). *Punción seca de los puntos gatillo, Una estrategia clínica basada en la evidencia, 1: Punción seca de los puntos gatillo*: Elsevier Health Sciences.
- Shah, J. P., Thaker, N., Heimur, J., Aredo, J. V., Sikdar, S., & Gerber, L. (2015). Myofascial trigger points then and now: a historical and scientific perspective. *PM&R*, 7(7), 746-761.
- Fett, D., Trompeter, K., & Platen, P. (2019). Prevalence of back pain in a group of elite athletes exposed to repetitive overhead activity. *PLoS One*, 14(1), e0210429. <https://doi.org/10.1371/journal.pone.0210429>
- Hidalgo-Lozano, A., Fernandez-de-las-Penas, C., Calderon-Soto, C., Domingo-Camara, A., Madeleine, P., & Arroyo-Morales, M. (2013). Elite swimmers with and without unilateral shoulder pain: mechanical hyperalgesia and active/latent muscle trigger points in neck-shoulder muscles. *Scand J Med Sci Sports*, 23(1), 66-73. <https://doi.org/10.1111/j.1600-0838.2011.01331.x>
- Noormohammadpour, P., Farahbakhsh, F., Farahbakhsh, F., Rostami, M., & Kordi, R. (2018). Prevalence of Neck Pain among Athletes: A Systematic Review. *Asian Spine J*, 12(6), 1146-1153. <https://doi.org/10.31616/asj.2018.12.6.1146>
- Skootsky, S. A., Jaeger, B., & Oye, R. K. (1989). Prevalence of myofascial pain in general internal medicine practice. *Western Journal of Medicine*, 151(2), 157-160.
- Park, J.-H., Shin, H.-J., Lee, S.-G., Lee, G.-C., Yoon, H.-J., Hong, W.-S., . . . Yoon, B.-C. J. J. o. I. A. o. P. T. R. (2010). Common Trigger Points on College-Level Athletes with Various Sports. *Journal of International Academy of Physical Therapy Research*, 1(1), 58-64.
- Jafri, M. S. (2014). Mechanisms of Myofascial Pain. *Int Sch Res Notices*, 2014. <https://doi.org/10.1155/2014/523924>
- Mayoral del Moral, O. (2005). Fisioterapia invasiva del síndrome de dolor miofascial. *Fisioterapia* (Madr., Ed. impr.), 69-75.
- Calvo-Lobo, C., Pacheco-da-Costa, S., & Hita-Herranz, E. (2017). Efficacy of deep dry needling on latent myofascial trigger points in older adults with nonspecific shoulder pain: a randomized, controlled clinical trial pilot study. *Journal of Geriatric Physical Therapy*, 40(2), 63.
- Cubukcu, S., Alimoglu, M. K., Samanci, N., & Gurbuz, U. (2007). Isokinetic and isometric muscle strength of the knee flexors and extensors in patients with the fibromyalgia syndrome and chronic myofascial pain syndrome. *Journal of Musculoskeletal Pain*, 15(3), 49-55.
- Lisinski, P., & Huber, J. (2017). Evolution of muscles dysfunction from myofascial pain syndrome through cervical disc-root conflict to degenerative spine disease. *Spine*, 42(3), 151-159.
- Espejo-Antúnez, L., Tejada, J. F.-H., Albornoz-Cabello, M., Rodríguez-Mansilla, J., de la Cruz-Torres, B., Ribeiro, F., & Silva, A. G. (2017). Dry needling in the management of myofascial trigger points: a systematic review of randomized controlled trials. *Complementary therapies in medicine*, 33, 46-57.
- Gattie, E., Cleland, J. A., & Snodgrass, S. (2017). The effectiveness of trigger point dry needling for musculoskeletal conditions by physical therapists: a systematic review and meta-analysis. *Journal of orthopaedic & sports physical therapy*, 47(3), 133-149.
- Prado, D. D. (2017). *Efectos sobre la fuerza muscular del tratamiento de puntos gatillo miofasciales mediante la técnica de punción seca*.
- Eldridge, S. M., Chan, C. L., Campbell, M. J., Bond, C. M., Hopewell, S., Thabane, L., . . . group, P. c. (2016). CONSORT 2010 statement: extension to randomised pilot and feasibility trials. *Pilot Feasibility Stud*, 2, 64. <https://doi.org/10.1186/s40814-016-0105-8>
- Tasoglu, O., Sahin Onat, S., Boluk, H., Tasoglu, I., & Ozgirgin, N. (2017). Comparison of two different dry-needling techniques in the treatment of myofascial pain syndrome. *Agri*, 29(1), 9-16. <https://doi.org/10.5505/agri.2016.38991>
- Yehoshua, I., Rimon, O., Mizrahi Reuveni, M., Peleg, R., & Adler, L. (2022). Dry needling for the treatment of acute myofascial pain syndrome in general practitioners' clinics: a cohort study. *BMC Prim Care*, 23(1), 339. <https://doi.org/10.1186/s12875-022-01951-0>
- Rozenfeld, E., Strinkovsky, A., Finestone, A. S., & Kalichman, L. (2021). Reliability of Trigger Point Evaluation in the Lower Leg Muscles. *Pain Med*, 22(10), 2283-2289. <https://doi.org/10.1093/pm/pnab148>
- Rozenfeld, E., Finestone, A. S., Moran, U., Damri, E., & Kalichman, L. (2017). Test-retest reliability of myofascial trigger point detection in hip and thigh areas. *J Bodyw Mov Ther*, 21(4), 914-919. <https://doi.org/10.1016/j.jbmt.2017.03.023>
- Bonilla, D. A., Kreider, R. B., Petro, J. L., Romance, R., Garcia-Sillero, M., Benitez-Porres, J., & Vargas-Molina, S. (2021). Creatine Enhances the Effects of Cluster-Set Resistance Training on Lower-Limb Body Composition and Strength in Resistance-Trained Men: A Pilot Study. *Nutrients*, 13(7). <https://doi.org/10.3390/nu13072303>
- Bonilla, D. A., Méndez, C. H., Angulo, O. J., Cruz, J. A., Chaves, J. L., Vargas-Molina, S., . . . Palma, L. H. (2021). Efectos del ejercicio grupal de moderada intensidad sobre la presión arterial y capacidad funcional en mujeres posmenopáusicas hipertensas. RICYDE. *Revista internacional de ciencias del deporte*, 17(66), 306-320. <https://doi.org/10.5232/ricyde2021.06602>
- Rosenthal, J. A. (1996). Qualitative Descriptors of Strength of Association and Effect Size. *Journal of Social Service Research*, 21(4), 37-59. https://doi.org/10.1300/J079v21n04_02
- Cumming, G. (2013). *Understanding The New Statistics; Effect Sizes, Confidence Intervals, and Meta-Analysis* (1st Edition ed.). New York: Routledge.

- Vargas-Molina, S., Garcia-Sillero, M., Kreider, R. B., Salinas, E., Petro, J. L., Benitez-Porres, J., & Bonilla, D. A. (2022). A randomized open-labeled study to examine the effects of creatine monohydrate and combined training on jump and scoring performance in young basketball players. *Journal of the International Society of Sports Nutrition*, *19*(1), 529-542. <https://doi.org/10.1080/15502783.2022.2108683>
- Pueo, B., Penichet-Tomas, A., & Jimenez-Olmedo, J. M. (2020). Reliability and validity of the Chronojump open-source jump mat system. *Biology of Sport*, *37*(3), 255-259. <https://doi.org/10.5114/biolsport.2020.95636>
- Stoll, T., Huber, E., Seifert, B., Michel, B. A., & Stucki, G. (2000). Maximal isometric muscle strength: normative values and gender-specific relation to age. *Clinical Rheumatology*, *19*(2), 105-113. <https://doi.org/10.1007/s100670050026>
- Martin, O. A., & Teste, F. P. (2022). A call for changing data analysis practices: from philosophy and comprehensive reporting to modeling approaches and back. *Plant and Soil*. <https://doi.org/10.1007/s11104-022-05329-0>
- Dexheimer, J. D., Schroeder, E. T., Sawyer, B. J., Pettitt, R. W., Aguinaldo, A. L., & Torrence, W. A. (2019). Physiological performance measures as indicators of crossfit® performance. *Sports*, *7*(4), 93.
- Kamali, F., Sinaei, E., & Morovati, M. (2019). Comparison of Upper Trapezius and Infraspinatus Myofascial Trigger Point Therapy by Dry Needling in Overhead Athletes With Unilateral Shoulder Impingement Syndrome. *Journal of Sport Rehabilitation*, *28*(3), 243-249. <https://doi.org/10.1123/jsr.2017-0207>
- Khan, I., Ahmad, A., Ahmed, A., Sadiq, S., & Asim, H. M. (2021). Effects of dry needling in lower extremity myofascial trigger points. *J Pak Med Assoc*, *71*(11), 2596-2603. <https://doi.org/10.47391/JPMA.01398>
- Ceballos-Laita, L., Medrano-de-la-Fuente, R., Estebanez-De-Miguel, E., Moreno-Cervino, J., Mingo-Gomez, M. T., Hernando-Garijo, I., & Jimenez-Del-Barrio, S. (2021). Effects of Dry Needling in Teres Major Muscle in Elite Handball Athletes. A Randomised Controlled Trial. *J Clin Med*, *10*(18). <https://doi.org/10.3390/jcm10184260>
- Perez-Bellmunt, A., Casasayas-Cos, O., Lopez-de-Celis, C., Rodriguez-Sanz, J., Rodriguez-Jimenez, J., Ortiz-Miguel, S., . . . Fernandez-de-Las-Penas, C. (2021). Effects of Dry Needling of Latent Trigger Points on Viscoelastic and Muscular Contractile Properties: Preliminary Results of a Randomized Within-Participant Clinical Trial. *J Clin Med*, *10*(17). <https://doi.org/10.3390/jcm10173848>
- Jimenez-Del-Barrio, S., Medrano-de-la-Fuente, R., Hernando-Garijo, I., Mingo-Gomez, M. T., Estebanez-de-Miguel, E., & Ceballos-Laita, L. (2022). The Effectiveness of Dry Needling in Patients with Hip or Knee Osteoarthritis: A Systematic Review and Meta-Analysis. *Life (Basel)*, *12*(10). <https://doi.org/10.3390/life12101575>
- Llurda-Almuzara, L., Labata-Lezaun, N., Meca-Rivera, T., Navarro-Santana, M. J., Cleland, J. A., Fernandez-de-Las-Penas, C., & Perez-Bellmunt, A. (2021). Is Dry Needling Effective for the Management of Plantar Heel Pain or Plantar Fasciitis? An Updated Systematic Review and Meta-Analysis. *Pain Medicine*, *22*(7), 1630-1641. <https://doi.org/10.1093/pm/pnab114>
- Fernandez-de-Las-Penas, C., Perez-Bellmunt, A., Llurda-Almuzara, L., Plaza-Manzano, G., De-la-Llave-Rincon, A. I., & Navarro-Santana, M. J. (2021). Is Dry Needling Effective for the Management of Spasticity, Pain, and Motor Function in Post-Stroke Patients? A Systematic Review and Meta-Analysis. *Pain Medicine*, *22*(1), 131-141. <https://doi.org/10.1093/pm/pnaa392>
- Perreault, T., Ball, A., Dommerholt, J., Theiss, R., Fernández-de-Las-Peñas, C., & Butts, R. (2022). Intramuscular Electrical Stimulation to Trigger Points: Insights into Mechanisms and Clinical Applications-A Scoping Review. *J Clin Med*, *11*(20). <https://doi.org/10.3390/jcm11206039>
- Zhang, Y., Du, N. Y., Chen, C., Wang, T., Wang, L. J., Shi, X. L., . . . Guo, C. Q. (2020). Acupotomy Alleviates Energy Crisis at Rat Myofascial Trigger Points. *Evid Based Complement Alternat Med*, *2020*, 5129562. <https://doi.org/10.1155/2020/5129562>
- Shah, J. P., Phillips, T. M., Danoff, J. V., & Gerber, L. H. (2005). An in vivo microanalytical technique for measuring the local biochemical milieu of human skeletal muscle. *J Appl Physiol*, *99*(5), 1977-1984. <https://doi.org/10.1152/jappphysiol.00419.2005>
- Hsieh, Y. L., Yang, C. C., Liu, S. Y., Chou, L. W., & Hong, C. Z. (2014). Remote dose-dependent effects of dry needling at distant myofascial trigger spots of rabbit skeletal muscles on reduction of substance P levels of proximal muscle and spinal cords. *Biomed Res Int*, *2014*, 982121. <https://doi.org/10.1155/2014/982121>
- Haser, C., Stöggel, T., Kriner, M., Mikoleit, J., Wolfahrt, B., Scherr, J., . . . Pfab, F. (2017). Effect of Dry Needling on Thigh Muscle Strength and Hip Flexion in Elite Soccer Players. *Med Sci Sports Exerc*, *49*(2), 378-383. <https://doi.org/10.1249/mss.0000000000001111>
- Mansfield, C. J., Vanetten, L., Willy, R., di Stasi, S., Magnussen, R., & Briggs, M. (2019). The Effects of Needling Therapies on Muscle Force Production: A Systematic Review and Meta-analysis. *J Orthop Sports Phys Ther*, *49*(3), 154-170. <https://doi.org/10.2519/jospt.2019.8270>
- Celik, D., & Yeldan, I. (2011). The relationship between latent trigger point and muscle strength in healthy subjects: a double-blind study. *Journal of Back and Musculoskeletal Rehabilitation*, *24*(4), 251-256.
- Doraisamy, M. A., & Anshul. (2011). Effect of latent myofascial trigger points on strength measurements of the upper trapezius: a case-controlled trial. *Physiotherapy Canada*, *63*(4), 405-409.

НЕГАЙНИЙ ВПЛИВ СУХОГО ГОЛКОВКОЛЮВАННЯ НА М'ЯЗОВУ СИЛУ НИЖНІХ КІНЦІВОК У СПОРТСМЕНІВ, ЯКІ ЗАЙМАЮТЬСЯ КРОСФІТОМ, ІЗ ЛАТЕНТНИМИ ТРИГЕРНИМИ ТОЧКАМИ: РАНДОМІЗОВАНЕ ПОТРІЙНО СЛІПЕ ПІЛОТНЕ КЛІНІЧНЕ ДОСЛІДЖЕННЯ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 11 с., 5 табл., 5 рис., 48 джерел.

Мета дослідження. Мета цього дослідження полягала в оцінці негайного впливу глибокого сухого голковколювання на змінні, пов'язані із силою м'язів нижніх кінцівок, у спортсменів-любителів, які займаються крос-тренінгом, із латентною тригерною точкою.

Матеріали та методи. Це потрійно сліпе пілотне клінічне дослідження з повторними вимірюваннями пройшли загалом 19 здорових чоловіків, які займалися кросфітом (27,8 [4,7] року; 79,8 [10,4] кг; 1,76 [0,07] см), з міофасціальною тригерною точкою в чотириголовому, сідничному або литковому м'язі. Учасники були випадково розподілені в експериментальну групу (ЕГ, n = 10) або в контрольну групу (КП, n = 9). Після розподілу на вихідному рівні та через 48 годин після втручання оцінювали силу м'язів нижніх кінцівок (вертикальний стрибок із присіду зігнувши ноги та вертикальний стрибок із зустрічним рухом) і вимірювали силу максимального ізометричного відведення стегна та чотириголового м'яза.

Результати. Результати виражені як Δ (СВ) [95% ДІ]; незміщена оцінка d Коена [dunb, 95% ДІ]). Було показано, що глибоке сухе голковколювання зменшує присутність м'язової тригерної точки. Максимальна ізометрична сила відведення стегна мала помірне або високе статистично значуще збільшення в ЕГ (лівий бік: 21,5 (16,9) [9,42, 33,57]; 0,55 [0,19, 0,99], правий бік: 20,3 (16,2) [8,70, 31,89]; 0,74 [0,25, 1,35]); однак контрольна група продемонструвала статистично значуще збільшення сили лише тих м'язів, що відводять ліве стегно (15,77 (15,37) [3,96, 27,59]; 0,57 [0,11, 1,12]), без статистично значущих змін у правому боці.

Висновки. Негайне скорочення міофасціальної тригерної точки спостерігалось при застосуванні глибокого сухого голковколювання, але не мало статистично значущого впливу на максимальну ізометричну силу або висоту стрибка порівняно з контрольною групою. Результати цього пілотного клінічного дослідження можуть бути використані для підготування майбутніх досліджень.

Ключові слова: сухе голковколювання, м'язова сила, тригерна точка, тригерна зона.

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