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Dry needling in the management of myofascial trigger points: A systematic review of randomized controlled trials

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ABSTRACT

Objective: This systematic review of randomized controlled trials aimed to examine the effectiveness of dry needling in the treatment of myofascial trigger points and to explore the impact of specific aspects of the technique on its effectiveness.
Methods: Relevant studies published between 2000 and 2015 were identified by searching PubMed, Scopus, The Cochrane Library and Physiotherapy Evidence Database. Studies identified by electronic searches were screened against a set of pre-defined inclusion criteria.
Results: Fifteen studies were included in this systematic review. The main outcomes that were measured were pain, range of motion, disability, depression and quality of life. The results suggest that dry needling is effective in the short term for pain relief, increase range of motion and improve quality of life when compared to no intervention/sham/placebo. There is insufficient evidence on its effect on disability, analgesic medication intake and sleep quality.
Conclusions: Despite some evidence for a positive effect in the short term, further randomized clinical trials of high methodological quality, using standardized procedures for the application of dry needling are needed.

1. Introduction

Myofascial Trigger Points (MTrPs) are "hyperirritable points in skeletal muscle that are associated with a hypersensitive palpable nodule in a taut band".[1] It is estimated that MTrPs are the primary cause of pain in 30–85% of those with musculoskeletal disorders.[2–4] The MTrPs seem to be associated with histological (shortening of involved sarcomeres and tissue hypoxia) [5] and biochemical (excessive release of acetylcholine, lowered pH and excessive release of P substance) [6,7] changes, which influence the process of sensitization of the central and peripheral nervous system.[6,8]

Myofascial pain syndrome is a regional muscular pain condition characterized by MTrPs found in one or more muscles and/or connective tissues.[9] It can be associated with pain, muscle spasm, increased sensitivity, stiffness, muscle weakness, decreased range of motion and autonomic dysfunction.[9] The mechanical stimulation of MTrPs can cause local and referred pain, motor dysfunction and autonomic phenomena.[9,10] Despite the clinical acceptance of MTrPs, its role as a relevant clinical entity in the pathogenesis of myofascial pain syndrome is still controversial.[11]

MTrPs and myofascial pain syndrome have been treated with several therapeutic modalities, including therapeutic ultrasound,[12,11] ischemic compression techniques,[12,13] muscle energy techniques,[13] stretching,[13] manipulation,[14] acupuncture [4[4]] and dry needling.[15] During the last decade, evidence on the role of dry needling of MTrPs in the management of several musculoskeletal disorders has been increasing, including plantar heel pain,[16] temporomandibular disorders,[17,18] epicondylalgia [19] or myofascial pain syndrome.[20] Dry needling consists of using a needle, as a physical agent, to create a mechanical stimulus with the goal of deactivating the trigger point.[21] It is an invasive procedure, where the needle is inserted through the skin and muscle into the MTrP.[15] Once the MTrP is deactivated, the needle is removed.[22] It is cheap, easy to learn and with low risks associated.[23] Despite being a technique commonly used by health professionals, its clinical effectiveness is not clear. A recent systematic review on the effectiveness of dry needling has focused on MTrPs associated with the

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neck and shoulder regions.[23] The authors concluded that dry needling can be recommended for relieving MTrP pain in neck and shoulders.[23] We aim to expand this review by adding studies on other anatomical regions, and exploring whether differences in the application of dry needling, such as the characteristics of the needle, the number of times that the needle was inserted into the MTrPs and the number of treatment sessions, can impact on its effectiveness. Thus, the aim of this study was to undertake a systematic review to examine the effectiveness of dry needling in the treatment of MTrPs and to explore the impact of specific aspects of the technique on its effectiveness.

2. Methods

2.1. Databases and search strategy

A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[24]

Relevant studies published between 2000 and 2015 were identified by searching PubMed, Scopus, The Cochrane Library and Physiotherapy Evidence Database (PEDro). The search terms were the following: “dry needling”, “trigger point”, “myofascial trigger point”, “myofascial pain syndrome”, combined as follows: (i) [trigger point* OR myofascial trigger point* OR myofascial pain syndrome*] AND [dry needling*]; (ii) [myofascial trigger point* AND dry needling*]; and (iii) [myofascial pain syndrome* AND dry needling*]. The reference lists of studies identified by electronic searches were screened to identify articles relating to the topic of the review that had been missed by the electronic search.

2.2. Selection criteria for studies

To be included in the present systematic review, studies had to fulfil the following inclusion criteria:

- Be a randomized clinical trial (RCT), investigating the effects of dry needling for the management of MTrPs and/or myofascial pain syndrome. Studies would have to have compared dry needling when applied alone or in combination with other treatment modalities against another treatment modality, a placebo or no treatment;
- Have applied a dry needling technique that conforms with the following definition: an invasive procedure (superficial or deep) consisting of using a needle without any chemical agent inserted into the skin over an active or latent MTrP and that does not follow the principles of the Traditional Chinese Medicine;
- Have diagnosed MTrPs using the criteria of Travell et al.,[10] and myofascial pain syndrome as a soft tissue rheumatism characterized by associated MTrPs in one or more muscles, taut bands, referred pain, sensory changes, and local twitch response [25];
- Report on at least one outcome related to pain intensity either using a visual analogue scale or a numeric pain rating scale;
- Be written in English;
- Be conducted in adult human participants.

Studies were excluded on the basis of the following: review articles, editorials or letters to the editor, case reports, studies not involving a dry needling intervention (e.g. acupuncture) or comparing different types of dry needling and studies where participants had other concurrent disorders.

2.3. Selection of studies

Two authors independently determined whether studies fulfilled the criteria for inclusion in this review through examination of study titles, abstracts, and key words and posteriorly the full text (Fig. 1). A standardized form was used to determine the eligibility of retrieved studies. When authors failed to reach an agreement; a third author was consulted.

2.4. Data extraction, data synthesis and methodological quality assessment

Two authors used a customized form to independently extract data relevant to the review aims, namely: study design, purpose, study sample, diagnosis, characteristics of the dry needling intervention, characteristics of the control intervention, and outcome measures. Regarding the intervention, the following details were retrieved: thickness and length of the needles; characteristics of the insertion (tilt angle of needle insertion, depth of insertion and frequency of needle movement); number of needle insertions; number of dry needling sessions; and criterion to finish the session.

The methodological quality of each randomized controlled trial was independently assessed by two authors using the PEDro scale.[26] A PEDro score between 6 and 10 is indicative of high quality; a score of 4–5 indicates fair quality; and, a score ≤ 3 indicates poor quality. A third author resolved disagreements.

3. Results

3.1. Study selection

From the web-based search, 90 articles were identified. Of these, 30 articles were duplicates and, therefore, were excluded. Of the 60 potentially eligible articles, 45 were discarded due to the following reasons: did not comprise a dry needling intervention (n = 30), did not apply the criteria described by Travell and Simons (n = 2) to define MTrP, used a single blinded within-subject design (n = 1), pain intensity was not an outcome measure (n = 1), review paper (n = 6), book chapter, comment or editorial (n = 5). Therefore, 15 articles [9,15,17,23,27–39] remained to be included in this review (Table 1).

3.2. Study characteristics

Tables 1–4 summarize the characteristics of included studies. The 15 studies enrolled a total of 761 participants, including participants with myofascial pain syndrome,[27–31,9,38–40]mechanical neck pain,[32,34,36,37] temporomandibular disorders [17] and total knee arthroplasty.[35] Total sample size in each included study ranged from 12 to 94 [29] and most participants were women.

With respect to the intervention, dry needling was compared against:

- no intervention [36]
- placebo/sham needling [28,17,35,38,39]
- botulinum toxin injection [9]
- lidocaine injection [27,29,30,9]
- oral drugs [29]
- acupuncture [32]
- laser [31,32]
- ischemic compression technique [34]
- dry needling combined with intramuscular stimulation [28]
- dry needling in the same muscle but not in an MTrP [37]

The comparisons add up to more than 15 as some studies used 3 groups.[28,29,31,32,9] Moreover, in four studies, in addition to the main intervention, home exercises were also prescribed. [27,29,30,34]

Regarding the outcome measures, pain intensity was the primary outcome in all studies (assessed either using a visual analogue scale or a numeric pain rating scale). In addition to pain intensity, studies measured range of motion (n = 11), symptoms of depression (n = 3), disability (n = 5), quality of life (n = 3), analgesic medication intake (n = 3) and number of MTrPs (n = 1) (Table 1).

The number of treatment sessions ranged from one [27,32] to eight [28]

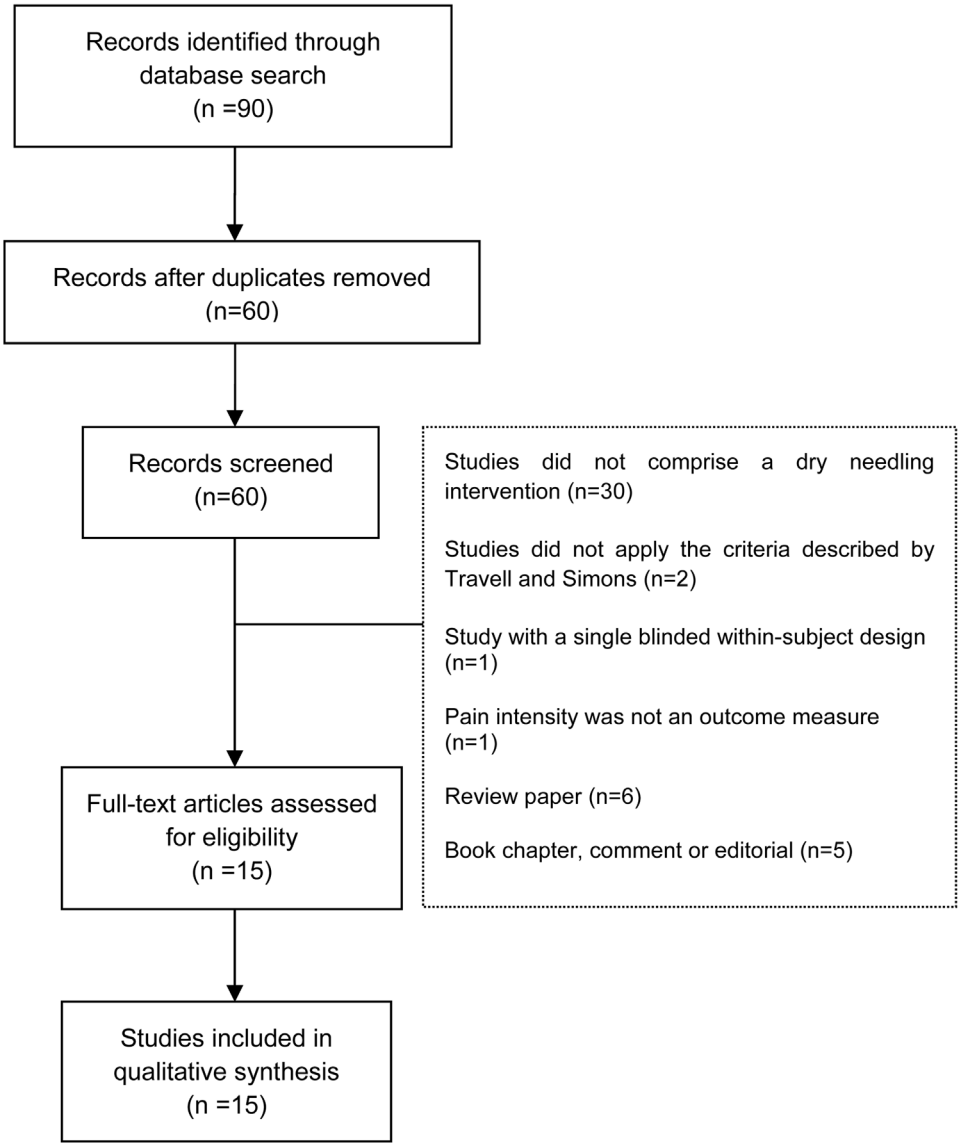

Fig. 1. Flow chart of study selection process.

(Table 1). The majority of studies assessed the short-term effects of dry needling, nonetheless some studies followed up the participants after the dry needling intervention.[27,30,31,9,35]

3.3. Study methodological quality

The 15 randomized controlled trials had a mean method quality score of 7.53 ± 1.30 out of 10, ranging from 5 [9] to 9 [28,32,34,36,37] in the PEDro scale (Table 2).

3.4. Effects of dry needling on the primary outcome: pain intensity

3.4.1. Dry needling vs. sham/placebo intervention or no intervention

Eleven studies compared dry needling against sham/placebo intervention or no intervention.[28,17,30–39] Some studies reported a short-term significant positive impact on pain intensity when comparing dry needling with sham needling [35,38,39] and when comparing dry needling with no intervention.[36] When comparing dry needling with needling outside the MTrPs, one study reported a significant decrease of pain intensity in the dry needling group compared with needling outside the MTrPs [37] while other found no between group difference.[17] No differences in pain intensity were also reported when comparing dry needling and sham laser acupuncture,[30] dry needling and placebo laser,[34] and dry needling and placebo-sham electroacupuncture.[28] A detailed description of these studies' results is presented in Tables 2–4.

3.4.2. Dry needling vs. pharmacological interventions

Four studies compared dry needling against pharmacological interventions.[27,28,29,9[27–29,9]] Two studies showed a significant and similar decrease in pain intensity between a group receiving dry needling and a group receiving lidocaine injections.[27,29] One study reported that dry needling was superior to lidocaine injections for pain intensity decrease,[28] while another study showed the opposite (lidocaine and botulinum toxin were superior to dry needling for pain intensity decrease).[9] A detailed description of these studies' results is presented in Table 3.

3.4.3. Dry needling vs. manual therapy or another intervention with needles

Two studies [34] compared dry needling against manual therapy and showed conflicting results: one showed similar effects between both techniques [34] and the other showed dry needling to be superior to manual therapy.[41] One study compared dry needling with the same dry needling intervention plus needling of multifidus muscle and reported a significant reduction in pain intensity that was similar in both groups.[30] A detailed description of these studies' results is presented in Table 4.

Table 1-
Main characteristics of the included trials.

Authors	Sample size	Diagnosis	Outcome measures	Period of assessment	Number of sessions
Irnich et al. [32]	34 (9 males, 25 females)	Cervical MPS	Pain Cervical ROM	-Baseline -After intervention	1
Ilbuldu et al. [31]	60 females Group 1: Placebo Laser (n = 20) Group 2: DN (n = 20) Group 3: Laser (n = 20)	MTrPs in the upper trapezius muscle	Pain Cervical ROM Functional status	-Baseline -After treatment -6 months follow up	4
Kamanli et al. [9]	29 (23 females, 6 males) Group 1: Lidocaine injection (n = 10) Group 2: DN (n = 10) Group 3: Botulinum toxin type A (n = 9)	MTrPs in the cervical and/or periscapular regions	Pain Cervical ROM PPT on MTrP Disability Anxiety and Depression	-Baseline -After treatment except ROM (1 month after treatment)	1
Ga et al. [30]	40 (4 males, 36 females) Group 1: DN (n = 18) Group 2: DN with paraspinal needling (n = 22)	Chronic MPS of upper trapezius muscle	Pain Cervical ROM Depression	-Baseline -At days 7, 14, and 28	3
Ay et al. [27]	80 (28 males, 52 females) Group 1: Lidocaine injection (n = 40) Group 2: DN (n = 40)	MPS with at least one MTrP located in the upper trapezius	Pain Cervical ROM Depression symptoms	-Baseline, -At 4 and 12 weeks after	1
Tsai et al. [43]	35 (14 males,21 females) Group 1: DN (n = 17) Group 2: Sham needling (n = 18)	Unilateral shoulder pain with active MTrP in the upper trapezius and latent MTrP in the ECRL muscle	Pain Cervical ROM PPT	-Baseline -After intervention	1
Dıracoglu et al. [17]	50 (7 males, 43 females) Group 1: DN (n = 25) Group 2: Sham DN (n = 25)	Myofascial pain with active MTrP in temporomandibular muscles	Pain PPT Pain-free maximal jaw opening	-Baseline -One week after the last needling	3
Eroğlu et al. [29]	60 (7 males, 53 females) Group 1: Flurbiprofen (n = 20) Group 2: Lidocaine injection (n = 20) Group 3: DN(n = 20)	MPS involving the neck and back region	Pain Neck and shoulder ROM PPT Quality of life	-Baseline -On the third and 14th days after treatment	1
Mayoral et al. [35]	40 (11 males, 29 females) Group 1: DN (n = 20) Group 2: Sham(n = 20)	Total knee arthroplasty	Pain Analgesics requirements Presence of active or latent MTrP and MPS Knee physical function and ROM	-Baseline -At months 1, 3, and 6 after treatment	1
Tekin et al. [40]	39 (8 males, 31 females) Group 1: DN (n = 22) Group 2: Sham needling (n = 17)	MPS with at least one active MTrP involving the cervical and thoracic region	Pain Quality of life Paracetamol intake Presence of LTRs	-Baseline -After the 1st treatment session -After the6th treatment session	6
Ziaeifar et al. [45]	33 (*sex not specified) Group 1:Compression technique on MTrP (n = 17) Group 2: DN (n = 16)	MTrP located in the upper trapezius muscle	Pain PPT Disability	-Baseline -After intervention	3
Couto et al. [28]	78 (*sex not specified) Group 1: DN (n = 26) Group 2: Placebo-Sham (n = 26) Group 3: Lidocaine injection (n = 26)	Myofascial pain syndrome	Pain PPT Sleep quality Quality of life	-Baseline -After intervention	8
Mejuto-Vazquez et al. [36]	17 (males 8, females 9) Group 1: DN (n = 9) Group 1: nointervention (n = 8)	Acute mechanical neck pain	Pain Cervical ROM PPT	-Baseline -After treatment -1 week follow-up	1
Llamas-Ramos et al. [34]	94 (males 32, females 62) Group 1: DN (n = 47) Group 2: Manual Therapy (n = 47)	Chronic mechanical neck pain	Pain Cervical ROM PPT Disability	-Baseline -After treatment -1 week follow-up -2 week follow-up	2
Pecos-Martin et al. [37]	72 (males 14, females 58) Group 1: DN (n = 36) Group 2: Placebo (n = 36)	Mechanical neck pain	Pain PPT Disability	-Baseline -After treatment -1 week follow-up -1 month follow-up	1

DN: Dry needling; ECRL: extensor carpi radialis longus; LTR: Local Twitch Response; MTrP: Myofascial Trigger Point; PPT: Pressure Pain Threshold; ROM: Range of Motion.

Table 2
Studies that compared dry needling (DN) against no intervention, a sham intervention or placebo.

Author	Interventions compared to DN	Results		Conclusions	PEDro Score
Irnich et al. [32]	- Needle Acupuncture (NLA) at distant points -Sham laser acupuncture	Pain intensity	DN− Pre: 3.3 ± 1.9., Post: 2.9 ± 2.2; NLA- Pre: 3.5 ± 2.3, Post: 1.9 ± 1.6; Sham laser − Pre: 3.0 ± 1.9, Post: 2.8 ± 1.9	NLA was significantly superior to both DN and sham laser; No difference between DN and sham laser.	9/10
		ROM (º)	DN − Pre: 4.6 ± 6.9, Post: 4.8 ± 7.0; NLA − Pre: 4.7 ± 9.9, Post: 5.1 ± 8.0; Sham − Pre: 4.7 ± 6.3, Post: 4.7 ± 7.1	DN and acupuncture significantly superior to sha m laser.	
Ilbuldu et al. [31]	-Laser -Placebo laser	Pain intensity	DN: VAS-rest: Pre: 5.1 ± 2.0, Post: 3.7 ± 2.3, $p < 05$; VAS-activity: Pre: 7.6 ± 1.5, Post: 5.3 ± 2.45, $p < 0.001$. Laser group: VAS-rest: Pre: 5.5 ± 2.0, Post: 2.1 ± 1.4, $p < 0.05$; VAS-activity: Pre: 7.2 ± 1.4, Post: 2.9 ± 2.0, $p < 0.001$.	Laser superior to other interventions. *No differences between groups at 6-month follow up.	7/10
		PPT	DN: Pre: 2.2 ± 1.0, Post: 2.5 ± 1.6, $p < 0.001$ Laser group: Pre: 2.7 ± 0.7, Post: 4.0 ± 1.2, $p < 0.001$		
		Analgesic intake	DN: Pre: 5.8 ± 4.3. Post: 3.6 ± 4.4 Laser group: Pre: 3.7 ± 3.0, Post: 0.9 ± 1.5	Laser superior to other interventions. No between groups difference at 6-month follow up.	
		ROM (º)	Flexion, Extension, Right lateral flexion and left lateral flexion. Pre-Posttest: $p \leq 0.01$ in both groups		
		Disability	Dimensions “Pain” and “Physical Activity”. Pre-Posttest: $p < 0.05$ in both groups		
Tsai et al. [39]	Superficial needling in ECRL	Pain intensity	DN: % change after treatment: 28.5 ± 21.8 Superficial needling: % change after treatment: 10.0 ± 8.1	DN superior to superficial needling.	6/10
		PPT (K/Pa)	DN: %change after treatment: 67.8 ± 38.8 Superficial needling: % change after treatment: 15.8 ± 11.3		
		ROM (º)	DN: % change after treatment: 25.8 ± 16.8 Superficial needling: % change after treatment: 9.5 ± 13.2		
Dıracoglu et al. [17]	Superficial needling away from MTrPs and an education program about TMJ disorders	Pain intensity	DN: Pre: 6.3 ± 1.5, Post: 3.9 ± 1.7, $p < 0.001$ Superficial needling: Pre: 5.7 ± 1.4, Post: 3.8 ± 1.5, $p < 0.001$ Between-group difference: $p = 0.478$	No difference between deep needling and exercise and superficial needling and exercise	8/10
		PPT:	DN: Pre: 2.6 ± 1.1, Post: 3.2 ± 1.1, $p < 0.001$ Superficial needling: Pre: 2.7 ± 0.4, Post: 2.8 ± 0.4, $p < 0.01$ Between-group difference: $p < 0.001$.	DN superior to superficial needling	
		Pain-free jaw opening (mm)	DN: Pre: 41.2 ± 7.7, Post: 40.1 ± 6.1, $p = 0.255$ Superficial needling: Pre: 39.50 ± 4.72, Post: 39.6 ± 4.2, $p = 0.679$ Between-group difference: $p = 0.411$	No difference between deep needling and exercise and superficial needling and exercise	
Tekin et al. [38]	Sham DN	Pain intensity:	DN: Pre: 6.6 ± 1.3, After the 1st session: 4.0 ± 1.6, After the 6th session: 2.2 ± 2.0 Sham DN: Pre: 6.4 ± 1.6, After the 1st session: 5.4 ± 1.6, After the 6th session: 5.3 ± 1.8 Between-group difference: After the 1st session: $p = 0.034$, After the 6th session: $p < 0.001$	DN superior to sham DN in 2nd and 3rd assessments	8/10
		Quality of life:	DN: All domains have a significant increase ($p < 0.05$). Sham DN: Significant increases in vitality only ($p < 0.05$).	DN superior to sham needling	
		Paracetamol intake:	DN: Significant decrease; $p < 0.001$ Sham DN: No significant difference; $p > 0.05$		
Mayoral et al. [35]	Sham needling,	Pain intensity:	Prevalence VAS = 0, DN: Pre: 0%, At 1 mo: 35%; Sham needling: 0%, At 1 mo: 10.5%, p= 0.042	DN superior to sham needling	7/10
		Presence of MTrPs	No difference between groups during 1st month ($p = 0.06$)		
		Analgesic intake	Analgesics decreased in DN rather than in sham needling ($p = 0.01$)		

(continued on next page)

Table 2 *(continued)*

Author	Interventions compared to DN	Results		Conclusions	PEDro Score
		ROM (values at 1-month follow-up)	No difference between-groups: p = 0.31	No between groups differences	
		Disability	No difference between groups at 1, 3 and 6 months; p > 0.05		
Mejuto-Vazquez et al. [36]	No intervention	Pain intensity	DN: Pre-post: −1.9 (95% CI: −3.1,−0.7); p < 0.01; Pre-1 wk: −3.7 (95%CI: −5.3,−2.2) ; p < 0.01 No intervention: Pre-post: 0.2 (95%CI: −0.3, 0.8); p > 0.05); Pre-1 wk: −0.7 (95%CI: −1.4, −0.1) ; p > 0.05 Between-group difference: Post: 2.1 (95%CI: 1.0,3.2); p < 0.01; 1wk: 3.0 (95%CI: 2.1,3.9); p < 0.01	DN superior to no intervention	9/10
		PPT(KPa)	Between-group difference: C5-C6, second metacarpal, tibialis anterior; Post and 1 wk (p < 0.01)		
		ROM (º):	Between-group difference: Cervical Flexion, Extension, Lateral flexion toward treated side, rotation toward treated side, rotation away from treated side: Post and 1 wk (p < 0.01)		
Pecos-Martin et al. [37]	DN outside the MTrP	Pain intensity:	DN: Pre-1 wk: 2.7 (95%CI: 2.0, 3.3); p < 0.001; Pre-1 mo: 3.2 (95%CI: 2.6, 3.8), p < 0.001. DN outside MTrP: Pre-1 wk: 0.3 (95%CI: −0.0, 0.6); p ≥ 0.05; Pre-1 mo: 0.5 (95%CI: 0.1, 0.9); p ≥ 0.05. Between-group difference: 1 wk post: 2.4 (95%CI: 1.6, 3.2); p < 0.001; 1mo: 2.7 (95%CI: 2.0, 3.4); p < 0.001	DN in MTrPs superior to DN out of MTrPs	9/10
		PPT(KPa):	DN: Pre-post: −1.5 (95%CI:1.6, 1.4); p < 0.001; Pre-1 wk: −1.5 (95% CI: −1.6, −1.4); p < 0.001; Pre-1 mo: −1.6 (95% CI: −1.7,−1.4); p < 0.001 DN outside MTrP: Pre-post: −0.6 (95%CI: −0.8, −0.5); p < 0.001; Pre-1 wk: −0.3 (-0.4, −0.3); p < 0.001; Pre-1 mo: −0.4 (95%CI: −0.3, −0.6); p > 0.05 Between-group difference: immediate post: −0.9 (95%CI: −1.1, −0.6); p < 0.001; 1 wk post: −1.2 (−1.41, −1.1); p < 0.001; 1mo: −1.4 (95%CI:−1.6, 1.2); p < 0.001		
		Disability	DN: Pre-1 mo: 9.7 (95%CI: 7.3–12.2) ; p < 0.001 DN outside MTrP: Pre-1 mo: 1.7 (95%CI:−0.1, 3.6) (p > 0.05) Between-group difference: 1mo: 8.0 (95%CI:5.0, 11.0) (p < 0.001).	DN into MTrPs superior to DN outside of MTrPs	

CI: confidence interval; DN: dry needling; ROM: range of motion; VAS: visual Analogue Scale; p: *p*-value; PPT: pressure pain threshold; MTrPs: myofascial trigger points; wk: week; mo: month; º: degrees.

Table 3
Studies that compared dry needling vs pharmacological interventions.

Author	Interventions compared to DN	Results		Conclusions	PEDro Score
Kamanli et al. [9]	Lidocaine injection (LIG) Botulin toxin injection (BTG) Both groups: home exercise	Pain intensity	DN: Pre:7.0 ± 2.7; Post:5.1 ± 2.9, p = 0.083; BTG: Pre:6.1 ± 2; Post: 2.7 ± 1.0, p = 0.012; LIG: Pre: 6.9 ± 1.4; Post:2.0 ± 1.7, p = 0.005 Between-group difference: LIG vs DNG: p = 0.023. BTG vs DNG: p = 0.022.	LIG and exercises superior to BTG and exercises and to DNG and exercises	5/10
		PPT (Kg/cm^2)	DN: Pre: 3.1 ± 0.4, Post: 3.8 ± 0.8, p = 0.000; BTG: Pre: 3.2 ± 0.6, Post: 4.0 ± 0.8, p = 0.001; LIG: Pre: 3.2 ± 0.4, Post: 4.4 ± 0.8, p = 0.000. Between-group difference: LDG vs DNG p = 0.008		
		Disability	DN: Pre:16.2 ± 6.9; Post:14.2 ± 7.0, p = 0.293; BTG: Pre:16.6 ± 6.; Post:10.1 ± 5.1, p = 0.021; LIG: Pre: 18.5 ± 6.6; Post:6.4 ± 4.8, p = 0.005 Between-group difference: LIG vs DNG: p = 0.023		
		Symptoms of depression	DN: Pre: 10.8 ± 4.1, Post:11.3 ± 3.7, p = 0.722; BTG: Pre: 12.6 ± 6.2, Post: 8.5 ± 4.8, p = 0.027; LIG: Pre: 9.2 ± 5.7,Post: 7.0 ± 3.5, p = 0.234.	BTG and exercises superior to. LIG and exercises and to DNG and exercises	
Eroğlu et al. [29]	Oral flurbiprofen (OF) Lidocaine injection (LIG) Both groups: Home exercise	Pain	OF: 0.46 [3.5 (0–10)]; LIG: 0.46 [3 (0–10)]; DN: 0.56 [5 (0–10)] Changes between groups: VAS Interaction groups: F: 0.41, p = 0.76	No between group differences.	7/10
		PPT ROM	OF: 0.45 [4 (3–7)]; LIG: 0.52 [4 (3–13)]; DN: 0.51 [4 (3–14)] Changes between groups: PPT: Interaction groups: F:1.22, p = 0.29 Right lateral flexion: OF:0.44 [45 (25–70)]; LIG: 0.53 [47.5 (30–85)]; DN: 0.51 [50 (20–70)]; Left lateral flexion: OF: 0.47 [45 (20–70)]; LIG: 0.56 [50 (25–80)]; DN: 0.45 [45 (20–70)]; Right rotation: OF: 0.46 [65 (35–90)]; LIG: 0.58 [70 (35–90)]; DN: 0.45 [65 (40–90)]; Left rotation: OF: 0.42 [65 (35–85)]; LIG: 0.56 [70 (30–85)]; DN: 0.50 [70 (35–90)] Changes between groups: Right lateral flexion: Interaction groups: F: 0.685, p = 0.56; Left lateral flexion: Interaction groups:0.55 p = 0.67; Right rotation: Interaction groups: F:0.40, p = 0.79, Left rotation: F:0.70, p = 0.56		
		Quality of life	No significant differences except for fatigue dimension on the third and 14th days in the lidocaine injection group (p = 0.02)	No difference between groups except for fatigue scores (DN and flurbiprofen superior to lidocaine).	
Ay et al. [27]	Lidocaine injection (LIG) plus a home-based exercise program	Pain	DN: Pre: 5.6 ± 1.3, Post 4 wk: 3.8 ± 0.5, 12th wk:1.3 ± 0.8, p < 0.001. Lidocaine injection: Pre: 5.8 ± 1.3, Post 4 wk: 2.3 ± 1.0, Post 12th wk: 0.9 ± 0.8, p < 0.001; Between-group difference: Post 4 wk: p = 0.053; Post 12th wk: p = 0.215	No difference between groups.	6/10
		ROM	Significant increase in flexion, extension, right lateral flexion, left lateral flexion, right rotation, left rotation in LIG and DN at 4 weeks (p < 0.001) and 12 weeks (p < 0.001) Between-group difference: Post 4 wk: p > 0.05; Post 12th wk:p > 0.05.		
		Disability	LIG: Pre: 14.5 ± 16.9, Post 4 wk: 10.7 ± 2.6 Post 12th wk: 9.9 ± 2.8, p < 0.001; DN: Pre: 12.1 ± 3.6, Post 4 wk: 10.9 ± 3.3,12th wk:10.1 ± 2.6, p < 0.001. Between-group difference: Post 4 wk: p = 0.716; Post 12th wk: p = 0.903		
Couto et al. [28]	Placebo-sham electroacupuncture Lidocaine injection (LIG)	Pain	Between-group difference: DN vs Placebo-sham (Relative Change 44.8% (33.6–63.9%), p < 0.001; DN vs LIG (Relative Change: 28.73% (7.5–49.7%), p < 0.01; LIG vs Placebo-sham (Relative change:22.5% (5.6–39.2%), p < 0.001	DN superior to placebo-sham and lidocaine	9/10
		PPT	Between-group difference: DN vs Placebo-sham (Relative Change: −58.6% (-81.8–35.1%), p < 0.001; LIG vs DN (Relative Change: −23.07% (−43.8–2.1),		

(continued on next page)

Table 3 *(continued)*

Author	Interventions compared to DN	Results	Conclusions	PEDro Score
		p = 0.004; Placebo-sham vs LIG (Relative change: − 29.13% (− 49.67–8.3), p < 0.001		
	Sleep quality	Between-group difference: DN vs Placebo-sham (Relative Change: − 32.24% (− 44.5–19.8%), p < 0.001; LIG vs DN (Relative Change: − 19.0% (− 30.2–7.8), p < 0.01; Placebo-sham vs LIG (Relative change: − 11.13% (− 24.6–2.1%), p < 0.001		
	Quality of life	Physical health: Between-group difference: DN vs Placebo-sham (Relative Change: − 22.8% (− 36.2–9.4%), p < 0.01; LIG vs DN (Relative Change: − 15.6% (− 27.2–3.9%), p < 0.01; Placebo-sham vs LIG (Relative change: − 6.3% (− 8.2–2.3), p > 0.05		
		Mental health: Between-group difference: DN vs Placebo-sham (Relative Change: 23.0% (13.0–32.9%), p < 0.001; LIG vs DN (Relative Change:11.9% (0.4–23.4%), p < 0.001; Placebo-sham vs LIG (Relative change:12.6% (3.0–22.1%), p < 0.001.	LIG superior to DN and placebo; DN superior to placebo	

BTG: Botulinum toxin group; DN: dry needling; DNG: dry needling group; LIG: Lidocaine injection; MTrPs: myofascial trigger points; mo:month; OF: Oral flurbiprofen; p: *p*-value; ROM: range of motion; Trp: trigger point; wk: week.

3.5. Effects on the secondary outcomes

3.5.1. Dry needling vs. sham/placebo intervention or no intervention

Six [28,17,31,36,37,39] out of eight studies measured Pressure Pain Threshold (PPT) (Table 2) and all reported an increased threshold after dry needling in comparison with sham/placebo group. Five studies [17,32,35,36,39] assessed range of motion of which three [32,36,39] showed a significant increase after dry needling. Two studies assessed disability; one using the Western Ontario and McMaster Universities Osteoarthritis Index [35] and the other using the Neck Pain Questionnaire [37] and only the last one reported a significant improvement in the group receiving dry needling comparing to the control group. Two studies [28,38] showed improved quality of life and reduced use of analgesic medication after the dry needling intervention (Table 2). One study also reported improved sleep quality.[28]

3.5.2. Dry needling vs. pharmacological interventions

Three studies measured PPT and reported conflicting results.[28,29,9] One study showed a significant and similar increase in PPT between a group receiving dry needling and another group receiving lidocaine injections [29]; another study reported that dry needling increased PPT more than lidocaine injections [28]; and the other study indicated that PPT increased more in the groups receiving botulinum toxin or lidocaine injections than in the group receiving dry needling [9] (Table 3).

Two studies showed similar improvements in range of motion [27,29] and quality of life [28,29] when comparing dry needling with lidocaine injections. Depressive symptoms were assessed in two studies,[27,9] one [27] showed a significant and similar improvement between dry needling and lidocaine injections while the other [9] showed no significant improvements both in the group receiving dry needling and in the group receiving lidocaine injections.

One study [28] assessed sleep quality and analgesic intake and showed that dry needling was superior to lidocaine injections for sleep quality, but had similar effects in terms of analgesic use (Table 3).

3.5.3. Dry needling vs. manual therapy or another intervention with needles

Two studies measured PPT and showed contrasting results: one Ziaeifar et al. [45] showed similar effects between both techniques and the other [34] showed dry needling to be superior to manual therapy (Table 4).

Two studies [30,34] measured range of motion and showed dry needling to have significant but similar effects when compared to manual therapy [34] and dry needling intervention plus needling of the multifidus muscle.[30]

Regarding disability, two studies showed significant and equivalent improvement for both dry needling and manual therapy.[34]

Ga et al. [30]showed dry needling intervention plus needling of multifidus muscle to be superior to dry needling alone in improving depressive symptoms.

3.6. Characteristics of the dry needling intervention

The way dry needling was delivered varied across studies (Table 5). Regarding the type of puncture performed (superficial or deep), only five studies indicated which type of puncture was performed and all used deep dry needling.[17,34–36,39] The length of the needles used to deliver the intervention varied between 25 mm [31,37,38] and 60 mm [30]and its diameter varied between 0.22 mm [17] and 0.30 mm.[30,35] Additionally, two studies [32] failed to report on the thickness and length of the needles.

The angle between the needle and the skin during needle insertion was reported only in four studies; two indicated that the insertion was perpendicular to the skin [27,38] and the other two that insertion was oblique to the skin [29,39] (Table 5).

The type of puncture was described in eleven studies and was deep in 9 [27–30,32,34–37] and deep and superficial in two studies.[17,39] The

Table 4
Studies included that compared dry needling vs manual therapy or another intervention with needles.

Author	Interventions compared to DN	Results		Conclusions	PEDro Score
Ga et al. [30]	DN plus needling of multifidus muscle at the C3-C5 level plus self-stretching exercises	Pain intensity	DN: Pre: 7.0 ± 1.3, Day 28: 3.8 ± 2.5, p < 0.001; DN + needling of multifidus: Pre: 6.4 ± 2.1, Day 28: 3.5 ± 2.4, p < 0.001. Between-group difference: p > 0.05	No between group difference	7/10
		ROM (º):	DN: Flexion: Pre: 42.2 ± 9.1, Day 28: 68.9 ± 11.2, p < 0.001; Tilting: Pre: 50.6 ± 13.2, Day 28: 70.0 ± 13.0, p < 0.001; Rotation: Pre: 136.1 ± 17.7, Day 28: 148.1 ± 18.1, p = 0.012; DN + needling of multifidus: Flexion: Pre: 49.1 ± 10.1, Day 28: 78.2 ± 7.8, p < 0.001; Extension: Pre: 64.1 ± 16.1, Day 28: 72.5 ± 13.5, p = 0.007; Tilting: Pre: 58.9 ± 21.2, Day 28: 84.8 ± 22.6, p < 0.001; Rotation: Pre: 138.2 ± 24.9; Day 28: 155.7 ± 20.3, p = 0.002. Between-group difference: days 7, 14, and 28: p > 0.05		
		Depression symptoms	DN: Pre: 5.4 ± 3.2, Day 28: 4.2 ± 3.7, p = 0.085; DN + needling of multifidus: 5.4 ± 3.6, Day 28: 3.9 ± 3.2, p = 0.024	DN with needling of multifidus superior to DN alone	
Ziaeifar et al. [45]	Trigger point manual compression (TPMC)	Pain intensity:	DN: Pre: 6.6 ± 1. 6, Post: 1.3 ± 1.9, p < 0.001 TPMC: Pre: 6.2 ± 1.3, Post: 3.1 ± 2.3, p < 0.001 Between-group difference: p = 0.01	DN superior to sustained compression	7/10
		PPT (Kg/cm^2):	DN: Pre: 10.6 ± 4.0, Post: 16.4 ± 4.7, p < 0.001 TPMC: Pre: 10.9 ± 3.9, Post: 14.5 ± 4.4, p < 0.001 Between-group difference: p = 0.08	No between group difference	
		Disability	DN: Pre: 24.7 ± 10.81. Post: 12.81 ± 10.1, p = 0.001; TPMC: Pre:26.44 ± 8.56. Post: 16.9 ± 11.6, p = 0.006; Between-group difference: p = 0.34		
Llamas-Ramos et al. [34]	Manual therapy (MT) with MTrP pressure release plus stretching of the upper trapezius muscle	Pain intensity:	DN: Pre-post: −4.3 (95%CI: −4.7, −3.9), p < 0.01; Pre-1 wk: −4.9 (95%CI: −5.3, −4.5), p < 0.01; Pre-2 wk: −5.3 (95%CI: −5.7, −5.9), p < 0.01 MT: Pre-post: −4.0 (95%CI: −4.5, −3.4), p < 0.01; Pre-1 wk: −4.6 (95%CI: −5.1, −4.1), p < 0.01; Pre- 2wk: −5.2 (95%CI: −5.6, −4.7), p < 0.01 Between-group difference: Post: 0.3 (95%CI: −0.3, 1.0); 1wk: 0.3 (95%CI: −0.2, 0.9); 2wk: 0.1 (95%CI: −0.4,0.7); p > 0.05	No between group difference	9/10
		PPT (KPa):	Between-group difference: immediately post: 59.0 (95%CI: 40.0, 69.2), p < 0.01; 1 wk post: 69.2 (95%CI: 49.5, 79.1), p < 0.01; 2wk post: 78.9(49.5, 89.0), p < 0.01	DN superior to manual therapy	
		ROM (º):	Between-group difference: neck flexion, extension, lateral flexions and rotations: Post,1 wk and 2 wk; p > 0.05	No between group difference	
		Disability	DN: Pre-2 wk: −13.7 (-15.2, −12.2), p < 0.01 MT: Pre-2 wk: −12.8 (-14.3, −11.4), p < 0.01 Between-group difference: 2 wk: p < 0.05		

DN:dry needling; MTrPs: myofascial trigger points; mo: month; p: *p*-value; PPT: pressure pain threshold; ROM: range of motion; wk: week.

movement of the needle in terms of frequency, duration and depth of repetitions was partially reported in three studies.[27,34,36] And no study reported on all these characteristics of needling.

Three studies [27,31,38] did not report on the criteria used to finish treatment. For the remaining, the criteria used to finish treatment were very heterogeneous and included, for instance, various number of twitch responses (to achieve 5 local twitch responses, to achieve 1 local twitch response or to exhaust all the local twitch responses),[29,32] a predetermined number of needle insertions [17,35] or time performing vertical movements with the needle [28] (Table 5). Five studies report on the clinical experience of the person performing dry needling either by indicating the number of years of clinical experience,[28,32,39] training on the dry needling technique [30] or simply by stating that the person was an experienced clinician.[35] No study was considered to adequately characterize the dry needling technique used.

4. Discussion

This systematic review aimed to examine the effectiveness of dry needling in the treatment of MTrPs and to explore the impact of specific aspects of the technique on its effectiveness. Fifteen RCTs that compared dry needling with sham/placebo intervention, no intervention or other interventions were identified and included in this systematic review. Results suggest that dry needling is effective for pain relief in the short term when compared to sham/placebo needling or no intervention.

4.1. Pain intensity

Our review suggests a short-term positive impact of dry needling on pain intensity and insufficient evidence on the long-term effectiveness, in line with the findings of previous systematic reviews.[15,23,42]

Dry needling seems to have a similar effect to pharmacological interventions. Our results are in line with a previous *meta*-analysis examining the effects of dry needling versus lidocaine injections for MTrP of the neck and shoulders.[42] The only study (out of 4) that found a pharmacological intervention to be superior to dry needling scored 5 out of 10 in the PEDro Scale and did not provide information on how the dry needling technique was performed. Furthermore, the absence of differences between dry needling and lidocaine injections were maintained at 14 days and 12 weeks after intervention.[27,29] There was no data on the long-term effectiveness of dry needling compared to pharmacological interventions. These results, contrast with the findings of Liu et al.,[23] who found wet needling to be superior to dry needling in the medium and long term.

The two studies that compared dry needling against manual therapy suggest dry needling to have at least similar effects to manual therapy for pain decrease.

Studies that found a positive effect of dry needling on pain intensity reported mean VAS decreases higher than 1.5, which is higher than 1.2 reported as the minimum clinical important difference in VAS,[33] suggesting that the difference in pain intensity after dry needling is clinically significant.

Table 5
Main characteristics of the intervention.

Author	Thickness and length of needles	Needle inclination	Type of puncture (deep or superficial)	Needle movement(frequency (Hz), duration, depth and/or number of repetitions)	Clinical experience	Criteria to end dry needling intervention
Irnich et **al.32**	-	-	Deep	-	More than 8 years	Until at least one LTR was elicited
Ibuldu et al.31	0.25 x 25 mm	-	-	-	-	-
Kamanli et al.9	0.50 x 32 mm	-	-	-	-	Each point was needled 8 to 10 times
Ga et al30	0.30 x 60 mm	-	Deep	-	Completed the "Trigger Point Injection Training Course" and the "Basic Course for Gunn IMS"	Needled forward and backward to the MTrP until there were no more LTRs
Ay et al.27	0.71 x 32 mm	90º	Deep	The needle was inserted a few times with fan-shaped movements	-	Non indicated
Tsai et al.39	0.5 x 50 mm	After penetration into the subcutaneous layer, it was directed obliquely to the MTrPs	Deep and Superficial	-	More than 10 years	Elicit as many LTRs as possible, until no more LTRs could be elicited. Usually 1–2 mins
Dıraçoğlu et al.17	0.22 x 30 mm	-	Deep and Superficial	-	-	The needle was stimulated 3 or 5 times
Eroğlu et al.29	0.71 x 38or 0.81 x 51 mm	30º	Deep	-	-	Until the LTR was no longer elicited or resistant muscle tautness was no longer perceived
Mayoral et al.35	0.30 x 50 mm	-	Deep	-	A trained and experienced physical therapist (years of experience not given)	20 insertions of the needle in each MTrP
Tekin et al.38	0.25 x 25 mm	90º	-	-	-	The needle was moved forward until the trigger point was reached. The needle was withdrawn immediately after pricking.
Ziaeifar et al.45	-	-	-	-	-	Needled forward and backward to the MTrP until there were no more LTRs
Couto et al28	0.25 x 40 mm	-	Deep	-	More than 6 years	A maximum stimulation time of 1 minute per MTrP and 3 minutes for multiple deep intramuscular stimulation
Mejuto et al.36	0.30 x 30 mm	10-15 mm	Deep	2-3 mm vertical motions with no rotations at approximately 1 Hz	More than 5 years	Once the first LTR was obtained, vertical motions for 25 to 30 s
Llamas et al.34	0.30 x 30 mm	10-15 mm	Deep	2-3 mm vertical motions with no rotations at approximately 1 Hz	More than 6 years	Once the first LTR was obtained, vertical motions for 25 to 30 s
Pecos et al.37	0.25 x 25 mm	-	Deep	-	12 years	Needle insertions were repeated 8 to 10 times

Hz: Hertz; IMS: Intramuscular Stimulation; LTR: Local Twitch Response; mm: milimeters; MTrP: Myofascial Trigger Point.

4.2. Secondary outcomes

Compared to sham/placebo, dry needling seems effective in the short term for increasing PPTs, improving quality of life and for increasing range of motion in the neck and shoulder, but not in the temporomandibular joint and knee. There is insufficient evidence on its effect for disability, analgesic medication intake and sleep quality. Dry needling has similar effects to pharmacological interventions for range of motion and quality of life; there is conflicting evidence for its effect on PPT and depressive symptoms and insufficient evidence for sleep quality and analgesic intake. Dry needling has similar effects to manual therapy for pressure pain threshold, range of motion and disability.

4.3. Aspects of the dry needling procedure

As previously referred, one of the aims of this review was to explore whether aspects of the technique, such as type of needling, type of movement performed or duration of the needling, could have an impact on its effectiveness. However most of the included studies give insufficient information on how they performed the dry needling technique. Nevertheless, the absence of a standardized way to describe and apply dry needling is one of the main findings of this systematic review and highlights the need to describe the procedure in a way that it could be replicated.

Conceivably, the amount of stimulation could have an important therapeutic effect. Investigating whether different aspects of the technique, for example the depth of the needle insertion, the angle of insertion, the number and frequency of insertions are associated to the dry needling effects can contribute to standardize the procedure and eventually to the development of guidelines that increase the effectiveness of this procedure in line with what has been done for acupuncture.[43]

There seems to be no association between the number of sessions and pain relief as 6 sessions [38] seem to have similar effects in terms of pain relief to one session [36,39] or two sessions.[34] Similarly, applying dry needling 3 times per week,[17] seems to have similar effects to applying dry needling once per week for two weeks [34] or once a week for 4 weeks.[31] It seems that the effects of dry needling in terms of pain decrease occur with a small number of sessions (1 or 2) and remain up to 4 weeks after the intervention.[35,37] In addition, using twitch responses as a criterion to end the technique seems to have similar results to ending after 8–10 needle insertions [37] or after 20 needle insertions [35] with no mention to any twitch response. This is in contrasts with the recommendations from Hong,[44] who states that local twitch responses are essential to obtain the best results for pain relief.

Regarding, depth of needle insertion it was not clear whether depth was defined before the intervention or whether it was based on tissue response when the needle was inserted. Some authors refer the need to elicit local twitch responses.[27–30,32] In the study of Pecos-Martin et al.,[37] it is reported that the needle is inserted into the MTrPs using fast-in fast-out movements, but it is not clear if the technique used is consistent with the technique described by Hong.[44,1] In contrast, other studies state specifically that the technique used was the Hong technique [35,39] and the depth of needle insertion (10–15 mm).[34,36]

Tsai et al. [39] and Diracoglu et al. [17] are the only studies that made a direct comparison between deep and superficial needling with conflicting results. Recently, Couto et al. [28] have highlighted the need to report on the location of needling, depth and rotation of the needle as technical aspects of dry needling that may help differentiate between deep and superficial needling and that might impact the results. For example, it has been shown that needle rotation increases the magnitude of hypoalgesia for acupuncture needle.[45]

4.4. Limitations

The heterogeneity of studies prevented meta-analysis in line with Cochrane Collaboration guidelines.[46] In addition, the incomplete description on how dry needling was applied limited our ability to assess the potential impact of aspects of the procedure on its effectiveness.

4.5. Clinical and research implications

Dry needling can be cautiously recommended to improve pain and range of motion (in the neck and shoulder) in the short term if compared to sham/placebo/no intervention or as an equivalent treatment option to pharmacological interventions. Nevertheless, the reduced number of studies precludes any firm recommendation.

Future studies should investigate the association between individual aspects of the dry needling procedure and its effects so that guidelines on how to apply dry needling to maximize its effectiveness are produced. Meanwhile, studies should describe dry needling in a way that it could be replicated, including the characteristics of the needle, needle inclination, type and depth of the puncture, movement of the needle (e.g. twisting, frequency of needling), duration of treatment and number of MTrPs treated. It seems also relevant to report on how MTrPs were identified and the clinical experience of the clinician using the procedure. Furthermore, larger, multicentric high quality randomized clinical trials that compare dry needling against other treatment interventions commonly used for musculoskeletal interventions, such as manual therapy or therapeutic exercise, are clearly needed.

5. Conclusions

Despite some evidence that dry needling can have a positive effect in the short term on pain, range of motion and quality of life when compared to sham/placebo/no intervention, and similar effects to pharmacological interventions, further randomized clinical trials of high methodological quality, using standardized procedures for dry needling application are needed.

Conflict of interest statement

None declared

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