

## SYSTEMATIC REVIEW

# The effectiveness of dry needling for patients with orofacial pain associated with temporomandibular dysfunction: a systematic review and meta-analysis



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### KEYWORDS

Dry needling;  
Orofacial pain;  
Temporomandibular disorder;  
Myofascial pain;  
Trigger point

### Abstract

**Background:** Orofacial pain of myofascial origin is often associated with temporomandibular joint dysfunction, affects chewing muscles and may lead to functional limitations. Dry needling is an intervention commonly used for inactivating myofascial pain trigger points.

**Objective:** To systematically review the effects of dry needling on orofacial pain of myofascial origin in patients with temporomandibular joint dysfunction.

**Methods:** This systematic review has pain intensity as primary outcome. Searches were conducted on April 13th, 2018 in eight databases, without publication date restrictions. We selected randomized controlled trials published in English, Portuguese, or Spanish, with no restrictions regarding subject ethnicity, age or sex.

**Results:** Seven trials were considered eligible. There was discrepancy among dry needling treatment protocols. Meta-analysis showed that dry needling is better than other interventions for pain intensity as well as than sham therapy on pressure pain threshold, but there is very low-quality evidence and a small effect size. There were no statistically significant differences in other outcomes.

**Conclusion:** Clinicians can use dry needling for the treatment of temporomandibular joint dysfunction, nevertheless, due the low quality of evidence and high risk of bias of some included studies, larger and low risk of bias trials are needed to assess the effects of dry needling on orofacial pain associated with temporomandibular joint dysfunction.

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## Introduction

Orofacial pain is a condition that affects both the soft and mineralized tissue of the oral cavity and face.<sup>1</sup> Myofascial pain is the second most recurrent type of orofacial pain, it is estimated that 33% of people have symptoms in the face and chewing muscles.<sup>1</sup> This condition is frequently associated with temporomandibular joint dysfunction (TMD), which also involves chewing muscles, periauricular area and related structures.<sup>2</sup> The incidence of TMD in the United States is estimated in 3.9% per year,<sup>3</sup> and the prevalence of pain related TMD in the Brazilian population is 25.6%.<sup>2</sup>

It is generally assumed that myofascial pain related to TMD<sup>4</sup> may originate from trigger points (TP), which are characterized by hypersensitivity of a palpable nodule or taut band and pain due to local muscle contraction, which can reduce range of motion.<sup>5</sup>

The treatment of myofascial pain is often based on inactivating the TP,<sup>6</sup> and therefore, a number of non-invasive methods have been used, including ischemic compression, passive stretching, transcutaneous electrostimulation nerve stimulation, massage, biofeedback, ultrasound, infrared laser, and cognitive behavioral therapy.<sup>7,8</sup>

In addition to these methods, a minimally invasive technique called dry needling (DN) has been developed in recent decades.<sup>7</sup> DN involves applying sterile monofilament needles that penetrate the skin and muscles, stimulating points underlying the TP region in order to regulate neuromuscular pain and movement deficits.<sup>1</sup>

Despite the widespread use of DN, there is no conclusive evidence of its effectiveness for treating orofacial pain related to the chewing muscles.<sup>9</sup> We aimed to systematically review to investigate the effects of DN on orofacial pain of myofascial origin in patients with TMD.

## Methods

To summarize the evidence about DN and orofacial pain, a systematic review of randomized controlled trials was conducted. We followed the recommendations of Cochrane Handbook for Systematic Reviews of Interventions<sup>10</sup> as well as the tutorial of systematic reviews of the Brazilian Journal of Physical Therapy.<sup>11</sup> This systematic review was prospectively registered on the PROSPERO database (CRD42017048449).

### Eligibility criteria

To be considered eligible for this systematic review, the studies had to be randomized controlled trials comparing DN with placebo/sham therapy or other interventions, published in English, Spanish or Portuguese, and had to address the effects of DN on orofacial pain of myofascial pain origin, without restrictions on publication date or on subject age, sex or ethnicity. Exclusion criteria included acupuncture or wet needling in the intervention group, the inclusion of subjects with neurologic, rheumatic, vascular, metabolic or neoplastic diseases or the involvement of surgical procedures in the orofacial region.

## Search strategy

The search was conducted on April 13th, 2018 in MEDLINE (via Pubmed), LILACS (via BVS), CINAHL (via EBSCO), Physiotherapy Evidence Database (PEDro), The Cochrane Central Register of Controlled Trials (by using Cochrane CENTRAL), SCOPUS, Web of Science and ProQuest.

Initially, a search was performed in Pubmed using the following search strategy: ((((((acup\*) OR needles[MeSH Terms]) OR dry needling) AND facial pain[MeSH Terms]) OR temporomandibular joint disorder[MeSH Terms]) OR trigger points[MeSH Terms]) OR myofascial pain syndrome[MeSH Terms] AND (randomized controlled trial[Publication Type] OR (randomized[Title/Abstract] AND controlled[Title/Abstract] AND trial[Title/Abstract])). After this trial, the search strategy was deemed adequate for use in the other databases.

## Study selection

In order to identify potentially eligible studies, two reviewers (MBA and MLN) independently selected the articles. After the articles had been selected according to title, the abstracts were analyzed, and articles meeting the eligibility criteria were read in full. The reviewers compared the studies and, in case of disagreement, a third reviewer (MAB) arbitrated. Any disagreements about a study's eligibility were decided by a consensus meeting.

## Data collection process

Two reviewers extracted the data from eligible studies independently using a standard form for data extraction. All analyses were conducted in Review Manager (RevMan) software (version 5.3; The Nordic Cochrane Centre, Copenhagen, Denmark).<sup>12</sup> The following information was extracted: authors; year of publication; study objective, characteristics of the participants (sex, age, diagnosis, symptom length); description of the intervention and control groups; description of outcomes (orofacial pain assessment instruments, pressure pain threshold (PPT) and pain-free maximum mouth opening (MMO)), type of comparison, description of the results, follow-up and studies included and excluded in the meta-analysis. The data extracted from all included studies are shown in [Table 1](#).

## Risk of bias in individual and across studies

The studies were evaluated individually for their risk of bias. The risk of bias was assessed using the Cochrane Collaboration risk of bias assessment tool, which rates studies as high, low or unclear risk of bias.<sup>10,13</sup> Two reviewers (CV and MBA) assessed randomization, allocation, blinding, incomplete data outcome, selective reporting and other bias, the assessment was standardized following the Cochrane Handbook for Systematic Reviews of Interventions.<sup>10</sup> In case of any disagreement, it solved by discussion, if the disagreement persists, a third assessor (MAB) arbitrated.

**Table 1** Summary of randomized clinical trials included in the review.

| Study, year                               | Participants   | Intervention group   | Intervention protocol                         | Comparison group  | Outcome measure           | Results  | Follow-up                 | Meta-analysis |
|---|--|--|---|---|---------------------------|--|---------------------------|---------------|
| Gonzalez-Perez et al., 2015 <sup>20</sup> | <i>n</i> = 48; 19F; 5M<br>Age: 18–65<br>Pain: ≥6 m     | DN lateral pterygoid.  | LTN: 1 min<br>Freq: 1 p/w<br>Duration: 3 w    | Methocarbamol; paracetamol.   | Pain intensity. MMO.      | Pain intensity 28 d ( <i>p</i> < 0.001); 70 d ( <i>p</i> = 0.011). MMO ( <i>p</i> > 0.05). | 28/70 d                   |               |
| Silva et al., 2012 <sup>21</sup>          | <i>n</i> = 20; 20F<br>Age: NS<br>Pain: NS              | DN masseter.   | LTN: NS<br>Freq: 1                            | DN; lidocaine injection.  | Pain intensity. PPT. MMO. | Pain intensity ( <i>p</i> > 0.05). PPT ( <i>p</i> > 0.05).                                 | 24 h<br>7/15 d<br>21/30 d |               |
| Itoh et al., 2012 <sup>22</sup>           | <i>n</i> = 16; 5F; 11M<br>Age: 19–24<br>Pain: ≥6 m     | DN masseter, temporalis, lateral pterygoid, DM, SM, SCM, TM. | LTN: 30 min<br>Freq: 1 p/w<br>Duration: 5 w   | Sham DN.  | Pain intensity. MMO.      | Pain intensity ( <i>p</i> = 0.003). MMO ( <i>p</i> = 0.236).                               | 5/10 w                    | X             |
| Diraçoğlu et al., 2012 <sup>16</sup>      | <i>n</i> = 52; 45F; 7M<br>Age: 18–57<br>Pain: ≥1 m e ½ | DN masseter, temporalis. Pain education.                     | LTN: NS<br>Freq: 1 p/w<br>Duration: 3 w       | Sham DN. Pain education.  | Pain intensity. PPT. MMO. | Pain intensity ( <i>p</i> = 0.478). PPT ( <i>p</i> < 0.001). MMO ( <i>p</i> = 0.411).      | 10 w                      |               |
| Fernandez et al., 2010 <sup>17</sup>      | <i>n</i> = 12F<br>Age: 20–41<br>Pain: ≥6 m             | DN masseter.   | LTN: NS.<br>Freq: 1 p/w<br>Duration: 2 w      | Sham DN.  | Pain intensity. PPT. MMO. | Pain intensity ( <i>p</i> < 0.001). PPT ( <i>p</i> < 0.001). MMO ( <i>p</i> < 0.001).      | X                         |               |
| McMillian et al., 1997 <sup>18</sup>      | <i>n</i> = 30F<br>Age: 20–50<br>Pain: ≥3 m             | DN masseter; sham procaine injection.                        | LTN: 1–2 min.<br>Freq: 1 p/w<br>Duration: 3 w | G1: Procaine injection; sham DN.<br>G2: Sham DN; sham procaine injection.   | Pain intensity. PPT.      | Pain intensity ( <i>p</i> > 0.05). PPT ( <i>p</i> > 0.05)                                  | X                         |               |
| Uemoto et al., 2013 <sup>19</sup>         | <i>n</i> = 21F<br>Age: 20–52<br>Pain: NS               | DN right masseter; lidocaine injection; SOM 10's.            | LTN: NS<br>Freq: 3<br>(72/48/72 h)            | G1: Laser masseter right (do: 4 J/cm <sup>2</sup> ); left (do: 8 J/cm <sup>2</sup> ); SOM 10's.<br>G2: placebo laser; SOM 10's. | Pain intensity. PPT. MMO. | There was no comparison between groups.  | X                         | X             |

m, months; NS, no specified; DM, digastric muscle; SM, splenius muscle; SCM, sternocleidomastoid muscle; TM, trapezius muscle; LTN, length of time of the needle; Freq, frequency; p/, per; w, week; D, day; do, dose; G, comparison group; SOM, stretching open mouth; PPT, pressure pain threshold; MMO, pain-free mouth opening.

Thereafter, the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system was used to measure the quality of evidence of each outcome. The GRADE system consists of five items: (1) study limitations (risk of bias); (2) inconsistency of results (heterogeneity); (3) indirectness of evidence; (4) imprecision of the effect estimates and (5) reporting bias. The quality of the evidence was classified into four categories: high, moderate, low and very low.<sup>14</sup> The assessment were made by two reviewers (CV and MBA) and if any disagreement were found, it was discussed, if there was no agreement between the reviewers, a third reviewer (MAB) arbitrated. The criteria used to downgrade the quality of evidence was based on informations given by the GRADE system and on the recommendations made by Atkins et al.<sup>15</sup> and Balslem et al.<sup>14</sup>

## Summary measures

For this systematic review the pain intensity was considered as primary outcome, PPT and pain-free MMO were considered as secondary outcomes.

## Synthesis of results

Data analyses were performed to determine the treatment effects of DN compared to sham therapy or other interventions. When necessary, the outcome measures were converted to a 10-point scale of orofacial pain intensity, Newtons or pounds were converted to kg/cm<sup>2</sup> for PPT and MMO was converted to a 100mm scale. The mean differences (MD) and 95% Confidence Interval (CI) were then computed. Analyses were carried out at 3 assessment points, with data from the included studies classified according

to the following intervals: (1) short-term follow-up (up to 3 months), (2) medium-term follow-up (3–6 months), and (3) long-term follow-up (beyond 6 months). Results with  $p$ -values lower than 0.05 were considered statistically significant. Clinical relevance was determined according to the effect size: small = MD < 1 (i.e. 1 point in NPRS or 10% of 10-mm VAS), medium = MD < 2 and large = MD  $\geq$  2.

## Meta-analysis

Meta-analysis of data across trials was conducted when the studies reported the same outcomes and used similar outcome measures that could be transformed to an equivalent unit measure. Review Manager (RevMan) software (version 5.3; The Nordic Cochrane Centre, Copenhagen, Denmark)<sup>12</sup> was used to conducted the meta-analysis.

## Heterogeneity of studies

Heterogeneity among studies was reported using the  $I^2$  statistic, defined in the Cochrane handbook as follows: 0–40% might not be important; 30–60% may represent moderate heterogeneity; 50–90% may represent substantial heterogeneity; 75–100% represents considerable heterogeneity.

## Results

### Study selection

As summarized in Fig. 1, a total of 3889 studies were found and 428 duplicates were removed. The 3461 remaining studies were filtered by title and abstract, of which seven articles were selected for full reading. Thus, seven<sup>16–22</sup> articles met the eligibility criteria and were included in this

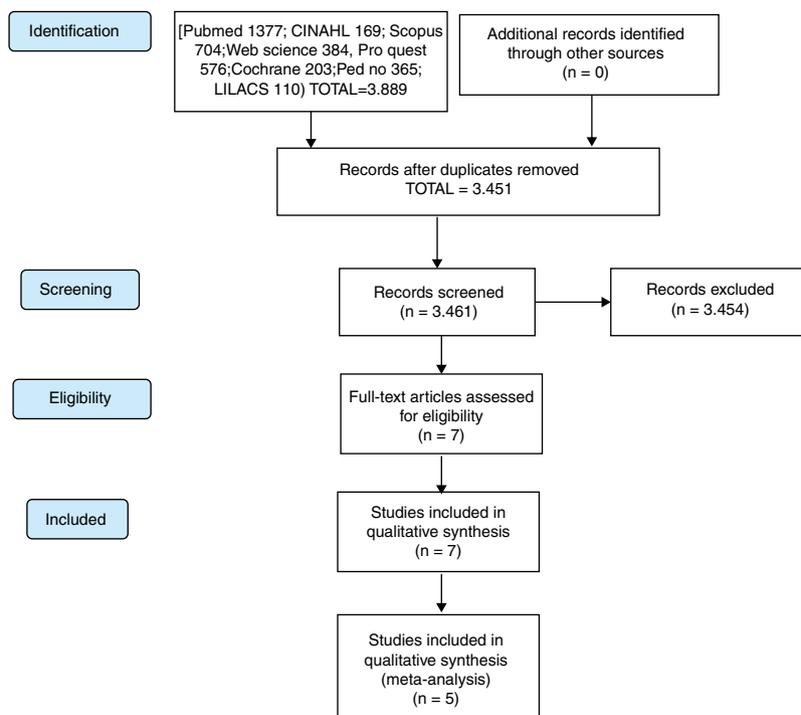


Figure 1 Flow diagram of included articles.

review, although only five<sup>16,21</sup> were included in the meta-analysis, since the data in two studies<sup>19,22</sup> was insufficient. All authors were contacted by email to clarify questions about their data, although, unfortunately, none responded.

## Study characteristics

The studies were published between 1997 and 2015. Their sample sizes ranged from 12 to 52 individuals (pooled  $n=199$ ) whose ages ranged from 18 to 65 years. Myofascial TMD was diagnosed using the following instruments: Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD),<sup>17,20,21,23</sup> HELKIMO – Clinical Dysfunction for Temporomandibular Disorders Index I e III,<sup>22</sup> the International Headache Society's myofascial pain classifications<sup>18</sup> and algometry.<sup>16</sup> The duration of orofacial pain symptoms ranged from 1½ months to 5 years. Follow-up ranged from 24 h to 10 weeks.

The studies involved several types of DN protocols. The duration of DN treatment was detailed in only three studies (1–2 min<sup>18,20</sup> and 30 min<sup>22</sup>). The response to needle manipulation was only specified in three studies,<sup>17,20,22</sup> i.e. therapist-verified involuntary local muscle contraction after TP needling. DN intervention lasted one,<sup>21</sup> three,<sup>16,18,20</sup> four<sup>19</sup> or five<sup>22</sup> sessions, with one weekly session being the most prevalent frequency.<sup>16,20–22</sup> Unfortunately, the poor

description of interventions is very common in papers, but it must be avoided and the researchers should start to use TIDiER checklist to do not forget any information about their interventions.<sup>24</sup>

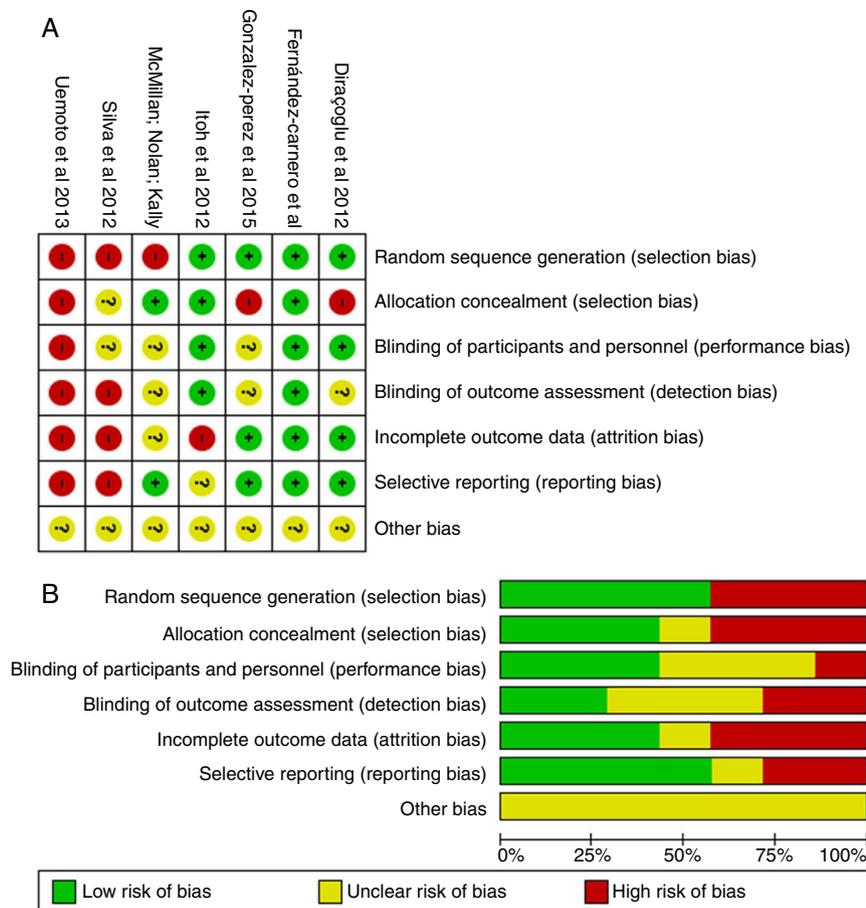
All studies assessed pain intensity with the Visual Analogue Scale (VAS)<sup>16,18,20–23</sup> or the Numeric Pain Rating Scale (NPRS).<sup>17</sup> PPT was measured with algometry, although two studies<sup>20,22</sup> did not evaluate this outcome. Pain-free MMO measurement was performed with a millimeter ruler<sup>16,17,20,22</sup> or caliper,<sup>19</sup> although two studies<sup>18,21</sup> did not assess MMO.

Only five studies<sup>16,22</sup> compared DN with sham/placebo. DN was also compared with an methocarbamol (380 mg) and paracetamol (300 mg),<sup>20</sup> lidocaine injection<sup>21</sup> and procaine injection.<sup>18</sup> Uemoto et al.,<sup>19</sup> who used infrared laser in their control group, did not compare it with DN and were thus excluded from the meta-analysis.

All study characteristics and the results of the individual studies are shown in Table 1.

## Risk of bias within studies

The risk of bias in the included articles was considered high, as shown in Fig. 2(A). The main risk of bias was related to the blinding of outcome assessment.



**Figure 2** Risk of bias summary: review authors' judgements about each risk of bias item for each included study (A) and about each risk of bias item presented as percentages across all included studies (B).

### Risk of bias across studies

The risk of bias across studies is shown in Fig. 2(B). Random sequence generation, allocation concealment and incomplete outcome data were the most prevalent risk of bias across the eligible trials.

### Quality of evidence

Quality assessment is shown in Fig. 3. Study quality was assessed using the GRADE system, which indicated very low quality with serious or very serious methodological problems. Due to missing data, it was not possible to use all the articles to assess any single outcome; at least two were removed in each case (Fig. 3).

### Synthesis of the results

#### Dry needling vs. sham

**Pain intensity.** There is very low quality evidence that no statistically significant difference was found between DN and sham for short-term orofacial pain (two trials, pooled  $n = 70$ ; MD = 0.30; 95% CI = -0.83 to 1.43;  $I^2 = 24\%$ ) (Fig. 4A). It was not possible to conduct a meta-analysis of the medium- and long-term effects. Other 2 studies<sup>22,25</sup> assessed this outcome but they were not part of meta-analyses due inconsistency of data, one of these studies<sup>22</sup> finding a significant reduction in pain ( $\rho = 0.003$ ) in the DN group compared to sham.

**Pressure pain threshold.** There is very low quality evidence that DN was better than sham therapy for PPT in the short-term (three trials, pooled  $n = 82$ ; MD = 0.56; 95% CI = 0.31 to 0.81;  $I^2 = 55\%$ ) (Fig. 4B), however, the effect size in favor

A

| Certainty assessment  |                   |                      |                      |                      |                           |                      | N: of patients |      | Effect            |   | Certainty        | Importance |
|---|-------------------|----------------------|----------------------|----------------------|---------------------------|----------------------|----------------|------|-------------------|---|------------------|------------|
| N: of studies   | Study design      | Risk of bias         | Inconsistency        | Indirectness         | Imprecision               | Other considerations | Dry Needling   | Sham | Relative (95% CI) | Absolute (95% CI)                           |                  |            |
| Orofacial Pain (assessed with: NPRS; Scale from: 0 to 10)             |                   |                      |                      |                      |                           |                      |                |      |                   |   |                  |            |
| 5   | randomised trials | serious <sup>a</sup> | serious <sup>b</sup> | serious <sup>c</sup> | very serious <sup>d</sup> | none                 | 55             | 56   | -                 | MD 0.54 higher (1.41 lower to 1.44 higher)  | ⊕○○○<br>VERY LOW | CRITICAL   |
| Pressure Pain Threshold (assessed with: Algometer)                    |                   |                      |                      |                      |                           |                      |                |      |                   |   |                  |            |
| 4   | randomised trials | serious <sup>a</sup> | serious <sup>b</sup> | serious <sup>c</sup> | serious <sup>e</sup>      | none                 | 48             | 48   | -                 | MD 8.77 higher (1.12 lower to 12.46 higher) | ⊕○○○<br>VERY LOW | IMPORTANT  |
| Maximum Mouth Opening (assessed with: ruler/mm; Scale from: 0 to 100) |                   |                      |                      |                      |                           |                      |                |      |                   |   |                  |            |
| 4   | randomised trials | serious <sup>f</sup> | serious <sup>b</sup> | serious <sup>c</sup> | very serious <sup>g</sup> | none                 | 45             | 46   | -                 | MD 1.74 higher (0.46 lower to 3.07 higher)  | ⊕○○○<br>VERY LOW | CRITICAL   |

CI: Confidence interval; MD: Mean difference

#### Explanations

- a. Two of the included articles did not specify the type of sequence generation process (McMillan et al; Uemoto et al.). Incomplete reports of the results, absence of intention-to-treat analyse.
- b. Small sample size of the studies, there was divergence among the treatments doses and also among control treatments.
- c. There are indirect evidences about intervention, comparator and direct comparison.
- d. Only two studies (Diraçoğlu et al and McMillan et al) had enough data to calculate Cohen's d Test.
- e. Three studies (McMillan et al; Diraçoğlu et al and Fernández-Cárnero et al) had enough data to calculate Cohen's d Test.
- f. One of the included articles did not specify the type of sequence generation process (Uemoto et al.). Incomplete reports of the results, absence of intention-to-treat analyse.
- g. Two studies (Diraçoğlu et al and Fernández-Cárnero et al) had enough data to calculate Cohen's d Test.

B

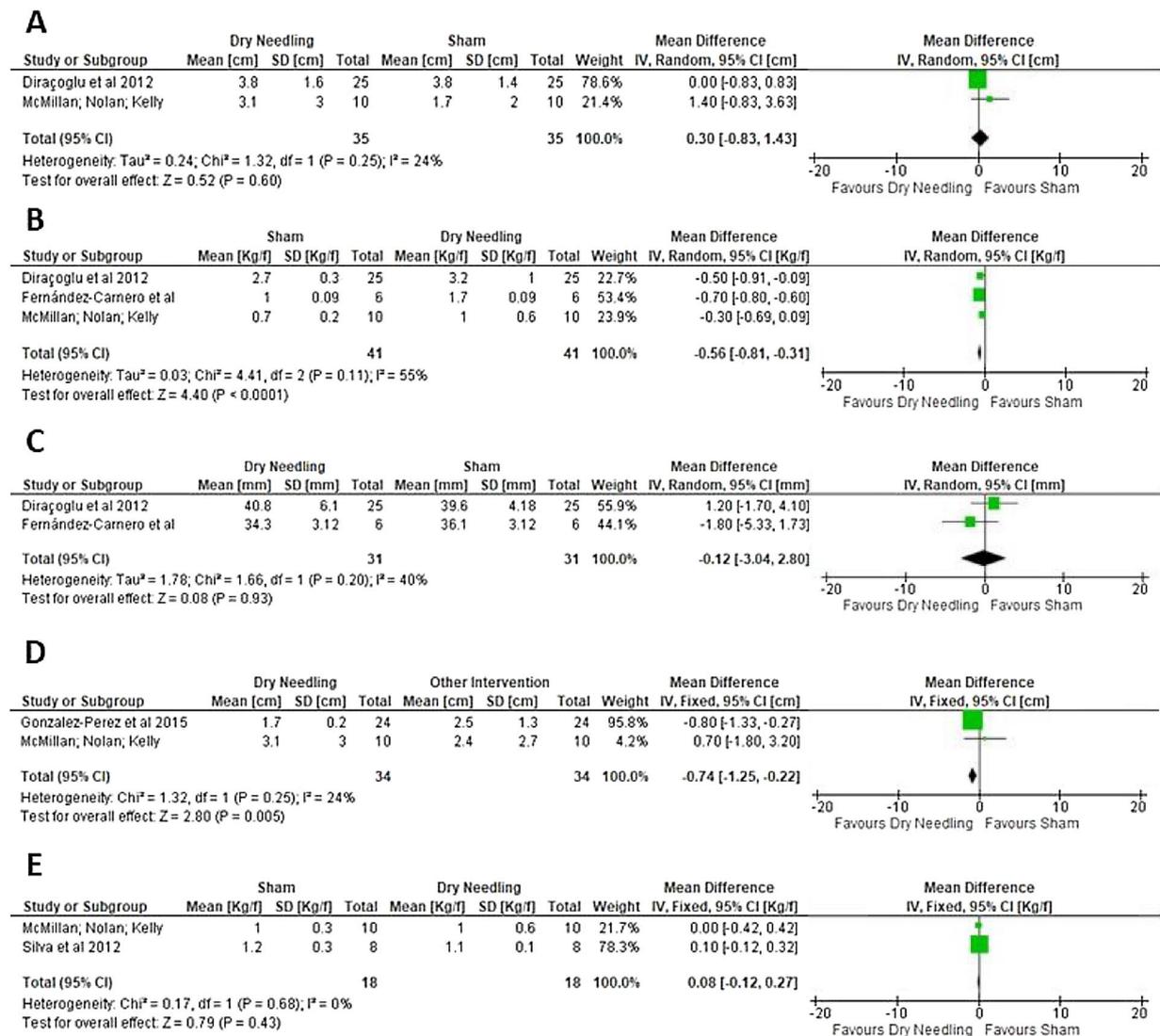
| Certainty assessment  |                   |                      |                      |                      |                           |                      | N: of patients |                    | Effect            |   | Certainty        | Importance |
|---|-------------------|----------------------|----------------------|----------------------|---------------------------|----------------------|----------------|--------------------|-------------------|---|------------------|------------|
| N: of studies   | Study design      | Risk of bias         | Inconsistency        | Indirectness         | Imprecision               | Other considerations | dry needling   | other intervention | Relative (95% CI) | Absolute (95% CI)                           |                  |            |
| Orofacial Pain (assessed with: NPRS; Scale from: 0 to 10)             |                   |                      |                      |                      |                           |                      |                |                    |                   |   |                  |            |
| 4   | randomised trials | serious <sup>a</sup> | serious <sup>b</sup> | serious <sup>c</sup> | very serious <sup>d</sup> | none                 | 49             | 49                 | -                 | MD 0.24 higher (1.41 lower to 1.12 higher)  | ⊕○○○<br>VERY LOW | CRITICAL   |
| Pressure Pain Threshold (assessed with: Algometer)                    |                   |                      |                      |                      |                           |                      |                |                    |                   |   |                  |            |
| 3   | randomised trials | serious <sup>a</sup> | serious <sup>b</sup> | serious <sup>c</sup> | very serious <sup>e</sup> | none                 | 25             | 25                 | -                 | MD 0.14 higher (1.12 lower to 0.87 higher)  | ⊕○○○<br>VERY LOW | IMPORTANT  |
| Maximum Mouth Opening (assessed with: ruler/mm; Scale from: 0 to 100) |                   |                      |                      |                      |                           |                      |                |                    |                   |   |                  |            |
| 2   | randomised trials | serious <sup>f</sup> | serious <sup>b</sup> | serious <sup>c</sup> | serious <sup>g</sup>      | none                 | 31             | 31                 | -                 | MD 0.73 higher (0.15 higher to 1.32 higher) | ⊕○○○<br>VERY LOW | CRITICAL   |

CI: Confidence interval; MD: Mean difference

#### Explanations

- a. Silva et al did not specify the type of sequence generation process. Incomplete reports of the results, absence of intention-to-treat analyse.
- b. Small sample size of the studies, there was divergence among the treatments doses and also among control treatments.
- c. There are indirect evidences about intervention, comparator and direct comparison.
- d. Only two studies (González et. al; McMillan et al) had enough data to calculate Cohen's d Test.
- e. Only one study (McMillan et al) had enough data to calculate Cohen's d Test.
- f. One of the included articles did not specify the type of sequence generation process (Uemoto et al.). Incomplete reports of the results, absence of intention-to-treat analyse.
- g. One study (González et al) had enough data to calculate Cohen's d Test.

Figure 3 Quality of evidence (GRADE) between Dry Needling versus Sham (A), and Dry Needling versus Other Interventions (B).



**Figure 4** Effect of Dry Needling vs. Sham Therapy on Pain (A), Pressure Pain Threshold (B) and Pain-free Maximum Mouth Opening (C), and effect of Dry Needling vs. Other Interventions on Pain (D) and Pressure Pain Threshold (E).

of DN was considered small ( $MD < 1$ ). It was not possible to conduct a meta-analysis of medium-term and long-term PPT effects because no study evaluated them. Itoh et al.,<sup>22</sup> did not assess this outcome.

**Pain-free maximum mouth opening.** There is very low quality evidence that no between-group difference was found in short-term pain-free MMO (2 trials, pooled  $n = 62$ ;  $MD = 0.12$ ;  $95\% \text{ CI} = -3.04 \text{ to } 2.80$ ;  $I^2 = 40\%$ ) (Fig. 4C). Medium- and long-term meta-analysis were not possible to be calculated due any study assessed these follow-ups. Itoh et al.,<sup>22</sup> assessed pain-free MMO although they did not find difference between groups ( $p > 0.05$ ). McMillan et al.,<sup>18</sup> did not assessed this outcome.

#### Dry needling vs. other interventions

**Pain intensity.** There is very low quality evidence that DN was better than other interventions for short-term pain (2 trials,  $n = 68$ ;  $MD = -0.74$ ;  $95\% \text{ CI} = -1.25 \text{ to } -0.22$ ;  $I^2 = 24\%$ ) (Fig. 4D), however, the effect size of the treatment was considered small ( $MD < 1$ ). Meta-analysis for medium- and

long-term effects was not possible due to the lack of data. Another two trials<sup>19,21</sup> assessed this outcome, however due the lack of data, they were not included in the meta-analysis. Uemoto et al.,<sup>19</sup> found an improvement in pain intensity after DN ( $p = 0.03$ ), nonetheless Silva et al.,<sup>21</sup> did not find significant improvement in this outcome ( $p > 0.05$ ). **Pressure pain threshold.** There is very low quality evidence that there was no statistically significant difference between DN and other interventions for short-term PPT (two trials, pooled  $n = 36$ ;  $MD = -0.08$ ;  $95\% \text{ CI} = -0.27 \text{ to } 0.12$ ;  $I^2 = 0\%$ ) (Fig. 4E). Meta-analysis was not performed for medium- or long-term effects due to the lack of data on these time-points. One trial<sup>19</sup> also assessed PPT but it was not included in the meta-analysis due to the lack of data. González-Pérez et al.,<sup>20</sup> did not assessed this outcome.

**Pain-free maximum mouth opening.** Meta-analysis of DN and other interventions in the short-term, medium-term and long-term for pain-free MMO was impossible. One study<sup>20</sup> assessed this outcome but due lack of data it was impossible

to run a meta-analysis. The quality evidence of this outcome was also classified as “very low quality” by the GRADE.

## Discussion

This systematic review and meta-analysis of 7 trials (pooled  $n=199$  individuals) investigated the effectiveness of DN compared to sham therapy,<sup>16,19–22</sup> other interventions (lidocaine injection,<sup>20–22</sup> procaine injection)<sup>18</sup> or combination drug therapy (methocarbamol and paracetamol)<sup>20</sup> for orofacial pain, PPT, disability and pain-free MMO in subjects with TMD-related myofascial pain. We found very-low-quality evidence that: (1) compared with sham therapy, DN increases PPT in the short-term, and (2) DN is more effective than other interventions at decreasing pain intensity.

Nevertheless, meta-analysis regarding DN and other interventions could only be applied at short-term follow-ups. No meta-analysis was possible for disability and pain-free MMO due to insufficient data. No statistically significant differences were found between DN and sham therapy in the short-term for pain or pain-free MMO. When DN was compared with other interventions for PPT, the same result was found. However, significant differences were found for PPT when DN was compared with sham therapy and for pain intensity when DN was compared with other interventions. These results suggest that DN increases PPT compared with sham therapy and decreases pain intensity compared to other interventions (lidocaine injection and combination drug therapy (methocarbamol and paracetamol)). Finally, no meta-analysis could be conducted for medium- or long-term effects in any outcome because none of the studies assessed medium or long-term follow-up.

Studies in this review that used sham therapy applied needles near the TP site. There is evidence that DN applied in the muscle belly or in the subcutaneous region of the fascia has effects on pain modulation in myofascial syndrome.<sup>26–28</sup> However, it is not clear whether DN is superior to placebo.<sup>7</sup> Similarly, studies using minimal/sham acupuncture procedures also suggest that sham acupuncture needles evoke a physiological response.<sup>29,30</sup> Another aspect that may explain why DN did not significantly decrease pain intensity compared to sham therapy may be the poor methodological quality of the included studies and their heterogeneity of protocols.<sup>16,18</sup>

The literature reports greater efficacy for laser therapy than dry needling. It has been suggested that laser therapy causes improvement in microcirculation, which would increase the oxygen supply to hypoxic cells and help remove cell metabolism waste products, thus breaking the vicious cycle of pain, muscle spasm and further pain. While laser therapy is the method of choice for patients with a fear of needles and healthcare professionals inexperienced with dry needling techniques, further controlled studies are still needed to conclusively demonstrate the greater efficacy of this method.<sup>23</sup>

Moreover, all but one of the studies recruited patients with chronic orofacial pain. Although it is known that treating chronic orofacial pain is complex and a biopsychosocial approach is necessary, only one study applied pain education in addition to DN. A systematic review on musculoskeletal conditions<sup>31</sup> and another on myofascial TPs<sup>32</sup> found similar

results about pain intensity and PPT, and both studies also found low-quality-evidence in their included studies.

## Conclusion

The studies included in this systematic review suggest that DN is better than sham therapy for PPT and better than other interventions for pain intensity in the short-term. Nevertheless, due to the very low quality of evidence, DN cannot be strongly recommended over sham therapy or other interventions.

To date, there is insufficient data to draw strong conclusions about DN for the treatment of orofacial pain associated with TMD. Randomized controlled trials of low risk of bias are strongly needed.

## Conflicts of interest

Marcos Lisboa Neves and Marina Barbosa de Almeida use dry needling therapy in clinical practice and provide post-graduate training programs. The other authors declare no conflicts of interest.

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