

REVIEW ARTICLE (META-ANALYSIS)

# Effectiveness of Dry Needling for Myofascial Trigger Points Associated With Neck and Shoulder Pain: A Systematic Review and Meta-Analysis



Lin Liu, MSc,<sup>a</sup> Qiang-Min Huang, MD, PhD,<sup>a,b</sup> Qing-Guang Liu, MSc,<sup>a</sup> Gang Ye, MCh,<sup>c</sup> Cheng-Zhi Bo, BSc,<sup>a</sup> Meng-Jin Chen, BSc,<sup>a</sup> Ping Li, PT<sup>b</sup>

From the <sup>a</sup>Department of Sport Medicine and the Center of Rehabilitation, School of Sport Science, Shanghai University of Sport, Shanghai; <sup>b</sup>Department of Pain Rehabilitation, Shanghai Hudong Zhonghua Shipbuilding Group Staff-worker Hospital, Shanghai; and <sup>c</sup>Department of Pain Rehabilitation, Tongji Hospital, Tongji University, Shanghai, China.

## Abstract

**Objective:** To evaluate current evidence of the effectiveness of dry needling of myofascial trigger points (MTrPs) associated with neck and shoulder pain.

**Data Sources:** PubMed, EBSCO, Physiotherapy Evidence Database, ScienceDirect, The Cochrane Library, ClinicalKey, Wanfang Data Chinese database, China Knowledge Resource Integrated Database, Chinese Chongqing VIP Information, and SpringerLink databases were searched from database inception to January 2014.

**Study Selection:** Randomized controlled trials were performed to determine whether dry needling was used as the main treatment and whether pain intensity was included as an outcome. Participants were diagnosed with MTrPs associated with neck and shoulder pain.

**Data Extraction:** Two reviewers independently screened the articles, scored methodological quality, and extracted data. The results of the study of pain intensity were extracted in the form of mean and SD data. Twenty randomized controlled trials involving 839 patients were identified for meta-analysis.

**Data Synthesis:** Meta-analyses were performed using RevMan version 5.2 and Stata version 12.0. The results suggested that compared with control/sham, dry needling of MTrPs was effective in the short term (immediately to 3 days) (standardized mean difference [SMD] = -1.91; 95% confidence interval [CI], -3.10 to -.73;  $P = .002$ ) and medium term (SMD = -1.07; 95% CI, -1.87 to -.27;  $P = .009$ ); however, wet needling (including lidocaine) was superior to dry needling in relieving MTrP pain in the medium term (SMD = 1.69; 95% CI, .40–2.98;  $P = .01$ ). Other therapies (including physiotherapy) were more effective than dry needling in treating MTrP pain in the medium term (9–28d) (SMD = .62; 95% CI, .02–1.21;  $P = .04$ ).

**Conclusions:** Dry needling can be recommended for relieving MTrP pain in neck and shoulders in the short and medium term, but wet needling is found to be more effective than dry needling in relieving MTrP pain in neck and shoulders in the medium term.

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Myofascial trigger points (MTrPs) are localized, hyperirritable spots in the skeletal muscles associated with palpable nodules in muscle fibers.<sup>1,2</sup> These spots can be classified into active MTrPs and latent MTrPs with referred pain and local twitch responses.<sup>1,3,4</sup> Epidemiological surveys have shown that 30% to 85% of the population in the United States and 18.7% to 85.1% in Germany has MTrP pain.<sup>5,6</sup>

Numerous studies have shown that MTrPs are prevalent in patients with chronic nontraumatic neck and shoulder pain.<sup>7-11</sup> A recent survey of 72 patients with shoulder pain showed that active MTrPs were prevalent in the infraspinatus (77%) and the upper trapezius muscles (58%), whereas latent MTrPs were prevalent in the teres major (49%) and anterior deltoid muscles (38%).<sup>12</sup> Persistence of MTrPs in neck and shoulder muscles for long periods will result in headache, neck and shoulder pain, dizziness or vertigo, limited neck and shoulder range of motion, abnormal sensation, autonomic dysfunction, and disability.<sup>10,13-16</sup>

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Conservative interventions for MTrPs include dry needling, wet needling (eg, lidocaine injection and some local anesthetic injections), ischemic compression, physiotherapy, laser, and oral drugs.<sup>17</sup> Of these therapies, dry needling has been widely used in clinical practice because of its simple operation and good efficacy.<sup>18,19</sup> In 2001, a systematic review conducted by Cummings and White<sup>18</sup> found that direct needling of MTrPs seems to be an effective treatment, but evidence of the long-term efficacy of needling therapies beyond placebo from clinical trials was lacking at that time. A systematic review with meta-analysis<sup>20</sup> found that dry needling, compared with control/sham, can decrease pain immediately after the treatment and in 4 weeks in patients with upper quarter myofascial pain syndrome. Nonetheless, the number of high-quality randomized controlled trials (RCTs) was limited, and evidence of the long-term efficacy of dry needling for myofascial pain syndrome associated with neck and shoulder pain was lacking in this meta-analysis; thus, large-scale, multiple-term RCTs are necessary to support this recommendation. More recently, another systematic review<sup>21</sup> found no significant difference between dry needling and lidocaine injection for MTrPs in neck and shoulders immediately after the treatment, at 1 month, and at 3 to 6 months; however, some errors affecting the meta-analysis results were identified; there was no difference between dry needling and physical therapy for MTrPs in neck and shoulders.

Therefore, this systematic review and meta-analysis aimed to determine the short-, medium-, and long-term effectiveness of dry needling in relieving pain in patients with MTrPs in neck and shoulders compared with control/sham dry needling, wet needling, and other treatments (including physical therapy, botulinum toxin injection, and miniscalpel-needle release).

## Methods

### Search strategy

A systematic review and meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.<sup>22</sup> We searched sequentially electronic databases (PubMed, EBSCO, Physiotherapy Evidence Database [PEDro], ScienceDirect, The Cochrane Library, ClinicalKey, Wanfang Data Chinese database, China Knowledge Resource Integrated Database, Chinese Chongqing VIP Information, SpringerLink) from database inception to January 2014. The searches were limited (where database facilities allowed) to RCTs or clinical trials, but without language restriction. The search terms were (acupu\* OR needl\*) AND (myofascial pain OR trigger point\* OR trigger area\* OR taut band\*) AND random\*. Moreover, supplementary searches were conducted online (eg, <http://www.google.cn> and <http://www.clinicaltrials.gov>) to obtain

#### List of abbreviations:

<b>CI</b>	<b>confidence interval</b>
<b>MCID</b>	<b>minimum clinically important difference</b>
<b>MTrP</b>	<b>myofascial trigger point</b>
<b>NRS</b>	<b>numerical rating scale</b>
<b>PEDro</b>	<b>Physiotherapy Evidence Database</b>
<b>RCT</b>	<b>randomized controlled trial</b>
<b>SMD</b>	<b>standardized mean difference</b>
<b>VAS</b>	<b>visual analog scale</b>

articles that could not be found in the databases via the university library website and to check for any omitted trials.

### Inclusion and exclusion criteria

Studies were included if they (1) had RCT design; (2) included patients with MTrPs associated with neck and shoulder pain; (3) used acupuncture or dry needling as an intervention; and (4) had at least 1 outcome measure of either visual analog scale (VAS) or numerical rating scale (NRS) to assess pain intensity. Meanwhile, studies were excluded if (1) MTrPs were not defined according to the criteria of Simons et al<sup>1</sup>; (2) MTrPs in patients with neck and shoulder pain were latent MTrPs; (3) different types of dry needling were compared with each other; (4) RCT subjects were animals; and (5) RCT reported no data/results.

### Study selection and data extraction

Two authors scanned the titles and abstracts independently, and studies that satisfied the inclusion and exclusion criteria were retrieved for full-text assessment. We extracted data on the sample size of the population, number of male and female patients, mean age of the population, duration of symptoms, diagnosis, location and interventions adopted for MTrPs, outcome measures, the time to achieve the outcome, and PEDro scores. The results of the study of pain intensity (VAS/NRS) were extracted in the form of mean and SD data.

Outcome measures were classified as short term if the measure was applied immediately to 3 days after the final reported treatment, medium term if applied 9–28 days after the final reported treatment, and long term if applied 2 to 6 months after the final reported treatment.

The remaining discrepancies in data extraction were resolved after a discussion between the 2 reviewers. A third reviewer adjudicated when necessary.

### Quality assessment

Two reviewers independently assessed the validity of the studies included by using the PEDro quality scale. Any disagreements were resolved with a discussion between the 2 reviewers. A third reviewer adjudicated when necessary. The PEDro scale rates the quality of RCTs that evaluate the therapeutic interventions on the basis of the presence or absence of key methodological components.<sup>23,24</sup> Studies with scores  $\geq 6/10$  were considered as high-quality evidence, and studies with scores  $\leq 5/10$  were considered as low-quality evidence.

### Data synthesis and statistical analysis

Nine separate meta-analyses were performed with pain on VAS/NRS as the outcome measure. The 9 meta-analyses are as follows: dry needling compared with control/sham in the short, medium, and long term; dry needling compared with wet needling in the short, medium, and long term; and dry needling compared with other treatments in the short, medium, and long term.

Meta-analyses were performed using RevMan version 5.2<sup>3</sup> with a continuous variable random-effects model to account for the additional uncertainty associated with interstudy variability in effect of the intervention.<sup>23</sup> Heterogeneity was assessed using the Cochran Q test, which had statistical significance ( $P < 0.1$ ), and the chi-square test ( $I^2$ ), which indicated inconsistency by a quantitative number.<sup>25</sup> An  $I^2$  value of 25%, 50%, and 75% represented small, moderate, and large degrees of heterogeneity,

respectively.<sup>24,26</sup> Effect sizes were measured using the standardized mean difference (SMD) and 95% confidence interval (CI).

To explore the heterogeneity between studies, we performed stepwise meta-regression using Stata version 12.0<sup>b</sup> and sensitivity analysis. By using random-effects univariate meta-regression models, we assessed the clinical and methodological variables that affected the association between dry needling and changes in pain intensity. On the basis of univariate meta-regression, we conducted sensitivity analyses to assess the subgroups of studies that are most likely to yield valid estimates of the intervention. Funnel plots were constructed to verify the existence of publication bias (outcome level).

## Results

### Study selection

The initial search resulted in 1489 hits (fig 1). After applying the inclusion and exclusion criteria, 20 RCTs were eligible and included in the review.

### Study characteristics

Table 1 summarizes the sample size of the population, number of male and female patients, mean age of the population, country or region of the population, diagnosis, inclusion criteria, intervention groups (independent variables), outcome measurements (dependent variables), time to achieve the outcomes, and PEDro scores.

### Risk of bias within studies

Table 1 lists the PEDro scores of 20 RCTs, in which 19 are rated as high-quality evidence ( $\geq 6/10$ ) and only 1 as low-quality evidence ( $\leq 5/10$ ). However, most RCTs did not commonly score points for concealed random allocation and blinding of therapists.

### Effect of dry needling versus control/sham

Comparing dry needling with control/sham, we found that studies including 6,<sup>29,30,35,37,43,45</sup> 6,<sup>31,36,38,41,43,44</sup> and 2 RCTs<sup>36,38</sup> in the short, medium, and long term, respectively, assessed the pain effects.

Figure 2 shows that there is a high heterogeneity between the trials in the short term ( $\chi^2=62.09$ ;  $I^2=92\%$ ;  $P<.0001$ ), medium term ( $\chi^2=38.75$ ;  $I^2=87\%$ ;  $P<.0001$ ), and long term ( $\chi^2=8.12$ ;  $I^2=88\%$ ;  $P=.004$ ). Therefore, random-effect models were used, and caution should be exercised while drawing the conclusion. We used univariate meta-regression models to explore the source of heterogeneity between trials. Initial pain intensity was the only covariate associated with the heterogeneity between studies in the medium term ( $P=.024$ ). The decrement in pain intensity induced by dry needling increased as the initial pain intensity increased (fig 3). Hence, we performed a sensitivity analysis by excluding the 2 studies<sup>34,36</sup> with the lowest value of the initial pain intensity. In the pooled analysis of the remaining 4 studies,<sup>30,33,35,37</sup> the heterogeneity was significantly low between the individual efficacy estimates ( $I^2=0\%$ ;  $P=.86$ ).

The meta-analysis revealed statistically significant effects of dry needling compared with control/sham in the short term (SMD = -1.91; 95% CI, -3.10 to -.73;  $P=.002$ ) and medium term (SMD = -1.07; 95% CI, -1.87 to -.27;  $P=.009$ ), but the meta-analysis revealed no statistically significant effects of dry

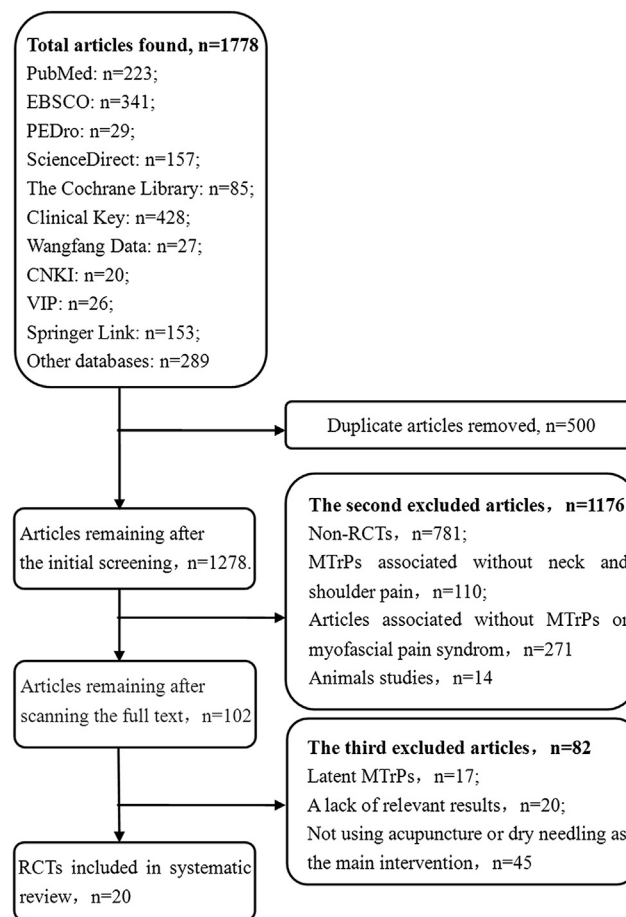


Fig 1 Flow diagram of search strategy and results. Abbreviations: CNKI, China National Knowledge Infrastructure Database; VIP, Chinese Chongqing VIP Information database.

needling compared with control/sham in the long term (SMD = -1.15; 95% CI, -3.34 to 1.04;  $P=.30$ ).

### Effect of dry needling versus wet needling

Comparing dry needling with wet needling, we found that 6 studies including 2,<sup>34,40</sup> 4,<sup>27,32,34,39</sup> and 1 RCTs<sup>27</sup> in the short, medium, and long term, respectively, assessed the pain effects.

Figure 4 shows low ( $\chi^2=7.74$ ;  $I^2=35\%$ ;  $P=.01$ ) and high ( $\chi^2=35.70$ ;  $I^2=92\%$ ;  $P<.0001$ ) heterogeneities between the trials in the short and medium term, respectively, and no heterogeneity in the long term. Although we observed low heterogeneity in the short term, the choice of the effects model will not have a significant effect on the pooled effect sizes; hence, we could use random-effects models to conduct the meta-analysis in all terms. The high heterogeneity ( $I^2=92\%$ ) in the medium term reminded us to exercise caution while interpreting the results. Data available from 6 pooled studies presented in fig 4 favored dry needling over wet needling. No statistically significant differences were observed in the short term (SMD = -.01; 95% CI, -.41 to .40;  $P=.98$ ) and long term (SMD = .33; 95% CI, -.11 to .78;  $P=.14$ ); however, significant effects of wet needling compared with dry needling were observed in the medium term (SMD = 1.69; 95% CI, .40–2.98;  $P=.01$ ).

**Table 1** Characteristics of the participants included in this systematic review

Study (Design and Country)	n (M/F)	Mean Age (y)*	Diagnosis (Duration*)	Inclusion Criteria	Intervention Group	Outcome Measure	Time to Achieve the Outcome (Baseline Pain*)	PEDro Scores
Ay et al, <sup>27</sup> 2010 (RCT, Turkey)	80 (28/52)	38.08±9.81, <sup>†</sup> 37.20±10.10 <sup>‡</sup>	MPS (34.27±40.95mo, <sup>†</sup> 30.63±37.25mo <sup>‡</sup> )	Regional pain, taut band, referred pain and sensory change, extreme sensitivity in taut band, ROM; at least 1 active MTrP in the upper trapezius muscle (≥1mo)	DN; lidocaine injection	Pain (VAS); AROM of the CS; depression (BDI)	Pretreatment (5.55±1.33cm, <sup>†</sup> 5.82±1.25cm <sup>‡</sup> ); 4wk; 12wk	6/10
Byeon et al, <sup>28</sup> 2003 (RCT, Korea)	30 (18/12)	50.9±9.7, <sup>†</sup> 50.2±9.9, <sup>§</sup> 51.2±9.9 <sup>  </sup>	MPS	MTrPs in the upper trapezius muscles; palpable taut band in the muscle	DN; IMS; IMES	Pain (VAS); MPQ; PROM of the CS	Pretreatment (6.2±1.1cm, <sup>†</sup> 6.4±1.6cm, <sup>§</sup> 6.2±1.4cm <sup>  </sup> ); 3d; 1wk; 2wk	6/10
Chou et al, <sup>29</sup> 2009 (RCT, China)	20 (8/12)	37.7±11.3, <sup>†</sup> 33.3±7.7 <sup>‡</sup>	Active MTrPs (5.9±3.3mo, <sup>†</sup> 5.8±2.8mo <sup>‡</sup> )	MTrPs in the unilateral upper trapezius muscle; no treatment with acupuncture; poor response to conservative and noninvasive treatments	Acupuncture; sham acupuncture	Pain (NRS); EPN amplitude	Pretreatment (7.4±0.8cm, <sup>†</sup> 7.4±0.8cm <sup>‡</sup> ); immediately	6/10
Chou et al, <sup>30</sup> 2011 (RCT, China)	45 (22/23)	34.1±10.7, <sup>†</sup> 33.9±8.3 <sup>‡</sup>	Unilateral MTrPs (6.1±2.2mo, <sup>†</sup> 6.2±2.2mo <sup>‡</sup> )	≥5/10 VAS score on the unilateral shoulder due to MTrPs in the upper trapezius muscle; no acupuncture treatment; poor response to conservative and noninvasive treatments	Modified acupuncture; placebo	Pain (NRS); PPT (algometry); ROM of the CS; EPN amplitude	Pretreatment (7.7±1.0cm, <sup>†</sup> 7.6±1.1cm <sup>‡</sup> ); immediately	6/10
DiLorenzo et al, <sup>31</sup> 2004 (RCT, Italy)	101 (28/73)	69.56±6.21, <sup>†</sup> 67.43±9.05 <sup>‡</sup>	Shoulder pain due to activation of MTrPs (3.53wk)	Patients 4–8 wk post—cerebrovascular accident who had undergone at least 3wk of physical therapy; shoulder pain (≥6/10 score on VAS)	DN; placebo	Pain (VAS); disability (RMI); quality of daytime rest and sleep	Pretreatment (7.93±0.87cm, <sup>†</sup> 8.02±0.83cm <sup>‡</sup> ); 10d; 16d; 22d	6/10
Ga et al, <sup>32</sup> 2007 (RCT, Korea)	39 (3/36)	79.22±6.80, <sup>†</sup> 75.90±8.69 <sup>‡</sup>	Chronic shoulder or neck pain due to MPS	≥6mo; aged >60y; complaining of chronic shoulder or neck pain	Acupuncture; lidocaine injection	Pain (VAS and FACES); PPI; PROM of the CS; depression (GDS-SF)	Pretreatment (6.98±1.32cm, <sup>†</sup> 6.43±2.08cm <sup>‡</sup> ); 1wk; 2wk; 4wk	7/10

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Table 1 (continued)

Study (Design and Country)	n (M/F)	Mean Age (y)*	Diagnosis (Duration*)	Inclusion Criteria	Intervention Group	Outcome Measure	Time to Achieve the Outcome (Baseline Pain*)	PEDro Scores
Ga et al, <sup>33</sup> 2007 (RCT, Korea)	40 (4/36)	79.22±6.80, <sup>†</sup> 76.27±8.63 <sup>§</sup>	Chronic MPS	Chronic MPS of the upper trapezius muscles based on physical examination and interview	DN; IMS	Pain (VAS and FACES); PPT; PROM of the CS; depression (GDS-SF)	Pretreatment (6.98±1.32cm, <sup>†</sup> 6.71±1.84cm <sup>§</sup> ); 1wk; 2wk; 4wk	9/10
Hong, <sup>34</sup> 1994 (RCT, USA)	58 (16/42)	41.7±14.4, <sup>†</sup> 42.2±14.4 <sup>‡</sup>	MPS (7.6±4.7mo, <sup>†</sup> 10.2±5.6mo <sup>‡</sup> )	Tender spots in taut bands, referred pain, LTR with palpation of MTrP, ROM of the CS for lateral bending to opposite side; at least 1 MTrP in the upper trapezius muscle	DN; lidocaine injection	Pain (VAS); PPT; ROM of the CS (goniometer)	Pretreatment (7.80±0.83cm, <sup>†</sup> 7.88±0.93cm <sup>‡</sup> ); immediately; 2wk	8/10
Hsieh et al, <sup>35</sup> 2007 (within-subject RCT, China)	14 (8/6)	60.2±13.2	Bilateral shoulder pain with active MTrPs	No treatment for at least 3mo; MTrPs in the bilateral infraspinatus muscles; no contraindication for dry needling; no condition for substance abuse; no surgery to the neck/upper limb; no differences in clinical presentation	DN; placebo	Pain (VAS); PPT; AROM and PROM of shoulder (goniometer)	Pretreatment (7.8±1.2 cm, <sup>†</sup> 7.7±1.4cm <sup>¶</sup> ); immediately	7/10
Ilbuldu et al, <sup>36</sup> 2004 (RCT, Turkey)	60 (0/60)	35.29±9.18, <sup>†</sup> 32.35±6.88, <sup>¶</sup> 33.90±10.36 <sup>#</sup>	MTrPs (38.48±31.94mo, <sup>†</sup> 36.95±33.65mo, <sup>¶</sup> 32.95±28.61mo <sup>#</sup> )	MTrPs in the upper trapezius muscles; local pain, pain and sensory changes referred from MTrP, palpable taut band, extreme sensitivity in 1 point in band, limited ROM	DN; placebo; laser	Pain (VAS); ROM of the CS (goniometer); functional status (NHP)	Pretreatment (5.10±1.97cm, <sup>†</sup> 5.70±1.81cm, <sup>¶</sup> 5.50±1.96cm <sup>#</sup> ); 4wk; 24wk	7/10
Irnich et al, <sup>37</sup> 2002 (crossover RCT, Germany)	34 (9/25)	51.9 y	MPS (36.7mo)	≥2mo; ROM in CS; cervical MPS or "irritation syndrome" (diffuse intense pain and irritated soft tissues with prolonged aggravation after motion and pressure)	DN; sham laser acupuncture; nonlocal acupuncture	Pain (VAS); ROM of the CS; repeatability of mobility change	Pretreatment (3.34±1.941cm, <sup>†</sup> 3.04±1.862cm, <sup>¶</sup> 3.50±2.264cm <sup>**</sup> ); immediately (15–30min)	9/10

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Table 1 (continued)

Study (Design and Country)	n (M/F)	Mean Age (y)*	Diagnosis (Duration*)	Inclusion Criteria	Intervention Group	Outcome Measure	Time to Achieve the Outcome (Baseline Pain*)	PEDro Scores
Itoh et al, <sup>38</sup> 2007 (RCT, Japan)	40 (11/29)	62.3±10.1, <sup>†</sup> 65.0±10.5 <sup>¶</sup>	Neck pain due to MTrPs (2.9±2.7y, <sup>†</sup> 2.3±1.5y <sup>¶</sup> )	≥6mo with no radiation; normal CS nerve function; aged ≥45y	Acupuncture; sham acupuncture	Pain (VAS); neck disability (NDI)	Pretreatment (6.70±1.32cm, <sup>†</sup> 6.41±2.07cm <sup>¶</sup> ); weekly; over 12wk	8/10
Kamanli et al, <sup>39</sup> 2005 (RCT, Turkey)	29 (6/23)	37.20±8.08, <sup>†</sup> 37.30±9.76, <sup>‡</sup> 38.3±5.26 <sup>††</sup>	MTrPs (32.50±21.99mo, <sup>†</sup> 49.20±34.96mo, <sup>‡</sup> 50.66±19.92mo <sup>††</sup> )	At least 1 MTrP on CS, back, or shoulder muscles with disease of at least 6mo in duration	DN; lidocaine injection; BTI	Pain (VAS); PPT; functional status; anxiety and depression; pain score	Pretreatment (7.03±2.68cm, <sup>†</sup> 6.90±1.43cm, <sup>‡</sup> 6.09±1.95cm <sup>††</sup> ); 4 wk	5/10
Krishnan et al, <sup>40</sup> 2000 (crossover RCT, USA)	30 (20/10)	38.5±10.28	MPS	Presence of trigger points, which are discrete tender areas in the upper trapezius muscles	Needle only; bupivacaine injection; ropivacaine injection; BD injection; RD injection	Pain (VAS)	Pretreatment; immediately	7/10
Ma et al, <sup>41</sup> 2010 (RCT, China)	43 (21/22)	42.2±5.3, <sup>†</sup> 42.3±5.1, <sup>¶</sup> 42.6±4.9 <sup>††</sup>	MPS (22.5±15.3y, <sup>†</sup> 20.8±16.5y, <sup>¶</sup> 21.8±15.9y <sup>††</sup> )	MTrPs in the unilateral upper trapezius muscles; ROM; no acupuncture or MSN treatment previously; follow instructions and complete a home-based stretching program	Acupuncture needling; placebo; MSN release	Pain (VAS); PPT; ROM of the CS (goniometer)	Pretreatment (6.2±1.9cm, <sup>†</sup> 6.3±1.7cm, <sup>¶</sup> 6.3±1.8cm <sup>††</sup> ); 2wk; 12wk	6/10
Rayegani et al, <sup>42</sup> 2014 (RCT, Iran)	28	32±10, <sup>†</sup> 38.6±4.2 <sup>§§</sup>	MPS (9.6±8.4y, <sup>†</sup> 9.8±9.6y <sup>§§</sup> )	≥2mo; MPS in the upper trapezius muscles; pain area that might radiate to neck, arm, and upper back and not confined to 1 dermatome or myotome; taut bands pressing pain; neurological test result was normal	DN; physiotherapy	Pain (VAS); PPT; quality of life (SF-36)	Pretreatment (2.9±2.8cm, <sup>†</sup> 3.6±2.6cm <sup>§§</sup> ); 1wk; 4wk	6/10

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Table 1 (continued)

Study (Design and Country)	n (M/F)	Mean Age (y)*	Diagnosis (Duration*)	Inclusion Criteria	Intervention Group	Outcome Measure	Time to Achieve the Outcome (Baseline Pain*)	PE德罗 Scores
Tekin et al, <sup>43</sup> 2013 (RCT, Turkey)	39 (8/31)	42.9±10.9, <sup>†</sup> 42.0±12.0 <sup>¶</sup>	MPS (63.5±50.7mo, <sup>†</sup> 57.9±48.3mo <sup>¶</sup> )	≥6mo; local spontaneous pain, referred pain or sensory changes from MTrP, palpable taut band, localized tenderness, ROM; at least 1 active MTrP	DN; sham intervention	Pain (VAS); quality of life (SF-36)	Pretreatment (6.6±1.3cm, <sup>†</sup> 6.4±1.6cm <sup>¶</sup> ); 3d; 4wk	8/10
Tough et al, <sup>44</sup> 2010 (RCT, UK)	41 (17/24)	34.2±10.8, <sup>†</sup> 36.9±10.9 <sup>¶</sup>	MTrPs pain due to whiplash injury (6.8±4.3wk, <sup>†</sup> 7.3±4.7wk <sup>¶</sup> )	Two to 16 wk duration and fulfilling the Grade II Quebec Task Force classification of WAD; ≥18y and making fully informed consent	Acupuncture; sham acupuncture	Pain (VAS); neck disability (NDI); anxiety and depression	Pretreatment (4.9±1.6cm, <sup>†</sup> 5.0±1.6cm <sup>¶</sup> ); 3wk; 6wk	7/10
Tsai et al, <sup>45</sup> 2010 (RCT, China)	35 (14/21)	46.4±12.2, <sup>†</sup> 41.5±10.4 <sup>¶</sup>	Unilateral shoulder pain due to MTrPs (7.5±3.9mo, <sup>†</sup> 6.8±4.5mo <sup>¶</sup> )	Unilateral shoulder pain caused by digital compression of MTrP in the upper trapezius muscle (tenderness and pain reproduction with palpation of a tight band)	DN; sham needling	Pain (NRS); PPT; ROM of the CS (goniometer)	Pretreatment (7.3±1.4cm, <sup>†</sup> 7.2±1.4cm <sup>¶</sup> ); immediately	6/10
Ziaieifar et al, <sup>16</sup> 2014 (RCT, Iran)	33	30.06±9.87, <sup>†</sup> 26.5±8.57 <sup>   </sup>	MTrPs	MTrPs in the upper trapezius muscles; taut band, tender spot, referred pain; ≥30mm on a VAS ranging from 0 to 100 mm	DN; compression technique	Pain (VAS); PPT; disability of arm, hand, and shoulder	Pretreatment (6.56±1.63cm, <sup>†</sup> 6.23±1.26cm <sup>   </sup> ); 9d	7/10

Abbreviations: AROM, active range of motion; BD, bupivacaine + dexamethasone; BDI, Beck Depression Inventory; BTI, botulinum toxin injection; CS, cervical spine; DN, dry needling; EPN, the end-plate noise; F, female; FACES, Wong-Baker Faces Pain Rating Scale; GDS-SF, Geriatric Depression Scale—Short Form; IMES, intramuscular electrical stimulation; IMS, intramuscular stimulation; LTR, local twitch response; M, male; MPQ, McGill Pain Questionnaire; MPS, myofascial pain syndrome; MSN, miniscapel needle; NDI, Neck Disability Index; NHP, Nottingham Health Profile; PPI, pressure pain intensity; PPT, pressure pain threshold; PROM, passive range of motion; RD, ropivacaine + dexamethasone; RMI, Rivermead Mobility Index; ROM, range of motion; SF-36, 36-Item Short Form Health Survey; WAD, whiplash associated disorders.

\* Values are mean ± SD.

† DN group.

‡ Lidocaine injection group.

§ IMS group.

|| IMES group.

¶ Placebo/sham group.

# Laser group.

\*\* Nonlocal acupuncture group.

†† BTI group.

‡‡ MSN group.

§§ Physiotherapy group.

||| Compression technique group.

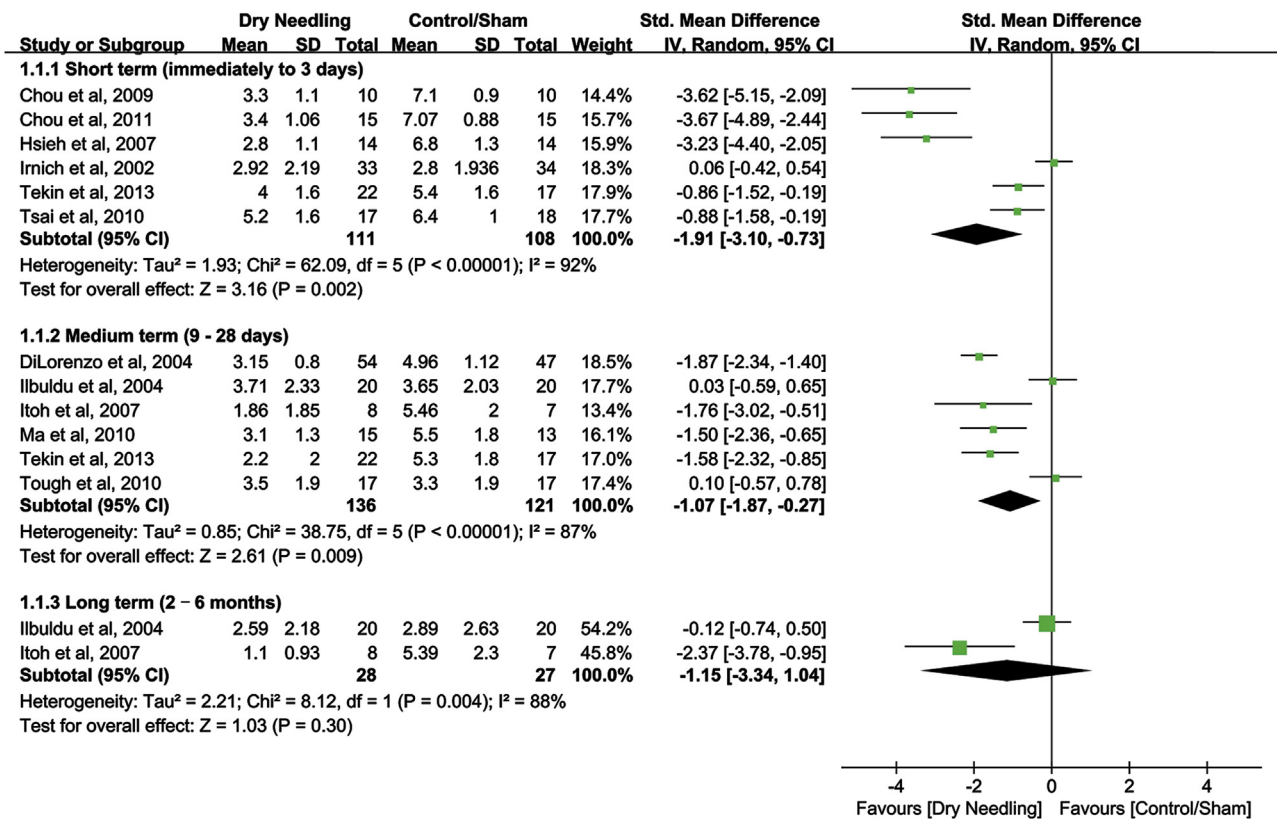


Fig 2 Forest plot for dry needling compared with control/sham in different terms.

**Effect of dry needling versus other treatments**

Comparing dry needling with other treatments, we found that 3 studies including 2 RCTs<sup>28,37</sup> in the short term and 7 studies including 6 RCTs<sup>16,28,33,36,39,41</sup> in the medium term and 2 RCTs<sup>36,41</sup> in the long term assessed the pain effects.

Figure 5 shows low ( $\chi^2=2.45$ ;  $I^2=18\%$ ;  $P=.29$ ), high ( $\chi^2=23.80$ ;  $I^2=75\%$ ;  $P=.0006$ ), and moderate ( $\chi^2=2.39$ ;  $I^2=58\%$ ;  $P=.12$ ) heterogeneities between the trials in the short, medium, and long term, respectively. The choice of the effects model will not have a significant effect on the pooled effect sizes; hence, we

used random-effects model to conduct the meta-analysis in the subgroup. We further used univariate meta-regression models to explore the source of heterogeneity between trials. Publication year was the only covariate associated with the heterogeneity between studies in the medium term ( $P=.007$ ). Pain intensity due to other treatments decreased as the publication year increased (see fig 3B). Hence, we further performed a sensitivity analysis by excluding 1 study<sup>16</sup> with the highest publication year. In the pooled analysis of the remaining 6 studies,<sup>34,35,42-44</sup> the heterogeneity was significantly low between the individual efficacy estimates ( $I^2=44\%$ ;  $P=.11$ ).

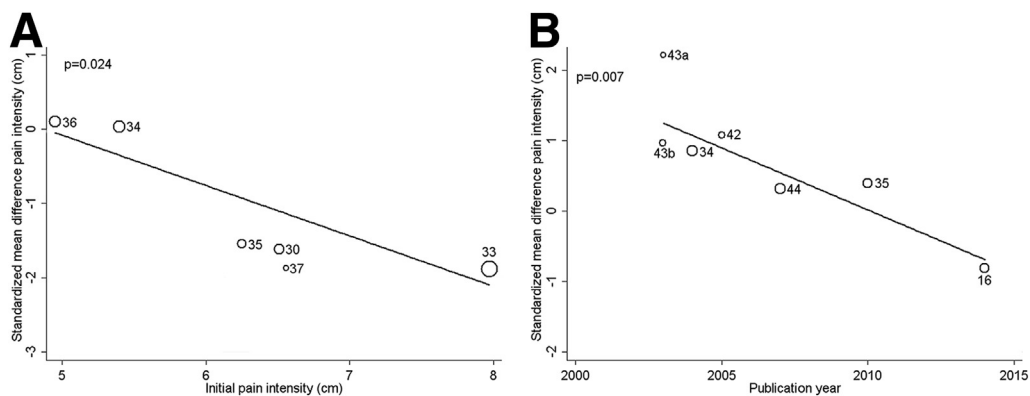
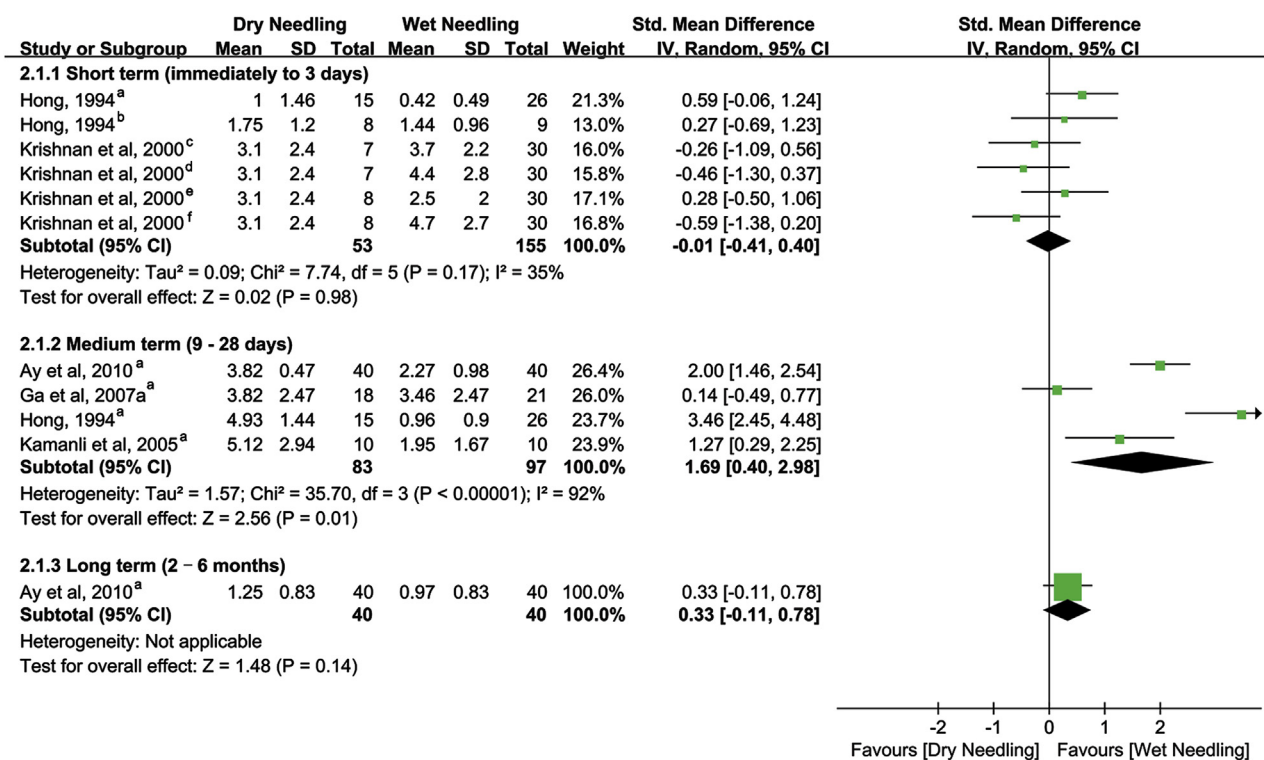


Fig 3 Meta-regression bubble plots: (A) association between initial pain intensity and SMD pain intensity when dry needling was compared with control/sham in the medium term; (B) association between publication year and SMD pain intensity when dry needling was compared with other treatments in the medium term. Each circle corresponds to a study, and reference number is shown.



**Fig 4** Forest plot for dry needling compared with wet needling in different terms. <sup>a</sup>Dry needling vs lidocaine injection without local twitch responses elicited. <sup>b</sup>Dry needling vs lidocaine injection with local twitch responses elicited. <sup>c</sup>Dry needling vs bupivacaine + dexamethasone injection. <sup>d</sup>Dry needling vs ropivacaine injection. <sup>e</sup>Dry needling vs bupivacaine injection. <sup>f</sup>Dry needling vs ropivacaine + dexamethasone injection.

Data available from the 3 pooled studies presented in [fig 5](#) favored other treatments over dry needling; no statistically significant differences were observed in the short term (SMD = .33; 95% CI, -.12 to .78;  $P = .15$ ) and long term (SMD = .58; 95% CI, -.18 to 1.34;  $P = .13$ ); however, significant effects of other treatments compared with dry needling were observed in the medium term (SMD = .62; 95% CI, .02–1.21;  $P = .04$ ).

## Publication Bias

Three funnel plots were constructed to assess the presence of publication bias ([fig 6](#)). The results indicated that 2 funnel plots were generally symmetrical, whereas 1 funnel plot from the comparison between dry needling and wet needling in the medium term was asymmetrical, which indicates that potential publication bias occurred. Publication bias may be attributed to the absence of a substantial number of studies or unpublished studies excluded.

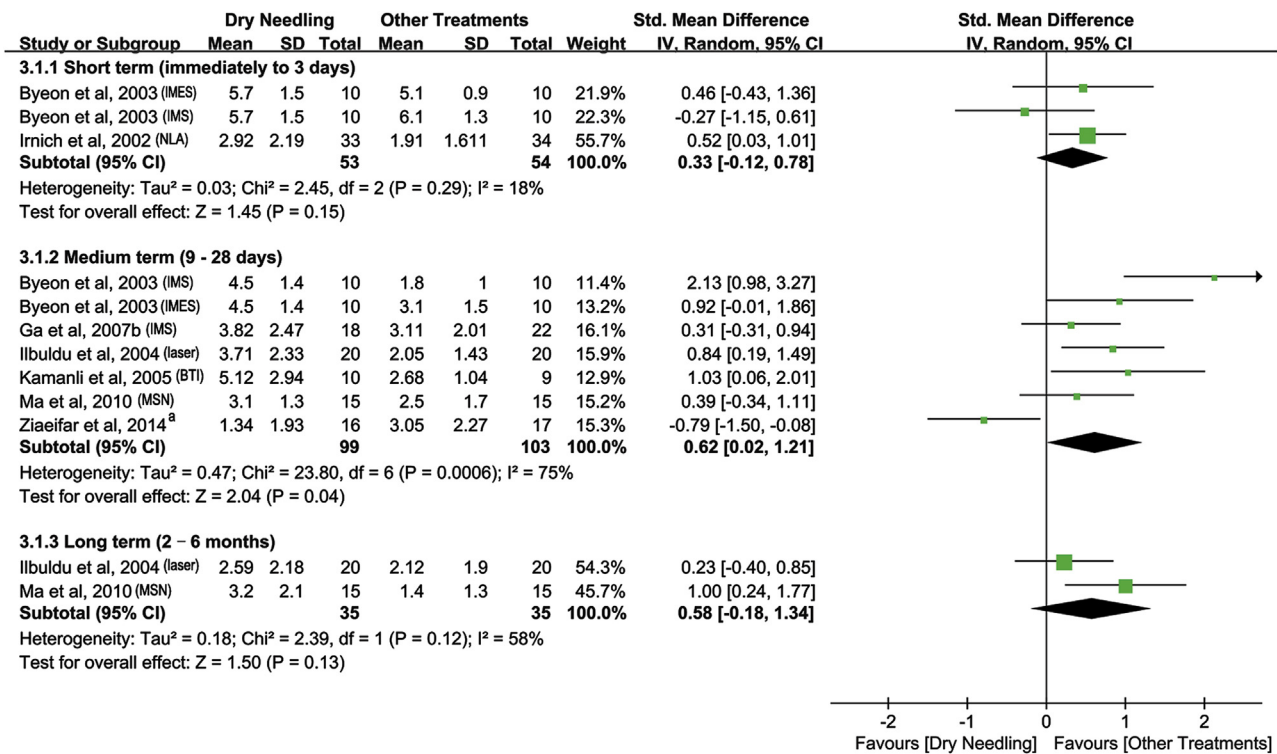
## Discussion

Twenty RCTs comparing dry needling with placebo or other treatments for MTrPs associated with neck and shoulder pain in different terms were identified for this review. Compared with control/sham, dry needling resulted in significant improvement, specifically in the short and medium term. However, wet needling of MTrPs associated with neck and shoulder pain was more effective than dry needling in the medium and long term. Furthermore, compared with dry needling, other treatments showed significant clinical effects in different terms. To date, data remain insufficient to draw conclusions about the long-term

effects of wet needling compared with dry needling on MTrPs associated with neck and shoulder pain.

Comparing dry needling with control/sham, we found that the SMD in the short term was 1.91cm,<sup>29,30,35,37,43,45</sup> which was greater than the 1.3cm/1.4cm minimum clinically important difference (MCID) reported by Bijur et al.<sup>46</sup> Moreover, a statistically significant difference in the short term was found when dry needling was compared with control/sham. Therefore, this review found sufficient evidence to support the claim that dry needling has significant clinical effects on MTrPs associated with neck and shoulder pain in the short term as compared with control/sham. In addition, the SMD in the medium term was 1.07cm,<sup>31,36,38,41,43,44</sup> which was lower than the reported 1.3cm/1.4cm MCID<sup>46</sup>; and a statistically significant difference in the medium term was found when dry needling was compared with control/sham. However, no statistically significant difference in the long term was found when dry needling was compared with control/sham. This effect may be worth exploring by using large-scale RCTs.

Comparing dry needling with wet needling, we found that the 1.69cm SMD in the medium term<sup>27,33,34,39</sup> was greater than the reported 1.3cm/1.4cm MCID.<sup>46</sup> A statistically significant difference was also found in this subgroup. On the basis of the current evidence, wet needling is found to be a better treatment than dry needling in the medium term. We found no statistical significance and clinical significance in the short<sup>34,40</sup> and long<sup>27</sup> term when dry needling was compared with wet needling. This was partly because different interventions were included in wet needling in the short term whereas only 1 study was included in the long term. Future studies will require sufficient sample sizes to adequately determine



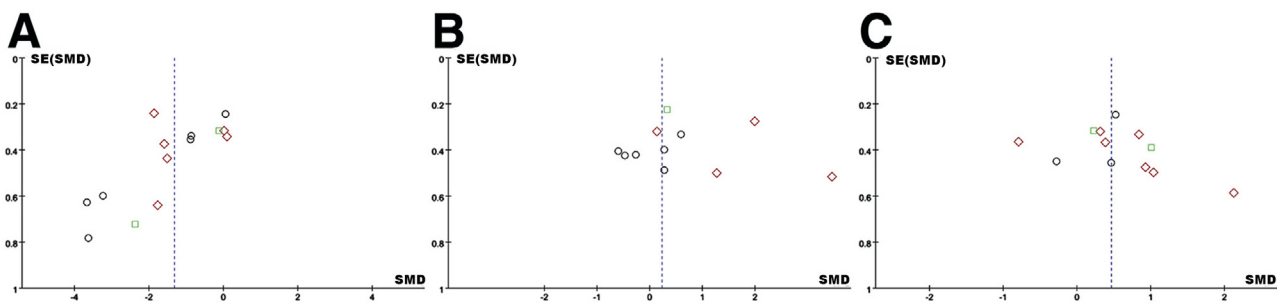
**Fig 5** Forest plot for dry needling compared with other treatments in different terms. Abbreviations: BTI, botulinum toxin injection; IMES, intramuscular electrical stimulation; IMS, intramuscular stimulation; MSN, miniscalpel-needle release; NLA, nonlocal acupuncture. <sup>a</sup>Dry needling vs compression.

whether wet needling was an optimal treatment for MTrPs associated with neck and shoulder pain in the short and long term.

Comparing dry needling with other treatments, we found that the SMD in the short, medium, and long term was .33,<sup>28,37</sup> .62,<sup>16,28,33,36,39,41</sup> and .58cm,<sup>36,41</sup> respectively, and all means were lower than the reported 1.3cm/1.4cm MCID.<sup>46</sup> Nevertheless, a statistically significant difference in the medium term was observed when dry needling was compared with other treatments. Therefore, none of the studies in this review was adequately powered to determine a significant change in pain when other treatments were compared with dry needling. This result was due to the pooled effects from different treatments. Hence, a large difference was observed among the included studies after meta-analysis.

**Study limitations**

In this systematic review, high heterogeneity was observed for most meta-analyses in the forest plots. High heterogeneity for these meta-analyses may be explained by clinical diversity (including some differences in subjects, different inclusion criteria between these studies, variance in the comparison treatments, and variance in the outcome measures) and methodological diversity (such as the design of random trial, use of blinding, and concealment of allocation). We tried using meta-regression to explore the sources of heterogeneity; however, ideal results were not obtained because of the absence of a substantial number of studies when dry needling was compared with control/sham in the short term. Therefore, the random-



**Fig 6** Funnel plots for all meta-analyses: (A) dry needling compared with sham/control; (B) dry needling compared with wet needling; and (C) dry needling compared with other treatments. Subgroups: circle, short term (immediately to 3 days); square, long term (2–6 months); diamond, medium term (9–28 days).

effects model addressed the heterogeneity of studies by considering the interstudy variation.<sup>47</sup>

Heterogeneity is almost inevitable among studies conducted independently by different investigators at different geographical regions. Therefore, using the random-effects model rather than the fixed-effects model was a conservative strategy when apparent statistical heterogeneity was observed in the data.<sup>25</sup> Meta-analysis performed using the random-effects model in the present review yielded results that were unbiased and provided an accurate estimate of the effects concerned; thus, the results were internally valid. The results were generalized to regular clinical practice when different studies of different population groups were combined; thus, the results were also externally valid.<sup>24,25</sup>

Another limitation of the review is that the data results reported by Rayegani et al<sup>42</sup> were not included in the meta-analysis, although the inclusion and exclusion criteria of the systematic review and meta-analysis were met, because the data results were not within the scope of the time definition of the short, medium, and long term. Therefore, large-scale, multiple-term, high-quality RCTs would be necessary to prove or exclude the significant advantages or disadvantages.

## Conclusions

On the basis of the available evidence to date, dry needling can be cautiously recommended for relieving MTrP pain in neck and shoulders in the short and medium term than control/sham, but wet needling is found to be more effective than dry needling in relieving MTrP pain in neck and shoulders in the medium term. On the basis of the results of 6 individual RCTs<sup>16,28,33,36,39,41</sup> included in the meta-analysis of 7 studies, other treatments can be cautiously recommended for relieving MTrP pain in neck and shoulders in the medium term than dry needling. However, scientific evidence proving the effectiveness of dry needling for MTrPs associated with neck and shoulder pain compared with wet needling and other treatments in the short and long term is insufficient. Accordingly, further research should include more large-scale, multiple-center, high-quality RCTs and adequate follow-up to provide the best evidence that can suggest the best therapeutic method in the clinic.

## Suppliers

- RevMan version 5.2; The Nordic Cochrane Centre.
- Stata version 12.0; StataCorp LP.

## Keywords

Meta-analysis; Neck pain; Needles; Randomized controlled trial; Rehabilitation; Shoulder pain; Trigger points

## Corresponding author

Qiang-Min Huang, MD, PhD, Department of Sport Medicine and the Center of Rehabilitation, School of Sport Science, Shanghai University of Sport, Keyanlou 4-408, Hengren Rd No. 188, Shanghai 200438, China. *E-mail address:* [huaqia404@aliyun.com](mailto:huaqia404@aliyun.com).

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