Manual acupuncture for myofascial pain syndrome: a systematic review and meta-analysis


ABSTRACT
Objective To assess the efficacy of manual acupuncture (MA) in the treatment of myofascial pain syndrome (MPS).

Methods We searched for randomised controlled trials (RCTs) comparing MA versus sham/placebo or no intervention in patients with MPS in the following databases from inception to January 2016: PubMed; Cochrane Library; Embase; Web of Science; and China Biology Medicine. Two reviewers independently screened the literature extracted data and assessed the quality of the included studies according to the risk of bias tool recommended by the Cochrane Handbook (V.5.1.0). Then, a meta-analysis was performed using RevMan 5.3 software.

Results Ten RCTs were combined in a meta-analysis of MA versus sham, which showed a favourable effect of MA on pain intensity after stimulation of myofascial trigger points (MTrPs; standardised mean difference (SMD) −0.90, 95% CI −1.48 to −0.32; p=0.002) but not traditional acupuncture points (p=0.05). Benefit was seen both after a single treatment (SMD −1.05, 95% CI −1.84 to −0.27; p=0.009) and course of eight sessions (weighted mean difference (WMD) −1.96, 95% CI −2.72 to −1.20; p<0.001). We also found a significant increase in pressure pain threshold following MA stimulation of MTrPs (WMD 1.00, 95% CI 0.32 to 1.67; p=0.004). Two of the included studies reported mild adverse events (soreness/haemorrhage) secondary to MA.

Conclusions Through stimulation of MTrPs, MA might be efficacious in terms of pain relief and reduction of muscle irritability in MPS patients. Additional well-designed/reported studies are required to determine the optimal number of sessions for the treatment of MPS.

INTRODUCTION
Myofascial pain syndrome (MPS) was first described by Dr Janet G Travell in 1942, and is now recognised as a common form of pain derived from muscle and its related fascia. Epidemiological data suggest that the prevalence of MPS in the general population may be as high as 85%. The main characteristics of MPS include the presence of one or more myofascial trigger points (MTrPs), stiff and involuntarily contracted muscles, and a sensitive reaction when firm pressure is applied to MTrPs. Common causes of MPS include acute or chronic soft-tissue injury, long-term chronic strain and poor posture. Other causes include metabolic, endocrine, mental and psychological disorders.

The most accepted theory regarding the pathophysiology of MPS is an integrated hypothesis, in which the aforementioned predisposing factors cause motor endplate dysfunction and an excessive release of acetylcholine. This accumulation of acetylcholine may initiate spontaneous electrical activity in MTrPs, causing a sustained contraction of the muscle fibres and formation of a taut band. Meanwhile, others believe that the spontaneous electrical activity originates from stimulation of muscle spindles by a dysfunctional sympathetic nervous system.

Manual acupuncture (MA) is a traditional acupuncture technique, which involves penetrating the body with thin, solid, metallic needles that are subsequently manipulated by hand. This technique has been applied for the treatment of pain for more than 2000 years in China. A recent study showed that acupuncture applied to MTrPs can activate the endogenous opioid system and prompt the release of endogenous opioid peptides (enkephalin and β-endorphin) to induce an analgesic effect. Acupuncture is now recognised as a safe, convenient treatment option for MPS.
and effective method, and is commonly used for the treatment of MPS.11

The efficacy of acupuncture for the treatment of MPS has been evaluated in recent years.7 12 13 However, due to heterogeneity in the number of sessions and in the location of the stimulus (ie, needling at MTrPs vs traditional acupuncture points), overall the findings remain inconclusive. It is possible that the efficacy of MA is affected by the number of sessions and the stimulation points chosen. Accordingly, the aim of our study was to perform an updated systematic review (SR) and to specifically examine for (by way of subgroup analysis) any specific evidence to support provision of a minimum number of sessions and/or use of certain points for needle insertion when using MA for the treatment of MPS.

METHODS

Data sources and search strategy

PubMed, The Cochrane Library, Embase, Web of Science and CBM (China Biology Medicine) were searched from their inception up to January 2016. Some additional studies were also retrieved after examination of the reference lists of relevant SRs. We used the following English language search terms to build our search strategy: (‘acupuncture’ OR ‘needling’ OR ‘dry-needling’ OR ‘needle’) AND (‘myofascial pain’ OR ‘trigger point’ OR ‘trigger-point’ OR ‘synalg’ OR ‘MPS’ OR ‘MPD’ OR ‘MTrP’) AND (‘randomized controlled trial’ OR ‘random allocation’ OR ‘double blind’ OR ‘single blind’ OR ‘controlled clinical trial’). In addition, we undertook a MeSH (Medical Subject Headings) term searching as follows: (Acupuncture[Mesh] OR Acupuncture Therapy[Mesh]) AND (Myofascial Pain Syndromes[Mesh] OR ‘Trigger Points[Mesh]) AND (Randomized Controlled Trial[Publication Type] OR ‘Randomized Controlled Trials as Topic[Mesh] OR ‘Controlled Clinical Trial[Publication Type] OR ‘Controlled Clinical Trials as Topic[Mesh]).

Inclusion and exclusion criteria

Only randomised controlled trials (RCTs), published in English or Chinese, were included in this SR. Studies needed to include patients with MPS that were diagnosed clinically according to the criteria defined by Simons et al2 (five major criteria and a minimum of one minor criterion). Patients with fibromyalgia, injury, systemic disease, neurological and metabolic disorders, metastatic disease, rheumatoid arthritis and osteoarthritis were excluded. Studies including pregnant women or participants that received other interventions before the study were also excluded.

Interventions and outcome measures

The study intervention needed to have been MA, the definition of which included dry needling (DN), a manual stimulation technique applied to MTrPs,14 which correspond closely to the ah shi points of traditional acupuncture practice.15 However, other types of acupuncture (eg, electroacupuncture, laser acupuncture) and mixed interventions were excluded. Controls groups could include either sham/placebo (efficacy trials) or no intervention (effectiveness trials). The primary outcomes were pain intensity, measured by visual analogue scale (VAS) or numerical rating scale (NRS), and pressure pain threshold (PPT). Secondary outcomes were adverse events and range of motion (ROM) at the neck (including flexion, extension, inclination and rotation).

Data extraction and quality assessment

After selecting studies according to the aforementioned inclusion and exclusion criteria, two independent reviewers (SHZ and XGZ) read the full articles and extracted the data before assessing the methodological quality of each RCT. Disagreements between the two reviewers were resolved by consultation with a third researcher (KHY). The quality of the RCTs was assessed using the risk of bias (RoB) tool recommended by the Cochrane Handbook V.5.1.0 (Cochrane Collaboration, London, UK). This assessment was performed considering six aspects: (1) random sequence generation; (2) allocation concealment; (3) blinding of participants and outcome assessors; (4) incomplete outcome data; (5) selective reporting; and (6) other bias.

Data synthesis and analysis

We used RevMan 5.3 software (Cochrane Collaboration) to perform a meta-analysis. The weighted mean difference (WMD) or standard mean difference (SMD) and their respective 95% CIs were calculated for continuous data. The Higgins I² test was used to assess heterogeneity with a significance level set at 50%. A fixed-effects model was used in the absence of substantial heterogeneity (I²<50%). Otherwise, a random-effects model was used (I²≥50%) and subgroup analysis was applied to explore this heterogeneity. Finally, a funnel-plot was used to assess publication bias.

RESULTS

Search results

As shown in figure 1, a total of 847 relevant studies were identified. Eighty-two references were obtained from PubMed, 216 from The Cochrane Library, 287 from Embase, 213 from Web of Science, and 49 from CBM. EndNote X7 software (Thomson Corporation, Stamford, USA) was used to eliminate duplicates (307 references). After evaluating the title and abstract of the identified references, 515 records were excluded and the remaining 25 articles were extracted for in-depth review. A further full-text screening excluded nine articles. Finally, 16 RCTs11 16–30 met our inclusion criteria.
Study characteristics
Out of 16 studies,\(^{11,16–30}\) 13\(^{11,16,17,19–26,29,30}\) chose sham needling as the control group, whereas one study\(^{27}\) chose placebo laser and two studies\(^{18,28}\) chose no intervention. A total of 477 patients were included in these 16 trials. The main characteristics of the included studies are presented in Table 1.

Risk of bias
Figure 2 shows the RoB of the included studies. Thirteen studies\(^{11,16–25,29,30}\) described an appropriate method of random sequence generation, 11\(^{11,16–20,22–25,29}\) used a computer-generated randomisation schedule and two\(^{21,30}\) employed selection of cards. One study\(^{26}\) was quasi-randomised; it allocated participants according to the sequence of involvement, and was thus rated as high risk. The two other studies\(^ {27,28}\) did not describe the method of random sequence generation. Three studies\(^{18,19,21}\) concealed allocation sequence by means of sealed, opaque envelopes. The remaining studies\(^ {11,16,17,20,22–30}\) did not report on allocation concealment. Ten studies\(^ {16,17,20–24,26,29,30}\) were double-blinded (participants and outcome assessors). Five studies\(^ {11,18,19,27,28}\) were single-blinded (outcome assessors only), although participant blinding was deemed not to be applicable for three out of five of these studies,\(^ {18,27,28}\) in which patients in the control arms received placebo laser or were left untreated. Finally, one study\(^ {25}\) did not report blinding. Three studies\(^ {17,20,21}\) reported part of their results in graphical form, one study\(^ {11}\) reported its results as median (IQR), and three studies\(^ {28–30}\) did not report any detailed data with mean±SD. Therefore, these studies were deemed to be at high risk of incomplete outcome data and selective reporting. Tekin et al\(^ {20}\) presented another potential source of bias due to a lack of justification regarding the reason for dropouts. No publication bias was observed, with the funnel-plot showing a symmetrical distribution (see online supplementary file 1).

Pain intensity
Twelve studies\(^ {11,16,18–20,22–26,28,29}\) evaluated pain intensity via VAS or NRS. Finally, eight sham-controlled studies\(^ {16,19,20,22–26}\) were combined in two meta-analyses (figure 3A, B), which showed that MA at MTrPs reduced pain intensity (SMD \(-0.90, 95\% \text{ CI } -1.48 \text{ to } -0.32, p=0.002\); heterogeneity: \(\chi^2=16.21, \Gamma^2=75\%, p=0.003\)) compared with sham. Irrespective of needling location, MA reduced pain intensity...
<table>
<thead>
<tr>
<th>First author and year</th>
<th>No. of participants (male/female)</th>
<th>Age (years)</th>
<th>Duration of symptoms</th>
<th>MPS regions</th>
<th>Intervention group</th>
<th>Control group</th>
<th>Stimulation points</th>
<th>Sessions</th>
<th>Outcome measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goddard 2002</td>
<td>18 (3/15)</td>
<td>35.49±10.63</td>
<td>Jaw muscles</td>
<td>Needles inserted to depth of 2–4 mm at sham points</td>
<td>LI4</td>
<td>1</td>
<td>Pain intensity: VAS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ilbuldu 2004</td>
<td>40 (0/40)</td>
<td>35.29±9.18</td>
<td>Upper trapezius</td>
<td>Placebo laser: machine turned on and set, but no beam applied</td>
<td>MTrP</td>
<td>12</td>
<td>NHP; PPT; ROM; Pain tolerance level: VAS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shen 2007</td>
<td>15 (1/14)</td>
<td>45.2±12.3</td>
<td>Masticatory muscles</td>
<td>Non-penetrating needle</td>
<td>LI4</td>
<td>1</td>
<td>Pain intensity: NRS; Mechanical pressure pain: VAS; headache: NRS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chou 2009</td>
<td>20 (8/12)</td>
<td>37.7±11.3</td>
<td>Upper trapezius</td>
<td>Non-penetrating needle</td>
<td>TE5, LI1</td>
<td>1</td>
<td>Pain intensity: NRS; EPN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shen 2009</td>
<td>28 (0/28)</td>
<td>36.94±13.82</td>
<td>Jaw muscles</td>
<td>Non-penetrating needle</td>
<td>LI4</td>
<td>1</td>
<td>Pain intensity: NRS; Jaw/face tightness: NRS; Mechanical pressure pain: VAS; Headache: NRS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Srbely 2010</td>
<td>40 (21/19)</td>
<td>48.2±15.2</td>
<td>Shoulder</td>
<td>Needle penetrated normal tissue</td>
<td>MTrP</td>
<td>1</td>
<td>PPT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sun 2010</td>
<td>34 (10/24)</td>
<td>45.4±17.8</td>
<td>Neck</td>
<td>Subcutaneous needling to depth of approximately 2 mm without manual stimulation</td>
<td>GB20, TE14, SB</td>
<td>6</td>
<td>Pain intensity: VAS; SF-36; ROM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tsai 2010</td>
<td>35 (14/21)</td>
<td>46.4±12.2</td>
<td>Upper trapezius</td>
<td>Subcutaneous needling</td>
<td>MTrP</td>
<td>1</td>
<td>Pain intensity: NRS; PPT; ROM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diracoğlu 2012</td>
<td>50 (7/43)</td>
<td>33.00±12.70</td>
<td>Temporomandibular muscles</td>
<td>1. Needling applied to areas away from the trigger points</td>
<td>BL40, GB34</td>
<td>2</td>
<td>Pain intensity: VAS; ROM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chen 2013</td>
<td>10 (--)</td>
<td>42.9±10.9</td>
<td>Upper trapezius</td>
<td>Subcutaneous needling</td>
<td>BL40, GB34</td>
<td>2</td>
<td>Pain intensity: VAS; ROM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tekin 2013</td>
<td>39 (8/31)</td>
<td>42.9±10.9</td>
<td>Upper back</td>
<td>Non-penetrating needle</td>
<td>MTrP</td>
<td>6</td>
<td>Pain intensity: VAS; SF-36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Santos 2014</td>
<td>22 (13/9)</td>
<td>38.5±5.1</td>
<td>Spine</td>
<td>No intervention</td>
<td>MTrP</td>
<td>10</td>
<td>Pain intensity: VAS; WHOQOL-BREF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Couto 2014</td>
<td>52 (0/52)</td>
<td>35.84±5.02</td>
<td>–</td>
<td>Sham EA device: (1) Electrical connection between stimulator and patient broken (2) Current prevented from passing through electrodes</td>
<td>MTrP</td>
<td>8</td>
<td>Pain intensity: VAS; PPT; SF-12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Continued
immediately after one session (SMD −1.05, 95% CI −1.84 to −0.27, p=0.009; substantial heterogeneity: \( \chi^2 = 16.39, I^2 = 82%, p=0.001 \)) and after eight sessions of treatment (WMD −1.96, 95% CI −2.72 to −1.20, p<0.001; no heterogeneity: \( \chi^2 = 0.11, I^2 = 0%, p=0.74 \)) compared with sham. No significant difference in effect was observed between MA and sham when only considering studies that simulated acupuncture points (SMD −1.17, 95% CI −2.39 to 0.04, p=0.06; substantial heterogeneity: \( \chi^2 = 16.33, I^2 = 82%, p=0.001 \)). Only one trial compared MA against no intervention reported on pain intensity via NRS and did not find any significant reduction.

Table 1

<table>
<thead>
<tr>
<th>First author and year</th>
<th>No. of participants (male/female)</th>
<th>Age (years)</th>
<th>Duration of symptoms</th>
<th>Intervention group</th>
<th>Control group</th>
<th>Control intervention</th>
<th>MPS regions</th>
<th>Intervention group</th>
<th>Control group</th>
<th>Control intervention</th>
<th>MPS regions</th>
<th>Intervention group</th>
<th>Control group</th>
<th>Control intervention</th>
<th>MPS regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mejuto-Vázquez 2014</td>
<td>18 (8/9)</td>
<td>25±4</td>
<td>Upper trapezius</td>
<td>3.1±0.8/day</td>
<td>3.4±0.7/day</td>
<td>No intervention</td>
<td>17</td>
<td>Upper trapezius</td>
<td>24±7</td>
<td>Upper trapezius</td>
<td>26±3±3.81</td>
<td>Upper trapezius</td>
<td>26±13±6.13</td>
<td>Upper trapezius</td>
<td>26±13±6.13</td>
</tr>
<tr>
<td>Aranha 2015</td>
<td>40 (0/40)</td>
<td>–</td>
<td>Upper trapezius</td>
<td>–</td>
<td>–</td>
<td>Needles inserted 1 cm distal to acupuncture points</td>
<td>–</td>
<td>24±7</td>
<td>26±3±3.81</td>
<td>26±13±6.13</td>
<td>6.11±5.11/year</td>
<td>7.00±4.14/year</td>
<td>Needles inserted 1 cm distal to acupuncture points</td>
<td>26±13±6.13</td>
<td></td>
</tr>
<tr>
<td>Mueller 2015</td>
<td>17 (0/17)</td>
<td>26.33±3.81</td>
<td>Upper trapezius</td>
<td>6.11±5.11/year</td>
<td>7.00±4.14/year</td>
<td>Needles inserted 1 cm distal to acupuncture points</td>
<td>–</td>
<td>24±7</td>
<td>26±3±3.81</td>
<td>26±13±6.13</td>
<td>6.11±5.11/year</td>
<td>7.00±4.14/year</td>
<td>Needles inserted 1 cm distal to acupuncture points</td>
<td>26±13±6.13</td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as mean±SD. EPN, endplate noise; MPS, myofascial pain syndrome; MTrP, myofascial trigger point; NHP, Nottingham Health Profile; NRS, numerical rating scale; PPT, pressure pain threshold; ROM, range of motion; SF-12, 12-Item Short-Form Health Survey; SF-36, 36-Item Short-Form Health Survey; WHOQOL-BREF, Short Form of WHO Quality of Life Questionnaire.

Figure 2

Risk of bias assessment for 16 included studies.

- **Random sequence generation (selection bias)**
- **Allocation concealment (selection bias)**
- **Blinding of participants and personnel (performance bias)**
- **Blinding of outcome assessment (detection bias)**
- **Incomplete outcome data (attrition bias)**
- **Selective reporting (reporting bias)**
- **Other bias**
immediately after one session of MA at MTrPs (WMD $-1.70$, 95% CI $-3.61$ to $0.21$, $p>0.05$).

**Pressure pain threshold**

Six studies$^{18, 19, 22, 23, 27, 30}$ assessed PPT, of which three (sham-controlled) studies$^{19, 22, 23}$ were combined in a meta-analysis using a random-effects model (figure 3C). The meta-analysis showed that MA at MTrPs increased PPT (WMD 1.00, 95% CI 0.32 to 1.67, $p=0.004$; heterogeneity: $\chi^2=10.16, I^2=80\%$, $p=0.06$). Two RCTs comparing MA with no intervention$^{18}$ and placebo laser$^{27}$ reported on PPT and found no significant increase immediately after one session (WMD 12.00, 95% CI $-76.46$ to $100.46$) or 12 sessions (WMD 0.06, 95% CI $-0.68$ to $0.80$) of MA at MTrPs, respectively.

**Range of motion**

No meta-analysis for the secondary outcome of ROM could be conducted, therefore results are presented descriptively. Compared with no intervention, Mejuto-Vázquez$^{18}$ found significant improvements in

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**Figure 3** Forest plots demonstrating effect of manual acupuncture (MA) relative to sham MA on primary outcome measures in patients with myofascial pain syndrome. (A) Pain intensity (standardised mean difference) including subgroup analyses for number of sessions and needling location (myofascial trigger points (MTrPs) versus acupuncture points). (B) Pain intensity (weighted mean difference (WMD)). (C) Pressure pain threshold (WMD) including subgroup analysis for number of sessions and needling location (MTrPs).
cervical extension, flexion and inclination (but not rotation) immediately after one session of MA at MTrPs (table 2). However, trials comparing against sham acupuncture17 and placebo laser27 did not demonstrate any significant improvement in cervical ROM.

Adverse events
 Mejuto-Vázquez et al18 reported on adverse events in their study, indicating that 88% of patients who received DN experienced mild discomfort (ie, upper trapezius muscle soreness) after treatment. However, they did not experience any increase in pain. Sun et al11 reported that one patient who received MA developed bruises over the acupuncture point region after the end of the third session. No other study reported any adverse events.

DISCUSSION

Summary of results
 In our meta-analysis, compared with sham acupuncture, MA showed favourable efficacy in terms of pain relief and reduction of muscle irritability through the stimulation of MTrPs. No evidence of analgesic efficacy was observed through the stimulation of acupuncture points. In addition, our results suggested that treatment of MPS with one or eight sessions of MA may be good alternatives to existing treatments. Two studies18 27 compared DN with no intervention and placebo laser, while four other studies11 28–30 did not report any detailed data; therefore, these studies were not combined in the meta-analysis of MA versus sham acupuncture. Moreover, the safety of acupuncture remains unclear due to a relative lack of studies reporting adverse events.

Overall, the design and reporting quality of the RCTs included in our SR ranged from poor to fair. High RoB existed in random sequence generation, incomplete outcome data and selective reporting, resulting in potential selection bias, attrition bias and reporting bias, respectively. Allocation concealment was arguably the weakest link in the design and reporting of the included RCTs. In particular, Tekin

Table 2 Effects of manual acupuncture on cervical range of motion

<table>
<thead>
<tr>
<th>ROM</th>
<th>Aranha et al17</th>
<th>Ilbuldu et al27</th>
<th>Mejuto-Vázquez18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>0.06 (−0.56 to 0.68)</td>
<td>0.83 (−0.10 to 1.48)</td>
<td>1.79 (0.61 to 2.96)</td>
</tr>
<tr>
<td>Extension</td>
<td>0.17 (−0.45 to 0.79)</td>
<td>0.54 (−0.10 to 1.17)</td>
<td>1.38 (0.29 to 2.46)</td>
</tr>
<tr>
<td>Indclination (right)</td>
<td>0.09 (−0.53 to 0.71)</td>
<td>0.03 (−0.59 to 0.65)</td>
<td>1.16 (0.11 to 2.21)</td>
</tr>
<tr>
<td>Indclination (left)</td>
<td>0.05 (−0.57 to 0.67)</td>
<td>0.45 (−0.18 to 1.08)</td>
<td>1.21 (0.15 to 2.27)</td>
</tr>
<tr>
<td>Rotation (right)</td>
<td>−0.22 (−0.84 to 0.40)</td>
<td>0.54 (−0.10 to 1.17)</td>
<td>0.80 (−0.20 to 1.80)</td>
</tr>
<tr>
<td>Rotation (left)</td>
<td>0.14 (−0.48 to 0.76)</td>
<td>0.39 (−0.24 to 1.01)</td>
<td>0.75 (−0.25 to 1.74)</td>
</tr>
</tbody>
</table>

Values are presented as standardised mean difference (95% CI). ROM, range of motion.
et al\textsuperscript{20} did not report any details regarding potential dropouts or withdrawals, which may have led to exclusion or attrition bias.

**Overall completeness and applicability of evidence**

The included studies primarily focused upon the efficacy of MA in terms of a reduction in pain intensity, increase in PPT and improvement in cervical ROM. However, in addition to regional pain, local tenderness in trigger points and loss of joint function, MPS may also be associated with psychiatric complications such as anxiety, sleeplessness and depression.\textsuperscript{31} Only two studies, namely those by Couto et al\textsuperscript{19} and Tekin et al\textsuperscript{20}, examined for any improvement in mental health.

High RoB, variable duration of symptoms and differences in the severity of initial conditions may partly influence the validity of the conclusions. Notably, the included studies only involved MPS symptoms of the neck, shoulders, face and back. Thus, the conclusions may not be applicable to other regions affected by MPS.

**Agreements and disagreements with other SRs**

Our results regarding the immediate effect of MA on pain are consistent with the findings of Kietrys et al\textsuperscript{13}, who included seven RCTs of DN compared with sham/control. Their review showed that DN decreased pain after treatment (immediately and after a 4-week follow-up); however, RoB was high in the studies included in this SR and we think that it is essential to carefully assess the RoB for each RCT included in order to judge the reliability of the findings. In fact, although most SRs dealing with the effects of acupuncture on pain have conducted an assessment of RoB using different scales, nearly half of them have failed to go on to incorporate the RoB assessment into the synthesis. It is highlighted in the Cochrane Handbook (V.5.1.0) that strictly assessing the RoB from a methodological point of view and incorporating it into the synthesis are essential components of the SR process. It also notes that failing to report this RoB assessment may influence the analysis, interpretation and conclusions of SRs.\textsuperscript{32, 33} Therefore, future SRs should pay attention to this issue. Ong et al\textsuperscript{12} only included one RCT (by Ilbuldu et al\textsuperscript{27}) that compared DN with placebo laser. They did not observe any significant difference in pain intensity between the two groups, both immediately post-treatment and at a 6-month follow-up. By contrast, our SR included 16 RCTs and is therefore able to provide stronger and more convincing evidence that MA is an effective therapy for the treatment of MPS. Our findings differ slightly from the latest SR (of 10 RCTs) evaluating the efficacy of MA for MPS, which found that DN was less effective at decreasing pain compared with placebo, but more effective at increasing ROM.\textsuperscript{7} We believe that this divergence of findings may originate from the differences in inclusion criteria used to select relevant RCTs. For example, in the aforementioned review, studies including patients suffering from other diseases (eg, irritation syndrome, segmental dysfunction) were eligible, while these were not allowed in the present study.

**Limitations**

Our study has several limitations that must be acknowledged. Firstly, significant statistical heterogeneity was observed in our meta-analysis. It is accepted that there are high levels of clinical heterogeneity across acupuncture trials.\textsuperscript{34} Meta-regression analysis requires an adequate number of included studies (\(n \geq 10\)) for each covariate model, otherwise false-positive results may occur.\textsuperscript{35} Consequently, we did not use meta-regression models to explore the source of heterogeneity between trials. Secondly, we were unable to assess the impact of MA on valuable outcome measures such as the Nottingham Health Profile (NHP) and 36-Item Short-Form Health Survey (SF-36) because only Ilbuldu et al\textsuperscript{27} and Tekin et al\textsuperscript{20} respectively, reported the use of these parameters. Thirdly, we were unable to assess the long-term efficacy of MA on MPS, since only Aranha et al\textsuperscript{17} and Ilbuldu et al\textsuperscript{27} reported long-term efficacy, at 1 and 6 months, respectively. Finally, with the potential for an increased number of RCTs focusing on this topic in the future, the results of this SR (like any) will have to be updated and improved.\textsuperscript{36} For example, a new high-quality RCT published in June 2016 showed that, compared with a sham strain-counterstrain technique, DN was effective at relieving pain after three sessions but did not result in a significant reduction of the neck disability score.\textsuperscript{37} Such findings serve to extend our data further.

**Implications for practice**

Our research findings can be used to guide doctors in the use of MA for the treatment of MPS. Thanks to its good analgesic effect, the application of MA may result in a reduction of opiate and antidepressant use, which could in turn help reduce adverse reactions caused by these drugs.\textsuperscript{38} Two studies reported mild adverse events only (soreness and haemorrhage) after treatment of MPS.\textsuperscript{11, 18} Therefore, MA can be considered to be a relatively safe intervention when performed by a qualified practitioner but is not a risk-free procedure.\textsuperscript{39} There is also still a need to determine the optimal number of MA sessions for the treatment of different conditions.

**Implications for research**

Firstly, the results of our RoB assessment suggest that best practice standards of trial design, registration and reporting (including endorsement of the Consolidation Standards of Reporting Trials (CONSORT) statement) are not uniformly followed.
Lack of registration can be associated with inappropriate design and reporting of RCTs, which may lead to systematic deviation that could seriously weaken the ability of RCTs to robustly demonstrate efficacy or effectiveness. Thus, there is an urgent need for greater adherence to current guidelines on RCT registration and reporting. Secondly, most of the patients in the studies included in this SR were outpatients, in whom it is difficult to monitor behaviour after leaving the hospital. It is possible that patients in the treatment or control groups might have received other interventions in the case of poor efficacy, which could potentially confound follow-up assessment. Therefore, future trials should assess outcomes immediately after the intervention and aim to enhance compliance with treatment as much as possible. Finally, there is an ongoing need to assess comparative effectiveness through SRs assessing MA against other existing therapies (eg, physiotherapy, injection therapy) for a horizontal comparison in order to select the best therapy for MPS.

CONCLUSIONS

In summary, we have demonstrated favourable efficacy of MA in terms of pain relief as well as the reduction of muscle irritability due to MPS when MTrPs (but not acupuncture points) are stimulated. A treatment period of eight sessions of MA is recommended, although as little as one session appears to be effective. The safety of MA and its impact on ROM at the neck require further investigation. Significant heterogeneity between studies and a paucity of data on the efficacy of MA on mental health outcomes and long-term symptomatic relief are the main limitations of our SR and further, well-designed studies with detailed reporting are needed to explore these residual areas of uncertainty.

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