Meta Analysis

Acupuncture for Myofascial Pain Syndrome: A Network Meta-Analysis of 33 Randomized Controlled Trials

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Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 11-19-2016
Revised manuscript received: 02-12-2017
Accepted for publication: 02-24-2017

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Background: Acupuncture techniques are commonly used as initial treatments for myofascial pain syndrome.

Objective: This study aimed to assess and compare the efficacy and safety of different techniques of acupuncture for myofascial pain syndrome.

Study Design: Network meta-analysis.

Setting: All selected studies were randomized controlled trials (RCTs).

Methods: The Cochrane Central Register of Controlled Trials, PubMed, Web of Science, EMBASE, and Chinese Biomedical Literature Database were searched from their inceptions to February 2016. Only full texts of RCTs comparing acupuncture therapies with any other therapies or placebo-sham acupuncture were included. Two reviewers independently assessed eligibility and extracted data. The primary outcomes included pain intensity, PPT, and adverse events. Secondary outcome was physical function.

Results: Thirty-three trials with 1,692 patients were included. Patients were allocated to 22 kinds of interventions, of which dry needling and manual acupuncture was the most frequently investigated intervention. Compared with placebo-sham acupuncture, scraping combined with warming acupuncture and moxibustion was found to be more effective for decreasing pain intensity (standardized mean difference (SMD) = -3.6, 95% confidence interval (CI) ranging from -5.2 to -2.1); miniscalpel-needle was more effective for increasing the PPT (SMD = 2.2, 95% CI ranging from 1.2 to 3.1); trigger points injection with bupivacaine was associated with the highest risk of adverse event (odds ratio = 557.2, 95% CI ranging from 3.6 to 86867.3); and only EA showed a significant difference in the ROM (SMD = -4.4, 95% CI ranging from -7.5 to -1.3).

Limitations: Lack of clarity concerning treatment periods, repetitive RCTs, and other valuable outcome measurements. The potential bias might affect the judgment of efficacy and safety.

Conclusions: The existing evidence suggests that most acupuncture therapies, including acupuncture combined with other therapies, are effective in decreasing pain and in improving physical function, but additional investigation on the safety of these therapies is required.

Key words: Myofascial pain syndrome, acupuncture, anesthesia, efficacy, safety, network meta-analysis, systematic review, randomized controlled trials

Pain Physician 2017; 20:E883-E902

Myofascial pain syndrome (MPS) is a common form of muscle disease, characterized by acute or chronic trigger points (TrPs) pain, muscle stiffness, and fatigue (1,2). MPS is the leading cause of chronic and persistent regional pain, including shoulder pain, chronic back pain, tension-type headaches, and facial pain (3,4). In pain clinics, the prevalence of MPS may reach up to 70% and appears to be more common in women (4). Management of MPS is based on a multidimensional approach. Failing to treat pain symptoms associated with MPS on time may result in dysfunction, disability, and financial loss for the patients (1,5).

Acupuncture therapy is usually considered to be a popular and effective form of initial treatment for MPS if performed by a skilled practitioner (4,6). It is the stimulation of specific points with one or more thin needles, including various techniques such as manual acupuncture (MA), electro-acupuncture (EA), dry-needling (DN), acupuncture points injection, and fire-needle (FN) (7). In Europe, approximately 80,000 physicians practice acupuncture (8). In the USA, about 6.3% of the population has been treated with acupuncture (9). In Germany, this proportion is higher (14.5% of the population) (10).

The efficacy of some acupuncture techniques for MPS have been evaluated in several systematic reviews (SRs), showing relieved pain and increased range of motion (ROM) (11,12). However, no comprehensive comparison between these different techniques is available to date, and few SRs have compared the safety of these techniques. When performing acupuncture therapies, there seems to be plenty of confusion about which technique is the best choice to treat MPS.

Network meta-analysis allows an integrated analysis of all randomized controlled trials (RCTs) that have compared different acupuncture therapies head to head or with placebo or sham acupuncture, while fully respecting randomization (13-15). The objective of this research is to assess and compare the efficacy and safety of different acupuncture therapies to treat MPS, by integrating all available direct and indirect evidence in a network meta-analysis.

Methods

Protocol and Registration

The protocol registration number is PROSPERO 2016:CRD42016038086. Available from www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42016038086

Selection Criteria

We considered RCTs of patients with MPS, that compared any of the following interventions: acupuncture therapies (e.g., MA, EA, DN, acupuncture points injection, FN, acupressure, auricular, etc.), other interventions (e.g., massage, stretching exercises, etc.), or placebo-sham acupuncture, for the treatment of pain. Trials had to report the results of pain relief, functional recovery, or adverse events. The RCTs comparing a single technique with different acupuncture points, reporting their results in the form of an abstract, or containing insufficient data were excluded.

Data Sources and Search Strategy

The Cochrane Central Register of Controlled Trials (CENTRAL), PubMed, Web of Science, EMBASE, and Chinese Biomedical Literature Database (CBM) were searched from their inceptions to February 2016. Two reviewers developed the basic search strategy as follows: (acupuncture OR electro-acupuncture OR electroacupuncture OR needl* OR dry-needling OR acusector OR auricular OR laser OR acupressure) AND ("myofascial pain" OR MPS* OR MPD* OR MTrP* OR trigger OR trigger-point*) AND random*. Additionally, all the available reviews related to MPS treatments were manually screened for any additional possibly relevant studies. We did not apply any language restriction (Supplementary file 1).

Study Selection and Data Extraction

According to the selection criteria, 2 independent reviewers screened all trials for inclusion and conducted the data extraction. In case of any disagreement between the 2 reviewers, a final decision was obtained by consensus after discussion or by the consultation of third reviewers.

We extracted data, using a pre-designed form, including general information about the study including the first author name, publication year, and financial support of articles; the patient characteristics such as mean age, gender, pain location, and mean duration of symptoms; the details of the intervention including the treatment techniques, the locations, and the number of sessions; the outcome data for pain, adverse events, and function; the trial design and the sample size; and the domains of risk of bias.

Outcome Measures

Our primary outcome measures were pain measurement and adverse events. Pain measurement in-

cluded pain intensity using a visual analog scale (VAS) or a numerical rating scale (NRS), and pressure pain threshold (PPT). Although somewhat different, both VAS and NRS are continuous variables that use a digital range usually comprised between 0 (no pain) to 10 (maximum pain) (16). The PPT is a continuous variable that is used to measure the perception of pain (17). Adverse event is an important outcome for assessing acupuncture safety. In this study, the number of patients experiencing at least one adverse event was assessed.

The secondary outcome was the functional status of patients. For this purpose, ROM was chosen as an objective assessment. Generally, the ROM is also a continuous variable ranging from 0 to 100, with higher scores indicating healthier functional status.

Risk of Bias Assessment

Two independent reviewers assessed the methodological quality of the selected trials. Any disagreement between reviewers was resolved by discussion. The Cochrane Collaboration Risk of Bias Tool (CCRBT) (18), which includes criteria on random sequence generation, concealment of allocation, blinding of participants and personnel, blinding of outcome assessors, incomplete outcome data, selective reporting, and other sources of bias, was used in the present network meta-analysis to assess the potential risk of bias of all selected trials. For each trial report, every CCRBT criteria was determined among 3 levels: low risk, high risk, or unclear risk (Supplementary file 2).

Data Synthesis and Analysis

A network meta-analysis within a frequentist model was used to combine direct and indirect evidence from all available RCTs. We used Stata 13.0 software (Stata Corporation, College Station, Texas, USA) to complete all analyses. First, a pair-wise meta-analysis was conducted using the DerSimonian and Laird method (19). Second, a network meta-analysis was processed using the mvmeta package of the Stata software, which is based on a multiple regression model. We checked evidence of inconsistency using the node-splitting method. A random effect model was selected since heterogeneity within the severity and treatments of MPS seemed probable. Results were reported with 95% confidence intervals (CIs), and a P value < 0.05 was considered statistically significant.

For continuous outcomes, such as pain intensity (VAS or NRS) and PPT, a standardized mean difference (SMD) was calculated to synthesize the effects, assuming that they were normally distributed. For dichotomous outcomes, such as adverse event, odds ratio (OR) were considered to measure a potential effect and a value of 0.5 was added to studies that reported zero event. For all outcomes, network diagrams were used to summarize the evidence. We summarized the characteristics of the included studies in a table and presented the comparisons across acupuncture therapies in different tables. For some outcomes, we also displayed the ranking probabilities of interventions by the surface under the cumulative ranking curve (SUCRA) (20) which would show the best rank mostly approaching 1. Comparison-adjusted funnel plots were conducted to assess the effects of the sample size on the results.

Results

Literature Search

A total of 1,548 references were identified from all searches. After screening them by title and abstract, we retrieved 61 full-text articles for further assessment. From these articles, we excluded 28 studies for the following reasons: did not report related outcomes (n = 10), studies were not RCTs (n = 8) or were reported only as abstract (n = 5), did not meet the diagnostic criteria of MPS (n = 3), and did not meet the requirements of intervention (n = 2). Finally, 33 (21-52) studies were included and analyzed (Fig. 1).

Study Characteristics

Table 1 shows an overview of the studies that were suitable for this network meta-analysis. The studies were published between 1994 and 2016, and included a total of 1,692 patients (range: 10 – 155) and 22 kinds of intervention. DN and MA were the most frequently investigated intervention. Across studies, the proportion of women patients ranged from 26% to 100%, the mean age of patients ranged from 24 to 79 years, the mean disease duration ranged from 3 days to 64 months, and the treatment (acupuncture) sessions ranged from one to 20. Almost half of the trials treated pain in the trapezius. The most commonly used acupuncture point was TrPs (22 trials). Figure 2 graphically displays the networks of evidence for all outcomes.

Overall, few studies were rated as low risk of bias. Only 6% of trials were judged to have a low risk of bias for blinding of patients and personnel, 24% for concealment of allocation, 45% for blinding of outcome assessors, 76% for random sequence generation, 85% for selective reporting, and 94% for incomplete

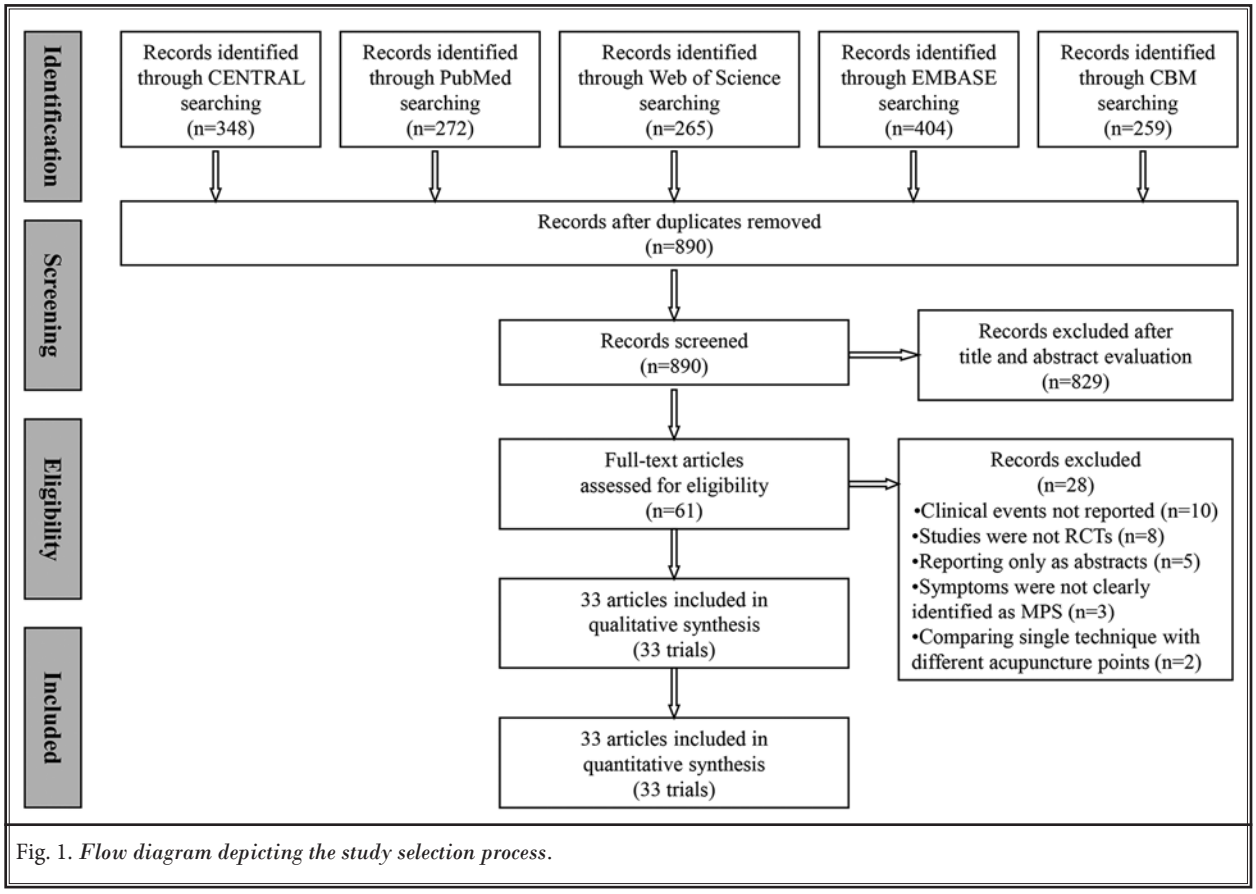

Fig. 1. *Flow diagram depicting the study selection process.*

outcome data. However, 32 (97%) of the 33 trials did not analyze the other sources of bias.

Meta-analyses

Primary outcomes: pain intensity, PPT, and adverse events.

Data on pain intensity were available from 28 RCTs. Direct pairwise random-effects meta-analyses showed significant cutback of VAS and NRS versus placebo-sham, from -0.8 (95% CI: -1.3 to -0.2) for TrP injection with lidocaine (LTrP-I) to -1.7 (-2.6 to -0.8) for miniscalpel-needle (MSN) (Table 2). When compared to other treatments, pairwise differences ranged from a significant reduction of -3.1 (-4.0 to -2.2) comparing DN and muscle energy technique (DN&MET) with MET to a significant increase of 1.1 (0.1 to 2.1) for DN versus TrP injection with botulinum toxin type A (BTX-A-TrP-I) (Table 2). The results of the network analysis showed a reduction of VAS compared to placebo-sham of -1.7 (-3.3 to -0.1) for TrP injection with bupivacaine (BTrP-I); -3.0 (-4.6 to -1.3) for DN&MET; -2.5 (-3.9 to -1.0) for EA and electro-spoon needle-cupping (EA&ESNC); -3.6 (-5.2 to -2.1) for scraping+warming acupuncture+moxibustion (SWAM); -1.9 (-3.4 to -0.4) for FN; -1.3 (-2.4 to -0.3) for MSN; -1.8 (-3.1 to -0.5) for multiple deep intramuscular stimulation therapy (MDIMST); -1.5 (-2.1 to -0.8) for LTrP-I; -0.6 (-1.2 to -0.2) for DN; -1.7 (-2.8 to -0.5) for EA; and -1.2 (-1.8 to -0.5) for MA. Comparisons across acupuncture therapies showed significant differences between DN and LTrP-I (0.8, 0.2 to 1.5), EA&ESNC (1.8, 0.3 to 3.3), and DN&MET (2.2, 0.7 to 3.7). No significant differences were observed between other acupuncture therapies. Table 3 shows the results of the network meta-analysis.

Values of PPT were available from 18 RCTs. Pairwise random-effects meta-analyses showed significant differences between PPT and placebo-sham for 4 treatments (DN, LTrP-I, MDIMST, and laser), from -0.8 (-1.4 to -0.3) for LTrP-I to 2.7 (1.9 to 3.6) for laser (Table 2). When other treatments were compared, intervention effects ranged from a -2.1 (-2.9 to -1.3) reduction for MET compared with DN, to a 3.6 (2.4 to 4.8) increase for MSN compared with stretch (Table 2). The network meta-analysis results showed a significant difference when compared to placebo: -2.4 (-3.3 to -1.4) for MET;

Table 1. *Characteristics of included trials.*

Studies	Interventions	Number of patients	Proportion of female (%)	Range of mean ages (years)	Pain location	Range of mean disease duration (months)	Acupuncture therapies		Risk of bias						
							Acupuncture points	Sessions	Random sequence generation	Concealment of allocation	Blinding of participants and personnel	Blinding of outcome assessors	Incomplete outcome data	Selective reporting	Other sources of bias
Aranha et al (2015) (21)	EA vs MA vs Placebo-Sham	60	100	27	Upper Trapezius	Unreported	GB20, GB21, LI4, LV4, TrPs	8	Low	Unclear	Unclear	Low	Low	High	Unclear
Ay et al (2010) (22)	LTrP-I vs DN	80	65	37 – 38	Trapezius	31 – 34	TrPs	4	Low	Unclear	Unclear	Unclear	Low	Low	Unclear
Chen et al (2013) (6)	MA vs Placebo-Sham	10	40	29 – 40	Upper Trapezius	Unreported	UB40, GB34	2	Low	Low	Low	Low	Low	High	Unclear
Chou et al (2009) (23)	MA vs Placebo-Sham	20	60	33 – 38	Upper Trapezius	6	SJ5, LI11	1	Low	Unclear	Unclear	Unclear	Low	Low	Unclear
Couto et al (2014) (24)	MDIMST vs LTrP-I vs Placebo-Sham	75	100	34 – 36	Unreported	Unreported	TrPs, Palpable Taut Band	8	Low	Low	Unclear	Low	Low	Low	Unclear
Diraçolu et al (2012) (25)	DN vs Placebo-Sham	50	86	33 – 36	Temporo-mandibular	Unreported	TrPs	3	Low	Unclear	Unclear	Low	Low	Low	Unclear
Edwards et al (2003) (26)	DN&Stretch vs Stretch vs Placebo-Sham	30	60	55 – 57	Unreported	10 – 16	TrPs	5	Low	Low	Unclear	Unclear	Low	Low	Unclear
Erika et al (2015) (27)	EA vs MA vs Placebo-Sham	27	100	26 – 30	Upper Trapezius	6 – 8	GB20, GB21, LI4, LV3, TrPs	8	Low	Unclear	Unclear	Low	Low	Low	Unclear
Ga et al (2007) (28)	MA vs LTrP-I	39	92	76 – 79	Upper Trapezius	6 – 8	TrPs	3	Low	Unclear	High	High	Low	Low	Unclear
Gazi et al (2011) (29)	BTrP-I vs MA	30	83	32 – 36	Trapezius, Levator Scapula, Sternocleidomastoid, Posterior of Neck, Scalene, Rhomboid, Infraspinatus, Deltoid, Pectoral, Extensor of the Forearm, Gluteal, Lumbar Paraspinalis	Unreported	TrPs vs (SI3, BL62, GB41, TW5, GB20, GB21, BL10, BL11, TW15, BL23, BL24, BL25, GB25, SI12, SI13, SI14)	8	Low	Low	Unclear	Unclear	Low	Low	Unclear

Table 1 (cont.). *Characteristics of included trials.*

Studies	Interventions	Number of patients	Proportion of female (%)	Range of mean ages (years)	Pain location	Range of mean disease duration (months)	Acupuncture therapies		Risk of bias						
							Acupuncture points	Sessions	Random sequence generation	Concealment of allocation	Blinding of participants and personnel	Blinding of outcome assessors	Incomplete outcome data	Selective reporting	Other sources of bias
Hong et al (1994) (30)	LTrP-I vs DN	58	72	42	Upper Trapezius	8	TrPs	2	Unclear	Unclear	High	Low	Low	Low	Unclear
Ilbuldu et al (2004) (31)	Placebo-Sham vs DN vs laser	60	100	32 – 35	Upper Trapezius	33 – 38	TrPs	12	Unclear	Unclear	Unclear	Low	Low	Low	Unclear
Jia et al (2009) (32)	MA vs LTrP-I	60	58	38	Back	3 – 15	Ex-B2, BL18, Pishu, BL23, BL25, B40, BL60, TrPs	6	Low	Unclear	Unclear	Unclear	Low	Low	Unclear
Jiang et al (2013) (33)	MA vs LTrP-I	66	64	38 – 41	Lumbar	5 – 7	Ex-B2, BL23, BL25, B40, BL60, TrPs	5	Low	Unclear	Unclear	Unclear	Low	Low	Unclear
Kamanli et al (2005) (34)	LTrP-I vs DN vs BTX-A-TrP-I	29	79	37 – 38	Trapezius, Levator Scapulae, Teres Minor, Supraspinatus, Infraspinatus	33 – 51	TrPs	1	Unclear	Unclear	Unclear	Low	Low	High	Unclear
Kumnerddee et al (2009) (35)	TTM vs MA	17	Unreported	26 – 29	Back	3 – 4	Unreported	5	High	Unclear	Unclear	Unclear	High	Low	Unclear
Llamas et al (2014) (36)	DN vs MT	94	66	31	Upper Trapezius	7	TrPs	2	Low	Low	Low	Unclear	Low	Low	Unclear
Ma et al (2010) (37)	MSN vs DN vs Stretch	43	51	42 – 43	Upper Trapezius	21 – 23	TrPs	2	Low	Unclear	Unclear	Unclear	Low	Low	Unclear
Ma et al (2014) (38)	SPM vs MA	90	26	43	Unreported	15 – 20	TrPs	10	Unclear	Unclear	Unclear	Unclear	Low	Low	Unclear
MJ et al (2014) (39)	DN vs Placebo-Sham	17	53	24 – 25	Upper Trapezius	3d	TrPs	1	Low	Low	High	Low	Low	Low	Unclear
Rayegani et al (2014) (40)	DN vs PT	28	Unreported	32 – 39	Upper Trapezius	10	the most painful area	1	Low	Unclear	Unclear	Unclear	Low	High	Unclear
Shen et al (2007) (41)	MA vs Placebo-Sham	15	93	42 – 45	Masticatory muscles	Unreported	LI4	1	High	Unclear	High	Low	Low	Low	Unclear

Table 1 (cont.). *Characteristics of included trials.*

Studies	Interventions	Number of patients	Proportion of female (%)	Range of mean ages (years)	Pain location	Range of mean disease duration (months)	Acupuncture therapies		Risk of bias						
							Acupuncture points	Sessions	Random sequence generation	Concealment of allocation	Blinding of participants and personnel	Blinding of outcome assessors	Incomplete outcome data	Selective reporting	Other sources of bias
Shen et al (2009) (42)	MA vs Placebo-Sham	28	100	37 – 45	Jaw	Unreported	LI4	1	Low	Unclear	High	Low	Low	Low	Unclear
Tekin et al (2013) (43)	DN vs Placebo-Sham	39	79	43	Upper Back	58 – 64	TrPs	6	Low	Unclear	High	Low	High	High	High
Tellez et al (2015) (44)	DN vs TrP-DN&EDU	12	67	36 – 37	Low Back	17 – 19	TrPs	3	Low	Low	High	Low	Low	Low	Unclear
Tsai et al (2010) (45)	DN vs Placebo-Sham	35	60	42 – 46	Upper Trapezius	7 – 8	TrPs	1	Low	Unclear	High	Low	Low	Low	Unclear
Wang et al (2006) (46)	SWAM vs MA	100	42	Unreported	Back	Unreported	B12, IL4, SI13, SI12, Jiafeng, TrPs	20	High	Unclear	Unclear	Unclear	Low	Low	Unclear
Wang et al (2016) (47)	EA&ESNC vs EA vs MA	60	57	47 – 51	Back	15d	GB21, GV14, B40, B39, G39, UB54, BL60, ST36	20	Low	Unclear	Unclear	Unclear	Low	Low	Unclear
Wei et al (2015) (48)	FN vs MA	72	46	42	Back	20 – 21	GB34, ST36, BL18, Pishu, BL23, BL25, Ex-B2, TrPs	20	Low	Unclear	Unclear	Unclear	Low	Low	Unclear
Yeganeh et al (2016) (49)	DN&MET vs MET vs DN	60	100	25 – 26	Upper Trapezius	Unreported	TrPs	2	High	Unclear	Unclear	Unclear	Low	Low	Unclear
Yin et al (2014) (50)	MA vs LTrP-I	100	54	35 – 37	Neck	8	TrPs	3	Low	Unclear	Unclear	Unclear	Low	Low	Unclear
Zheng et al (2014) (51)	MSN vs DN	155	40	39 – 42	Neck and Back	60	TrPs	1	Low	Low	High	Low	Low	Low	Unclear
Ziaeifar et al (2014) (52)	DN vs TCT	33	Unreported	27 – 30	Upper Trapezius	Unreported	Unreported	3	Low	Unclear	Unclear	Unclear	Low	Low	Unclear

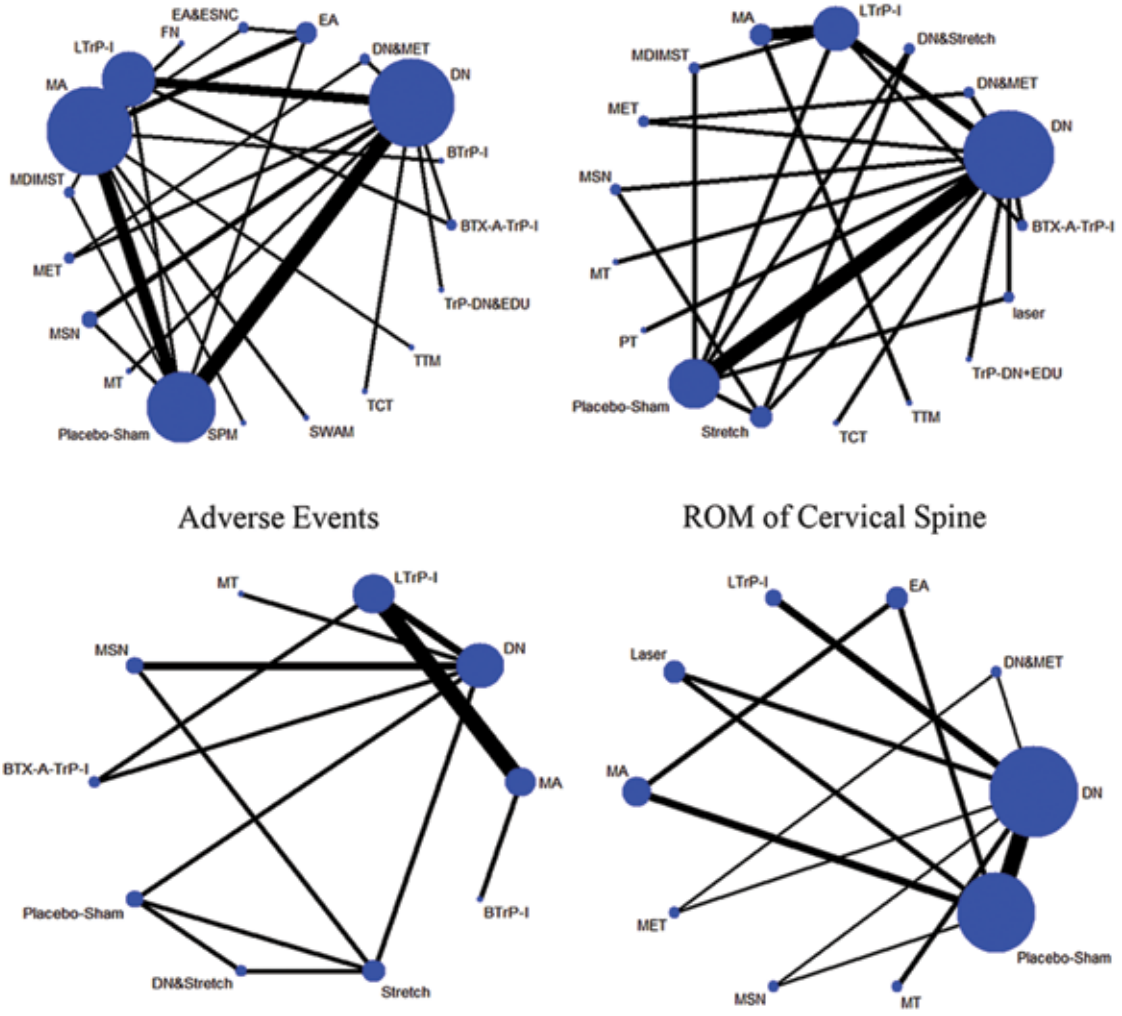

Fig. 2. *Network maps for efficacy and safety outcomes.*
Nodes represent the competing techniques and their size is proportional to the number of participants; edges represent the available direct comparisons between pairs of techniques and their width is proportional to the number of trials comparing every year.

-0.9 (-1.6 to -0.2) for MT; -0.7 (-1.3 to 0) for stretch; 0.6 (0.2 to 0.9) for DN; 0.8 (0.3 to 1.3) for LTrP-I; 1.0 (0.4 to 1.6) for MA; 1.5 (0.8 to 2.1) for MDIMST; 1.5 (0.8 to 2.2) for laser; and 2.2 (1.2 to 3.1) for MSN (Table 4). Among acupuncture treatments, MSN increased PPT to a greater extent compared to all other treatments. The value was up to 2.5 (1.3 to 3.7) when MSN was compared with DN&stretch (Table 4).

Data on adverse events were available from 12 RCTs, reporting a total of 179 participants with events. Meta-analyses were conducted on 9 RCTs, as 3 RCTs reported no adverse events. The results of the direct pairwise random-effects meta-analyses showed that only one treatment was compared with placebo-sham, with an OR of 96.3 (3.4 to 2715.3) (Table 2). When other treatments were compared, ORs were lower, with significant differences ranging from 4.1 (1.7 to 9.8) when DN was compared with MT, to 69.0 (3.4 to 1422.1) when DN was compared with stretch (Table 2). Among acupuncture treatments, the results of the network meta-analysis showed a significant increased risk of adverse events compared to placebo-sham for

Table 2. *Direct pairwise random-effects meta-analyses of outcomes.*

Interventions	Pain Intensity (VAS&NRS)				Pressure Pain Threshold (PPT)				Adverse Events				ROM of Cervical Spine			
	SMD	95% CI		*P* value	SMD	95% CI		*P* value	OR	95% CI		*P* value	SMD	95% CI		*P* value
BTrP-I vs MA	-0.54	-1.27	0.19	0.14	-	-	-	-	**26**	**3.69**	**183.42**	0	-	-	-	-
DN vs BTX-A-TrP-I	**1.08**	**0.11**	**2.05**	**0.03**	-0.06	-0.96	0.84	0.9	0.18	0.01	4.28	0.29	-	-	-	-
DN vs Laser	-	-	-	-	-0.22	-0.84	0.4	0.49	-	-	-	-	-0.16	-0.59	0.28	0.49
DN vs MT	-0.19	-0.59	0.22	0.37	**2.11**	**1.6**	**2.62**	**0**	**4.05**	**1.67**	**9.84**	0	0.01	-0.28	0.3	0.94
DN vs Placebo-Sham	**-0.95**	**-1.63**	**-0.26**	**0.01**	**0.4**	**0.07**	**0.73**	**0.02**	**96.33**	**3.42**	**2715.26**	**0.01**	**0.51**	**0.21**	**0.81**	**0**
DN vs PT	-	-	-	-	-0.06	-0.8	0.68	0.88	-	-	-	-	-	-	-	-
DN vs Stretch	-	-	-	-	**1.68**	**0.81**	**2.55**	**0**	**69**	**3.35**	**1422.05**	**0.01**	-	-	-	-
DN vs TCT	**-0.81**	**-1.52**	**-0.1**	**0.03**	0.59	-0.11	1.29	0.1	-	-	-	-	-	-	-	-
DN vs TrP-DN&EDU	0.38	-0.76	1.52	0.51	**-1.48**	**-2.78**	**-0.17**	**0.03**	-	-	-	-	-	-	-	-
DN vs DN&MET	**-2.09**	**-2.87**	**-1.31**	**0**	-	-	-	-	-	-	-	-	**-1.5**	**-2.21**	**-0.79**	**0**
DN&MET vs MET	**-3.08**	**-4.01**	**-2.15**	**0**	-	-	-	-	-	-	-	-	**1.6**	**0.88**	**2.31**	**0**
DN&Stretch vs Placebo-Sham	-	-	-	-	-0.15	-0.91	0.6	0.69	-	-	-	-	-	-	-	-
DN&Stretch vs Stretch	-	-	-	-	0	-0.75	0.75	1	-	-	-	-	-	-	-	-
EA vs MA	-	-	-	-	-	-	-	-	-	-	-	-	0.14	-0.29	0.58	0.52
EA vs Placebo-Sham	-	-	-	-	-	-	-	-	-	-	-	-	0.16	-0.29	0.6	0.48
EA&ESNC vs EA	**-0.54**	**-1.17**	**0.09**	**0.09**	-	-	-	-	-	-	-	-	-	-	-	-
EA&ESNC vs MA	**-1.58**	**-2.3**	**-0.87**	**0**	-	-	-	-	-	-	-	-	-	-	-	-
FN vs MA	**-0.74**	**-1.22**	**-0.26**	**0**	-	-	-	-	-	-	-	-	-	-	-	-
Laser vs Placebo-Sham	-	-	-	-	**2.73**	**1.86**	**3.61**	**0**	-	-	-	-	**0.57**	**0.12**	**1.02**	**0.01**
LTrP-I vs BTX-A-TrP-I	-0.52	-1.44	0.4	0.27	0.38	-0.53	1.29	0.42	0.18	0.01	4.28	0.29	-	-	-	-
LTrP-I vs DN	**-1.33**	**-2.27**	**-0.39**	**0.01**	0.24	-0.32	0.8	0.4	0.31	0.02	4.62	0.4	0.28	-0.1	0.65	0.15
LTrP-I vs Placebo-Sham	**-0.76**	**-1.32**	**-0.19**	**0.01**	**-0.82**	**-1.39**	**-0.26**	**0**	-	-	-	-	-	-	-	-
MA vs LTrP-I	0.1	-0.14	0.35	0.4	0.15	-0.13	0.42	0.3	0.47	0.09	2.5	0.38	-	-	-	-
MA vs Placebo-Sham	-1.25	-2.52	0.03	0.06	-	-	-	-	-	-	-	-	-0.03	-0.45	0.38	0.88
MDIMST vs LTrP-I	**-0.77**	**-1.33**	**-0.21**	**0.01**	0.01	-0.53	0.56	0.97	-	-	-	-	-	-	-	-
MDIMST vs Placebo-Sham	**-1.33**	**-1.93**	**-0.73**	**0**	**1.32**	**0.72**	**1.92**	**0**	-	-	-	-	-	-	-	-
MET vs DN	0.65	0.01	1.29	0.05	**-2.11**	**-2.89**	**-1.33**	**0**	-	-	-	-	-0.24	-0.87	0.38	0.44
MSN vs DN	**-0.62**	**-0.92**	**-0.33**	**0**	**0.87**	**0.12**	**1.63**	**0.02**	0.67	0.27	1.67	0.39	0.76	0.02	1.5	0.05
MSN vs Placebo-Sham	**-1.72**	**-2.59**	**-0.84**	**0**	-	-	-	-	-	-	-	-	**1**	**0.21**	**1.79**	**0.01**
MSN vs Stretch	-	-	-	-	**3.58**	**2.35**	**4.8**	**0**	**39.46**	**1.98**	**787.71**	**0.02**	-	-	-	-
SPM vs MA	-0.24	-0.66	0.17	0.25	-	-	-	-	-	-	-	-	-	-	-	-

Table 2 con't. *Direct pairwise random-effects meta-analyses of outcomes.*

Interventions	Pain Intensity (VAS&NRS)			Pressure Pain Threshold (PPT)			Adverse Events			ROM of Cervical Spine		
	SMD	95% CI	*P* value	SMD	95% CI	*P* value	OR	95% CI	*P* value	SMD	95% CI	*P* value
Stretch vs Placebo-Sham	-	- -	-	0	-0.77 0.77	0.99	-	- -	-	-	- -	-
SWAM vs MA	**-2.46**	**-2.99 -1.94**	**0**	-	- -	-	-	- -	-	-	- -	-
TTM vs MA	0.92	-0.09 1.92	0.08	**-1.47**	**-2.56 -0.38**	**0.01**	-	- -	-	-	- -	-

Statistically significant differences are in bold.

MSN, DN, BTX-A-TrP-I, and BTrP-I, with respective ORs of 76.2 (1.4 to 4187.2), 117.0 (2.7 to 5101.7), 407.1 (2.6 to 64588.2), and 557.2 (3.6, 86867.3). The OR value was approximately zero when MA was compared with BTrP-I. No significant differences were found between other acupuncture therapies. Table 4 shows the results of the network meta-analysis.

Secondary outcome: ROM

Data on ROM were available from 10 RCTs, and only about the cervical spine. Compared to placebo-sham, pairwise random-effects meta-analyses showed significant increases for 3 treatments: from 0.5 (0.2 to 0.8) with DN to 1.0 (0.2 to 1.8) with MSN (Table 2). When compared to other treatments, significant differences were observed and ranged from a reduction of -1.5 (-2.2 to -0.8), when comparing DN with DN&MET, to an increase of 1.6 (0.9 to 2.3), when comparing DN&MET with MET (Table 2). The network analysis results showed a greater increase in ROM when laser was compared to EA (4.8, 0.8 to 8.8), and exhibited a greater cutback when EA was compared to DN&MET (-6.2, -11.5 to -0.9); only EA was significantly different (-4.4, -7.5 to -1.3) from placebo-sham (Table 3). No significant differences were found among other acupuncture therapies (Table 3).

Inconsistency Analyses

Node-splitting analysis did not detect any inconsistency among ROM and adverse events. However, it showed inconsistency for pain intensity between DN and LTrP-I ($P = 0.02$), DN and placebo-sham ($P = 0.04$); and PPT between MA and MT ($P = 0.0$), EA and sparrow-pecking (SPM) ($P = 0.048$), MDIMST and SPM ($P = 0.045$), BTX-A-TrP-I and SPM ($P = 0.04$), BTX-A-TrP-I and placebo-sham ($P = 0.04$), and SPM and placebo-sham ($P = 0.045$).

Rank Probability

Table 5 shows, for each treatment, the likelihood of being the most efficient treatment. Regarding pain score, SWAM, DN&MET, and EA&ESNC showed greater effects than the other treatments, whereas standard manual treatment (TCT) and MET exhibited the worst effects. With respect to PPT, MSN, laser, and MDIMST showed greater effects than the others, whereas MT and stretch exhibited the worst effects. For acupuncture treatments, MA showed greater safety than others when considering adverse events, whereas BTrP-I and BTX-A-TrP-I exhibited the worst effects. With regard to ROM, MSN showed the greater effects, whereas EA showed the worst effects.

Discussion

In this network meta-analysis investigating the efficacy and safety of different acupuncture treatments compared to placebo-sham or other physical treatments (e.g., MDIMST, MET, TCT, etc.), SWAM seemed to be the most effective for pain relief, although its safety and its effect on physical function remained unclear; MSN seemed to be more effective to improve PPT and physical function, although its safety was quite low; MA seemed to be the safest method compared with other acupuncture techniques, however the analgesic effects were weak; DN&MET seemed to be more effective to increase ROM. As well, according to the comprehensive review, DN and TrPs injection seemed to have moderate treatment effects for MPS, although these techniques are more commonly used by clinicians. It is difficult to determine which treatment is the best considering the complexity of

Table 3. *Network meta-analysis of the outcomes on VAS and NRS, and ROM.*

ROM (SMD)																											
0.64 (-2.11, 3.38)	0 (-2.48, 2.49)	**-4.4 (-7.46, -1.34)**	0.52 (-1.22, 2.26)	0.23 (-4.37, 4.82)	-	0.51 (-2.94, 3.97)	0.85 (-2.15, 3.85)	-	1.06 (-2.75, 4.86)	-	-	-	-	-	-	-	1.91 (-2.69, 6.51)	-	-	Placebo-Sham
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	TrP-DN&EDU	-0.95 (-2.81, -0.91)
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	BTrP-I	-0.75 (-3.14, 1.65)	**-1.69 (-3.32, -0.05)**
-1.25 (-6.13, 3.62)	-1.89 (-6.91, 3.14)	**-6.22 (-11.54, -0.91)**	-1.37 (-5.44, 2.7)	-1.64 (-5.81, 2.52)	-	-1.37 (-6.38, 3.64)	-1.03 (-5.75, 0.69)	-	-1.89 (-6.29, 2.51)	-	-	-	-	-	-	-	-	DN&MET	-1.29 (-3.53, 0.93)	-2.02 (-4.3, 0.26)	**-2.96 (-4.57, -1.34)**
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SPM	0.26 (-1.73, 2.26)	-0.46 (-2.78, 1.85)	-1.4 (-2.92, 0.12)
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	EA&ESNG	-1.07 (-2.98, 0.84)	-0.79 (-2.79, 0.22)	-1.51 (-3.82, 0.79)	**-2.45 (-3.94, -0.96)**
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SWAM	-1.19 (-3.13, 0 .75)	**-2.23 (-4.16, -0.3)**	-0.82 (-2.98, 1.34)	-1.95 (-3.97, 0.07)	-2.68 (-5.02, -0.34)	**-3.62 (-5.17, -2.06)**
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FN	1.67 (-0.27, 3.61)	0.54 (-1.39, 2.47)	-0.5 (-2.42, 1.41)	0.91 (-1.24, 3.06)	-0.22 (-2.23, 1.79)	-0.95 (-3.28, 1.38)	**-1.89 (-3.43, -0.35)**
-	-	-	-	-	-	-	-	-	-	-	-	-	BTX-A-TrP-I	0.45 (-1.57, 2.47)	**2.14 (0.11, 4.17)**	1.01 (-0.99, 3.01)	-0.03 (-2.04, 1.97)	1.39 (-0.66, 3.43)	0.25 (-1.84, 2.34)	-0.47 (-2.7, 1.763)	-1.41 (-2.89, 0.08)
-	-	-	-	-	-	-	-	-	-	TTM	1.08 (-1.14, 3.3)	1.55 (-0.59, 3.68)	**3.24 (1.09, 5.39)**	2.11 (-0.02, 4.24)	1.06 (-1.06, 3.19)	**2.48 (0.14, 4.81)**	1.35 (-0.86, 3.55)	0.62 (-1.88, 3.12)	-0.32 (-2.11, 1.47)
0.81 (-4.75, 6.38)	-1.1 (-5.5, 3.31)	**-5.44 (-10.19, -0.69)**	-0.58 (-4.34, 3.08)	-0.87 (-6.43, 4.69)	-	-0.58 (-5.28, 4.11)	-0.25 (-4.62, 4.13)	-	MSN	-1.03 (-3.03, 0.96)	0.08 (-1.6, 1.76)	0.54 (-1.24, 2.33)	**2.23 (0.43, 4.03)**	1.11 (-0.65, 2.86)	0.06 (-1.71, 1.83)	1.48 (-0.27, 3.23)	0.34 (-1.53, 2.21)	-0.38 (-2.34, 1.58)	**-1.32 (-2.36, -0.28)**
-	-	-	-	-	-	-	-	MDIMST	-0.5 (-2.09, 1.09)	-1.53 (-3.63, 0.57)	-0.42 (-2.27, 1.44)	0.05 (-1.85, 1.95)	1.74 (-0.18, 3.65)	0.61 (-1.27, 2.49)	-0.43 (-2.32, 1.45)	0.98 (-1, 2.97)	-0.15 (-2.13, 1.83)	-0.88 (-3.05, 1.3)	**-1.81 (-3.09, -0.53)**
-0.26 (-3.78, 3.35)	-0.9 (-4.72, 2.93)	**-5.24 (-9.46, -1.03)**	-0.37 (-2.77, 2.02)	-0.66 (-5.49, 4.17)	-	-0.38 (-4.17, 3.42)	LTrP-I	0.35 (-0.91, 1.61)	-0.14 (-1.25, 0.98)	-1.16 (-2.9, 0.57)	-0.05 (-1.46, 1.35)	0.41 (-1.07, 1.9)	**2.1 (0.6, 3.6)**	0.98 (-0.49, 2.44)	-0.07 (-1.54, 1.4)	1.35 (-0.27, 2.97)	0.21 (-1.37, 1.8)	-0.51 (-2.36, 1.33)	**-1.45 (-2.13, -0.77)**
-0.06 (-3.91, 4.02)	-0.58 (-4.74, 3.57)	**-4.93 (-9.45, -0.4)**	-0.05 (-2.96, 2.85)	-0.34 (-5.44, 4.75)	-	MT	1.03 (-0.48, 2.53)	1.37 (-0.52, 3.26)	0.89 (-0.75, 2.53)	-0.14 (-2.38, 2.1)	0.98 (-0.97, 2.93)	1.44 (-0.62, 3.49)	**3.13 (1.06, 5.19)**	2.0 (-0.03, 4.03)	0.96 (-1.09, 3.0)	**2.38 (0.38, 4.38)**	1.24 (-0.89, 3.37)	0.51 (-1.67, 2.7)	-0.42 (-1.9, 1.06)
-	-	-	-	-	TCT	0.59 (-1.4, 2.58)	**1.62 (0.01, 3.24)**	1.97 (-0.01, 3.95)	1.49 (-0.26, 3.23)	0.46 (-1.86, 2.78)	1.57 (-0.47, 3.61)	2.03 (-0.11, 4.17)	**3.72 (1.57, 5.87)**	**2.6 (0.48, 4.71)**	1.55 (-0.58, 3.68)	**2.97 (0.89, 5.06)**	1.83 (-0.38, 4.04)	1.11 (-1.16, 3.38)	0.18 (-1.42, 1.77)
0.34 (-4.52, 5.21)	-0.3 (-5.31, 4.72)	-4.64 (-9.95, 0.68)	0.23 (-3.83, 4.29)	MET	-0.13 (-2.18, 1.91)	0.46 (-1.5, 2.42)	1.5 (0.08, 3.08)	1.84 (-0.11, 3.79)	1.36 (-0.35, 3.07)	0.33 (-1.96, 2.63)	1.45 (-0.56, 3.46)	1.91 (-0.21, 4.02)	**3.6 (1.47, 5.72)**	**2.47 (0.38, 4.56)**	1.43 (-0.68, 3.53)	**2.84 (1.31, 4.36)**	1.71 (-0.48, 3.89)	0.98 (-1.26, 3.23)	0.05 (-1.51, 1.61)
0.11 (-2.61, 2.83)	-0.54 (-3.54, 2.46)	**-4.89 (-8.37, -1.4)**	DN	-0.62 (-2.04, 0.8)	-0.79 (-2.25, 0.67)	-0.19 (-1.53, 1.15)	**0.84 (0.18, 1.51)**	1.19 (-0.14, 2.51)	0.71 (-0.23, 1.64)	-0.32 (-2.12, 1.47)	0.79 (-0.61, 2.2)	1.25 (-0.3, 2.81)	**2.94 (1.37, 4.51)**	**1.82 (0.29, 3.34)**	0.77 (-0.76, 2.31)	**2.19 (0.72, 3.67)**	1.05 (-0.6, 2.7)	0.33 (-1.4, 2.06)	**-0.60 (-1.19, -0.18)**
4.8 (0.77, 8.82)	**4.25 (1.25, 7.26)**	EA	-1.04 (-2.26, 0.18)	-1.67 (-3.54, 0.2)	-1.84 (-3.73, 0.06)	-1.24 (-3.04, 0.56)	-0.21 (-1.36, 0.95)	0.14 (-1.49, 1.77)	-0.34 (-1.83, 1.15)	-1.37 (-3.3, 0.56)	-0.26 (-2.03, 1.52)	0.21 (-1.5, 1.92)	**1.9 (0.18, 3.62)**	0.78 (-0.57, 2.12)	-0.27 (-1.96, 1.42)	1.14 (-0.77, 3.05)	0 (-1.79, 1.8)	-0.72 (-2.83, 1.39)	**-1.66 (-2.80, -0.51)**
0.58 (-3.1, 4.25)	MA	0.49 (-0.54, 1.52)	-0.55 (-1.31, 0.21)	-1.18 (-2.78, 0.43)	-1.34 (-2.98, 0.3)	-0.74 (-2.28, 0.79)	0.29 (-0.31, 0.89)	0.63 (-0.69, 1.96)	0.15 (-1.0, 1.31)	-0.88 (-2.5, 0.75)	0.23 (-1.25, 1.72)	0.7 (-0.66, 2.07)	**2.4 (1.02, 3.77)**	1.27 (-0.09, 2.62)	0.22 (-1.12, 1.56)	1.63 (-0.02, 3.29)	0.5 (-0.97, 1.97)	-0.23 (-2.11, 1.66)	**-1.16 (-1.83, -0.5)**
Laser	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VAS and NRS (SMD)																					
Statistically significant differences are in bold; Reading from left to right.																					

the results. Consequently, clinicians have to take into account the clinical conditions and the willingness of their patients when they make treatment decisions.

To date, after analyzing the data of 33 RCTs including a total of 1,692 patients, we observed that few direct head-to-head trials comparing acupuncture therapies have been reported or are ongoing, thus limiting the usage of a direct meta-analysis of their comparative clinical profiles. Based on common controlled treatments, our network meta-analysis has

Table 4. *Network meta-analysis of the outcomes on adverse events and PPT.*

Adverse Events (OR)																				
-	21.45 (0.25, 1846.46)	**116.98 (2.68,5101.69)**	-	-	28.86 (0.47, 1754.76)	45.39 (0.64, 3206.39)	-	**76.22 (1.39, 4187.16)**	-	**407.11 (2.57, 64588.17)**	-	**557.2 (3.57, 86867.31)**	-	-	1.87 (0.01, 269.42)	-	-	Placebo-Sham
-			-	-			-		-		-		-	-	-	-	DN&Stretch	-0.42 (-1.23, 0.38)
-	11.32 (0.21, 616.81)	**61.67 (2.45, 1554.30)**	-	-	15.21 (0.41, 562.0)	23.94 (0.55, 1045.97)	-	**40.24 (1.62, 998.57)**	-	**214.69 (2.01, 22925.54)**	-	**293.99 (2.81, 30777.39)**	-	-	Stretch	-0.32(-1.1, 0.47)	**-0.68 (-1.34, -0.02)**	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	TrP-DN&EDU	**1.6 (0.19, 3.02)**	1.25 (-0.23, 2.73)	0.93 (-0.37, 2.22)	
-	-	-	-	-	-	-	-	-	-	-	-	-	PT	**-1.84 (-3.25,-0.44)**	**-1.27 (0.2,2.35)**	0.92 (-0.24, 2.08)	0.6 (-0.31, 1.51)	
-	**0.04 (0, 0.42)**	0.21 (0.01, 6.05)	-	-	0.05 (0, 2.16)	0.08 (0.01, 1.24)	-	0.14 (0, 5.08)	-	0.74 (0.01, 56.13)	-	BTrP-I	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	-	-	DN&MET	-	-1.01 (-2.11, 0.1)	**-1.48 (-2.91,-0.05)**	0.36 (-0.64, 1.37)	0.01 (-1.08, 1.11)	-0.31 (-1.14, 0.51)	
-	0.05 (0, 1.99)	0.29 (0.01, 8.47)	-	-	0.07 (0, 3.02)	0.11 (0, 3.29)	-	0.19 (0.01, 7.12)	-	BTX-A-TrP-I	0.81 (-0.33, 1.95)	-	-0.13 (-1.34, 1.08)	-0.6 (-2.12, 0.91)	**1.24 (0.14, 2.35)**	0.89 (-0.29, 2.07)	0.57 (-0.36, 1.5)	
-	-	-	-	-	-	-	-	-	TTM	0.3 (-1.72, 1.13)	0.59 (-0.82, 2.0)	-	-0.35 (-1.81, 1.11)	-0.82 (-2.54, 0.9)	1.03 (-0.36, 2.41)	0.67 (-0.75, 2.1)	0.35 (-0.88, 1.59)	
-	0.28(0.02, 4.28)	1.54(0.4, 5.87)	-	-	0.38 (0.05, 3.1)	0.60 (0.06, 6.45)	-	MSN	**1.64 (0.15, 3.13)**	**1.51 (0.27, 2.74)**	**2.42 (1.29, 3.55)**	-	**1.48 (0.29, 2.67)**	1.0 (-0.5, 2.51)	**2.98 (1.93, 4.02)**	**2.5 (1.34, 3.66)**	**2.18 (1.23, 3.12)**	
-	-	-	-	-	-	-	MDIMST	-0.95(-2.11, 0.2)	0.93(-0.37, 2.22)	0.79 (-0.26, 1.84)	**1.69 (0.69, 2.68)**	-	0.75 (-0.32, 1.81)	0.27 (-1.13, 1.68)	**2.12 (1.21, 3.03)**	**1.77 (0.78, 2.77)**	**1.46 (0.8, 2.11)**	
-	0.47(0.13, 1.76)	2.57(0.36, 18.48)	-	-	0.63 (0.05, 8.14)	LTrP-I	**-0.68 (-1.3, -0.06)**	**-1.58 (-2.61, -0.55)**	0.31 (-0.82, 1.44)	0.17 (-0.71, 1.05)	**-1.06 (0.2, 1.92)**	-	0.12 (-0.82, 1.06)	-0.35 (-1.67, 0.96)	**1.49 (0.71, 2.28)**	**1.14 (0.25, 2.04)**	**0.82 (0.33, 1.31)**	
-	0.75(0.04, 13.13)	4.05(0.8, 20.41)	-	-	MT	**-1.78 (-2.53, -1.04)**	**-2.44 (-3.32, -1.56)**	**-3.32 (-4.43, -2.21)**	**-1.46(-2.82, -0.1)**	**-1.59(-2.65, -0.54)**	-0.68 (-1.61, 0.25)	-	**-1.62 (-3.45, -0.61)**	**-2.09 (-3.45, -0.74)**	-0.25 (-1.15, 0.65)	-0.6 (-1.6, 0.39)	**-0.93 (-1.62, -0.23)**	
-	-	-	-	TCT	**1.03 (0.07, 2.0)**	-0.71 (-1.62, 0.2)	**-1.36 (-2.39, -0.34)**	**-2.24 (-3.47, -1.02)**	-0.39 (-1.85, 1.07)	-0.52 (-1.7, 0.66)	0.39 (-0.67, 1.46)	-	-0.55 (-1.68, 0.59)	-1.02 (-2.48, 0.44)	-3.04 (-4.26, -1.82)	0.83 (-0.21, 1.87)	0.47 (-0.65, 1.6)	0.15 (-0.72, 1.02)	
-	-	-	MET	**-2.58 (-3.77, -1.38)**	**-1.46 (-2.53, -0.39)**	**-3.2 (-4.22, -2.18)**	**-3.86 (-4.99, -2.74)**	**-4.74 (-6.05, -3.43)**	**-2.88 (-4.41, -1.36)**	**-3.02 (-4.28, -1.75)**	**-2.08 (-2.89, -1.27)**	-	**-3.04 (-4.26, -1.82)**	-3.12 (-5.04, -1.99)	**-1.67 (-2.81, -0.53)**	**-2.02 (-3.24, -0.81)**	**-2.35 (-3.33, -1.37)**	
-	0.18(0.02, 1.97)	DN	**2.4 (1.22, 3.59)**	0.33 (-0.45, 1.11)	**1.44 (0.86, 2.02)**	-0.3 (-0.77, 0.17)	**-0.96 (-1.63, -0.29)**	**-1.84 (-2.76, -0.92)**	0.02 (-1.21, 1.25)	0.11 (-1.0, 0.77)	**0.8 (0.07, 1.53)**	-	-0.14 (-0.96, 0.69)	-0.61 (-1.84, 0.62)	**1.23 (0.56, 1.9)**	**0.88 (0.06, 1.7)**	**0.56 (0.21, 0.91)**	
-	MA	0.45 (-0.18, 1.08)	**3.25 (2.19, 4.31)**	0.76 (-0.2, 1.73)	**1.88 (1.07, 2.69)**	0.19 (-0.17, 0.54)	-0.5 (-1.21, 0.21)	**-1.4 (-2.48, -0.31)**	0.51 (-0.56, 1.57)	0.35 (-0.6, 1.3)	**1.24 (0.31, 2.16)**	-	0.3 (-0.7, 1.3)	-0.18 (-1.53, 1.18)	**1.67 (0.81, 2.54)**	**1.32 (0.36, 2.28)**	**1.0 (0.39, 1.61)**	
Laser	0.46 (-0.42, 1.34)	**0.95 (0.22, 1.68)**	**3.75 (2.63, 4.88)**	**1.27 (0.23, 2.31)**	**2.38 (1.49, 3.28)**	0.65 (-0.15, 1.44)	-0.01 (-0.93, 0.9)	0.9 (-2.06, 0.26)	0.97 (-0.43, 2.36)	0.83 (-0.27, 1.94)	**1.74 (0.75, 2.74)**	-	0.81 (-0.27, 1.88)	0.33 (-1.08, 1.74)	**2.18 (1.24, 3.11)**	**1.83 (0.81, 2.85)**	**1.52 (0.82, 2.22)**	
PPT (SMD)																		

Statistically significant differences are in bold; Reading from left to right.

allowed for indirect comparisons between different acupuncture therapies, and synthesized the indirect results and the direct results. However, it is obvious that several statistically significant results in pairwise meta-analysis failed to reach statistical significance in network meta-analysis, such as the results of DN versus BTX-A-TrP-I, MSN in pain score, DN versus DN TrP plus neuroscience education (TrP-DN&EDU) in PPT, BTrP-I versus MA in adverse events, and DN versus DN&MET in ROM. Interestingly, our pairwise meta-analysis showed that DN is superior to DN&MET regarding pain relief, however the outcome is the opposite when considering the network meta-analysis. By checking inconsistency with the node-splitting model, which showed minor inconsistency between the direct and the indirect results, we considered the possible causes of the variation as follows: only one or 2 trials comparing the related treatments, small effect size of the trials, and the results of indirect comparisons are stronger.

Although no significant difference was found in many comparisons of the present network meta-analysis, SUCRA displayed the ranking probabilities of each treatment among the outcomes. SWAM, MSN, MA, and DN&MET were all of high probability to become the most efficient treatment, individually for pain relief, PPT, adverse events, and ROM. Many acupuncture treatments combined with other techniques, such as SWAM, DN&MET, EA&ESNC, and DN&stretch, ranked ahead of the other physical therapies regarding efficacy. As a majority of 14 treatments had no data concerning adverse events, whether their safety can overweigh MA or not is uncertain. Moreover, the number of adverse events for safety was low and our estimates of ORs imprecise, as indicated by the wide credibility intervals. Given the small sample size of the few included trials, establishing the safety assessment of acupuncture therapies with sufficient precision would require more trials with larger sample sizes.

The quality of this analysis is restricted by the quality of the underlying data. Aside other sources of bias, whether participants, personnel, and investigators in most trials were properly blinded was unclear yet, which may affect authenticity of the observations. As for acupuncture treatments, physicians have to operate according to the disease, making blinding difficult. However, it is necessary to blind the patients and the personnel responsible for data collection and analysis. Considering the present trials on acupuncture, it appears that placebo-sham acupuncture with imitating appearance and practices, piercing the non-acupuncture points, and blocking the observation of patients is a recommended practice to design the blinding of patients (53). More importantly, for subjective observation such as pain score, investigators should also be blinded.

To the best of our knowledge, 3 comprehensive SRs (12,54,55) related to acupuncture for MPS have been published. Kietrys et al (54) compared DN to placebo DN and revealed that DN may be effective in decreasing pain immediately after treatment and until 4 weeks post-treatment. The study of Tong et al (12) showed that MSN might have a positive effect on MPS. A new meta-analysis from Rodriguez-Mansilla et al (55) found that DN was less effective on decreasing pain, but was more effective on increasing ROM when compared to a sham DN. While previous meta-analysis assessed the efficacy of a single acupuncture technique or restricted their analyses only to efficacy outcomes, we collected high-level clinical evidence for acupuncture therapies to provide a comprehensive picture of their efficacy and safety. Our study confirmed the previous notions of DN and MSN for pain relief, but showed that DN may have no effect on ROM, and that MSN may have lower safety than other acupuncture treatments. In addition, we find that SWAM may have a positive effect on pain relief, which is better than DN and MSN, but the other outcomes regarding SWAM, especially the outcome regarding adverse events, require further investigation. Compared with previous reviews, our study presents, for the first time, the comparisons between acupuncture treatments regarding PPT and safety, and the results are based on randomized evidence, which may provide better reference for clinical decisions than before. We therefore believe that our study provides the best available evidence on the efficacy and safety of acupuncture therapies.

There are several limitations in this network meta-analysis. Firstly, most included RCTs had different end points, most of which lasted less than 10 treatment sessions. Studies with more uniform periods of treatment would better support our conclusions. Secondly, most comparisons were performed based on only one or 2 small RCTs, and most results had wide credibility intervals, so the potential for bias should be acknowledged. This problem could be solved by more repetitive RCTs comparing different acupuncture therapies in the future. Thirdly, our results are based on the direct and the indirect comparisons between therapies; with the potential increased number of head-to-head trials in the future, some results may change. Fourthly, some

Table 5. *Rank Probability of SUCRA*.

Treatment	VAS/NRS		PPT		Adverse Events		ROM	
	SUCRA	Mean Rank	SUCRA	Mean Rank	SUCRA	MeanRank	SUCRA	Mean Rank
Placebo-Sham	11.4	16.9	34.6	11.5	92.2	1.6	41.3	6.3
MA	45.6	10.8	75.3	5	66.5	3.7	43.1	6.1
EA	64	7.5	-	-	-	-	1.2	9.9
DN	27.1	14.1	55.3	8.2	27.1	6.8	54.1	5.1
MET	14.6	16.4	0	17	-	-	48.6	5.6
TCT	12.9	16.7	40.9	10.5	-	-	-	-
MT	26.1	14.3	10.3	15.3	60.5	4.2	53.3	5.2
LTrP-I	57.3	8.7	66.7	6.3	48.9	5.1	62	4.4
MDIMST	67	6.9	87.8	3	-	-	-	-
MSN	51.6	9.7	97.8	1.4	38.4	5.9	63.3	4.3
TTM	22.3	15	47.9	9.3	-	-	-	-
BTX-A-TrP-I	56	8.9	56.5	8	16.9	7.7	-	-
FN	67.6	6.8	-	-	-	-	-	-
SWAM	96.5	1.6	-	-	-	-	-	-
EA&ESNC	82.5	4.2	-	-	-	-	-	-
SPM	54.6	9.2	-	-	-	-	-	-
DN&MET	88.9	3	26	12.8	-	-	75.1	3.2
BTrP-I	62	7.8	-	-	10.6	8.2	-	-
TrP-DN&EDU	42	11.4	68.7	6	-	-	-	-
Stretch	-	-	14.7	14.7	89	1.9	-	-
DN&Stretch	-	-	22.4	13.4	-	-	-	-
Laser	-	-	88.4	2.9	-	-	58	4.8
PT	-	-	56.8	7.9	-	-	-	-

valuable outcome measurements, like the Nottingham Health Profile (NHP), were not analyzed in our study, due to the low number of trials reporting this outcome. This also affects the judgment of potential efficacy and this issue should thus be considered in further studies. Finally, the insufficient blinding of most studies may have caused potential bias in the assessment of efficacy and safety.

Conclusions

Overall, most acupuncture therapies, including acupuncture combined with other therapies, showed superiority over the other single physical therapies in terms of pain decrease and physical function improvement, with SWAM, MSN, and DN&MET generally performing better in different outcomes. However, their safety still cannot be ascertained. Our analysis suggests that more head-to-head trials comparing acupuncture therapies in MPS patients with larger sample sizes and using sufficient blinding are warranted. Given their ambiguity on safety, ongoing and further RCTs should pay more attentions to the adverse events potentially occurring during acupuncture therapies. Moreover, as uncertainty remains, clinicians need to fully take into account the clinical conditions and the willingness of their patients when they tailor such therapies.

Acknowledgments

Thanks to Prof. Fujian Song from Norwich Medical School of Faculty of Medicine and Health Science of University of East Anglia for his help at various stages of the review.

Author Contributions

XX.L., JH.T., and KH.Y. were responsible for the conception and design of the study. XX.L., R.W., J.Z, and L.G. did the analysis and interpreted the analysis in collaboration with L.L. and JY.Z. XX.L., R.W., X.X, and

X.S. were responsible for the acquisition of data. XX.L., R.W., and KH.Y. wrote the first draft of the article. XX.L and R.W contributed equally to this manuscript. All authors critically revised the article for important intellectual content and approved the final version of the manuscript. KH.Y. and JH.T. obtained public funding.

Funding

This article presents independent research funded by the National Nature Science Foundation of China (NSFC, Grant Reference Number 81373882), titled "A methodology study of developing a reporting guideline of systematic review/meta-analysis on acupuncture." The views expressed are those of the authors and not necessarily those of the NSFC. The funders had no role in study design, data collection, data synthesis, data interpretation, or writing the report.

Supplementary file 1. *Search Strategies*

1. Cochrane Central Register of Controlled Trials (CENTRAL)
Patient
#1 MeSH descriptor: [Myofascial Pain Syndromes] explode all trees
#2 "myofascial pain syndromes":ti,ab,kw OR "myofascial pain syndrome":ti,ab,kw OR synalg*:ti,ab,kw OR "myofascial pain":ti,ab,kw OR MPS*:ti,ab,kw OR MPD*:ti,ab,kw
#3 MeSH descriptor: [Temporomandibular Joint Disorders] explode all trees
#4 "Temporomandibular Joint Disorders":ti,ab,kw OR "Temporomandibular Joint Disorder":ti,ab,kw OR TMJ*:ti,ab,kw OR "Costen's Syndromes":ti,ab,kw OR "Costen's Syndrome":ti,ab,kw OR "Costen Syndromes":ti,ab,kw OR "Costen Syndrome":ti,ab,kw
#5 MeSH descriptor: [Trigger Points] explode all trees
#6 trigger point*:ti,ab,kw OR trigger-point*:ti,ab,kw OR MTrP*:ti,ab,kw OR TrP*:ti,ab,kw
#7 #1 OR #2 OR #3 OR #4 OR #5 OR #6
Interventions
#8 MeSH descriptor: [Acupuncture Therapy] explode all trees
#9 MeSH descriptor: [Acupuncture Analgesia] explode all trees
#10 MeSH descriptor: [Acupuncture] explode all trees
#11 MeSH descriptor: [Electroacupuncture] explode all trees
#12 MeSH descriptor: [Needles] explode all trees
#13 acupuncture:ti,ab,kw OR electro-acupuncture:ti,ab,kw OR electroacupuncture:ti,ab,kw OR needl*:ti,ab,kw OR dry-needl*:ti,ab,kw OR acusector:ti,ab,kw OR auricular:ti,ab,kw OR laser*:ti,ab,kw OR acupressure:ti,ab,kw
#14 MeSH descriptor: [Meridians] explode all trees
#15 MeSH descriptor: [Acupuncture Points] explode all trees
#16 meridian*:ti,ab,kw OR acupoint*:ti,ab,kw
#17 #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16
#18 #7 AND #17
2. PubMed
RCT
#1 "Clinical Trials, Phase II as Topic"[Mesh] OR "Clinical Trials, Phase III as Topic"[Mesh] OR "Clinical Trials, Phase IV as Topic"[Mesh] OR "Controlled Clinical Trials as Topic"[Mesh] OR "Randomized Controlled Trials as Topic"[Mesh] OR "Intention to Treat Analysis"[Mesh] OR "Pragmatic Clinical Trials as Topic"[Mesh] OR "Clinical Trials, Phase II"[Publication Type] OR "Clinical Trials, Phase III"[Publication Type] OR "Clinical Trials, Phase IV"[Publication Type] OR "Controlled Clinical Trials"[Publication Type] OR "Randomized Controlled Trials"[Publication Type] OR "Pragmatic Clinical Trials as Topic"[Publication Type] OR "Single-Blind Method"[Mesh] OR "Double-Blind Method"[Mesh]
#2 random*[Title/Abstract] OR blind*[Title/Abstract] OR singleblind*[Title/Abstract] OR doubleblind*[Title/Abstract] OR trebleblind* [Title/Abstract] OR tripleblind*[Title/Abstract]
#3 #1 OR #2

Supplementary file 1 con't. ***Search Strategies***

Patient
#4 "Myofascial Pain Syndromes"[Mesh] OR "Temporomandibular Joint Dysfunction Syndrome"[Mesh] OR "Trigger Points"[Mesh]
#5 "myofascial pain syndromes"[Title/Abstract] OR "myofascial pain syndrome"[Title/Abstract] OR synalg*[Title/Abstract] OR "myofascial pain"[Title/Abstract] OR MPS*[Title/Abstract] OR MPD*[Title/Abstract] OR "Temporomandibular Joint Disorders"[Title/Abstract] OR "Temporomandibular Joint Disorder"[Title/Abstract] OR TMJ*[Title/Abstract] OR "Costens Syndromes"[Title/Abstract] OR "Costens Syndrome"[Title/Abstract] OR "Costen Syndromes"[Title/Abstract] OR "Costen Syndrome"[Title/Abstract] OR trigger point*[Title/Abstract] OR trigger-point*[Title/Abstract] OR MTrP*[Title/Abstract] OR TrP*[Title/Abstract]
#6 #4 OR #5
Interventions
#7 "Acupuncture"[Mesh] OR "Acupuncture Therapy"[Mesh] OR "Acupuncture, Ear"[Mesh] OR Electroacupuncture[Mesh] OR Meridians[Mesh] OR "Acupuncture Points"[Mesh]
#8 acupuncture[Title/Abstract] OR electro-acupuncture[Title/Abstract] OR electroacupuncture[Title/Abstract] OR needl*[Title/Abstract] OR dry-needl*[Title/Abstract] OR acusector[Title/Abstract] OR auricular[Title/Abstract] OR laser*[Title/Abstract] OR acupressure[Title/Abstract]
#9 #7 OR #8
#10 #3 AND #6 AND #9
EMBASE
RCT
#1 'multicenter study (topic)'/exp OR 'phase 2 clinical trial (topic)'/exp OR 'phase 3 clinical trial (topic)'/exp OR 'phase 4 clinical trial (topic)'/exp OR 'controlled clinical trial (topic)'/exp OR 'randomized controlled trial (topic)'/exp OR 'single blind procedure'/exp OR 'double blind procedure'/exp
#2 random*:ab,ti OR blind*:ab,ti OR singleblind*:ab,ti OR doubleblind*:ab,ti OR trebleblind*:ab,ti OR tripleblind*:ab,ti
#3 #1 OR #2
Patient
#4 'myofascial pain'/exp OR 'temporomandibular joint disorder'/exp OR 'trigger point'/exp
#5 'myofascial pain syndromes':ab,ti OR 'myofascial pain syndrome':ab,ti OR synalg*:ab,ti OR 'myofascial pain':ab,ti OR mps:ab,ti OR mpss:ab,ti OR mpd:ab,ti OR mpds:ab,ti OR 'temporomandibular joint disorders':ab,ti OR 'temporomandibular joint disorder':ab,ti OR tmj:ab,ti OR tmjs:ab,ti OR 'costens syndromes':ab,ti OR 'costens syndrome':ab,ti OR 'costen syndromes':ab,ti OR 'costen syndrome':ab,ti OR 'trigger point':ab,ti OR 'trigger points':ab,ti OR 'trigger point*':ab,ti OR mtrp*:ab,ti OR trp*:ab,ti
#6 #4 OR #5
Interventions
#7 'acupuncture'/exp OR 'acupressure'/exp OR 'acupuncture analgesia'/exp OR 'electroacupuncture'/exp OR 'catgut embedding'/exp
#8 acupuncture:ab,ti OR 'electro acupuncture':ab,ti OR electroacupuncture:ab,ti OR needle:ab,ti OR 'needling':ab,ti OR acusector:ab,ti OR auricular:ab,ti OR laser:ab,ti OR lasering:ab,ti OR acupressure:ab,ti
#9 #7 OR #8
#10 #3 AND #6 AND #9
Web of Science
RCT
#1 TS=("randomized controlled trial" OR "multicenter study" OR "clinical trial" OR "single blind procedure" OR "controlled clinical trial" OR "double blind procedure")
#2 TI=(random* OR blind* OR singleblind* OR doubleblind* OR trebleblind* OR tripleblind*)
#3 #1 OR #2
Patient
#4 TS=("myofascial pain" OR synalg* OR mps* OR mpd* OR "temporomandibular joint disorders" OR "temporomandibular joint disorder" OR tmj* OR "costens syndromes" OR "costens syndrome" OR "costen syndromes" OR "costen syndrome" OR "trigger point" OR "trigger points" OR trigger-point* OR mtrp* OR trp*)
#5 TI=("myofascial pain" OR synalg* OR mps* OR mpd* OR "temporomandibular joint disorders" OR "temporomandibular joint disorder" OR tmj* OR "costens syndromes" OR "costens syndrome" OR "costen syndromes" OR "costen syndrome" OR "trigger point" OR "trigger points" OR trigger-point* OR mtrp* OR trp*)

Supplementary file 1 con't. *Search Strategies*

#6 #4 OR #5
Interventions
#7 TS=(acupuncture OR electro-acupuncture OR electroacupuncture OR needl* OR dry-needling OR acusector OR auricular OR laser OR acupressure)
#8 TI=(acupuncture OR electro-acupuncture OR electroacupuncture OR needl* OR dry-needling OR acusector OR auricular OR laser OR acupressure)
#9 #7 OR #8
#10 #3 AND #6 AND #9
Chinese Biomedical Literature Database (CBM)
RCT
#1 ″随机对照试验(主题)″[不加权:扩展] OR ″临床对照试验(主题)″[不加权:扩展] OR ″多中心研究(主题)″[不加权:扩展] OR ″临床试验, Ⅱ期(主题)″[不加权:扩展] OR ″临床试验, Ⅲ期(主题)″[不加权:扩展] OR ″临床试验, Ⅳ期(主题)″[不加权:扩展] OR ″临床试验(主题)″[不加权:扩展] OR ″双盲法″[不加权:扩展] OR ″随机分配″[不加权:扩展] OR ″单盲法″[不加权:扩展]
#2 "随机对照试验″[全字段:智能] OR ″临床对照试验″[全字段:智能] OR ″临床试验, Ⅱ期″[全字段:智能] OR ″临床试验, Ⅲ期″[全字段:智能] OR ″临床试验, Ⅳ期″[全字段:智能]
#3 #1 OR #2
Patient
#4 "肌筋膜疼痛综合征″[不加权:扩展] OR ″颞下颌关节功能紊乱综合征″[不加权:扩展] OR ″穴, 阿是″[不加权:扩展]
#5 "肌筋膜疼痛″[全字段:智能] OR ″颞下颌关节功能紊乱″[全字段:智能] OR ″阿是穴″[全字段:智能] OR ″触发点″[全字段:智能] OR ″扳机点″[全字段:智能] OR ″激痛点″[全字段:智能]
#6 #4 OR #5
Interventions
#7 "针刺疗法″[不加权:扩展] OR ″针刺镇痛″[不加权:扩展] OR ″电针″[不加权:扩展] OR ″经络″[不加权:扩展] OR ″穴位按压″[不加权:扩展] OR ″针刺, 耳″[不加权:扩展] OR ″针刺穴位″[不加权:扩展]
#8 "针刺″[全字段:智能] OR ″针法″[全字段:智能] OR ″刺法″[全字段:智能] OR ″毫针″[全字段:智能] OR ″穴位注射″[全字段:智能] OR ″三棱针″[全字段:智能] OR ″皮肤针″[全字段:智能] OR ″电针″[全字段:智能] OR ″皮内针″[全字段:智能] OR ″割治″[全字段:智能] OR ″埋线″[全字段:智能] OR ″耳针″[全字段:智能] OR ″干针″[全字段:智能] OR ″激光″[全字段:智能] OR ″穴位按压″[全字段:智能] OR ″指压″[全字段:智能]
#9 #7 OR #8
#10 #3 AND #6 AND #9

Supplementary file 2. Criteria of CCRBT and the Way to Assess the Risk of Bias of Randomized Trials.

CCRBT Criteria	**Characteristic and rating criteria[a]**
1. Random sequence generation (selection bias).	Low risk - adequate (any truly random process, e.g. random number table; computer random number generator).
	High risk - inadequate (any wrong or non-random process, e.g. odd or even date of birth; hospital or clinic record number).
	Unclear risk - no or unclear information provided.
2. Allocation concealment (selection bias).	Low risk - allocation undertaken independently and blind to investigator (e.g. telephone or central randomization; consecutively numbered, sealed, opaque envelopes);
	High risk - not concealed (e.g. open random allocation; unsealed or non-opaque envelopes; alternation; date of birth);
	Unclear risk - not reported or unclear information provided.
3. Blinding of participants and personnel (performance bias).	Low risk – convincingly blind (e.g. a placebo that could not be distinguished from the active solution was used in the control group);
	High risk - participants or personnel were aware of group assignment;

Supplementary file 2 con't. Criteria of CCRBT and the Way to Assess the Risk of Bias of Randomized Trials.

CCRBT Criteria	Characteristic and rating criteria[a]
	Unclear risk - not reported or unclear information provided.
4. Blinding of outcome assessment (detection bias).	Low risk - assessors blinded to group;
	High risk - assessors were aware of group assignment;
	Unclear risk - not reported or unclear information provided.
5. Incomplete outcome data (attrition bias).	Low risk - less than 10% missing data;
	High risk - more than 10% missing data;
	Unclear risk - not reported or unclear information provided.
6. Selective outcome reporting (reporting bias).	Low risk - all of the study's pre-specified outcomes have been reported;
	High risk - not all the study's pre-specified outcomes have been reported;
	Unclear risk - not reported or unclear information provided.
7. Other potential sources of bias.	Low risk – no other potential sources of bias;
	High risk - some other potential sources of bias and no related explanation;
	Unclear risk - not reported or unclear information provided.

[a]According to the Cochrane Pain, Palliative and Supportive Care Review Group (PaPaS) guidance on sample size[14], for each trial we evaluated the risk of bias based on number of participants in each study arm.

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