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REVIEW ARTICLE (META-ANALYSIS)

Evidence for Dry Needling in the Management of Myofascial Trigger Points Associated With Low Back Pain: A Systematic Review and Meta-Analysis

Lin Liu, PhD,[a] Qiang-Min Huang, MD, PhD,[a,b] Qing-Guang Liu, PhD,[a] Nguyen Thitham, PhD,[a] Li-Hui Li, PhD,[a] Yan-Tao Ma, MSc,[a] Jia-Min Zhao, MSc[a]

From the [a]Department of Sport Medicine and the Center of Rehabilitation, School of Sport Science, Shanghai University of Sport; and the [b]Department of Pain Rehabilitation, Shanghai Hudong Zhonghua Shipbuilding Group Staff-worker Hospital, Shanghai, China.

Abstract

Objective: To evaluate the current evidence of the effectiveness of dry needling of myofascial trigger points (MTrPs) associated with low back pain (LBP).

Data Sources: PubMed, Ovid, EBSCO, ScienceDirect, Web of Science, Cochrane Library, CINAHL, and China National Knowledge Infrastructure databases were searched until January 2017.

Study Selection: Randomized controlled trials (RCTs) that used dry needling as the main treatment and included participants diagnosed with LBP with the presence of MTrPs were included.

Data Extraction: Two reviewers independently screened articles, scored methodologic quality, and extracted data. The primary outcomes were pain intensity and functional disability at postintervention and follow-up.

Data Synthesis: A total of 11 RCTs involving 802 patients were included in the meta-analysis. Results suggested that compared with other treatments, dry needling of MTrPs was more effective in alleviating the intensity of LBP (standardized mean difference [SMD], −1.06; 95% confidence interval [CI], −1.77 to −0.36; $P=.003$) and functional disability (SMD, −0.76; 95% CI, −1.46 to −0.06; $P=.03$); however, the significant effects of dry needling plus other treatments on pain intensity could be superior to dry needling alone for LBP at postintervention (SMD, 0.83; 95% CI, 0.55−1.11; $P<.00001$).

Conclusions: Moderate evidence showed that dry needling of MTrPs, especially if associated with other therapies, could be recommended to relieve the intensity of LBP at postintervention; however, the clinical superiority of dry needling in improving functional disability and its follow-up effects still remains unclear.

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Low back pain (LBP) is a worldwide health problem and the most common reason for musculoskeletal disorders, especially in sedentary people, and even in highly trained athletes.[1,2] It has been estimated that as many as 85% of citizens in developed countries experience LBP at some point throughout their lifetime; therefore, LBP has become one of the most common reasons for medical visits to physician offices and emergency departments in the United States.[3,4] LBP can result in significant levels of disability, producing significant restrictions on work efficiency and quality of life of patients.[5] More importantly, it also imposes huge economic burden on families and society.[6]

At present, the management of LBP comprises a range of different intervention strategies (eg, minimally invasive surgery, exercise therapy, acupuncture and dry needling, physiotherapy, behavioral therapy, massage, oral drugs).[7,8] Among these strategies, dry needling is becoming an increasingly popular nonsurgical treatment method for relieving LBP and improving functional disability related to pain because of its simple operation and good efficacy.[9,10] In clinical practice, dry needling usually refers to deep dry needling, which is a minimally invasive procedure during which a thin filiform needle is directly inserted into an active myofascial trigger point (MTrP), with the condition of

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eliciting a local twitch response.[11] MTrP is a palpable and hyperirritable nodule located in the taut bands of skeletal muscles, and has visible morphologic changes of muscle tissues under optical microscope enlargement.[12,13] Numerous studies have shown that the MTrPs activated in skeletal muscles can cause intolerable pain, functional limitation, physical and mental weakness, and motor ataxia.[14] Dry needling that targets MTrPs can disrupt the dysfunctional neuromuscular activity in the muscles, decrease muscle tone, and normalize the neurochemical pathways of muscles.[15,16] Therefore, it has been used by a growing number of physical therapists, chiropractors, and other clinicians in health care and clinical rehabilitation in recent years.[12,17]

However, scientific evidence-based medical proof to determine the effectiveness of dry needling for LBP is limited and inadequate. A Cochrane systematic review in 2005 showed that dry needling appears to be a useful adjunct to other therapies for chronic LBP, but it remained unclear whether the therapeutic effect of dry needling was superior to those of other therapies.[8] The evidence quality of this systematic review was also low because of the small treatment numbers at that time. Furthermore, because only a limited number of randomized controlled trials (RCTs) on dry needling of MTrPs for LBP were available, most data analyzed in current systematic reviews on needling for LBP were from studies of Chinese acupuncture therapy.[8,18-21] Nevertheless, the evidence of Chinese acupuncture therapy makes it difficult for MTrP therapists to be relied on to design suitable treatment regimens given that the theories and techniques in dry needling and acupuncture may substantially differ.[16]

Therefore, this systematic review and meta-analysis aims to provide a comprehensive and quantitative evaluation of the current evidence of the postintervention and follow-up effectiveness of dry needling alone on the treatment of MTrPs associated with LBP compared with other treatments (including laser therapy, tender point needling, superficial dry needling, acupoint acupuncture, sham dry needling, and physical therapies).

Methods

This systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.[22]

Search strategy

PubMed, Ovid, EBSCO, ScienceDirect, Web of Science, Cochrane Library, CINAHL, and China National Knowledge Infrastructure databases were searched from database inception to January 2017. The Medical Subject Headings, text words, and word variants for lower back pain and dry needling were used and combined in the searches. The searches were limited (in the database facilities allowed) to RCTs but without language restriction. The details of the search strategy are presented in supplemental appendix S1 (available online only at http://www.archives-pmr.org/). In addition, the reference lists of the included studies and relevant reviews were searched for eligible studies.

List of abbreviations:

CI	**confidence interval**
LBP	**low back pain**
MD	**mean difference**
MTrP	**myofascial trigger point**
***N*fs**	**fail-safe number**
RCT	**randomized controlled trial**
SMD	**standardized mean difference**

Inclusion and exclusion criteria

Studies were included if they (1) adopted the RCT design, (2) included patients diagnosed with LBP with the presence of MTrPs, (3) used dry needling alone as an intervention, and (4) used pain intensity and/or functional disability as outcome measure to assess the curative effect. By contrast, studies were excluded if (1) MTrPs were not defined using the criteria of Simons et al,[16] (2) dry needling combined with acupoint acupuncture was used, (3) different types of dry needling (in the text, it is referred to as deep dry needling, excluding superficial dry needling) were compared with one another, (4) full text cannot be obtained, and (5) RCTs had no available data.

Study selection and data extraction

Two authors independently scanned the titles and abstracts. The studies that satisfied the inclusion and exclusion criteria were retrieved for full-text assessment. The extracted data included the first author, publication year, RCT design, country, sample size, number of men and women, mean age of the population, duration of LBP, interventions (including the frequency and duration of interventions), primary outcome measures, and follow-up time. The results regarding the outcome measures were extracted in the form of mean and SD data. For crossover trials, the summary data were used as if they had been derived from parallel trials. For trials with >2 intervention groups, the experimental group was compared with the control group by combining the data of all relevant control groups.[23]

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

Quality assessment

Two reviewers independently assessed the validity of the included studies by using the methodologic quality criteria list, which was adapted from the Cochrane handbook of reviews of interventions and recommended in the updated method guideline for systematic reviews in the Cochrane Back and Neck Group.[23,24] The findings of each study were assessed by the blinded reviewers to be yes, no, or unsure (if the results were poorly presented or a major flaw was present in the study design), which represented low risk of bias, high risk of bias, and unclear risk of bias, respectively.

Data synthesis and statistical analysis

For the purpose of the review, 6 subgroup meta-analyses were performed based on the different types of control groups, different assessment times, and different outcome measures. The subgroup meta-analyses included comparisons between dry needling and other treatments for (1) pain intensity at postintervention, (2) functional disability at postintervention, (3) pain intensity during follow-up period, and (4) functional disability during

follow-up period and comparisons between dry needling and dry needling plus other treatments for (5) pain intensity at postintervention and (6) functional disability at postintervention.

The meta-analyses were performed using RevMan 5.3,[a] with a continuous variable random effects model to account for the additional uncertainty between studies.[25] Heterogeneity was assessed using the Cochran Q test with statistical significance ($P<0.1$) and chi-square test (I^2) to indicate inconsistency with a quantitative number.[23] The I^2 values of 25%, 50%, and 75% represented small, moderate, and large degrees of heterogeneity, respectively.[26] The source of high heterogeneity among trials was explored by univariate meta-regression analysis with Stata 12.0.[b] The effect sizes were measured using mean difference (MD) or standardized mean difference (SMD), and 95% confidence interval (CI). Sensitivity analyses were conducted by excluding individual study.[23] Potential publication bias was verified by Egger regression test and the fail-safe numbers (*N*fs).[27,28] Finally, the overall quality of the evidence was assessed using the Grades of Recommendation, Assessment, Development, and Evaluation approach, with the 4 levels of quality in the Grades of Recommendation, Assessment, Development, and Evaluation system being high, moderate, low, and very low.[29]

Results

Study selection

A total of 784 articles were identified from PubMed, Ovid, EBSCO, ScienceDirect, Web of Science, Cochrane Library, CINAHL, and China National Knowledge Infrastructure databases, the reference lists of the included studies, and relevant reviews for eligible studies (fig 1). After applying the inclusion and exclusion criteria, 11 RCTs[11,30-39] were eligible and included in the systematic review and meta-analysis, with a total of 802 patients.

Study characteristics

Table 1 summarizes the study characteristics of all the involved RCTs. Of the 11 studies, 10 (90.9%) were parallel RCTs, and 1 (9.1%) was a crossover RCT. Furthermore, 10 studies (90.9%) were conducted in Asia, and 1 (9.1%) was conducted in Europe. The included studies were published from 2004 to 2016. The total number of patients in each study ranged from 9 to 200, with 384

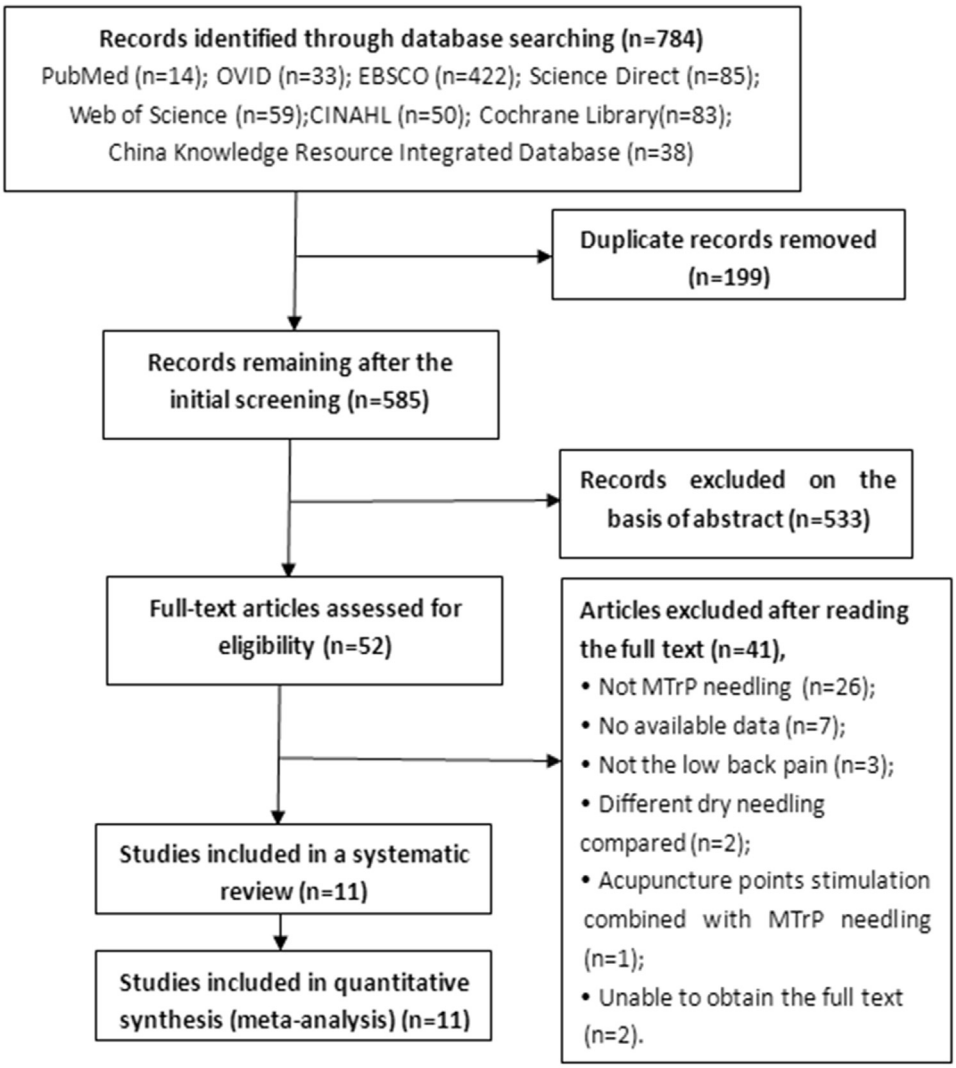

Fig 1 Flow diagram of search strategy and results.

Table 1 Participant characteristics of studies included in this systematic review

Study	RCT Design (Country)	n (M/F)	Age (y)	Duration of LBP	Intervention Group (Frequency; LTR*)	Control Group (Frequency)	Primary Outcome Measures	Total Time of Intervention and Follow-Up
Chen[30]	Parallel (China)	58 (31/27)	41.48±8.14† 42.31±7.93‡	>6mo	Dry needling (1 time/2d; no)	Super laser therapy (10min/time, 1 time/2d)	Pain intensity (VAS); functional disability (RDQ)	40d and 3mo
Hirota et al[31]	Parallel (Japan)	9 (4/5)	72.3±3.1† 71.6±3.9‡	3.1±1.4y† 5.8±4.0y‡	Dry needling (once a week; yes)	Tender points needling (once a week)	Pain intensity (VAS); functional disability (RDQ)	5wk and 1mo
Itoh et al[32]	Crossover (Japan)	26 (9/17)	73.5±10.0† 78.8±4.7‡	4.2±3.5y† 5.4±6.2y‡	Dry needling (10min/time, once a week; yes)	Sham dry needling (10min/time)	Pain intensity (VAS); functional disability (RDQ)	3wk and 3wk
Itoh et al[33]	Parallel (Japan)	35 (25/10)	71.9±3.7† 70.1±8.9§ 73.8±7.0‖	7.4±4.5y† 5.2±2.6y§ 5.4±3.7y‖	Dry needling (30min/time, 6 times/wk; yes)	Superficial dry needling (30min/time, 6 times/wk); acupoints acupuncture (30min/time, 6 times/wk)	Pain intensity (VAS); functional disability (RDQ)	9wk and 3wk
Itoh and Katsumi[34]	Parallel (Japan)	44 (29/15)	72.3±3.7† 70.1±8.9§ 73.8±7.0‖ 70.8±4.9¶	7.1±4.4y† 5.2±2.6y§ 5.4±3.7y‖ 4.6±3.4y¶	Dry needling (30min/time, once a week; yes)	Superficial needling (30min/time, once a week); acupoints acupuncture (30min/time, once a week) sham dry needling (30min/time, once a week)	Pain intensity (VAS); functional disability (RDQ)	3wk and 3wk
Kuang[35]	Parallel (China)	80 (41/39)	34—66	45—122mo	Dry needling (30min/time, 1 time/2d; no)	Acupoints acupuncture (30min/time, 1 time/2d)	Pain intensity (VAS); functional disability (RDQ)	1mo and none
Long et al[36]	Parallel (China)	300 (152/148)	54.00±2.31† 55.00±1.98‖ 55.00±1.78#	6.80±1.26y† 6.30±1.35y‖ 6.30±1.05y#	Dry needling (once a week; yes)	Acupoints acupuncture (15min/time, 1 time/d, 6 time/course) dry needling plus acupoints acupuncture	Pain intensity,** function status††	8wk and none
Mahmoudzadeh et al[11]	Parallel (Iran)	58 (26/32)	36.1±7.8† 35.6±8.5‡	16.5±21.0mo† 20.3±23.6mo‡	Dry needling (15min/time, 1 time/2d; yes)	Standard physical therapy (45min/time, 1 time/2d)	Pain intensity (VAS); functional disability (ODI)	20d and 2mo
Shen and Ding[37]	Parallel (China)	60 (35/25)	41.4±9.5† 42.4±10.1‡	4.5±1.2mo† 4.4±1.3mo‡	Dry needling (30min/time, 1 time/2d; no)	Acupoints acupuncture (30min/time, 1 time/2d)	Pain intensity (VAS); functional disability (ODI)	4wk and none
Yang and Zhou[38]	Parallel (China)	120	Not reported	Not reported	Dry needling (1 time/wk; no)	Local anesthetic injection	Pain intensity (VAS)	4wk and none
Tellez-García et al[39]	Parallel (Spain)	12 (4/8)	37±13† 36±5#	19±8mo† 17±9mo#	Dry needling (1 time/wk; yes)	Dry needling plus neuroscience education (30min/time, 1 time/wk)	Pain intensity (VAS); functional disability (RDQ, ODI)	3wk and 1wk

Abbreviations: F, female; LTR, local twitch response; M, male; ODI, Oswestry Disability Index; RDQ, Roland-Morris Disability Questionnaire; VAS, visual analog scale.

* Was there local twitch response during the treatment of dry needling in this study?

† Dry needling group.

‡ Other treatments group.

§ Superficial dry needling group (because needles were inserted into the skin rather than trigger points in muscles).

‖ Acupoints acupuncture group.

¶ Sham dry needling group.

\# Dry needling plus other treatments group.

** The assessment of pain intensity: 0 (no pain), 1 (mild pain), 2 (moderate pain), and 3 (severe pain).

†† The assessment of functional disability: 0 (no restriction), 1 (mild restriction), 2 (moderate restriction), and 3 (severe restriction).

Table 2 Risk of bias within studies included in the systematic review and meta-analysis

Study	1	2	3	4	5	6	7	8	9	10	11	12	13
Chen[30]	Yes	Yes	No	No	Unsure	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hirota et al[31]	Unsure	Unsure	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Itoh et al[32]	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Itoh et al[33]	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Itoh and Katsumi[34]	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kuang[35]	Yes	No	Unsure	No	Unsure	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Long et al[36]	Unsure	Unsure	No	No	Unsure	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Mahmoudzadeh et al[11]	Yes	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Shen and Ding[37]	Unsure	Unsure	Unsure	No	Unsure	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yang and Zhou[38]	Yes	Unsure	No	No	Unsure	Yes	Yes	Yes	Unsure	Yes	Yes	Yes	Yes
Téllez-García et al[39]	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Abbreviations: 1, Was the method of randomization adequate?; 2, Was the treatment allocation concealed?; 3, Was the patient blinded to the intervention?; 4, Was the care provider blinded to the intervention?; 5, Was the outcome assessor blinded to the intervention?; 6, Was the dropout rate described and acceptable?; 7, Were all randomized participants analyzed in the group to which they were allocated?; 8, Are reports of the study free of suggestion of selective outcome reporting?; 9, Were the groups similar at baseline regarding the most important prognostic indicators?; 10, Were cointerventions avoided or similar?; 11, Was the compliance acceptable in all groups?; 12, Was the timing of the outcome assessment similar in all groups?; 13, Are other sources of potential bias unlikely?

men (56.3%) in 682 patients (because 1 study[38] did not report the number of men and women in the text). The duration of LBP was from acute to chronic; however, most LBP cases reported (9/11 studies) were chronic.

Although dry needling was applied in all 11 RCTs, only 7 RCTs reported that local twitch response was elicited during the needling of MTrPs. Furthermore, the treatments for the control group included superficial dry needling in 2 studies; acupoint acupuncture in 5 studies; MTrP sham dry needling in 2 studies; and super laser therapy, tender points needling, standard physical therapy, local anesthetic injection, and dry needling plus neuroscience education in the remaining 5 studies. Of the 11 RCTs, 10 (90.9%) used the visual analog scale to assess the scores of pain intensity. Of these 10 studies, 7 and 3 trials used the Roland-Morris Disability Questionnaire and the Oswestry Disability Index to assess the functional disability related to LBP, respectively. In addition, the total time of interventions and follow-up ranged from 20 days to 9 weeks and from none to 3 months, respectively.

Risk of bias within studies

Table 2 shows the risk of bias within the studies of 11 RCTs, of which 6 presented high or unsure risk in random assignment and

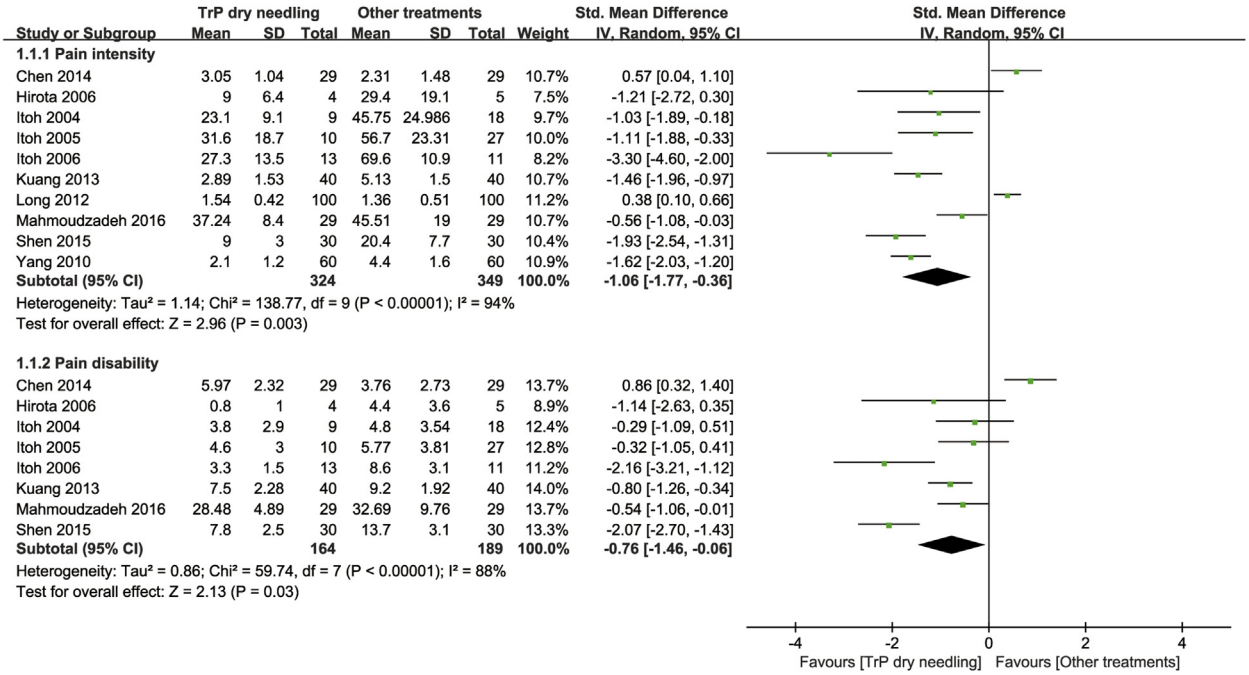

Fig 2 Forest plot for dry needling compared with other treatments at postintervention. Abbreviations: Std., standard; TrP, trigger point.

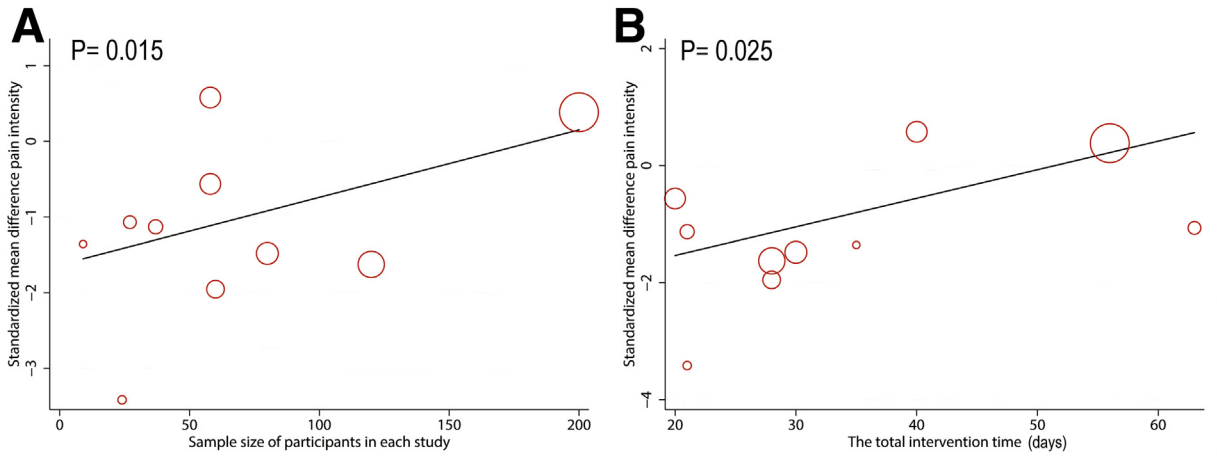

Fig 3 Meta-regression bubble plots: (A) association between sample size of participants and standardized mean difference pain intensity when dry needling was compared with other treatments at postintervention; and (B) association between the total intervention time and standardized mean difference pain intensity when dry needling was compared with other treatments at postintervention. Each circle corresponds to a study.

allocation concealment, and only 3 used blinding to patients, 1 blinding to care providers, and 4 blinding to assessors. Other risks of bias in individual trials were very low (eg, similar baseline indicators, description of dropout rate, timing of the outcome assessment).

Dry needling versus other treatments at postintervention

In comparison with other treatments, the effectiveness of dry needling of MTrPs for LBP at postintervention was assessed in terms of pain intensity and functional disability in 10 trials[11,30-38] involving 673 patients and 8 trials[11,30-35,37] with 353 patients, respectively.

The pooled results in the random effects models demonstrated the statistically significant effects of dry needling compared with other treatments in pain intensity (I^2=94%; SMD, −1.06; 95% CI, −1.77 to −0.36; P=.003) and functional disability (I^2=88%; SMD, −0.76; 95% CI, −1.46 to −0.06; P=.03) (fig 2). Although the univariate meta-regression analyses revealed that the covariates associated with the heterogeneity among trials on pain intensity were sample size and the total intervention time of dry needling (P=.015 and P=.025, respectively) (fig 3), random effects models were still used to account for the additional uncertainty associated with trial-trial variability in the effect of the intervention.[23,25] However, the source of high heterogeneity was not observed among trials on functional disability.

In addition, based on the different measurement instruments of pain intensity and functional disability, the following results of subgroup analyses were observed: dry needling had a 1.56-cm (95% CI, 0.67−2.44 cm) improvement in visual analog scale scores compared with other treatments in 10 trials[11,30-38] (P=.0006), a 2.32-point (95% CI, 0.02−4.66 points) improvement in Roland-Morris Disability Questionnaire scores in 7 trials[30-35,37] (P=.05), and a 4.41-point (95% CI, 0.44−8.38 points) improvement in Oswestry Disability Index scores in 1 trial[11] (P=.03).

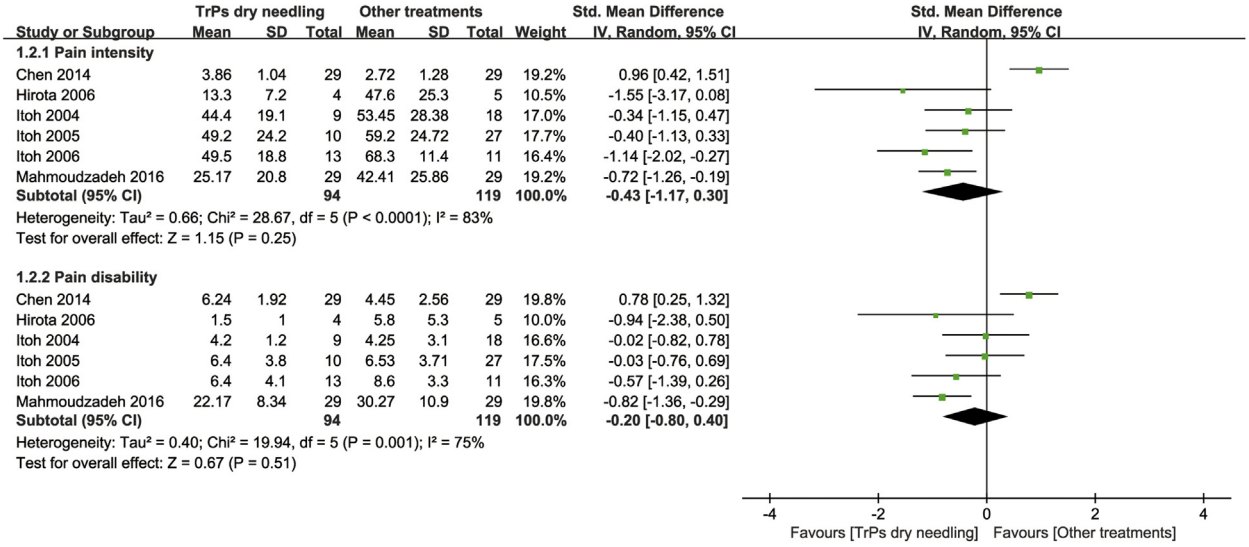

Fig 4 Forest plot for dry needling compared with other treatments at follow-up. Abbreviations: Std., standard; TrP, trigger point.

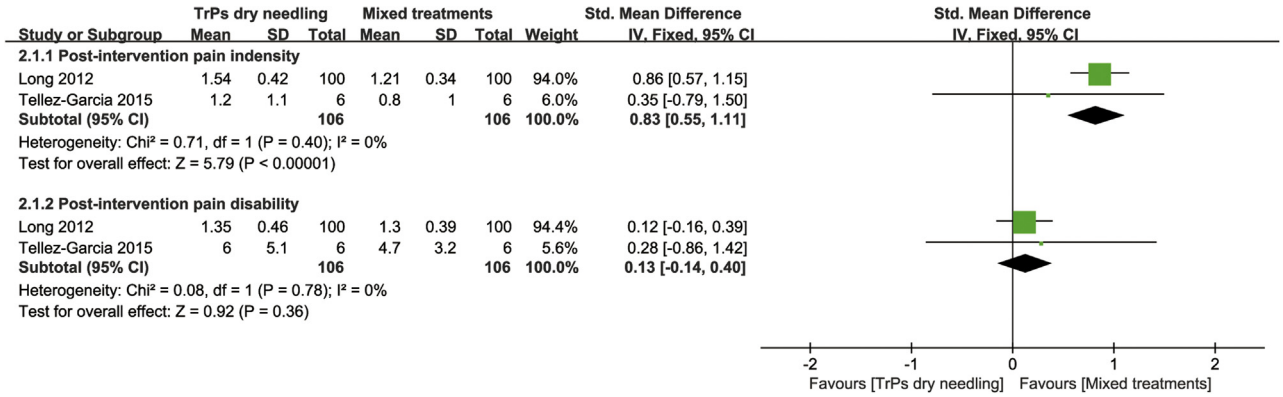

Fig 5 Forest plot for dry needling compared with combined treatments of dry needling plus other treatments at postintervention. Abbreviations: Std., standard; TrP, trigger point.

Dry needling versus other treatments at follow-up

A total of 6 trials[11,30-34] involving 213 patients with LBP assessed the follow-up effectiveness of dry needling (the needle inserting into MTrPs related to LBP) compared with other treatments in terms of alleviating pain intensity and functional disability.

The data available from the pooled studies in figure 4 in the random effects models showed no significant effects of dry needling for LBP compared with other treatments in the improvement of pain intensity (I^2=83%; SMD, −0.43; 95% CI, −1.17 to 0.30; P=.25; visual analog scale scores: I^2=85%, MD, −1.10cm; 95% CI, −2.79 to 0.60cm; P=.21) and functional disability (I^2=75%; SMD, −0.20; 95% CI, −0.80 to 0.40; P=.51; Roland-Morris Disability Questionnaire in 5 trials: I^2=68%; MD, −0.32 points; 95% CI, −2.08 to 1.45 points; P=.73). However, the limited data from 1 trial[11] showed the significant superiority of dry needling in improving Oswestry Disability Index scores (MD, −8.10 points; 95% CI, −13.10 to −3.10 points; P=.001).

Sensitivity analyses were conducted by removing 1 study[30] that offered inferior evidence for the follow-up effect of dry needling. The pooled analyses of the remaining studies that used fixed-effects models significantly favored dry needling in pain intensity (I^2=0%; SMD, −0.68; 95% CI, −1.03 to −0.34; P<.0001) and functional disability (I^2=16%; SMD, −0.46; 95% CI, −0.84 to −0.09; P=.02).

Effect of dry needling versus dry needling plus other treatments

Although only 2 studies[36,39] investigated the postintervention effects of dry needling of MTrPs compared with dry needling plus other treatments, significant effects were observed in the meta-analysis of studies assessing pain intensity in favor of dry needling plus other treatments (I^2=0%; SMD, 0.83; 95% CI, 0.55−1.11; P<.00001; visual analog scale: MD, 1.04cm; 95% CI, 0.71−1.38cm; P<.00001) (fig 5). However, no significant difference was observed in the assessment of functional disability (I^2=0%; SMD, 0.13; 95% CI, −0.14 to 0.40; P=.36) (see fig 5).

Publication bias

Egger regression test (supplemental fig S1, available online only at http://www.archives-pmr.org/) and the calculated *N*fs showed a small likelihood of publication bias for the meta-analysis of RCTs studying pain intensity at postintervention (P=.084 and *N*fs=305), functional disability at postintervention (P=.458 and *N*fs=91), pain intensity at follow-up (P=.277 and *N*fs=7), and functional disability at follow-up (P=.526 and *N*fs<0).

Quality of evidence

The quality of evidence of the main outcomes is shown in supplemental figure S2 (available online only at http://www.archives-pmr.org/). The quality of evidence that supports the postintervention effect of dry needling was moderate compared with those of other treatments in terms of alleviating the pain intensity in patients with LBP.

Discussion

This systematic review summarizes the totality of evidence to date in relation to the effectiveness of dry needling for the treatment of LBP and includes a total of 11 RCTs involving 802 patients with LBP. The low-to-moderate-quality evidence showed that compared with other treatments, dry needling resulted in significant reduction in pain intensity and functional disability at postintervention. However, dry needling plus other treatments for LBP was more effective than dry needling alone in pain intensity reduction at postintervention, but the quality of evidence was low. To date, data remain insufficient to draw conclusions regarding the follow-up effects of dry needling compared with other treatments in treating LBP.

Overall completeness and applicability of evidence

At postintervention, the MD in pain intensity (visual analog scale scores) between dry needling and other treatments was 1.56cm, which was greater than the 1.3 to 1.4cm minimum clinically important difference reported by Bijur et al.[40] Moreover, a significant statistical difference was found from the pooled data. Therefore, this review showed moderate-quality evidence to support the claim that dry needling has beneficial clinical effects on alleviating the intensity of LBP at postintervention; however, the total intervention time varied from 20 days to 9 weeks. The significant clinical effects may be interpreted by a gate control mechanism that rapidly penetrating dry needling into a MTrP might stimulate the large diameter afferent sensory nerve fibers, which could lead to an inhibition in the dorsal horn of the spinal cord by blocking the pain information generated in the MTrP's nociceptor.[41]

In addition, although significant statistical difference in functional disability was found when dry needling was compared with other treatments, the MDs in the Roland-Morris Disability Questionnaire and Oswestry Disability Index scores were only 2.32 and 4.41 points, respectively, which were lower than the 5.0 point minimum clinically important difference reported by Stratford et al[42] and the Oswestry Disability Index score of $\leq$20% (10.0 point minimum clinically important difference) reported by Schwind et al.[43] Therefore, the clinical effects of dry needling on functional disability because of LBP may be worth exploring using large-scale RCTs.[41]

At follow-up, no statistically significant superiority of dry needling was found, and the MDs in pain intensity and functional disability were lower than those minimum clinically important difference values reported in previous studies because of the presence of a high risk-of-bias trial. Furthermore, the overall evidence quality of the meta-analyses of pain intensity and functional disability were low and very low, respectively. Accordingly, more high-quality RCTs in future studies should be sufficient to determine adequately whether dry needling is the optimal treatment for patients with LBP in the long term.

In clinical practice, dry needling is often combined with other physical therapies in treating LBP. This review showed that dry needling plus other treatments was significantly superior to dry needling alone in the improvement of pain intensity; however, the 1.04cm in visual analog scale scores was lower than the 1.3 to 1.4cm minimum clinically important difference reported by Bijur et al,[40] and the evidence quality was also low. Furthermore, the postintervention effects of dry needling plus other treatments on functional disability remain unclear because of the lack of adequate amounts of RCTs.

Study limitations

Although some significant effects were observed, this systematic review presents several inevitable limitations. First, certain methodologic risks of bias downgraded the quality of evidence. These risks are because of inadequate or unsure methods of random assignment and allocation concealment in 6 trials, and the limited blinding to patients, care providers, or outcome assessors in most of the trials given the nature of interventions. Second, the clinical heterogeneity cannot be ignored in this review. For example, the meta-regression analyses revealed that sample size and the total intervention time seriously affected the pooled effects on pain intensity at postintervention. Furthermore, the suitability of the evidence for other regions is uncertain, given that 90.9% of the population of patients with LBP are from Asia. In addition, the insufficient sample sizes may have led to publication bias in the meta-analysis of RCTs at follow-up as indicated by the small and negative *N*fs. Therefore, large, multiple-term, and high-quality trials are necessary to prove or disregard significant benefits or disadvantages.

Conclusions

Despite its limitations, this systematic review and meta-analysis provided a moderate quality of evidence recommending dry needling over other treatments to relieve the pain intensity of LBP at postintervention. However, scientific evidence proving the effectiveness of dry needling of MTrPs on LBP compared with other treatments at follow-up remains insufficient. Accordingly, more multiple-center RCTs with high-quality, large samples, and adequate follow-up, should be conducted to provide high-quality evidence that could suggest the best clinical therapeutic method.

Suppliers

a. RevMan 5.3; The Nordic Cochrane Centre.
b. Stata 12.0; StataCorp.

Keywords

Low back pain; Meta-analysis [publication type]; Needles; Randomized controlled trial as topic; Rehabilitation; Trigger points

Corresponding author

Qiang-Min Huang, MD, PhD, Keyanlou 4-408, Hengren Rd No 188, Shanghai 200438, China. *E-mail address:* huaqia404@aliyun.com.

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Supplemental Appendix S1 Search Strategies for All Databases

1. Pubmed:

#1 "random*"[Text Word] OR allocation[Text Word] OR "random allocation"[Text Word] OR placebo[Text Word] OR single blind[Text Word] OR single blind method[Mesh] OR double blind[Text Word] OR double blind method[Mesh] OR "randomized controlled trial*"[Text Word] OR "RandomizedControlled Trials as Topic"[Mesh] OR "Randomized Controlled Trial" [Publication Type]
#2 protocol[Title]
#3 #1 NOT #2
#4 dry needling[Title/Abstract] OR acupuncture[Title/Abstract] OR Acupuncture[MeSH Terms] OR needl*[Title/Abstract]
#5 Myofascial Pain Syndromes[MeSH Terms] OR trigger points [MeSH Terms] OR trigger point*[Title/Abstract] OR taut band* [Title/Abstract] OR myofascial pain*[Title/Abstract]
#6 backache[Title/Abstract] OR dorsalgia[Title/Abstract] OR lumbago[Title/Abstract] OR lumbar pain[Title/Abstract] OR coccyx[Title/Abstract] OR coccydynia[Title/Abstract] OR sciatica[Title/Abstract] OR spondylosis[Title/Abstract] OR back disorder*[Title/Abstract] OR Back Pain[MeSH Terms] OR Low Back Pain[MeSH Terms]
#7 #3 AND #4 AND #5 AND #6

2. OVID:

Databases:Journals@Ovid Full Text January 24, 2017, Database Info Icon Your Journals@Ovid, Database Info Icon Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present
1 (dry needling or acupuncture or needl$ or acup$).ab,kw,sh,ti.
2 (myofascial pain syndromes or myofascial trigger point$ or trigger point$ or taut band$ or myofascial pain$).ab,kw,sh,ti.
3 (random$ or allocation or random allocation or placebo or single blind or double blind or randomized controlled trial or RCT).ab,kw,sh,ti.
4 (back pain or low back pain or backache or dorsalgia or lumbago or lumbar pain or coccyx or coccydynia or sciatica or spondylosis or back disorder$).ab,kw,sh,ti.
5 1 and 2 and 3

3. EBSCO

Databases: Dissertations;SPORTDiscus with Full Text;Library, Information Science & Technology Abstracts with Full Text; MEDLINE;MEDLINE Complete;American Doctoral Dissertations; Rehabilitation & Sports Medicine Source)
S1 TX (random* OR allocation OR random allocation OR placebo OR single blind OR double blind OR randomized controlled trial OR RCT OR pilot study)
S2 SU (single blind method OR double blind method OR Randomized Controlled Trials as Topic OR Controlled Clinical Trials as Topic OR Clinical Trials as Topic OR Pilot Projects)
S3 S1 OR S2
S4 AB (dry needling OR acupuncture OR needl* OR acup*)
S5 SU Acupuncture
S6 S4 OR S5
S7 TX(myofascial pain syndromes OR myofascial trigger point* OR trigger point* OR taut band* OR myofascial pain*)
S8 SU Myofascial Pain Syndromes
S9 S7 OR S8
S10 TX (back pain or low back pain or backache or dorsalgia or lumbago or lumbar pain or coccyx or coccydynia or sciatica or spondylosis or back disorder*)
S11 SU (back pain or low back pain or lumbar pain)
S12 S10 AND S11
S13 S3 AND S6 AND S9 AND S12

4. ScienceDirect

TITLE-ABSTR-KEY(dry needling ORacupuncture OR acup* OR needl*) AND ALL(myofascial pain syndromes OR myofascial trigger point* OR trigger point* OR taut band* OR myofascial pain*)

5. Web of Science

databases: Web of ScienceTM Core Collection (2010-present); KCI-Korean Journal Database (1980-present); Russian Science Citation Index (2005-present); SciELO Citation Index (1997-present)
#1 TS＝(dry needling ORacupuncture OR acup* OR needl*)
#2 TS＝(myofascial pain syndromes OR myofascial trigger point* OR trigger point* OR taut band* OR myofascial pain*)
#3 TS＝(back pain or low back pain or backache or dorsalgia or lumbago or lumbar pain or coccyx or coccydynia or sciatica or spondylosis or back disorder*)
#4 TS＝(random* OR allocation OR random allocation OR placebo OR single blind OR double blind OR randomized controlled trial OR RCT OR pilot study)
#5 #1 AND #2 AND #3 AND #4

6. CINAHL

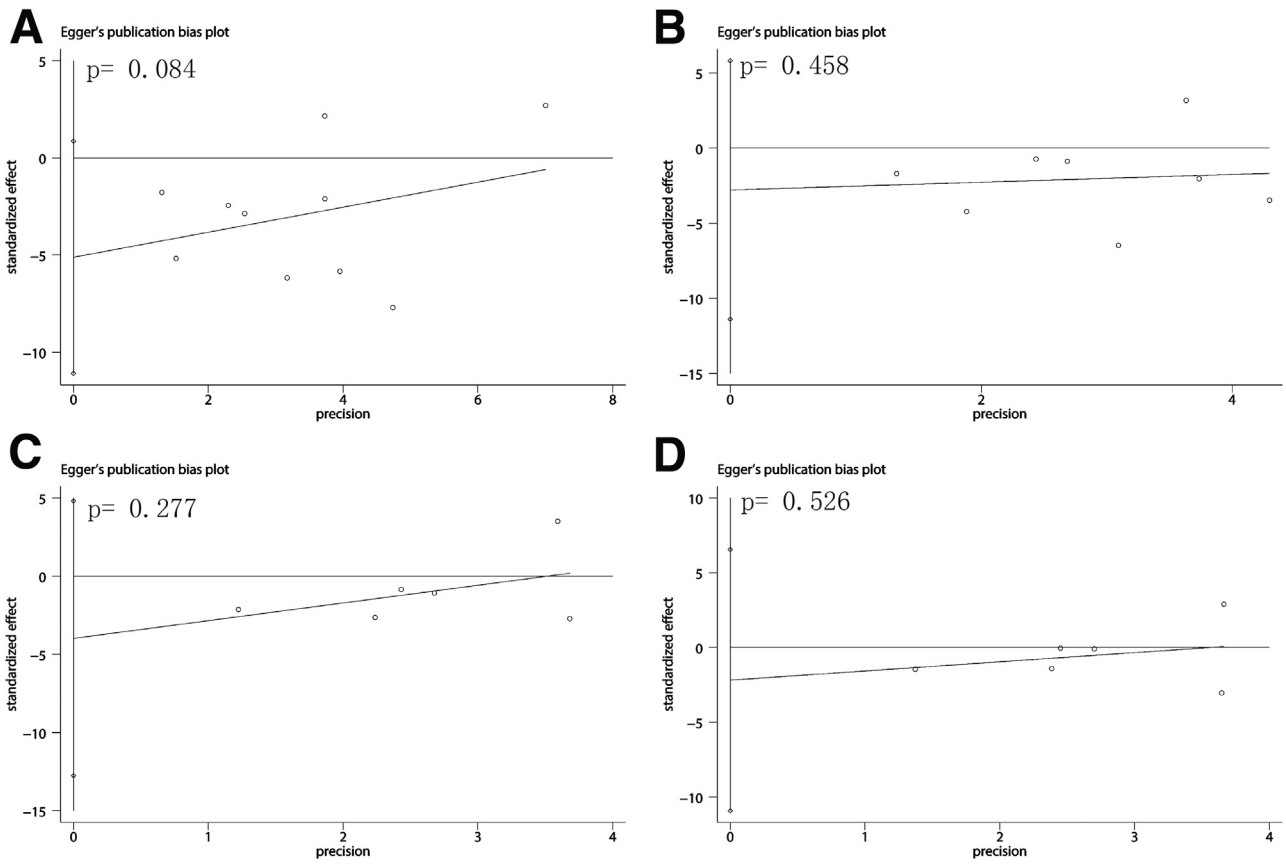
Database:CINAHL Complete
S1 SU random* OR allocation OR random allocation OR placebo OR single blind OR double blind OR randomized controlled trial OR RCT OR pilot study
S2 SUdry needling OR acupuncture OR needl* OR acup*
S3 TX myofascial pain syndromes OR myofascial trigger point* OR trigger point* OR taut band* OR myofascial pain*
S4 TX back pain or low back pain or backache or dorsalgia or lumbago or lumbar pain or coccyx or coccydynia or sciatica or spondylosis or back disorder*
S5 S1 AND S2 AND S3 AND S4

7. Cochrane Library

'dry needling OR acupuncture OR needl* OR acup* in Title, Abstract, Keywords and myofascial pain syndromes OR myofascial trigger point* OR trigger point* OR taut band* OR myofascial pain* and back pain or low back pain or backache or dorsalgia or lumbago or lumbar pain or coccyx or coccydynia or sciatica or spondylosis or back disorder* in Trials'

8. China Knowledge Resource Integrated Database

(SU ＝扳机点 or SU ＝激痛点 or SU ＝肌筋膜触发点 or SU ＝肌筋膜疼痛综合征) and (SU ＝针刺 or SU ＝干针 or SU ＝针灸 or SU ＝小针刀 or SU ＝针) and SU＝('随机'+'对照'+'单盲'+'双盲'+'临床对照试验'+'随机对照试验') and AB＝'腰'



Supplemental Fig S1 Egger publication bias plots: (A) meta-analysis of studying pain intensity at postintervention; (B) meta-analysis of studying functional disability at postintervention; (C) meta-analysis of studying pain intensity at follow-up; and (D) meta-analysis of studying functional disability at follow-up.

Trigger point dry needling compared to other treatments for low back pain

Bibliography: [trigger point dry needling] for [low back pain].

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects: Risk with Other treatments	Anticipated absolute effects: Risk difference with Trigger point dry needling (95% CI)
Dry needling vs other treatments at post-intervention - Pain intensity	673 (10 studies)	⊕⊕⊕⊖ **MODERATE** due to risk of bias			The mean dry needling vs other treatments at post-intervention - pain intensity in the intervention groups was **1.06 standard deviations lower** (1.77 to 0.36 lower)
Dry needling vs other treatments at post-intervention - Pain disability	353 (8 studies)	⊕⊕⊖⊖ **LOW** due to risk of bias, imprecision			The mean dry needling vs other treatments at post-intervention - pain disability in the intervention groups was **0.76 standard deviations lower** (1.46 to 0.06 lower)
Dry needling vs other treatments at follow-up - Pain intensity	155 (5 studies)	⊕⊕⊖⊖ **LOW** due to risk of bias, imprecision			The mean dry needling vs other treatments at follow-up - pain intensity in the intervention groups was **0.68 standard deviations lower** (1.03 to 0.34 lower)
Dry needling vs other treatments at follow-up - Pain disability	155 (5 studies)	⊕⊖⊖⊖ **VERY LOW** due to risk of bias, imprecision, publication bias			The mean dry needling vs other treatments at follow-up - pain disability in the intervention groups was **0.46 standard deviations lower** (0.84 to 0.09 lower)
Dry needling vs dry needling plus other treatments at post-intervention - Pain intensity	212 (2 studies)	⊕⊕⊖⊖ **LOW** due to risk of bias, imprecision			The mean dry needling vs dry needling plus other treatments at post-intervention - pain intensity in the intervention groups was **0.83 standard deviations higher** (0.55 to 1.11 higher)
Dry needling vs dry needling plus other treatments at post-intervention - Pain disability	212 (2 studies)	⊕⊖⊖⊖ **VERY LOW** due to risk of bias, imprecision, publication bias			The mean dry needling vs dry needling plus other treatments at post-intervention - pain disability in the intervention groups was **0.13 standard deviations higher** (0.14 lower to 0.4 higher)

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

Supplemental Fig S2 Quality of overall evidence based on the Grades of Recommendation, Assessment, Development and Evaluation (GRADE) system.