# Acupuncture for Temporomandibular Disorders: A Systematic Review

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***Aims:*** *To assess the effectiveness of acupuncture for the symptomatic treatment of temporomandibular disorders (TMD) from a review of studies using randomized controlled trials (RCTs).* ***Methods:*** *Electronic databases were systematically searched for articles reporting RCTs investigating acupuncture for TMD. The methodological qualities of eligible studies were assessed using the criteria described in the Cochrane Handbook.* ***Results:*** *Nineteen reports were systematically reviewed. There was moderate evidence that classical acupuncture had a positive influence beyond those of placebo (three trials, 65 participants); had positive effects similar to those of occlusal splint therapy (three trials, 160 participants); and was more effective for TMD symptoms than physical therapy (four trials, 397 participants), indomethacin plus vitamin $B_1$ (two trials, 85 participants), and a wait-list control (three trials, 138 participants). Only two RCTs addressed adverse events and reported no serious adverse events.* ***Conclusion:*** *This systematic review noted moderate evidence that acupuncture is an effective intervention to reduce symptoms associated with TMD. There is a need for acupuncture trials with adequate sample sizes that address the long-term efficacy or effectiveness of acupuncture.*
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**Key words:** acupuncture, myofascial pain, randomized controlled trials, systematic review, temporomandibular disorders

Temporomandibular disorders (TMD) include a group of conditions that affect the temporomandibular joint (TMJ), masticatory muscles, and associated head and neck musculoskeletal structures, and may present as a cluster of joint and muscle disorders.[1] TMD are also known as craniomandibular disorders (CMD) and are a frequent cause of facial pain problems.[2] TMD usually manifest as one or more of the following signs or symptoms: pain, joint sounds, limitation in jaw movement, muscle tenderness, and joint tenderness.[3] It is also commonly associated with other symptoms affecting the head and neck region such as headache, ear-related symptoms, and cervical spine disorders.[4,5] Patients with persistent TMD frequently report symptoms of depression, poor sleep quality, and low energy.[6] Prevalence studies have reported approximately 75% of the population have at least one sign of joint dysfunction that includes abnormal jaw movement, joint noises, and tenderness on palpation, and approximately 33% of people have at least one symptom such as facial pain and joint pain.[7,8]

The pathogenesis of pain in TMD is unclear, with physical, biochemical, and psychological factors all potentially playing a role.[9] Currently management of TMD include reassurance (patient education, self care, and behavior therapy), acupuncture, physiotherapy (such as ultrasound, mega pulse, short-wave therapy, diathermy, laser, heat, cold, transcutaneous electrical nerve stimulation, mobilizations, massages, stretching, instructions, exercises, and biofeedback), splint therapy, occlusal adjustment, surgery (arthrocentesis, arthroscopy), pharmacological intervention, and combined approaches.[1,10–13]

Published surveys on complementary and alternative medicine (CAM) use suggest that CAM is sought most frequently for musculoskeletal and pain disorders.[14–16] A recent survey has documented the relatively frequent concurrent use of CAM and conventional therapies by patients with TMD.[17] Nearly two-thirds of the respondents (62.5%) reported using CAM therapies for TMD or related conditions.[17] Among those respondents who reported using acupuncture, the technique was reported as the satisfactory CAM therapy for TMD, with 72.8% of respondents "extremely satisfied" or "very helpful."[17]

Since the most recent systematic review[18] on four randomized control trials (RCTs) on acupuncture for TMD, 10 RCTs[19–28] (two[23,24] incorporating a nonpenetrating needle placebo control) have been published. Therefore, the aim of this systematic review was to assess the effectiveness of acupuncture for the symptomatic treatment of TMD from a review of studies using RCTs.

## Materials and Methods

### Search Strategy

The following sources were searched up to July 2008: The Cochrane Library including the Cochrane Central Register of Controlled Trials (CENTRAL, 2008); MEDLINE, EMBASE, Allied and Complementary Medicine Database (AMED), CINAHL, PsycInfo, Korean medical databases (including the National Assembly Library, KoreaMed, Korean Studies Information Service System, DBpia, and Korea Institute of Science Technology Information and Research Information Service System), a Japanese database (Japan Science and Technology Information Aggregator Electronic), Chinese databases (which included the China Academic Journal, Century Journal Project, China Doctor/ Master Dissertation Full Text DB, and China Proceedings Conference Full Text DB), BIREME (Latin American and Caribbean Center on Health Sciences Information), and MEDPILOT (German medical databases). The authors also searched databases of clinical trials such as Current Controlled Trials (http://www.controlled-trial.com), National Center for Complementary and Alternative Medicine (NCCAM) at the US National Institutes of Health (NIH) (http://nccam.nih.gov/), and the Complementary and Alternative Medicine Specialist Library at the National Health Service National Library for Health (http://www.library.nhs.uk/cam/) for on-going studies, funded research, and protocols. The reference lists of articles were checked for further relevant publications and experts in complementary medicine, acupuncture research groups, or oral health groups were asked for information concerning any additional trials. A further manual search was conducted of relevant journals, symposia, and conference proceedings, and relevant trials were retrieved; all identified publications were cross-referenced *(Journal of Oral Rehabilitation, Journal of Oral and Maxillofacial Surgery, Journal of Craniomandibular Practice, Acta Odontologica Scandinavica, Journal of the American Dental Association, Journal of Cranio - mandibular Disorders, Journal of Orofacial Pain, Journal of Korean Academy of Craniomandibular Disorders)*. If necessary, personal contact was made with the authors of the published studies to request additional data.

Key words used to search RCTs were ("acupuncture" OR "electroacupuncture" OR "meridian" OR "acupoint" OR "acupoint injection" OR "auricular acupuncture") AND ("temporomandibular joint disorders" OR "temporomandibular joint dysfunction syndrome" OR "craniomandibular disorders" OR "myofascial pain syndromes" OR "temporomandibular joint" OR "TMJ" OR "CMD" OR "TMD" OR "TMDs" OR "temporomandibular"). All of the various databases utilized for this study possessed their own subject headings and each database was searched independently.

### Study Selection

*Types of Studies.* The review was restricted to RCTs that compared acupuncture with a control group to assess the efficacy of acupuncture for the treatment of TMD. No restriction was imposed on studies with respect to language, publication types, blinding, and the type of design such as parallel or crossover. Crossover trials were included as long as outcome data were available for each treatment segment prior to crossover. The review excluded quasi-randomized trials.

*Types of Participants*. The study included all patients with TMD diagnosed by clinical and/or imaging criteria regardless of their age, race, gender, profession, or residential location. Trials with patients having congenital abnormalities, concomitant inflammatory or neoplastic conditions, or with a recent history of acute trauma were excluded.

*Types of Intervention*. Clinical trials evaluating classical acupuncture, electroacupuncture, electrical auricular acupuncture, auricular acupuncture, warm-needle acupuncture, and acupoint injection were included. Both traditional acupuncture (classical meridian points) and contemporary acupuncture (nonmeridian, trigger points, or electroacupuncture-points according to Voll) were included. Regarding auricular acupuncture, trials with a traditional Chinese type or a European type (auriculo-therapy) were included. Trials with acupuncture-related stimulation (for example, seed, laser, acupressure, magnetic devise, or moxibustion) were excluded. Studies that assessed the combined effect of acupuncture with other therapies (for example, acupuncture plus short-wave diathermy, or acupuncture plus moxibustion therapy) were excluded because the purpose of the review was to assess the effects of acupuncture alone. Trials that compared different forms of acupuncture to each other were also excluded. Types of control interventions considered in this review included no treatment (wait-listed or treatment as usual), placebo treatment (such as nonpenetrating needle, or placing either short-wave or ultrasonic physiotherapy appliances in proximity to the TMJ but not activating the TMJ) superficial acupuncture (so-called sham-acupuncture or minimal acupuncture), actual physiotherapy, relaxing appliances, pharmacological interventions, any occlusal appliance, orthodontic treatment, or surgery.

*Types of Outcome Measures*. The primary outcomes were pain in the TMJ and masticatory muscles (pain intensity or pain relief recorded using a visual analog scale [VAS] or a validated categorical scale, data on frequency, severity, or duration of pain), tenderness on palpation of TMJ and masticatory muscles, global measures (such as the Helkimo anamnestic index and/or dysfunction index), mandibular movement (range of motion, maximum interincisal opening, quantitative measurements of lateral movement, and protrusion), joint sounds, proportion of patients who improved after treatment as self-assessed by the patient or via a clinical assessment carried out by the clinician (categorical data were converted to binary outcomes; eg, improved/not improved), and subjective assessments by the patients (such as pain on face and jaw, clicking of the joints, and dysfunction). Secondary outcomes assessed were other clinically important outcomes (eg, headache) and adverse effects from treatment (incidence and type of side effects).

### Data Abstraction and Quality Assessment

Each study identified by the search strategy was assessed against the inclusion criteria by one of the reviewers. Where there was uncertainty regarding eligibility, a second reviewer also assessed the study and a decision was reached through discussion and consensus. Both reviewers independently assessed whether the studies met the inclusion criteria with disagreements resolved by discussion. Further information was sought from the authors where papers contained insufficient information to make a decision about eligibility. Data extraction was undertaken for relevant articles through the use of a properly designed data extraction form. The data extraction form was based on several papers and was modified as needed before use. The quality assessment of all studies was undertaken by two reviewers following the detailed descriptions of these categories provided in the Cochrane Handbook for Systematic Reviews of Interventions.[29] The following questions were assessed: *(1)* Was the allocation sequence adequately generated? *(2)* Was allocation adequately concealed? *(3)* Was knowledge of the allocated interventions adequately prevented during the study? *(4)* Were incomplete outcome data adequately addressed? *(5)* Were reports of the study free of suggestions of selective outcome reporting? *(6)* Was the study apparently free of other problems that could put it at a risk of bias? A "Yes" answer indicated a low risk of bias (A), "Unclear" indicated a uncertain risk of bias (B), and a "No" answer indicated a high risk of bias (C).

### Data Analysis

The RCTs were clinically heterogeneous with respect to the type of the interventions (methods of acupuncture, type of control) and outcomes. Furthermore, the outcomes were poorly presented in some studies. Therefore, it was decided not to pool the data statistically, but to perform a qualitative review. The method of best evidence synthesis[30] was used to formulate conclusions on the effectiveness of acupuncture for each type of control. This method consists of five levels of evidence and takes into account the methodological quality and the outcome of the studies:[31]

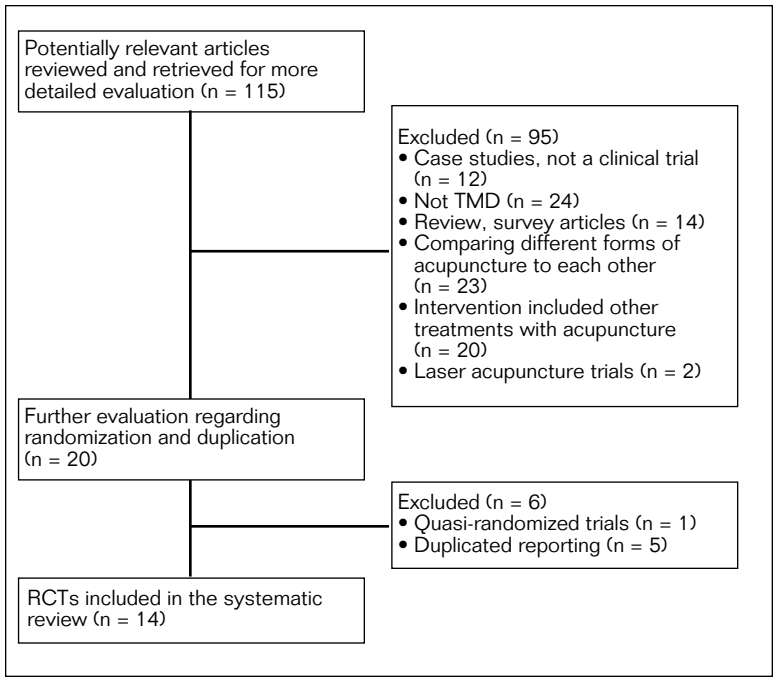


**Fig 1** Flow diagram showing the number of studies included and excluded from the systematic review.

- Level 1: *strong evidence*—consistent findings among multiple higher-quality RCTs (> 75% of the RCTs report the same findings)
- Level 2: *moderate evidence*—consistent findings among multiple lower-quality RCTs and/or one higher-quality RCT
- Level 3: *limited evidence*—one lower-quality RCT
- Level 4: *conflicting evidence*—inconsistent findings among multiple trials (RCTs)
- Level 5: *no evidence*—no RCTs

An RCT was considered to be of high quality if the methodological quality satisfied all six Cochrane categories. "Multiple" was defined as more than one.

## Results

### Study Description

Fourteen RCTs covering 808 patients were included in this systematic review. An initial search identified 115 potentially relevant articles. Ninety-five articles were initially excluded because they did not meet the inclusion criteria. Among them, 20 papers involved a combined intervention of acupuncture with other therapies in the experimental group, for example, acupuncture–moxibustion and acupuncture–spinal tuina therapy. Two studies were laser acupuncture trials.[32,33] The remaining 20 studies were further evaluated regarding randomization; one trial was found to be quasi-randomized trials.[34] The remaining 19 studies met the inclusion criteria and were systematically reviewed. Among them, one trial was reported three times[35–37] and another trial was reported four times,[38–41] and each report concerned a different end point or measurement point. These reports were included in this review for sufficient data, but the results were considered as one study. Figure 1 summarizes the search results based on the quality of reporting of meta-analyses (QUOROM) flow diagram.[42]

The key data are summarized in Table 1. Of the 14 trials, 6 were conducted in mainland China,[19,20,25–28] 2 were conducted in Sweden,[38,43] 2 in the United States,[23,44] 1 in Austria,[22] 1 in Finland,[35] 1 in the United Kingdom,[24] and 1 in South Korea.[21] The trials were published in 6 reports between 2006 and 2008. There was considerable diversity in the clinical presentation and diagnosis of participants with TMD among the included studies. Two of the studies used the research diagnostic criteria established by Dworkin and LeResche[45] to classify the patients as having myogenous TMD. Most of the studies used their own diagnostic criteria, based on signs and symptoms of the patients. The number of participants ranged from 15 to 170 patients. The number of patients per study group was less than 20 in six studies.[21–24,43,44] Except for two trials,[20,35] 12 of the 14 studies gave detailed criteria for inclusion

**Table 1 Characteristics of RCTs of Acupuncture for TMD**

| Study | No. of subjects [range or mean age] | Location | Inclusion criteria | Intervention type, treatment frequency (treatment period); treated acupoints | Type of control group | Quality assessment* |
|---|---|---|---|---|---|---|
| Goddard et al, 2002[44] | 18 [22 – 52 y] | USA | RDC/TMD by Dworkin and LeResche[45] | AT, 1 se; LI4, ST6 | Superficial AT (Sham AT at nonacupoints) | A-B-A-A-A-A |
| Johansson et al, 1991[43] | 45 [NR] | Sweden | Signs and symptoms of CMD, headache or facial pain | AT, 6 se (3 months); 3 to 7 adjunctive acupoints and LI4 | (a) Occlusal splints (b) Wait-list | B-B-A-B-A-A |
| Li and Rong, 2003[19] | 40 [12 – 50 y] | China | TMD with muscular dysfunction or articular dysfunction | EAT plus AI, 20 se (22 days); ST6, SI18, LI4 | Indomethacin 25 mg and Vitamin $B_1$ 0.2 tablet 3 times/day | B-B-C-B-B-C |
| List et al, 1992[38]<br>List et al, 1993[41]<br>List and Helkimo, 1992a[39]<br>List and Helkimo,1992b[40] | 110 [19 – 76 y] | Sweden | Signs and symptoms of CMD of primarily muscular origin, pain > 6 months | AT plus EAT, 6 to 8 se (6 to 8 weeks); ST6,7, SI18,19, BL2,10, GV20, GB20,21, EX Qianzheng, EX2 Taiyang, LI4, ST36, and adjunctive points | (a) Occlusal splints (b) Wait-list (3 months) | B-B-B-C-A-A |
| Luo et al, 2001[20] | 41 [19 – 47 y] | China | Signs and symptoms of TMD | AT, 20 se (25 days); GB2,20, ST7, SI19, TE17, LI4 | Ultrasound therapy, 20 se | B-B-C-B-B-C |
| Park et al, 1999[21] | 38 [13 – 54 y] | Korea | Signs and symptoms of TMD | EAT, 6 se (2 weeks); LI4, SI19, TE17,BL10, GB2,21, ST5,6,7 | Wait-list | B-B-C-B-A-A |
| Raustia et al,1985[35]<br>Raustia et al, 1986[36]<br>Raustia and Pohjola, 1986[37] | 50 (27.8 y) | Finland | TMJ dysfunction | AT, 3 se (1 month); Adjunctive points | Standard stomatognathic treatments | B-B-B-B-A-A |
| Schmid-Schwap et al, 2006[22] | 23 [17 – 59 y] | Austria | Female patients with TMJ pain and tenderness of craniomandibular musculature | AT, 1 se; LI4, SI2,3, ear, sternum (acupuncture needles) and intraoral points (insulin syringes with 0.5 mL) | Sham laser treatment (SI2,3, ear, and maxilla and mandible retromolar without contact and being activated) | B-A-A-A-A-A |
| Shen and Goddard, 2007[23] | 15 (43.1 y) | USA | Chronic myofascial pain syndrome of masticatory muscles; pain ≥ 12 weeks | AT, 1 se; LI4 | Placebo AT (non-penetrating needling) | B-B-A-A-A-A |
| Smith et al, 2007[24] | 27 (40.5 y) | UK | RDC/TMD by Dworkin and LeResche[45] | AT, 6 se (over 3 weeks); ST7 | Placebo AT (non-penetrating needling) | A-A-A-A-A-A |
| Wang, 1996[25] | 66 [15 – 50 y] | China | Signs and symptoms of TMJ dysfunction | EAT, NR; ST6,7, SI19 | Massage, NR | B-B-C-B-B-C |
| Zhang, 2008[26] | 45 [18 – 55 y] | China | TMD with muscular dysfunction or articular dysfunction | Warm-AT, 20 se (20 days); ST7, TE17, SI19 | Indomethacin 25 mg 3 times and Vitamin $B_1$ 10 mg 3 times/day | B-B-C-B-B-C |
| Zhong et al, 2007[27] | 120 [20 – 50 y] | China | Signs and symptoms of TMJ dysfunction | Warm-AT, 10 se (10 days); ST6,7, LI4 and adjunctive points | Ultrasound therapy 10 se | A-B-C-B-B-C |
| Zhu, 2007[28] | 170 [15 – 48 y] | China | Signs and symptoms of TMJ dysfunction | EAT, 30 se (30 days); SI19, GB2, ST7, TE17, LI4, TE5 | Manual therapy, 30 se | B-B-C-B-B-C |

Abbreviations: se = sessions; NR = not reported; AT = classical acupuncture; AI = acupoint injection; EAT = electroacupuncture; RDC/TMD = Research Diagnostic Criteria for TMD.

*(1) Was the allocation sequence adequately generated? (2) Was allocation adequately concealed? (3) Was knowledge of the allocated interventions adequately prevented during the study? (4) Were incomplete outcome data adequately addressed? (5) Were reports of the study free of suggestion of selective outcome reporting? (6) Was the study apparently free of other problems that could put it at a risk of bias?

Key: (A) indicates Yes; (B), Unclear; (C), No.

and/or exclusion of patients in the study. The types of acupuncture techniques used in the trials included classical acupuncture, warm-needle acupuncture, electroacupuncture, acupoint injection, and intraoral acupuncture; warm-needle acupuncture is one of the needling acupuncture techniques in which a needle is inserted into an acupoint and moxa (*Artemisia vulgaris*) is attached and burned on top of the needle to provide heat via the needle. Varied styles of acupuncture were used in the included RCTs: individualized (7%), standardized (72%), and semistandardized (21%) acupuncture. Semistandardized acupuncture has been defined as a set formula of points supplemented by some additional points individually chosen for each patient. Various acupoints for acupuncture treatments were used in the included RCTs; the ST6,7, LI4, or SI19 acupoints were commonly selected in over 5 trials. The frequency of overall treatment sessions ranged from 1 to 30. Comparison groups included placebo needle, sham treatment, superficial acupuncture (sham acupuncture), occlusal splints, physical therapy, pharmacological treatments, and wait-list. There was variation in the type of measurement used for the main outcomes. Pain was measured using a VAS, numerical analog scale, and presence or absence of headache. Other measured outcomes included clinical dysfunction scores, tenderness, range in movement, sounds, locking and deviation in opening of mouth, and overall improvement.

### Methodological Quality

*Sequence Generation.* Three of the included trials described adequate methods of randomization. Two studies[27,44] referred to a random number table and one study[24] used a computer-generated randomization for sequence generation. The other trials did not describe the sequence generation process.

*Allocation Concealment.* Two studies[22,24] ensured that allocations were concealed by using envelopes. The other trials received allocation scores of "B" as they did not have clear descriptions of their method of allocation concealment.

*Blinding.* Four studies reported blinding of the assessor and participants by using nonpenetrating placebo needle,[23,24] sham acupuncture at nonacupoints,[44] and sham inactive laser intervention.[22] In one trial,[43] participants were not blinded; however, investigators were blind to treatment group assignment and outcome assessments. Two trials reported an independent assessor but did not mention the blinding of the assessor.[35,38] The other studies did not blind participants or acupuncturists or outcome assessment; the outcome measurements were likely to be influenced by this lack of blinding.

*Incomplete Outcome Data.* Three studies had no participant losses, or the missing data balanced in numbers across intervention groups.[22,23,44] In one study,[24] "intention-to-treat" analysis was done with one dropout. The risk of bias in the other included trials is unclear because the numbers randomized into each intervention group were not clearly reported.

*Selective outcome reporting.* Six studies analyzed continuous outcomes as a dichotomous variable, with the further possibility of selecting from multiple cut-off points.[19,20,25–28]

*Other sources of bias.* The six trials used insensitive and subjective criteria measured as the women with pain relief, reduced pain, or no improvement.[19,20,25–28] An insensitive instrument can lead to under- or overestimation of the effects.

### Data Analysis

*Acupuncture Versus Inactive Treatment.* One high-quality RCT demonstrated that classical acupuncture had greater influences on VAS for pain intensity and the number of areas of pain, headache, VAS scores for functional impairment, tenderness, maximum opening and maximum pain free opening, and joint sounds than those of placebo acupuncture (Table 2).[24] The other trials using placebo needles showed significant improvements of the classical acupuncture group in pain tolerance of the masseter muscle ($P = .027$), but could not find significant differences in facial pain, headache, and neck pain between both groups.[23] A comparison with sham laser treatment in one study reported significant reduction in VAS for pain ($P = .033$) and tenderness, and pain on pressure in neck and masticatory muscles ($P < .05$).[22] The results from the three trials involving 65 participants provided moderate evidence of a positive influence of acupuncture beyond those of placebo.

*Acupuncture Versus Superficial Acupuncture (Sham Acupuncture).* One study compared classical acupuncture with superficial acupuncture ("sham acupuncture") at nonacupoints.[44] Both groups showed significant reduction in VAS ($P = .001$), but there was not a significant difference between groups (Table 2). The limited evidence from this single trial involving 18 participants was consistent with the ability of classical acupuncture and superficial acupuncture to reduce pain evoked by mechanical stimulation of the masseter muscle in TMD patients.

**Table 2 Outcomes of RCTs of Acupuncture Versus Inactive Treatment or Sham Acupuncture**

| Control/study | Pain | Dysfunction score | Tenderness | Mandibular movement/ joint sound |
|---|---|---|---|---|
| **Placebo AT** | | | | |
| Smith et al, 2007[24] | Reduced VAS for pain intensity ($P = .001$) from baseline, number areas of pain ($P = .003$) presence of headache ($P = .014$) in AT | Reduced VAS for functional impairment from baseline in AT ($P = .001$) | Improved tenderness of left masseter, right temporalis, and both lateral pterygoid muscles in AT | Improved maximum opening ($P = .02$), maximum pain free opening ($P < .0001$) from baseline in AT; improved joint sounds values in only one subject for AT, no changes in placebo |
| Shen and Goddard, 2007[23] | No between-group differences in numeric scales for facial pain, headache, or neck pain | | Significant difference in pain tolerance of the masseter muscle with AT versus placebo ($P = .027$) | |
| **Sham laser treatment** | | | | |
| Schmid-Schwap et al, 2006[22] | Significant higher reduction in VAS with AT ($P = .033$) | | Significant differences in tenderness and pain on pressure in neck and masticatory muscles with AT versus sham ($P < .05$) | Significant difference in mouth opening of patients with restricted opening between groups ($P = .037$) |
| **Superficial AT (Sham AT)** | | | | |
| Goddard et al, 2002[44] | Reduced VAS from baseline within both groups ($P = .001$); no difference between-groups | | | |

*Acupuncture Versus Occlusal Splint Therapy.* With respect to pain, clinical dysfunction score, tenderness, and subjective symptoms, two trials compared acupuncture to occlusal splints. The trials showed significant reductions of both groups from baseline.[38,43] There were not significant differences between groups (Table 3). One of the trials using classical acupuncture plus eletroacupuncture reported similar results in pain, clinical dysfunction score, and subjective symptoms at 6 and 12 months follow-up.[39] One study also reported similar results in modified clinical dysfunction score compared to occlusal splint therapy combined with counseling and muscular exercise for the lower jaw.[35] The data from these three trials involving 160 participants provide moderate evidence of the positive effects of acupuncture similar to those of conventional occlusal splint therapy.

*Acupuncture Versus Wait-list Control.* Three trials reported significant differences in pain between acupuncture and wait-list (Table 3). With respect to clinical dysfunction score and subjective symptoms, two trials using classical acupuncture,[38] or classical acupuncture plus electroacupuncture,[43] also showed significant differences between both groups. One study reported significant improvements in pressure pain threshold.[41] One study failed to reach a significant level in pressure pain threshold ($P = .055$), but showed significant results in noise frequency ($P = .016$) and limitation of motion ($P = .004$) between electroacupuncture and wait-list groups.[21] The data from the three trials involving 138 participants provide moderate evidence that acupuncture is more effective than a wait-list control at relief for patients with TMD.

*Acupuncture Versus Physical Therapy.* Three studies showed significant differences in responder rate with improvement of TMD symptoms comparing warm-needle acupuncture versus ultrasound therapy,[27] electroacupuncture versus manual therapy,[28] or electroacupuncture versus massage.[25] One study,[20] provided only as an abstract, reported a difference in responder rate with improvement of TMD symptoms without mentioning statistical values comparing classical acupuncture versus ultrasound therapy (Table 4). The findings provide moderate evidence (four trials, 397 participants) that acupuncture is more effective for TMD's symptoms than physical therapy such as ultrasound therapy, manual therapy, or massage.

**Table 3 Outcomes of RCTs of Acupuncture Versus Occlusal Splints or Wait-list Control**

| Control/study | Pain | Dysfunction score | Tenderness | Mandibular movement/joint sound/overall improvement |
|---|---|---|---|---|
| **Occlusal splints** | | | | |
| Johansson et al, 1991[43] | Reduced VAS for facial pain and headache within both groups from baseline ($P < .05$); no between-group differences | Reduced clinical dysfunction score within both groups from baseline ($P < .01$); no between-group differences | Reduced number of masticatory muscles tender within both groups from baseline ($P < .05$); no between-group differences | Improved subjective symptoms within both groups; no between-group differences |
| List et al, 1992[38]<br>List et al, 1993[41]<br>List and Helkimo, 1992[39]<br>List and Helkimo, 1992[40] | Reduced frequency in AT, intensity of pain (VAS) in both groups from baseline; no between-group differences. Similar results at 6-, and 12-months follow-up | Improved clinical dysfunction score in both groups from baseline; no between-group differences. Similar results at 6-, and 12-months follow-up | Improved pressure pain threshold in both groups from baseline: no between-group differences; no significant differences in both groups compared with short-term results at 6-month follow-up | Improved subjective evaluation (98% versus 65%; $P < .001$), Activity of Daily Living ($P < .01$) with AT versus occlusal splints. Significant differences from baseline at 6-, and 12-months follow-up |
| **Standard somatognathic treatments** | | | | |
| Raustia et al, 1985[35]<br>Raustia et al, 1986[36]<br>Raustia and Pohjola, 1986[37] | | Similar improved modified clinical dysfunction score in both groups; no between-group differences | | No between-group differences in responder rate with subjective patient estimates at 3-month follow-up |
| **Wait-list** | | | | |
| Johansson et al, 1991[43] | Significant difference in VAS for facial pain and headache with AT versus wait-list ($P < .01$) | Significant difference in clinical dysfunction score with AT versus wait-list ($P < .01$) | | Significant difference in subjective symptoms with AT versus wait-list ($P < .01$) |
| List and Helkimo, 1992[40]<br>List et al,1993[41]<br>List et al,1992[38]<br>List and Helkimo, 1992[39] | Reduced frequency and intensity of pain (VAS) with AT versus wait-list ($P < .01$) | Significant difference in clinical dysfunction score with AT versus wait-list | Improved pressure pain threshold with AT versus wait-list ($P < .05$) | Improved activity of daily living with AT versus wait-list ($P < .01$) |
| Park et al, 1999[21] | Reduced pain numerical analogue scale with EAT versus wait-list ($P = .001$) | | Improved pressure pain threshold in EAT from baseline; no between-group differences on ST7 point ($P = .055$) | Reduced noise frequency ($P = .016$), limitation of motion ($P = .004$) with EAT versus wait-list; reduced maximum comfortable opening and active range of motion ($P < .001$) from baseline within EAT |

**Table 4 Outcomes of RCTs of Acupuncture Versus Physical Therapy or Pharmacologic Treatments**

| Control/interventions | Study | Overall improvement |
|---|---|---|
| **Physical therapy** | | |
| Ultrasound therapy | Luo et al, 2001[20] | Difference in responder rate with improvement of TMD symptoms between AT versus control (95.1% versus 75% ) |
| | Zhong et al, 2007[27] | Significant difference in responder rate with improvement of TMD symptoms between warm-AT versus control (91.7% versus 66.7%, $P < .05$) |
| Manual therapy | Zhu, 2007[28] | Significant difference in responder rate with improvement of TMD symptoms between EAT versus control (95.5% versus 82.5%, $P < .05$) |
| Massage | Wang, 1996[25] | Significant difference in responder rate with improvement of TMD symptoms between EAT versus control (97.8% versus 91.2%, $P < .001$) |
| **Pharmacological treatments** | | |
| Indomethacin and Vitamin $B_1$ | Li and Rong, 2003[19] | Significant difference in responder rate with improvement of TMD symptoms between EAT plus AI versus control (95.0% versus 80.0%, $P < .05$) |
| | Zhang, 2008[26] | Significant difference in responder rate with improvement of TMD symptoms between warm-AT versus control (95.7% versus 68.2%, $P < .05$) |

*Acupuncture Versus Pharmacologic Treatment.* Two studies found significant differences in responder rate with improvement of TMD symptoms in favor of warm-needle acupuncture, or electroacupuncture plus acupoint injections compared with indomethacin plus vitamin $B_1$ (Table 4).[19,26] This is moderate evidence (two trials, 85 participants) that acupuncture is more effective for TMD symptoms than pharmacologic treatment such as indomethacin plus vitamin $B_1$.

### Adverse Events

Adverse events were addressed only in two studies. One trial[40] reported minimal adverse events, while the other trial[22] reported no serious adverse events or complications in the classical acupuncture group. In one of the trials,[40] classical acupuncture plus electroacupuncture was associated with an enhanced relaxed feeling, improved sleep, temporarily increased pain, and eleven cases of minor hematoma.

## Discussion

This review has revealed moderate evidence for the efficacy of acupuncture in management of TMD. The results support the view that the specific effects of acupuncture are short-term but have important clinical treatment benefits. Given the plethora of treatments for TMD, it is important to contextualize the results of the current review with respect to current guidelines. The effects of acupuncture are equivalent to the results for treatments that are currently advocated (eg, occlusal splints, physical therapy such as manual therapy).

There was moderate evidence that acupuncture has a positive influence beyond those of placebo, which updates the previous evidence based on one sham acupuncture RCT that showed no difference between classical acupuncture and sham acupuncture.[44] Important aspects of the acupuncture and sham acupuncture control need to be considered to interpret properly this finding. This lack of difference between sham and real acupuncture raises consideration of how appropriate controls can be chosen. First, although a superficial insertion method was used in the control group, this is not an inert placebo method because it elicits peripheral sensory stimulation. It does not seem to be possible to insert needles without any sensorial stimulation.[46,47] In fact, even a very gentle form of placebo referred to as minimal or microacupuncture, where the needle is superficially inserted and left for a very short time with no further stimulation, seems to exert an effect.[48] Second, although nonacupoints were used in the control group, these may also not be inert. A current ongoing discussion in the acupuncture field is whether the acupuncture points should be referred to as acupuncture areas or zones, as needling in the areas around the traditional acupuncture points may also be efficient.[48] Indeed, some evidence suggests that sham acupuncture may not be inert.[49,50] Finally, it appears that the effect induced from the superficial insertion is strong enough to induce significant reduction in symptoms of TMD in the responders, negating any difference between the two methods.[44] Whether the results were due to the effectiveness of the noninert sham needling or a placebo effect could not be determined. Until recently, attempts at providing a control group for acupuncture, reflecting a similar therapeutic setting as well as being neurophysiologically inert, have been unsuccessful. Recent studies have provided evidence of a method which enabled adequate blinding of the participant while maintaining an identical therapeutic setting to that of real acupuncture.[51–53] Indeed, in this review, the two studies favoring real classical acupuncture over placebo acupuncture used a nonpenetrating needling as the control.[23, 24] In the present study's qualitative synthesis, these two latter comparisons were separated out to show moderate evidence that acupuncture alone is a positive influence from placebo acupuncture (based on the addition of two new trials), whereas the findings for acupuncture/sham acupuncture provide conflicting evidence.

This review also has provided moderate evidence that there is a significant difference between acupuncture and indomethacin plus vitamin $B_1$, and physical therapy. For other comparisons, the addition of the one RCT either strengthened or confirmed the previous conclusions by providing moderate evidence favoring acupuncture over waitlist. However, the review is unable to make many firm statements about the strength of the evidence, since the RCTs had poor quality and used various types of acupuncture. The included articles suffered from methodological flaws including incomplete reporting of randomization procedure, the lack of blinding, and follow-up results. Variations in outcome variables made comparison across trials problematic.

This systematic review has several limitations. The trials satisfying the inclusion criteria were clinically as well as methodologically heterogeneous with respect to the TMD diagnosis, type of TMD, different acupoints, type of acupuncture variants, and variants of outcome measures for evaluating

treatments of TMD. There was a limitation of generalization in the control interventions. Pharmacotherapy for TMD includes nonsteroidal anti-inflammatory agents, tricyclic antidepressants, and selective serotonin-reuptake inhibitors. However, two trials included in this review used only indomethacin as the control intervention. Use of the qualitative method for synthesizing the evidence has its limitations. Consistency of evidence was determined by group consensus, but this method is sensitive to how studies are categorized, since meeting the criterion of a certain level of evidence depends on the number of studies present in a category. Many of the reviewed studies were of low quality and had methodological shortcomings such as an inadequate level of blinding and power calculations. Although blinding of the therapist who applies acupuncture would be difficult, blinding of patients and other care providers as well as outcome assessors should be attempted to minimize the performance and assessment bias of trials. It should also be emphasized that trials with acupuncture should be randomized, blinded (including assessor blinding), well-controlled for placebo effects, have adequately concealed allocations, and utilize an appropriate level of power through sample size determination.

In conclusion, the results of this systematic review provide moderate evidence that acupuncture is an effective intervention to reduce symptoms associated with TMD. There is a need for acupuncture trials with adequate sample sizes that address the long-term efficacy or effectiveness of acupuncture.

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