A Systematic Review of the Effectiveness of Physical Therapy Interventions for Temporomandibular Disorders

Background and Purpose. The purpose of this qualitative systematic review was to assess the evidence concerning the effectiveness of physical therapy interventions in the management of temporomandibular disorders. Methods. A literature search of published and unpublished articles resulted in the retrieval of 36 potential articles. Results. Twelve studies met all selection criteria for inclusion in the review: 4 studies addressed the use of therapeutic exercise interventions, 2 studies examined the use of acupuncture, and 6 studies examined electrophysical modalities. Two studies provided evidence in support of postural exercises to reduce pain and to improve function and oral opening. One study provided evidence for the use of manual therapy in combination with active exercises to reduce pain and to improve oral opening. One study provided evidence in support of acupuncture to reduce pain when compared with no treatment; however, in another study no significant differences in pain outcomes were found between acupuncture and sham acupuncture. Significant improvements in oral opening were found with muscular awareness relaxation therapy, biofeedback training, and low-level laser therapy treatment. Discussion and Conclusion. Most of the studies included in this review were of very poor methodological quality; therefore, the findings should be interpreted with caution. [McNeely ML, Armijo Olivo S, Magee DJ. A systematic review of the effectiveness of physical therapy interventions for temporomandibular disorders. Phys Ther. 2006;86:710–725.]

Key Words: Electrophysical modalities, Exercise, Manual therapy, Physical therapy, Systematic review, Temporomandibular joint disorders.

Margaret L McNeely, Susan Armijo Olivo, David J Magee
Temporomandibular disorders (TMDs), also referred to as craniomandibular disorders, consist of a group of pathologies affecting the masticatory muscles, the temporomandibular joint (TMJ), and related structures. Temporomandibular disorder is considered a musculoskeletal disorder of the masticatory system that affects more than 25% of the general population. Temporomandibular disorder is usually manifested by one or more of the following signs or symptoms: pain, joint sounds, limitation in jaw movement, muscle tenderness, and joint tenderness. It also is commonly associated with other symptoms affecting the head and neck region such as headache, ear-related symptoms, and cervical spine disorders. Patients with chronic TMD frequently report symptoms of depression, poor sleep quality, and low energy. Furthermore, chronic TMD has been found to interfere with normal social activity and interpersonal relationships and to negatively affect the ability to maintain employment.

The American Academy of Craniomandibular Disorders and the Minnesota Dental Association have cited physical therapy as an important treatment. Physical therapy is intended to relieve musculoskeletal pain, reduce inflammation, and restore oral motor function. Numerous physical therapy interventions are potentially effective in managing TMD, including electrophysical modalities, exercise, and manual therapy techniques. Electrophysical modalities include interventions such as ultrasound, microwave, laser, and transcutaneous electrical nerve stimulation (TENS). Physical therapy interventions often include therapeutic exercises for the masticatory or cervical spine muscles to improve strength (ie, the force-generating capacity of muscle) and mobility in the region. Manual therapy techniques are commonly used to reduce pain and restore mobility. Oral exercise devices, such as the Therabite Jaw Motion Rehabilitation System, are mechanical aids that provide passive stretch to the TMJ to improve mandibular range of motion. Physical therapy interventions also may include, or focus on, associated impairments of the craniocervical system such as poor posture, cervical muscle spasm, cervical pain, or referred pain from the cervical spine. Acupuncture also was included as an intervention in this review because it is considered a specialty field within the scope of practice for many physical therapists working in countries such as Canada, the United Kingdom, and Australia.

Management of TMD, however, most often involves a multidisciplinary approach. Dentists, orthodontists, psychologists, physical therapists, and physicians work together to address the condition of the patient with TMD. Conservative treatment is considered to be the treatment of choice because the symptomatology of the condition often is improved by use of occlusal splints, physical therapy, medication, and orthodontic treatment. Many reviews have been published on conservative treatments, often recommending a multidisciplinary treatment approach for TMD; however, research evidence supporting this approach is usually not provided.

More recently, there has been an interest in the relative effectiveness of specific conservative interventions for TMD, and, as a result, a number of systematic reviews have been performed in the area. One systematic review by Ernst and White, published in 1999, examined the efficacy of acupuncture for TMD. Based on preliminary findings from only 3 trials in the area, the authors concluded that, although acupuncture may be a potentially effective intervention for TMD, more rigorous trials were needed to confirm this conclusion. A meta-analysis, also published in 1999, examined the efficacy of electromyographic (EMG) biofeedback for TMD. Based on their meta-analysis of 13 studies, the authors concluded that there was evidence to support the use of EMG biofeedback in the management of TMD. The conclusions of the meta-analysis, however, were based on data from controlled and uncontrolled trials, and the findings therefore should be interpreted with caution.

More recently, 2 separate systematic reviews have examined the effectiveness of stabilization splint therapy

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Ms McNeely and Ms Armijo Olivo conceived the project, developed the protocol, conducted searches, coordinated reviewers, provided data collection and extraction, and provided manuscript preparation. Dr Magee contributed to protocol and to manuscript preparation and review.

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Cochrane Library and Best Evidence (1991–first quarter 2005), ISI Web of Science (1965–March 3, 2005), PubMed (1966–March 3, 2005), Lilacs (1982–March 3, 2005), EBM reviews–Cochrane Central Register of Controlled Trials (1991–first quarter 2005), and CINAHL (1982–February week 4, 2005). Key words and medical subject headings related to TMD and physical therapy were identified prior to initiating the search with the assistance of a librarian who specialized in health science databases. The key words included: “craniomandibular disorder(s),” “temporomandibular disorder(s),” “temporomandibular joint,” “orofacial pain,” “physical therapy,” “physiotherapy,” “exercise(s),” “rehabilitation,” and “therapy.” Two independent investigators screened the titles of publications found in the databases, and, if available, the abstract of the publication as well. If either investigator felt that any published article potentially met the inclusion criteria, or if there was inadequate information to make a decision, a copy of the article was obtained.

The next phase of the search strategy involved searching for unpublished studies and for studies potentially overlooked or absent from the databases. This involved hand searching the references of all retrieved articles for potential studies and hand searching selected journals (Journal of Oral Rehabilitation, Journal of Orofacial and Maxillofacial Surgery, Journal of the American Dental Association, Cranio, Journal of Orofacial Pain, and Physical Therapy). In order to locate unpublished research, we searched Web sites housing details of clinical trials, theses, or dissertations. Citation indexing was used to track referencing of key authors in the field, and local experts were contacted for further information.

A rating form was developed to determine eligibility of the retrieved papers (Appendix 1). Each criterion was graded on a yes/no basis (ie, the published paper had to provide enough information to adequately meet the criterion). In order for papers to be included in the review, the paper had to meet all criteria on the rating form. When discrepancies occurred between reviewers in the overall rating of an article, the rating forms were compared, the reasons for the discrepancies were identified, and a consensus was reached. All disagreements were resolved by consensus. Kappa statistics were calculated using SPSS version 12.0 software to determine the level of agreement between raters on both trial inclusion and quality score. Based on the criteria described by Landis and Koch, an agreement score above .61 was considered acceptable.

Quality Assessment
Assessments of quality were completed independently by the 2 independent reviewers. Each study was evaluated

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1 SPSS Inc, 233 S Wacker Dr, Chicago, IL, 60606.
using the previously validated 5-point Jadad scale to assess the completeness and quality of reporting of RCTs as well as to assess for potential bias in the trial (Appendix 2). This widely used scale focuses on 3 dimensions of internal validity: quality of randomization, double blinding, and withdrawals. This scale is the only published instrument that has been created according to psychometric principles. A score is assigned from 0 to 5, with higher scores indicating higher quality in the conduct or reporting of the trial. A trial scoring at least 3 out of 5 is considered to be of strong quality. Trials scoring below 3 are considered to be methodologically weak.

**Critical Appraisal**

Each study also was critiqued using a rating system originally developed de Vet et al in 1997. This rating system provides more detailed evaluation of the study methods and has been used previously in systematic reviews in physical therapy. Specifically, this tool examines criteria relevant to the practice of physical therapy such as participant characteristics, sample size, description of interventions, and the validity and reliability of the chosen outcome measures (Appendix 3). Table 2 provides a summary of the rating criteria of the rating scale. Each quality criterion was evaluated separately. At present, there are no clear decision rules for establishing cutoff scores for high- and low-quality trials using this tool; therefore, summary scores were not used.

**Results**

The search of the literature resulted in a total of 1,138 published articles. No unpublished manuscripts were identified. Of the 1,138 published articles, 36 were considered to be potentially relevant. Independent review of these 36 articles led to the inclusion of 14 articles representing 12 studies. Reasons for exclusion of the 22 studies are provided in Table 1. The kappa (κ) values for agreement between the raters were .88 for inclusion in the review and .76 for Jadad quality score. Only 3 of the included studies were considered to be of strong methodological quality. Further details on the study characteristics are provided in Table 2 (page 717).

**Diagnosis**

There was considerable diversity in the clinical presentation and diagnosis of participants with TMD among the included studies (Tab. 3, page 720). Six of the studies examined the effectiveness of the physical therapy interventions in muscular TMD (myogenous TMD). Two studies evaluated the effectiveness of physical therapy treatments in patients with articular TMD (arthrogenous TMD), and 3 studies investigated the use of physical therapy in patients with mixed diagnoses of TMD (included both myogenous and arthrogenous TMD). Six of the studies used the research diagnostic criteria established by Dworkin and LeResche to classify the patients as having myogenous TMD. One study also used the research diagnostic criteria to establish the arthrogenous TMD diagnosis. The remaining studies used their own diagnostic criteria, based on signs and symptoms of the patients.

**Effectiveness of Exercise Interventions and Manual Therapy**

Four studies examined the effect of exercise interventions on TMD. The methodological quality of these 4 studies was considered weak (Tab. 2). Two studies examined the effect of posture training (in combination with other therapies) on myogenous TMD and reported significant improvements in pain and oral opening in favor of the addition of postural exercise training. After 1 month, Komiyama et al found a significant increase in mouth opening in patients who received postural training compared with patients receiving only
cognitive intervention or compared with the control group. Wright et al\textsuperscript{44} found a statistically significant improvement in maximum pain-free opening, pain threshold, and the modified symptom severity index in patients receiving postural treatment compared with patients receiving self-management instructions alone.

Carmeli et al\textsuperscript{32} compared the effect of manual therapy in combination with active exercise with the effect of treatment with occlusal splint therapy on anteriorly displaced temporomandibular disks in patients with arthrogenous TMD. The authors reported significant improvement in pain and oral opening in favor of the manual therapy/exercise group. The only study\textsuperscript{37} reporting a nonsignificant finding from exercise examined the benefit of an oral exercise device on oral opening, pain, and wellness in patients with mixed TMD. In this study, Grace et al\textsuperscript{37} reported finding no significant benefit from the addition of the oral exercise device to traditional therapies or when the oral exercise device was used as part of a home program.

**Effectiveness of Acupuncture Interventions**

Two studies\textsuperscript{36,40,41} (1 weak study and 1 strong study) examined the use of acupuncture in the treatment of myogenous TMD. List and colleagues\textsuperscript{40,41} (the weak study) assigned participants to 1 of 3 groups: acupuncture, occlusal splint therapy, or control. Significant differences in pain threshold, pain intensity, and clinical dysfunction score were found in favor of acupuncture compared with the control group. No significant differences, however, were found between the acupuncture and occlusal splint therapy groups. Goddard et al\textsuperscript{36} (the strong study) evaluated the effect of acupuncture compared with sham acupuncture and found no significant difference in pain threshold response between the groups.

**Effectiveness of Electrophysical Modalities**

Six studies\textsuperscript{31,34,35,39,42,43,48} (2 strong studies and 4 weak studies) examined the efficacy of various electrophysical modalities in the treatment of TMD pain and dysfunction. There was considerable heterogeneity among the studies in the type of TMD, the chosen modality and comparison group, and in the frequency and duration of the treatment (Tab. 2). In the study by Al-Badawi et al\textsuperscript{31} (a strong study), 6 treatments of pulsed radio-frequency energy (PRFE) therapy were not found to be significantly better than sham PRFE for arthrogenous TMD. Treacy\textsuperscript{42} (a weak study) reported that 20 sessions of TENS were not significantly better than muscular awareness relaxation therapy (MART) or sham TENS. Significant improvements were found, however, in oral opening and electromyographic activity for the MART group when compared with treatment with TENS and sham TENS.

Wieselmann-Penknerr et al\textsuperscript{43} (a weak study) reported that 3 sessions of TENS were not significantly better in improving pain for myogenous TMD compared with biofeedback. In the studies by Dalhstrom and colleagues\textsuperscript{34,48} and Funch and Gale\textsuperscript{35} (2 weak studies), biofeedback was not found to be significantly better in reducing pain when compared with relaxation therapy or occlusal splint therapy. Biofeedback training, however, did result in significant improvement in oral opening when compared to occlusal splint therapy.\textsuperscript{34,48} Kulekcioglu et al\textsuperscript{39} (a strong study) reported significant improvements in active and passive oral opening and in lateral deviation range of motion, following 15 sessions of low-level laser therapy compared with sham laser. In the same study, however, no significant differences were found in pain reduction between the groups.

**Adverse Events**

Adverse events were reported only in the study by Al-Badawi et al.\textsuperscript{31} The authors reported skin irritation or color changes at the application site of the PRFE during treatment in 4 participants. The authors also reported that the device made an irritating high-pitched sound that required the use of earplugs during treatment sessions.

**Discussion and Critical Appraisal**

In the present systematic review, many publications were found that addressed treatment of TMD; however, few published studies met the criteria for inclusion in the review. The requirement for RCTs and the criteria established for the type of participants eliminated many potential studies for review. Many of the studies in this review were considered methodologically weak when evaluated by the Jadad scale and further limitations were identified through the critical appraisal process (Tab. 4, page 721).

**Exercise and Manual Therapy**

Exercise therapy has long been used in the treatment of TMDs. Therapeutic exercise interventions are prescribed to address specific TMJ impairments and to improve the function of the TMJ and craniomandibular system.\textsuperscript{68} Most exercise programs are designed to improve muscular coordination, relax tense muscles, increase range of motion, and increase muscular strength (force-generating capacity).\textsuperscript{69} The most useful techniques for re-education and rehabilitation of the masticatory muscles have been reported as manual therapy, muscle stretching, and strengthening exercises.\textsuperscript{70} Passive and active stretching of muscles or range-of-motion exercise are performed to increase oral opening and decrease pain.\textsuperscript{70} Postural exercises also are recommended to restore or optimize the alignment of the craniomandibular system.\textsuperscript{8}
Two of the 12 selected studies in this systematic review evaluated the effectiveness of postural correction exercises for patients with TMDs.38,41 Both of these studies examined patients with myogenous TMD and used the research diagnostic criteria of Dworkin and LeResche67 to establish the diagnosis. The positive findings of these 2 studies (reduced pain and improved oral opening), therefore, can be generalized to this specific group of patients and is in line with the present approach for treatment of TMD.71–73 From a methodological point of view, the study by Wright et al14 was considered a weak study according to the Jadad score; however, this study provided considerably more detail (ie, randomization, blinded, sample size, good control of potential confounders) than the other studies included in this review. The main concern with this study was that the treatment protocol was not described in enough detail to allow for replication of the intervention. In the study by Komiyama et al,36 both the Jadad quality assessment and in the critical appraisal identified numerous concerns. In particular, the article lacked details on the method of randomization, postural exercise protocol, chosen outcome measures, and agreement to participate.

Only one study, by Carmeli et al,32 was designed to evaluate exercise in patients with articular TMD. The authors compared the effects of a manual therapy and exercise program with the use of a repositioning splint in participants with an anterior displaced temporomandibular disk. The results of this study support the use of the combined manual therapy and exercise to reduce pain and increase range of motion. Overall, however, this study was considered methodologically weak. Furthermore, the study sample size was small, the mobilization protocol was not described in enough detail to allow replication, and no information was provided on the validity and reliability of the chosen outcome measures.

Grace et al37 evaluated the use of an oral exercise device in the treatment of patients with mixed TMD. The authors analyzed 3 groups: the first group received traditional therapies; the second group received traditional therapy and an oral exercise device; and the third group received education and instruction in home care and the use of an oral exercise device. This study, although described as an RCT, sequentially assigned participants to treatment groups. Further limitations of this study included a poor description of baseline characteristics of participants (eg, medication use, previous treatment), a small sample size, and the fact that the chosen interventions included multiple treatments. The use of multiple uncontrolled treatments in this study clouds any conclusions about the relative effectiveness of the oral exercise device.

Despite these methodological limitations, the evidence in support of manual therapy and oral and postural exercises to reduce pain and improve range of motion is of definite clinical interest.33,37 More information, however, is required on the optimal exercise prescription. In particular, details on frequency, intensity, and time and type of the specific exercise used in treatment protocols is essential to allow for replication in the clinical setting.

**Acupuncture**

Acupuncture is increasingly being used in the treatment of musculoskeletal conditions in North America.74 At present, the mechanisms underlying the action of acupuncture are unclear.75 Acupuncture may stimulate the production of endorphins, serotonin, and acetylcholine within the central nervous system, or it may relieve pain by acting as a noxious stimulus.75,76

Both studies36,40,41 included in this systematic review reported improvements in pain with acupuncture treatment; however, acupuncture was not found to be significantly better than sham acupuncture or occlusal splint therapy. The study by Goddard et al36 found that pain improved with a single treatment of either traditional or sham acupuncture. Although a within-group difference was found in the group receiving traditional acupuncture, the difference between the groups was not statistically significant. The study was considered strong by the Jadad scale; however, the small sample size of the study (n=16) would suggest that the study was inadequately powered to detect a difference between the groups.

The study by List and colleagues40,41 examined the effect of 6 to 8 treatments of acupuncture. Although the authors reported that acupuncture was significantly better than no treatment in reducing pain, no significant differences were found between acupuncture and occlusal splint therapy. The study was considered weak by the Jadad criteria and was deficient in a number of criteria on the critical appraisal: there was inadequate information on baseline characteristics of participants (eg, medication use), agreement to participate, and data collection methods (eg, validity and reliability of outcome measures). Furthermore, independent assessors were not used to administer outcome measures. Given the methodological concerns of studies by Goddard et al36 and List and colleagues,40,41 further research in this area is warranted before ruling out any potential effect of acupuncture treatment.

**Electrophysical Modalities**

Electrophysical modalities, such as shortwave diathermy, ultrasound, laser, and TENS, are commonly performed in the clinical setting.51 Electrophysical modalities are intended to reduce inflammation, promote muscular relaxation, and increase blood flow by altering capillary permeability.51 The literature suggests that treatments with electrophysical modalities, performed early in the
The studies included in this review examined the benefits of various electrophysical modalities including PRFE, biofeedback, laser therapy, and TENS. Comparison interventions included no treatment control, sham treatment, relaxation therapy, occlusal splint therapy, and behavioral management. No evidence was found to support the use of any of the electrophysical modalities to reduce pain. The significant benefits reported from the use of electrotherapeutic modalities were increased oral opening and lateral deviation range of motion measures.

**PRFE.** The study by Al-Badawi et al examined the effect of PRFE on pain, oral opening, and lateral deviations. This study was considered strong by the Jadad criteria. The concerns with this study were that the authors did not provide information on agreement to participate, sample size calculation, or on the validity and reliability of chosen outcome measures. Based on this small study, at present, there is no evidence to support the use of PRFE to reduce pain in arthrogenous TMD. The within-group improvement in oral opening and lateral deviations found with PRFE treatment, however, suggests the need for evaluation with a larger sample size.

**TENS.** The studies performed by Treacy and Wieselmann-Penknern et al that examined the efficacy of TENS were considered to be methodologically weak, and the sample sizes in these 2 studies were small. Numerous other concerns were identified with these studies (Tab. 4); therefore, further research is warranted before dismissing any effect of TENS. In the study performed by Treacy, improvement in oral opening and electromyographic activity occurred in the comparison group receiving MART; however, this finding is based on a single, small, poor-quality study.

**Biofeedback.** The studies examining biofeedback that were performed by Dahlstrom and colleagues and Funch and Gale also were considered weak. Furthermore, our critical appraisal of these studies identified numerous concerns with the design and reporting of trial methods. Dahlstrom and colleagues did report significant improvement in oral opening with biofeedback; however, the study did not use independent assessors and few details were provided on data collection methods.

**Laser therapy.** Kuleckioglu et al reported significant improvements in active and passive oral opening and in lateral deviation range of motion with laser therapy treatment and was considered strong by Jadad criteria. Although the study also included use of independent outcome assessment, no details were provided on agreement to participate, on sample size calculation, on data collection methods, or on the number of participants starting and finishing the study.

**Limitations**

Although this systematic review is the first to investigate the effectiveness of physical therapy interventions in patients with TMD, the review does have some limitations that need to be acknowledged. The findings of this review are specific to TMD (nonsurgical) and to the field of physical therapy. As with any systematic review, there is the potential for selection bias; however, we used a comprehensive search strategy and included publications in any language. In addition, 2 independent reviewers were used, and reasons for study exclusions were clearly documented. Although attempts were made to identify unpublished studies, no such studies were found.

The heterogeneity among studies, particularly with respect to the TMD diagnosis, study intervention, and chosen control/comparison intervention, was a challenge of this review. This diversity, as well as the small sample sizes and poor methodological quality of many of the studies, limits overall conclusions and highlights the need for further research.

**Conclusions**

**Implications for Practice**

The results of this systematic review support the use of active and passive oral exercises and exercises to improve posture as effective interventions to reduce symptoms associated with TMD. More information on the exercise prescription, however, is necessary to allow for replication in clinical setting. At present, there is inadequate information to either support or refute the use of acupuncture in the treatment of TMD. There is no evidence to support the use of electrophysical modalities to reduce TMD pain; however, the evidence suggests improvements in oral opening may result from treatment with MART, biofeedback training, and low-level laser therapy treatment. Most of the studies included in this review were of very poor methodological quality; therefore, these findings must be interpreted with caution.

**Implications for Research**

There is a clear need for well-designed RCTs examining physical therapy interventions for TMD. Trials should be large enough to be clinically meaningful, adequately powered, and include valid and reliable outcome measures. Furthermore, attempts should be made to blind assessors performing outcome measures and, where possible, the participants as well. Investigators should consider the findings of this systematic review when designing trials and attempt to overcome the limitations of the studies presented. Based on the positive effects of active and passive exercise, postural exercises, and manual therapy, high-quality trials with larger sample sizes are clearly warranted in these areas.
### A. Exercise Interventions

<table>
<thead>
<tr>
<th>First Author, Year, Location</th>
<th>Participants</th>
<th>Interventions and Control/Comparison Groups</th>
<th>Frequency and Duration</th>
<th>Primary End Points</th>
<th>Results</th>
<th>Authors’ Conclusions</th>
<th>Quality Score</th>
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<tbody>
<tr>
<td>Carmeli et al, 2001 Israel</td>
<td>N=36 (26 female, 10 male; mean age=19-43 y)</td>
<td>Manual mobilization and active exercises vs Soft, flat-plane occlusal repositioning splint</td>
<td>4 wk treatment: Manual therapy every 2nd or 3rd day; active exercises 4-6× per day for 5 min duration Splint worn 24 hr/d</td>
<td>Active range of motion: oral opening Pain scale: 0=&quot;no pain&quot; to 5=&quot;severe pain&quot;</td>
<td>Manual therapy and exercises significantly better than splint in reducing pain (P&lt;.05) and improving oral opening (P&lt;.05)</td>
<td>Manual mobilization and active exercises more effective to improve pain and range of motion than soft repositioning splint</td>
<td>Jadad score: 1 Randomized: yes Described: no Double blind: no Blinding described: no Withdrawals: no</td>
</tr>
<tr>
<td>Grace et al, 2002 USA</td>
<td>N=45 (38 female, 7 male; mean age=18-76 y)</td>
<td>Traditional therapies</td>
<td>2× per week for 2 mo Oral device: 2× per day for 1-2 min at a time; resistance progressed</td>
<td>Oral opening and lateral deviation (mm) Pain VAS: 0=&quot;no pain&quot; to 10=&quot;very painful&quot; (3 time points: today; over last week; predict next week) Joint noises: auscultation with stethoscope Wellness scale: 5 questions</td>
<td>No statistically significant differences within/ between groups for any outcomes</td>
<td>Further research needed: increased exercise times and larger sample size</td>
<td>Jadad score: 1 Randomized: yes Described: no Double blind: no Blinding described: no Withdrawals: yes Deducted 1 point for sequential assignment to groups</td>
</tr>
<tr>
<td>Komiyama et al, 1999 Japan</td>
<td>N=60 (49 female, 11 male; mean age=39.1 y)</td>
<td>Cognitive behavioral (CB): education on chronic pain, stress reduction, and relaxation training vs CB with posture correction: posture group also received posture training at each session vs Control group</td>
<td>1 session per month for 12 mo: both intervention groups</td>
<td>Oral opening (pain-free range of motion) Pain intensity at maximum mouth opening (VAS 100-mm scale) Disturbance in daily life (VAS 100-mm scale)</td>
<td>Posture group had a statistically significant improvement in oral opening compared to control (P&lt;.05) at all time points Pain: both intervention groups significantly better than control at 6 and 9 mo (P&lt;.05) Disturbance in daily life: both intervention groups significantly better than control group at 6 mo (P&lt;.05) No statistically significant difference between groups for any outcomes at 12 mo</td>
<td>Posture correction in daily life has a positive effect on myofascial pain associated with limited mouth opening</td>
<td>Jadad score: 2 Randomized: yes Described: no Double blind: no Blinding described: no Withdrawals: yes</td>
</tr>
<tr>
<td>Wright et al, 2000 USA</td>
<td>N=60 (51 female, 9 male; mean age=18-60 y)</td>
<td>TMD self-management instructions alone (rest masticatory muscles, avoid parafunctional habits, apply heat or cold, use nonprescription anti-inflammatory medications) vs Posture training and TMD self-management instructions</td>
<td>4 wk duration Posture group: 2 sessions with physical therapist Each exercise had specific instructions for number of repetitions</td>
<td>Maximum pain-free oral opening (mm) Pain threshold: with pressure algometer at 2 points (masseter and trapezius muscles in kg/cm²) Modified symptom severity index (VAS each for TMJ and neck)</td>
<td>Maximum pain-free opening significantly greater improvement in posture group (P&lt;.05) There was a statistically significant improvement in the modified symptom severity index for both TMJ and neck (P&lt;.001) in favor of posture group</td>
<td>Posture training and TMD self-management together are more effective than self-management alone for muscular TMD</td>
<td>Jadad score: 2 Randomized: yes Described: yes Double blind: no Blinding described: no Withdrawals: no</td>
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### B. Acupuncture

<table>
<thead>
<tr>
<th>First Author, Year, Location</th>
<th>Participants</th>
<th>Intervention and Control/Comparison Groups</th>
<th>Frequency and Duration</th>
<th>Primary End Points</th>
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<th>Authors’ Conclusions</th>
<th>Quality Score</th>
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<tr>
<td>Goddard et al, 2002 USA</td>
<td>N=18 (15 female, 3 male)</td>
<td>Acupuncture (4 specific points; depth 10–30 mm) vs Sham acupuncture (4 sham points; depth 2–4 mm)</td>
<td>Single session: 30 min</td>
<td>Pain: 100-mm VAS (maximal pain evoked by mechanical stimulus using algometer)</td>
<td>No significant differences between the groups (P=.255)</td>
<td>Pain reduction resulting from needling may not be dependent on whether needling is performed in standard acupuncture points or in other areas</td>
<td>Jadad score: 5</td>
</tr>
<tr>
<td>List et al, 1992/1993 Sweden</td>
<td>N=55 (46 female, 9 male)</td>
<td>Acupuncture vs Occlusal splint therapy Control</td>
<td>6–8 wk duration</td>
<td>Pain threshold (algometer) in kg/cm²/s Clinical dysfunction score (CDS): included oral opening, function, palpation of TMJ and masticatory muscles, and pain with movement Pain intensity: 100-mm VAS (“no pain” to “worst pain imaginable”)</td>
<td>Significant differences between the 2 treatment groups and control group for pain (P&lt;.05), CDS (P&lt;.01), and pain intensity (P&lt;.01)</td>
<td>Acupuncture and occlusal splint therapy have a significant effect on pain threshold, CDS, and pain intensity in patients with TMD</td>
<td>Jadad score: 2</td>
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### C. Electrophysical Modalities

<table>
<thead>
<tr>
<th>Authors, Year, Location</th>
<th>Participants</th>
<th>Intervention and Control/Comparison Groups</th>
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<th>Authors’ Conclusions</th>
<th>Quality Score</th>
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<tbody>
<tr>
<td>Al-Badawi et al, 2004 USA</td>
<td>N=40 (31 female, 9 male)</td>
<td>Pulsed radio-frequency energy therapy (PRFE): 6 treatment units of 15 s each with 7-s rest vs Sham PRFE</td>
<td>2 wk duration</td>
<td>Pain: numeric rating scale (0=“no pain,” 10=“pain as bad as it can be”) Oral opening and lateral deviations: Therabite measuring scale (mm)</td>
<td>No significant differences between the groups. A significant reduction in pain over time in both groups. The PRFE group showed a significant increase in mouth opening and lateral deviations.</td>
<td>PRFE is a safe and effective treatment for TMJ arthralgia</td>
<td>Jadad score: 3</td>
</tr>
<tr>
<td>Dahlstrom and colleagues, 1982/1984 Sweden</td>
<td>N=30 (30 female, mean=28.6 y)</td>
<td>Biofeedback vs Occlusal splints</td>
<td>6 weeks duration</td>
<td>Clinical dysfunction score (1 = non-pain, 3 = very severe) Oral opening</td>
<td>No significant differences between the groups</td>
<td>The 2 treatments were equally effective in the short term</td>
<td>Jadad score: 2</td>
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<tr>
<td>Funch and Gale, 1984 USA</td>
<td>N=57 (51 female, 6 male)</td>
<td>Biofeedback (specific to site of pain) vs Relaxation therapy (tape-recorded relaxation sequence)</td>
<td>12 wk duration, 1× per week</td>
<td>Post-treatment and 2-y follow-up Pain: 6-point scale (0=“no pain at all” to 6=“pain severe enough to interfere with behavior and to be incapacitating”), collected weekly</td>
<td>No significant differences between the groups</td>
<td>Knowledge of pretherapy factors, particularly clinical, may allow for more optimal assignment to treatment</td>
<td>Jadad score: 1</td>
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</table>

(continued)
<table>
<thead>
<tr>
<th>First Author, Year, Location</th>
<th>Participants</th>
<th>Intervention and Control/Comparison Groups</th>
<th>Frequency and Duration</th>
<th>Primary End Points</th>
<th>Results</th>
<th>Authors’ Conclusions</th>
<th>Quality Score</th>
</tr>
</thead>
</table>
| **Kulekcioglu et al., 39 2003**  Turkey | N=35  
Sex: 28 female, 7 male  
Age: 20-59 y  
[mean=37 y] | Gallium-arsenide low-level laser therapy ([LLLT] with daily range of motion, stretching, and posture exercises vs Placebo (sham laser) with daily range of motion, stretching, and posture exercises | Duration: not stated; 15 sessions  
Daily exercises both groups | Pain: 100-mm VAS  
Oral opening and lateral deviations: ruler (mm)  
Joint sounds: auscultation  
Number of tender points: palpation | No significant differences between the groups in pain reduction  
Significant improvement in favor of LLLT for active and passive oral opening (P < 0.01), right and left lateral deviations (P < 0.006, P < 0.001), and number of tender points (P < 0.006) after treatment (significant effect at 1-mo follow-up as well) | LLLT in combination with exercise can be considered as an option in management of TMD  
Treatment effects were similar in myogenic and arthrogenic cases | Jadad score: 3  
Randomized: yes  
Described: no  
Double blind: yes  
Blinding described: yes  
Withdrawals: no |
| **Treacy, 42 1999**  Sweden | N=24  
Sex: 10 female, 14 male  
Age: 20-38 y  
[mean=25 y] | Muscular awareness relaxation training ([MART]) vs Transcutaneous electrical nerve stimulation ([TENS]) vs Sham TENS | 4 mo duration  
20 treatment sessions of 30 min duration, twice a week: all groups | Electromyographic activity  
Discomfort: 6-point scale  
(0 = "absence of discomfort." to 6 = "great discomfort")  
Oral opening  
Breaths per minute | No significant difference in change in discomfort between groups  
MART group significantly improved oral opening compared with other groups [TENS group: P < 0.05, sham TENS group: P < 0.01], electromyographic activity for pterygoideus/S, masseter tension (P < 0.05) and frontalis muscle (P < 0.01), and decrease in breaths per minute (P < 0.05) | MART superior to TENS and sham TENS in decreasing muscular tension when treatment is administered 2 x per week for 4 mo | Jadad score: 1  
Randomized: yes  
Described: no  
Double blind: no  
( Single only)  
Blinding described: no  
Withdrawals: no |
| **Wieselmann-Penner et al., 43 2001**  (pilot study)  Austria | N=20  
Sex: 13 women, 7 men  
Age: 22-58 y  
[mean=27 y] | Electromyographic biofeedback to relax masseter and temporalis muscles vs TENS | 1-wk duration, 3 sessions per group | Electromyographic activity  
Skin conductance level | No significant differences between groups  
Trend for decreased mean electromyographic levels for both groups after treatment sessions  
Increase in skin conductance levels during treatment for both groups in sessions I and II which stabilized for session III | Both treatments lead to local relaxation of masticatory muscles | Jadad score: 1  
Randomized: yes  
Described: no  
Double blind: no  
Blinding described: no  
Withdrawals: no |

**a** VAS = visual analog scale, TMD = temporomandibular disorder, TMJ = temporomandibular joint.  
**b** Traditional therapies were stated to include any of the following: oral stabilization appliances, medications, home physical therapy or exercises, patient education, stress reduction therapy, and therapy or physical modalities.  
**c** Facial Concepts Inc, PO Box 99, Blue Bell, PA 19422 (http://www.facialconcepts.com/newsite/tmd_therapy.htm).
Table 3.
Classification of Studies According to Diagnosisa

<table>
<thead>
<tr>
<th>Muscular Temporomandibular Disorders</th>
<th>Articular Temporomandibular Disorders</th>
<th>Mixed Temporomandibular Disorders</th>
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</thead>
<tbody>
<tr>
<td>Komiyama et al38: myofascial pain with limited opening according to Dworkin and LeReshe67</td>
<td>Carmeli et al32: diagnosis of anterior temporomandibular disks with unstable excursive reduction (no further details provided)</td>
<td>Grace et al37: TMJ dysfunction with a primary diagnosis of muscular dysfunction (51.1% of patients); however, 42.2% had a secondary diagnosis of a functional problem (reducing disk displacement) and 6.7% had a secondary diagnosis of an inflammatory TMD</td>
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<tr>
<td>Wright et al64: TMD research diagnosis criteria for muscle disorders according to Dworkin and LeReshe67</td>
<td>Al-Badawi et al31: patients had a clinical diagnosis of arthralgia as defined by the research diagnostic criteria of Dworkin and LeReshe66</td>
<td>Dahlstrom et al33 and Dahlstrom and Carlsson34: signs and symptoms of mandibular dysfunction (ie, TMJ sounds, feeling stiffness of the jaw and fatigue, facial and jaw pain, locking, pain on movement of the jaw)</td>
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<tr>
<td>Goddard et al36: myofascial pain according to Dworkin and LeReshe67</td>
<td></td>
<td>Funch and Gale35: chronic TMJ pain, not specific whether pain was myogenous or arthrogenous</td>
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<tr>
<td>Treacy42: patients were diagnosed as having bruxism based on the criteria of Phillips et al3b</td>
<td></td>
<td>Kulecioglu et al39: patients had orofacial pain, TMJ sounds, limited mouth opening, or TMJ locking, tenderness in masticatory and cervical muscles</td>
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<tr>
<td>Wieselmann-Penker et al43: patients were diagnosed as having bruxism according to the following criteria:</td>
<td>• Pain and tenderness to palpation of the masticatory muscles with a chronicity of at least 6 mo</td>
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<td>• No evidence of joint pathology based on clinical examination and radiographs</td>
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<tr>
<td>List and colleagues40: signs and symptoms of CMD of primarily muscular origin</td>
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a TMJ = temporomandibular joint, TMD = temporomandibular disorder, CMD = craniomandibular disorder.

References


### Table 4.
Critical Appraisal of Included Studies by Group

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<th>Primary Author and Year</th>
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* 1=study design, 2=baseline characteristics, 3=agreement to participate, 4=intervention, 5=sample size, 6=data collection methods, 7=blinding, 8=participants starting/finishing, 9=external validity, 10=statistical tests. **P**=pass, met criterion; **M**=moderate, incomplete/partially met criterion, **F**=fail, did not meet criterion (the fail rating was also assigned if no information was provided in the publication on a specific criterion).


26 Haywood S. *Systematic Overview Project*. Edmonton, Alberta, Canada: Alberta Heritage Foundation for Medical Research; 1997.


Appendix 1.
Physical Therapy Effectiveness Project Relevance Tool—Primary Studies

STUDY: Physical Therapy Intervention for Temporomandibular Disorders

INSTRUCTIONS FOR COMPLETION:
1. Circle Y or N for each relevance criterion
2. Record inclusion decision: article must satisfy all relevant criteria
3. Ensure that no exclusion criteria are included
4. Record if additional references are to be retrieved
5. Complete validity form for articles to be included

RELEVANCE CRITERIA:
1. Does this article evaluate a physical therapy intervention or program? Y N
2. Is the intervention within the scope of physical therapist practice? Y N
3. Are the participant inclusion criteria covered?
   a. Clinical diagnosis of temporomandibular disorder Y N
   b. Age: adult >18 years Y N
   c. Musculoskeletal problem Y N
   d. Pain impairment Y N
   e. No other serious comorbid conditions Y N
4. Not examining a postsurgical intervention for temporomandibular dysfunction Y N
5. Are one or more appropriate outcomes measured (eg, range of motion, pain, functional outcome measure, quality of life, patient satisfaction, muscular activity, electromyography)? Y N
6. Is the article a randomized controlled trial (described as random/randomized/random allocation/random assignment)? Y N

REVIEWER DECISION:
1. Include in critical appraisal (Yes = Y to all relevance criteria) Y N
   If yes, please complete validity form
2. Additional references Y N
   If yes, mark items on reference list of article

IF DISCREPANCY IN INCLUSION DECISION:
Reason for discrepancy:
   Oversight Y N
   Differences in interpretation of criteria Y N
   Differences in interpretation of study Y N

FINAL DECISION: INCLUDE IN STUDY Y N

Appendix 2.
Scoring of Jadad Scale

Score: Assign a score of 1 point for each “yes” or 0 points for each “no.”
1. Was the study described as randomized (this includes the use of words such as randomly, random, and randomization)?
2. Was the study described as double-blind (blinding of patients and evaluators, not necessarily therapists)?
3. Was there a description of withdrawals and dropouts (explicit statement that all included patients were analyzed or if the number and reasons for dropouts in all groups are given separately)?

Give 1 additional point if:
   For question 1, the method to generate the randomization sequence was described and appropriate (table of random numbers, computer generated).
   For question 2, the method of double blinding was described and it was appropriate (independent blinded assessors used, identical placebo or active placebo treatment, neither the person doing the assessments nor the study participant could identify the intervention being assessed).

Deduct 1 point if:
   For question 1, the method to generate the randomization sequence was described and was inappropriate (alternate allocation to groups or according to date of birth, hospital number, etc).
   For question 2, the method of blinding was inappropriate (the person doing the assessment and/or the study participant could identify the intervention being assessed).
### Appendix 3.
Critical Appraisal—Included Studies

**STUDY: Interventions for Temporomandibular Disorders (Included Studies)**

1. **Type of Study**
   - i. Random (P)
   - ii. Pre-experimental/quasi-random (M)
   - iii. Case control/cross-sectional (F)
   - iv. Descriptive (F)

2. **Baseline Characteristics**
   - i. Sex (Y N)
   - ii. Age (Y N)
   - iii. Medication (Y N)
   - iv. Simultaneous treatment (Y N)

3. **Agreement to Participate**
   - i. >80% (P)
   - ii. 60–80% (M)
   - iii. <60% (F)
   - iv. Cannot tell (F)

4. **Intervention**
   - i. Range of motion/stretching (Y N)
   - ii. Modalities: _______
   - iii. Mobilization (Y N)
   - iv. Strength/resistance exercise training (Y N)

5. **Sample Size**
   - i. Appropriate: a priori effect size/power (P)
   - ii. Appropriate, no justification provided (M)
   - iii. Small, justification provided (pilot) (M)
   - iv. Small and no justification provided (F)

6. **Data Collection Methods**
   - **Self reported**
     - i. Reliable test instrument (Y N)
     - ii. Valid test instrument (Y N)
     - iii. Sensitive (Y N)
     - iv. Well described (Y N)
   - **Clinician performed (range of motion, functional outcome)**
     - i. Intervarability (Y N)
     - ii. Intraratability (Y N)
     - iii. Reliable test instrument (Y N)
     - iv. Valid test instrument (Y N)
     - v. Sensitivity (Y N)
     - vi. Well described (Y N)

7. **Blinding**
   - Patients (Y N)
   - Clinicians (Y N)
   - Assessors (Y N)

8. **Participants Starting and Finishing Study**
   - i. Immediate >80% (P)
   - ii. Posttreatment >80% (P)
   - iii. Follow-up >80% (P)

9. **External Validity**
   - i. Clinically important outcomes? (Y N)
   - ii. Results applicable to clinical setting (i.e., treatment benefits worth potential harms/costs)? (Y N)
   - iii. Patients similar to clinical setting for demographics, severity, comorbidity, and other prognostic factors? (Y N)
   - iv. All participants accounted for at conclusion? (Y N)

10. **Were there statistical tests of the intervention effects?**
    - i. Appropriate/suitable statistical tests (Y N)
    - ii. Precision and variability (e.g., P value and confidence interval) (Y N)

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*P=pass, met criterion; M=moderate, incomplete/partially met criterion, F=fail, did not meet criterion (the fail rating was also assigned if no information was provided in the publication on a specific criterion).*

*If differences in baseline characteristics between groups were statistically controlled, P=3 or M=2, F=1.

*P=all, M=1–3, F=0.

*Outcome: P=all, M=validity+(2–3), F=invalidity or 0–1, N/A is not a fail for this category.

*P=6 or all, M=validity+(2–3), F=validity+(0 or 2), N/A is not a fail for this category. Scoring for outcome measure: P=all outcomes received a score of P, M=1–2 outcomes received a score of P, F=none of the outcome measures met all criteria.*

*P=all, M=1, F=0, N/A is not a fail for this category.

*P=all, M=1–3, F=0.

*P=all, M=1, F=0.