Effectiveness of Thrust Manipulation of the Cervical Spine for Temporomandibular Disorder: A Systematic Literature Review

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ABSTRACT

Background and Purpose: Individuals with temporomandibular disorder commonly experience pain in and around the temporomandibular joint, decreased mouth opening, headaches, tinnitus, and dizziness. Common treatments for temporomandibular disorder include modalities, soft tissue mobilizations, mandibular mobilizations/manipulations, tongue controlled mouth opening exercises, alterations in diet and habits, and massage. Due to the biomechanical and physiological relationship between the temporomandibular joint and the cervical spine, it has been hypothesized that treatment for temporomandibular disorder could be directed to the cervical spine. Spinal manipulation, which has been validated in the literature as an acceptable form of treatment to decrease pain and improve function, could be aimed at the cervical spine to affect temporomandibular joint pain. The purpose of this systematic review of the literature is to determine the effectiveness of cervical manipulation on the treatment of symptoms related to temporomandibular disorder.

Methods: The authors used Google Scholar, Cochrane, Scopus, PubMed, Ovid MEDLINE, and Cumulative Index of Nursing and Allied Health (CINAHL) when conducting a review of the research. Additional studies were added to the search from an outside source. Studies were eliminated by title, abstract, and review of complete text. The 6 remaining articles were read and graded using the PEDro scale. Inclusion criteria included the use of a cervical manipulation applied to the cervical spine to assess changes in symptoms in patients with TMD symptoms.

Results: All 6 studies used cervical manipulation as a form of treatment. The studies that evaluated painfree active maximal mouth opening (PFAMMO) reported changes ranging from 1-15 mm with varied statistical significance. The studies that used the Visual Analog Scale (VAS) and/or pain scale reported a minimal change of 4.5 out of 10 indicating a significant reduction. With regard to the two randomized controlled trials that evaluated pain pressure threshold (PPT), changes ranged from 0.1 kg/cm²-0.2 kg/cm². Two of the 6 studies supported the use of cervical spine manipulation as an effective treatment option for improving symptoms related to temporomandibular joint dysfunction.

Limitations: Limited available research, low PEDro scores, weak study designs, variation in manipulation methods, small sample sizes, and the simultaneous use of other treatment interventions.

Conclusion: High velocity low amplitude thrust manipulation applied to the cervical spine may be beneficial in achieving positive effects in patients with TMD symptoms. If a clinician is considering treating TMD only with cervical manipulation, further study to support its determined effects is needed.

Key Words: cervical manipulation, temporomandibular disorder, high velocity low amplitude

INTRODUCTION

The temporomandibular joint (TMJ), is used on a daily basis and is the most commonly used joint in the body.1 Patients with temporomandibular disorders (TMD) will often experience headaches, tinnitus, pain, limited mouth opening, joint noises, ear aches, dizziness, and neck symptoms potentially originating from areas in close proximity to the TMJ or within the TMJ itself.1 A national U.S. sample of 30,978 people found that 4.6% of the population reported having TMD-like symptoms.2 Additionally, it has been shown that in patients who reported TMD-like symptoms, nearly 59% had comorbid pains with the strongest correlation being neck pain.3

The research literature has identified that the TMJ and cervical spine have a complex functional biomechanical relationship.4,5 Altering position of the cervical spine (ie, forward head position) changes the natural alignment of cervical vertebrae as well as the positioning of the TMJ.5,6 Temporomandibular disorder patients have been shown to be more likely to have postural abnormalities such as forward head position and decreased cervical lordosis.5,8 Prolonged poor posture places undue stress on cervical vertebrae/disk, muscles, and neurovascular structures that may result in headaches, trigger points, and pain referral patterns.6,9-11 It has been suggested that a proportionate relationship between TMJ dysfunction and neck pain exists, and that TMD symptoms are often misinterpreted and treated improperly.12,13

Common treatments for TMD symptoms have included modalities, soft tissue mobilizations, mandibular mobilizations and manipulations, tongue controlled mouth opening exercises, alterations in diet and habits, and massage with varied success.1 More recently, the literature has focused on intervention directed towards the cervical spine in hopes to affect TMD symptoms.13,17 Patients with TMD seek treatment from a variety of practitioners, including dentists, physiatrists, physical therapists, and chiropractors.14 Manipulations to the spine has been widely accepted as a treatment intervention for decreasing pain and improving function/mobility in multiple areas of the body.10-13 This prior research warrants an investigation into using cervical manipulation as a means of treatment for TMD-related symptoms. The current literature is lacking in systematic reviews on the effectiveness of cervical manipulation for TMD. The purpose of this systematic review of the literature is to determine the effectiveness of cervical manipulation on the treatment of symptoms related to TMD.

METHODS

A search was conducted in July 2014 to locate literature to determine if manipulations applied to the cervical spine can be effective in the treatment of TMJ disorders. For this systematic review, a search was conducted using the following databases: Google Scholar, Cochrane, Scopus, PubMed, Ovid MEDLINE, and Cumulative Index of Nursing and Allied Health (CINAHL). The search terms used in this review of the literature included temporomandibular syn-
drome, temporomandibular joint, cervical spine manipulation, cervical spine, TMJ, TMD, spinal manipulative therapy, and manipulation. Results were limited to English language only.

After deletion of duplicates, a total of 22 articles were exported into Refworks based on relevance to the topic after screening of the title. Studies were considered eligible for inclusion in this review if they included the use of a manipulation applied to the cervical spine to assess the effectiveness on the change in symptoms in those patients diagnosed with TMD. Studies were excluded from our review if they did not detail the use of manipulation applied to the cervical spine in patients with TMD symptoms. Studies were also excluded if treatment was performed to the TMJ joint instead of the cervical spine. Our definition of manipulation, for the purposes of this review, is a high velocity low amplitude thrust delivered to any cervical segment. Joint mobilizations were excluded if they were not high velocity, low amplitude thrusts. After reviewing the abstracts, 6 articles were excluded because they did not include the use of cervical manipulations. The remaining 16 articles were obtained in full text and reviewed by at least two members of the group. Of the 16 reviewed, one was excluded because it involved the use of cervical manipulations on asymptomatic patients, and 10 articles were excluded because the manual techniques used did not include cervical manipulations. The faculty research advisor provided us with 3 additional articles, which were excluded after reading the full text because they did not meet the inclusion criteria. One additional article was located for potential inclusion through review of the references section of the other reviewed articles. This left 6 articles remaining for inclusion in the review, which were read again in full text. A flowchart illustration is provided in Appendix 1. A summary of the remaining 6 articles can be found in Table 1.

After considering several research grading scales, the PEDro scale was selected because it is widely used and known as a valid measure of the methodological quality of clinical trials. It is also used to identify if trials are likely to be internally valid.24 The PEDro scale was used to determine the quality and risk of bias for the studies selected. The PEDro scale is an 11-item scale that is used to rate the quality of RCTs. Each item contributes one point to the total possible score, 11 points.24 Points were only awarded to our 6 remaining studies when a criterion was clearly reported. The 11 criteria are listed in Appendix 2. All members graded the selected articles and cross referenced the results to ensure agreement and conclude a final score. The faculty research advisor was informed of the grades and agreed with the group’s scoring rationale. Several of the articles were not randomized clinical trials and thus received low scores on the PEDro scale due to lack of blinding procedures and the lack of control groups. However these articles were included in the review due to the limited amount of results found in the literature pertaining to the research topic.

RESULTS

Tables in Appendix 2 were created to compare results across all 6 studies. Article scores from the PEDro scale ranged from zero to 8 out of 11 with a higher score correlating with higher levels of evidence. Two articles scored an 8,26 one article scored a 2,27 and 3 articles scored a zero.28-30 Sample sizes range from 1 to 122.25,30 Ages range from 20-47.25-30 Two studies are randomized controlled trials,25,26 3 studies are case reports,26-30 and one study is a prospective case series.27 In regard to outcome measures, two studies used the visual analog scale (VAS),27,30 4 studies used painfree active maximal mouth opening (PFAMMO),25-27,29 two studies used pressure pain threshold (PPT),25,26 one study used a 0-10 pain scale,29 and one study had no outcome measures.28 All studies used cervical spine manipulation as a form of treatment. The authors of the review concluded, based on the results of all 6 studies, that cervical spine manipulation may be an effective treatment option for improving symptoms related to TMJ dysfunction.

Painfree Active Maximal Mouth Opening

Four studies used PFAMMO as an outcome measure to assess the effects of cervical spine manipulation.25-27,29 Painfree active maximal mouth opening was measured in millimeters (mm) from the upper and lower central incisors. Normal PFAMMO range is considered to be between 40-50 mm for mouth opening and 8 mm for lateral excursion.31 Two of the studies reported mean gains in maximal mouth opening ranging from 1.5 to 3.5 mm.25,26 Two other studies reported the median gain in maximal mouth opening ranging from 1 to 15 mm.27,29 The two randomized controlled trials reported significant findings with PFAMMO when comparing the control to treatment group.25,26 The prospective case series and case study both showed improvements in PFAMMO but no statistical analyses were done.27,29 A summary of the data collected can be found in Table 2.

Visual Analog Scale/0-10 Pain Scale

Two studies included the VAS as an outcome measure to quantify changes in TMJ pain before and after treatment.27,30 One study used a 0-10 pain scale.27 The VAS is measured in millimeters on a 100 mm scale. A higher rating signifies more intense pain reported by the subject. A higher rating on the 0-10 pain scale also signifies a more intense pain. The prospective case series reported a 45 mm median decrease in pain when compared to baseline.27 Yulli30 reported a baseline of 7 out of 10 on the VAS and a posttreatment VAS score of 0 out of 10. Houle29 reported baseline TMJ pain rated 5/10 and 2/10 TMJ on the eighth visit. There were no reported pain measurements for this patient on subsequent visits. All of the studies reported improvements in pain for all subjects, but none of the studies reported any statistical analyses. A summary of the data collected can be found in Table 3.

Pain Pressure Threshold

Two studies used PPT as an outcome measure to determine the point when pressure on bones or muscles around the TMJ became painful. A higher PPT (kg/cm²) means that the bone or muscle being tested can withstand higher amounts of pressure without being painful to the subject. Both randomized controlled trials demonstrated an increase in PPTs after treatment.25,26 Mansilla et al25 reported a mean PPT baseline of .8 kg/cm² over the sphenoid bone and a post-treatment mean PPT of .9 kg/cm². Oliveira et al28 reported mean PPTs over the masseter and temporalis muscles. Mean baseline PPTs for both masseter and temporalis were 2.6 ± 0.7 kg/cm². Mean posttreatment PPTs for both masseter and temporalis were 2.8 ± 0.7 kg/cm².26 Both studies reported this data to be statistically significant.25,26 A summary of the data collected can be found in Table 4.

DISCUSSION

The purpose of this systematic review is to investigate the effectiveness of cervical manipulations on the treatment of symptoms related to TMD. The results of the 6 included studies demonstrated that cervical spine manipulation is an effective treatment option for improving symptoms related to TMD. However several limitations can be cited and are listed in the following sections.
Table 1. Results from Included Studies

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design</th>
<th>Subjects, Gender</th>
<th>Age</th>
<th>Intervention</th>
<th>Chronicity of TMD</th>
<th>Outcome Measures</th>
<th>Conclusions</th>
<th>PEDro Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcantara, 2002</td>
<td>Case Report</td>
<td>1; Female</td>
<td>41</td>
<td>Chiropractic approach of the Gonstead technique (high velocity, low amplitude trust) to reduce atlas subluxation</td>
<td>Not reported</td>
<td>None Reported</td>
<td>A HVLA trust to reduce atlas subluxation resulted in a reduction of TMJ symptoms and a decrease in headaches for a period of 9 months following treatment for the patient</td>
<td>0</td>
</tr>
<tr>
<td>DeVocht, 2003</td>
<td>Prospective Case Series</td>
<td>9; 7 females and 2 males</td>
<td>Median age of 27, range of 21 to 47 years</td>
<td>Use of the AAI while following the Activator Method, International protocol to the full spine and to the TMJ</td>
<td>Median of 8 years, ranging from 1 to 40 years</td>
<td>Visual Analog Scale (VAS) and Pain-Free Active Maximal Mouth Opening</td>
<td>TMD symptoms improved following treatment using the Activator Methods, International protocol for adjusting the TMJ</td>
<td>2</td>
</tr>
<tr>
<td>Houle, 2009</td>
<td>Case Study</td>
<td>1; Male</td>
<td>35</td>
<td>Chiropractic care include joint mobilizations of the TMJ, myofascial therapy, trigger point therapy, light spinal mobilizations of the upper cervical spine</td>
<td>Chronic – 8 years of constant pain</td>
<td>Visual Analog Scale (VAS) and Active Maximal Mouth Opening</td>
<td>After treatment aimed towards the TMJ and cervical spine, patient reported an absence of pain and muscle tenderness at the jaw and an increase in active mouth opening</td>
<td>0</td>
</tr>
<tr>
<td>Mansilla-Ferragut, 2009</td>
<td>Randomized Controlled Trial</td>
<td>37; Female</td>
<td>35, ± 8</td>
<td>Manipulative group: spinal manipulation directed at the AO joint. Control group: manual contact intervention</td>
<td>Symptoms present for at least 6 months</td>
<td>Pain-Free Active Maximal Mouth Opening and Pressure Pain Thresholds (PPTs)</td>
<td>Application of an AO joint manipulation results in an increase in active mouth opening and pressure pain thresholds</td>
<td>8</td>
</tr>
<tr>
<td>Oliveira-Campelo, 2010</td>
<td>Randomized Controlled Trial</td>
<td>122; 31 men and 91 women</td>
<td>20, ± 3</td>
<td>Manipulative group: AO joint trust Soft tissue group: inhibition technique over the suboccipital muscles Control group: No intervention</td>
<td>Not reported</td>
<td>Pain-Free Active Maximal Mouth Opening and Pressure Pain Thresholds (PPTs)</td>
<td>AO joint manipulation produces immediate increase in PPTs over latent TrPs in the masseter and temporalis muscles and increases minimum mouth opening</td>
<td>8</td>
</tr>
<tr>
<td>Yuill, 2009</td>
<td>Case Report</td>
<td>1; Male</td>
<td>31</td>
<td>Soft tissue therapy technique of ART, hyoid mobility treatment, TMJ mobilizations, and spinal manipulative therapy with rotary adjustment to C1-C2</td>
<td>Acute onset of symptoms</td>
<td>Visual Analog Scale (VAS)</td>
<td>The use of soft tissue therapy, hyoid mobility treatment, and spinal manipulative therapy was shown to decrease bilateral TMJ pain and bilateral temporal headaches</td>
<td>0</td>
</tr>
</tbody>
</table>

Abbreviations: AO, atlantooccipital joint; ART, active release technique; AAI, activator adjusting instrument II; HVLA, high velocity, low amplitude.
Definition of Cervical Manipulation

All 6 of our studies examined the effects of cervical manipulations on the treatment of symptoms associated with TMD.25-30 For the purposes of this literature review, we defined cervical manipulations as a high velocity, low amplitude thrust directed towards the cervical spine. We excluded articles discussing manipulations or mobilizations directed at the TMJ, unless they also included cervical manipulation as an additional intervention.27,29,30 Mansilla-Ferragut et al25 explains that manual treatment directed to the cervical segments of the spine has effects on decreasing sensitivity and pain over the muscles of mastication and over the TMJ. While we did define cervical manipulation to include high velocity, low amplitude thrust directed towards the cervical spine, we did not narrow the meaning of the manipulation to include only one specific technique. Furthermore, there was no standard technique for manipulation or standard protocol for frequency of treatment. In addition, patients in some studies received interventions besides cervical manipulation.25-27,29,30 In one case study, the clinician provided full spine adjustment and manipulations directly to the TMJ with an instrument.27 A case study by Houle and Descarrreaux29 was chosen for inclusion, even though the authors described the intervention as “light spinal mobilizations,” because the articles cited in reference to the intervention described manipulations, and we determined that there was a high likelihood that this was an issue in etymology, rather than technique, as the terms mobilization and manipulation are sometimes used interchangeably. These issues are further discussed in the limitations section below. Since there was not a standard manipulation or intervention protocol, it is more challenging to assert that cervical manipulations reduce symptoms of TMD. However, when reviewing the included articles, the general theme emerges that it appears likely that cervical manipulations have a positive effect on TMD symptoms. All 6 studies included in this review demonstrated improvements in symptoms in patients with TMD in some combination of outcome measures including PFAMMO,25-27,29 PPT,25,26 and a 0-10 pain scale.29

Main Findings/Strength of Evidence for Each Outcome

As previously mentioned, outcomes measures that were measured in the 6 articles we reviewed included PFAMMO,25-27,29 PPT,25,26 and a 0-10 pain scale.29 In regards to PFAMMO, 4 studies used this as an outcome measure and all 4 demonstrated improvements, ranging from 1.0 mm mean difference to 9.0 mm median difference, supporting the theory that cervical manipulations may improve symptoms of TMD.25-27,29 In terms of changes in pain scale, in one study the patient reported a decrease in pain from 5/10 at evaluation to 2/10 during the 8th visit.29 Significant improvements in TMD symptoms were also reported in the VAS in two other studies.27,30 Finally, in regards to PPT data, two studies reported small improvements in reported PPT after interventions.25,26

One may argue that some of the differences in outcome measures, such as changes in PPT may be statistically significant but not clinically relevant. For example, the RCT by Mansilla-Ferragut et al25 found a mean difference of 0.1 kg/cm² in PPT after intervention, which was determined to be statistically significant but has little clinical relevance to a practitioner. On the other hand, one may also argue that some of the increases in PFAMNO after intervention are not statistically significant. When looking at Table 2, the

Table 2. Synthesis of Results for Maximal Mouth Opening Data

<table>
<thead>
<tr>
<th>Author and Year</th>
<th>Mean Pre-Tx MMO (Baseline)</th>
<th>Mean Post-Tx MMO</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mansilla, 2008</td>
<td>35.4 mm (95% CI, 33.3-37.4)</td>
<td>38.8 mm (95% CI, 36.6-41.1)</td>
<td>3.5 mm (95% CI, 2.4-4.6)</td>
</tr>
<tr>
<td>Oliveira, 2010</td>
<td>46.4 mm + 6.8 (95% CI, 44.4, 48.4)</td>
<td>47.9 mm ± 6.6 (95% CI, 45.9, 49.9)</td>
<td>1.5 mm + 1.5 (95% CI, 1.0, 1.9)</td>
</tr>
<tr>
<td>Devocht, 2003</td>
<td>MEDIAN 38.0 mm</td>
<td>MEDIAN 44.5 mm</td>
<td>MEDIAN 9.0 mm</td>
</tr>
<tr>
<td>Houle, 2009</td>
<td>11 mm</td>
<td>12 mm</td>
<td>1.0 mm</td>
</tr>
</tbody>
</table>

Abbreviation: MMO, maximal mouth opening

Table 3. Synthesis of Results for Visual Analog Scale and Pain Scale Data

<table>
<thead>
<tr>
<th>Author and Year</th>
<th>Scale</th>
<th>Pre-Tx (Baseline)</th>
<th>Post-Tx</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devocht, 2003</td>
<td>VAS (reported in mm)</td>
<td>MEDIAN 65 mm (17-85)</td>
<td>MEDIAN 15 mm (1-53)</td>
<td>50 mm (16-32)</td>
</tr>
<tr>
<td>Yuill, 2009</td>
<td>VAS (reported 0/10)</td>
<td>7/10</td>
<td>0/10</td>
<td>7/10</td>
</tr>
<tr>
<td>Houle, 2009</td>
<td>Pain Scale (0/10)</td>
<td>5/10</td>
<td>8th visit 2/10, not measured in further tx sessions</td>
<td>3/10</td>
</tr>
</tbody>
</table>

Abbreviation: VAS, Visual Analog Scale

Table 4. Synthesis of Results for Pain Pressure Threshold Data

<table>
<thead>
<tr>
<th>Author and Year</th>
<th>Mean Pre-Tx PPT (Baseline)</th>
<th>Mean Post-Tx PPT</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mansilla, 2008</td>
<td>Sphenoid Bone: 0.8 (95% CI, 0.6-0.9)</td>
<td>Sphenoid Bone: 0.9 (95% CI, 0.7-1.0)</td>
<td>Sphenoid Bone: 0.1 (95% CI, 0.0-0.2)</td>
</tr>
<tr>
<td>Oliveira, 2010</td>
<td>Masseter: 2.6 ± 0.7 (95% CI, 2.4, 2.8) Temporalis: 2.6 ± 0.7 (95% CI, 2.3, 2.8)</td>
<td>Masseter: 2.8 ± 0.7 (95% CI, 2.6, 3.1) Temporalis: 2.8 ± 0.7 (95% CI, 2.5, 3.1)</td>
<td>Masseter: 0.2 ± 0.4 (95% CI, 0.1, 0.4) Temporalis: 0.2 ± 0.3 (95% CI, 0.1, 0.4)</td>
</tr>
</tbody>
</table>

Abbreviation: PPT, pain pressure threshold
average baseline measurement in both of the RCTs\textsuperscript{25,26} and one case study by Houle and Descarreaux\textsuperscript{29} all met normal range of motion values, therefore, finding large differences in PFAMMO would be infeasible and needs to be considered when evaluating the results. However, small increases in PFAMMO may be clinically significant for patients as it may allow them to resume normal activities that they may otherwise have been unable to do. For example, in the case study by Houle and Descarreaux,\textsuperscript{29} the subject experienced an increase in PFAMMO of only 1 mm from pre- to posttreatment, but subjectively reported that he could insert a tobacco pipe between his teeth, a task which he had been unable to do for years, thereby improving his perceived quality of life (QOL).\textsuperscript{29} It should be noted that in this case study, the participant also received other interventions besides cervical manipulation.\textsuperscript{29}

The quantitative improvements in symptoms in patients with TMD previously discussed, in addition to other reported subjective improvements in symptoms in some studies, support the use of cervical manipulation, in coordination with other interventions, which leads to positive effects and improvements in TMD care.

Risks of Cervical Manipulation

One possible reason for the limited quantity of studies on the topic of cervical manipulation is that there is some controversy as to whether possible risks associated with the technique are too great. Some hypothesized adverse effects include ischemic stroke and carotid artery dissection.\textsuperscript{32,33} However, a recent literature review by Chung et al\textsuperscript{30} did not identify valid evidence that can be used to support or refute the presence of an association between cervical spine manipulation and internal carotid artery dissection. Nevertheless, many physical therapists may be hesitant to use cervical manipulations, thus highlighting the need for additional, high quality research on the topic to provide context to the issue.

Funding Bias

None of the 6 articles reviewed identified any outside source of compensation or funding.\textsuperscript{25,30} One study used an instrument, the Activator Adjusting Instrument II (AAI) designed by Activator Methods International of Phoenix, AZ, to deliver manipulations and mobilizations but did not report receiving any funding from the maker of the instrument.\textsuperscript{25}

Limitations and Recommendations for Future Research

The literature is limited regarding the effectiveness of cervical manipulations towards the treatment of TMD, therefore, only 6 articles met the inclusion criteria for this review. Two of the articles (Mansilla-Ferragut, 2009\textsuperscript{25} and Oliveira-Campelo, 2010\textsuperscript{26}) supported the effectiveness of this intervention. This current review has several limitations that must be addressed in order to make recommendations for clinical use. First, it must be recognized that the lower quality study designs of the reviewed articles were a limiting factor. Only two articles\textsuperscript{25,26} were randomized clinical trials, while the remaining 4 articles were case series studies. The two RCTs were the highest rated articles and both received a score of 8 out of 11 on the PEDro scale.\textsuperscript{25,26} The case series studies were included in this review and were weak in study design due to the lack of control groups to compare the effects of a manual treatment directed at the cervical spine, the lack of blinding of the therapists and subjects, and the lack of between group statistical comparisons for the outcome measures. These articles were not excluded due to limited research in this area of topic and the value of the results. The overall trend of all of the remaining articles supported cervical manipulation for treatment of TMJ disorders.

Secondly, 3 of the 6 articles were single case studies and had small sample sizes.\textsuperscript{26-30} In addition, one article only used female subjects.\textsuperscript{25} Therefore, we do not know if the effects of this manual treatment can be generalized to the male population of similar age. Also, some studies lacked a long-term follow-up appointment to examine the effects of cervical manipulation on outcome measures such as maximal mouth opening and the VAS. Future research should include a long-term follow-up and a greater sample size including both male and female subjects. Results were limited to English only, however, one potentially relevant study was found in another language but was not included in this due to the unavailability in English. In addition, unpublished articles were located but were not included in this review because of lack of availability. Therefore, the research presented in this review of the literature may not be representative of all the existing body of evidence on this topic.

The use of other treatment interventions in these 6 studies is another limitation within this review of the literature. In a case series report by Yuill et al,\textsuperscript{30} the subject received active release soft tissue therapy, hyoid mobility treatment, and spinal manipulative therapy with rotary adjustment to C1-2. In addition, the case series by Houle and Descarreaux\textsuperscript{29} completed chiropractic care of myofascial therapy, trigger point therapy, and spinal mobilizations of the upper cervical spine. The randomized controlled trial by Oliveira-Campelo et al,\textsuperscript{26} randomly assigned subjects to 3 groups—a manipulative group, a soft tissue group, and a control group—who received no intervention. Consequently, it is difficult to establish conclusions about the effectiveness of cervical manipulations due to multiple interventions performed on the patients, in addition to cervical spine manipulations. Within our final 6 articles, 5 had a common variable of using either using the VAS, PFAMMO, and PPT as the outcome measure. However, one article by Alcantara et al\textsuperscript{30} reported no outcome measures, beyond the patient’s subjective report of improvement in symptoms, to examine the efficiency of the manual treatment. Further studies should consider an appropriate set of outcomes measures to help clinicians determine the value of their plan of care.

The variability between the studies regarding cervical manipulation is another limitation. There is not a standard technique of cervical manipulation directed towards the cervical spine for the treatment of TMD. The protocol varied between studies, which makes it difficult to determine conclusions and make clinical recommendations for further research and clinical practice. The DeVocht et al\textsuperscript{27} prospective case series used full spinal manipulation, including cervical manipulation, but did not specify the exact technique, frequency, or location of manipulation. Recommendations for future research should focus on incorporating stronger research designs to determine if cervical manipulations can make an impact on TMD symptoms.

Another possible limitation involves variability in the onset and duration of symptoms among the sample patient populations in the reviewed articles. In some studies, the onset of TMD symptoms were acute,\textsuperscript{30} while in other cases the duration of symptoms was much longer, with onset of symptoms occurring years in the past.\textsuperscript{27,29,30} In one instance, the subject of the case report by Houle and Descarreaux\textsuperscript{29} reported experiencing pain of insidious onset and of a constant nature for the last 8 years. In the randomized controlled trial by Mansilla-Ferragut and colleagues,\textsuperscript{25} inclusion criteria were that TMD symptoms were present for a minimum of 6 months.\textsuperscript{30} This raises the question as to whether cervical manipulation may have varying levels of effec-
tiveness on TMD symptoms depending on whether the symptoms are acute or chronic. A 2010 Cochrane review by Gross et al found that the use of cervical manipulations on the relief of subacute/chronic neck pain, revealed “moderate quality of evidence suggesting manipulation and mobilization produced similar effects on pain, function and patient satisfaction. There is low quality evidence showing manipulation alone versus a control may provide intermediate and short-term relief following 1 to 4 sessions.” Gross et al also found that “optimal technique and dose need to be determined.” Further research also found that “optimal technique and dose need to be determined.”

Further research on the effectiveness of cervical manipulations on TMD symptoms should address the issue of symptom variation in terms of being of an acute versus chronic nature in order to provide guidance for patient plan of care and treatment. Another factor that needs to be considered when determining treatment is the origin of TMD symptoms. A recent article by Harrison et al detailed the different disorders of TMD symptoms, potential patient presentation, and appropriate means of intervention for each disorder. Cervical manipulation may or may not be an appropriate intervention for all of the different TMDs and is another factor that needs to be considered when deciding treatment interventions.

CONCLUSION

The literature in this review demonstrates that cervical manipulations are effective in improving symptoms in patients with TMD symptoms. While the literature reviewed was somewhat limited in quantity and quality, two articles exhibited strong data to support the use of manipulations. The overall theme that emerged was that patients in all studies appeared to have decreased symptoms related to TMD as a result of interventions including, but not limited to, cervical spinal manipulation. This being the case, the authors of this review believe that cervical manipulation along with conventional treatment appears to be beneficial in treating TMD. However if a clinician is considering treating TMD solely with manipulation, then further study is needed to lend support to this treatment alone.

Clinical Recommendation

The articles and data reviewed in this paper demonstrate that, in combination with other treatment interventions, cervical manipulation is useful in the treatment of TMD. The use of cervical manipulation alone for treatment of TMD requires further research.

REFERENCES

21. Martinez-Segura R, Fernandez-de-las-Penas C, Ruiz-Saez M, Lopez-Jimenez...


Appendix 2. PEDro Grading Scale

1. Eligibility criteria were specified.
2. Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received.
3. Allocation was concealed.
4. The groups were similar at baseline regarding the most important prognostic indicators.
5. There was blinding of all subjects.
6. There was blinding of all therapists who administered the therapy.
7. There was blinding of all assessors who measured at least one key outcome.
8. Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups.
9. All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed by “intention to treat.”
10. The results of between-group statistical comparisons are reported for at least one key outcome.
11. The study provides both point measures and measures of variability for at least one key outcome.