Effectiveness of Manual Physical Therapy, Therapeutic Exercise, and Patient Education on Bilateral Disc Displacement Without Reduction of the Temporomandibular Joint: A Single-Case Design

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Study Design: Single-case A1-B-A2 design.
Objective: To determine if manual physical therapy, therapeutic exercise, and patient education would be an effective management strategy for a patient with a disc displacement without reduction of both temporomandibular joints.
Background: A number of conservative management strategies have been proposed for the treatment of temporomandibular disorders. However, little evidence exists to indicate the effectiveness of physical therapy interventions in patients with bilateral disc displacement without reduction.
Methods and Measures: Phase A1 of the study consisted of a baseline condition in which no intervention was initiated. Phase B included manual physical therapy, therapeutic exercise, and patient education focusing on the temporomandibular joint and cervical spine. Phase A2 consisted of withdrawal of the intervention. The Steigerwald/Maher disability questionnaire was used to collect data relative to function. A visual analog scale was used to collect pain data and maximal mouth opening measurements were obtained as an indicator of range of motion. Visual analysis and the 2 standard deviation band method of statistical analysis were used to compare data.
Results: Following the implementation of the intervention phase, the patient demonstrated significant reductions in pain and improvements in maximal mouth opening and function as measured by the Steigerwald/Maher disability questionnaire. These observed improvements were maintained at the time of a 3-month follow-up.
Conclusions: The results of our study suggest that manual physical therapy, therapeutic exercise, and patient education may have been an effective management strategy for a patient with bilateral disc displacement without reduction of the temporomandibular joints. Further outcome studies in the form of randomized controlled trials are needed to determine the clinical utility of this treatment approach in a larger population. *J Orthop Sport Phys Ther 2004;34:535-548.*

Key Words: *jaw, maximal mouth opening, orofacial pain, temporomandibular disorder*

The International Association for the Study of Pain[22] defines temporomandibular disorder (TMD) as "aching in the muscles of mastication, sometimes with occasional brief severe pain on chewing, often associated with restricted jaw movement and clicking or popping sounds." Temporomandibular disorder is often characterized by orofacial pain, limited or deviated range-of-motion, joint clicking, and headaches.[6,33] The etiology of TMD has been attributed to a number of factors, including bruxism,[3] trauma, and occupational stressors.[12] Although it is speculated that approximately 70% of the general population will exhibit signs of temporomandibular disorder, only 5% will seek medical or dental treatment.[6,33]

Temporomandibular disorder is a collective term that encompasses masticatory muscle pain as well as disorders of the temporomandibular joint (TMJ), including capsulitis, degenerative joint disease, and internal derangement.[33] One of the most commonly recognized temporomandibular disor-

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ders is internal derangement.[3] Dimitroulis[6] has defined internal derangement as a disorder in which the articular disc is in an abnormal position, resulting in mechanical interference and restriction of the normal range of mandibular function. It has been purported that internal derangement occurs in a sequential fashion from disc displacement with reduction, to disc displacement with reduction and intermittent locking, and finally disc displacement without reduction.[27] Anatomically, a disc displacement without reduction acts as a mechanical obstruction to anterior translation of the condyle, which results in limited opening of the mouth.[24,27]

Occlusal splints and physical therapy are the primary nonsurgical treatment options for patients with anterior disc displacement without reduction.[5] Although occlusal splints are frequently utilized, the evidence to support their effectiveness is scant.[19] Physical therapy is commonly utilized in the treatment of patients with TMD, toward the general goals of reducing adverse loading and pain, and facilitating a return to full, pain-free function.[5,26] Several studies have investigated the effectiveness of physical therapy in patients with anterior disc displacement without reduction.[12,18,21,25,34] However, numerous methodological limitations, including heterogeneity of subjects and loose inclusion criteria of the studies, have limited the ability to utilize the results in determining the effectiveness of physical therapy interventions to a specific subgroup of patients with TMD (ie, disc displacement without reduction).

The purpose of our study was to investigate the effectiveness of manual therapy, therapeutic exercise, and patient education in a patient presenting with bilateral disc displacement without reduction, utilizing a single-case design.

METHODS

Prior to initiating the interview process, the patient was informed that she might be a potential candidate for a single-case design study and asked if she would be interested in volunteering to participate. After agreeing, the patient reviewed and signed an informed consent form which had previously been approved by the Institutional Review Board at Franklin Pierce College, Concord, NH.

History

The patient was a 24-year-old, white, ectomorphic female with a 19-month complaint of insidious onset TMJ pain. Her symptoms initially originated at the right TMJ, but within a few months, also affected the left TMJ. Pain was exacerbated by mouth opening and at times also when closing the mouth. She reported that initially her jaw was ''clicking,'' but as symptoms progressed, this subsided and eventually led to episodes of being unable to open her mouth because it would become ''locked.''

At the time of the evaluation she reported a constant pain in her right TMJ that increased when attempting to fully depress the mandible. However, her pain quickly subsided as she returned the mandible to its resting position. She also reported a history of occipital headaches which started soon after she began experiencing problems with her jaw.

The patient was employed as a childcare provider and continued to work full time despite her symptoms. She reported difficulty talking, which was demonstrated by conscious guarding of the mandible during the interview, yawning, and eating certain foods (bagels, steak, hamburgers). Previous management strategies included a trial of physical therapy (moist heat, ultrasound, massage) approximately 6 months prior to her evaluation and a period of wearing an occlusal splint (approximately 4 months prior to the evaluation). Although she reported that physical therapy had mildly reduced her symptoms, she never made a full recovery and reported a rapid return of her pain following discharge from therapy. She reported that the occlusal splint did not appear to serve any benefit and admitted to discontinuing its use after a few months. The investigators of this study did not evaluate the features of the occlusal splint. At the time of the evaluation, she was not taking any medications, with the exception of an occasional ibuprofen (200 mg) when symptoms were exacerbated. She reported the ibuprofen only mildly decreased her pain.

The patient reported a history of bruxism. She denied any history of systemic disease and a general review of the systems (musculoskeletal, neuromuscular, integumentary, and cardiovascular/pulmonary) was negative. Radiographs taken 10 months previous were normal. The patient had undergone magnetic resonance imaging (MRI) within a few months of her physical therapy evaluation, which revealed bilateral anterior disc displacement in both open and closed mouth projections (Figure 1).

Tests and Measures

Active mandibular depression was measured at 28 mm, which increased her symptoms. At the end range of the available mandibular depression there was a slight deflection of the jaw to the right. The patient was able to fully close the jaw. Lateral excursion was limited to 3 mm to the left and 4 mm to the right. Mandibular protrusion was limited 2 mm and exacerbated the patient's symptoms. Auscultation performed with a stethoscope over the TMJs during active motions did not reveal any joint clicking; however, crepitus was noted bilaterally. Visual estimation of active cervical range of motion revealed that side-bending was limited by approximately 25% and

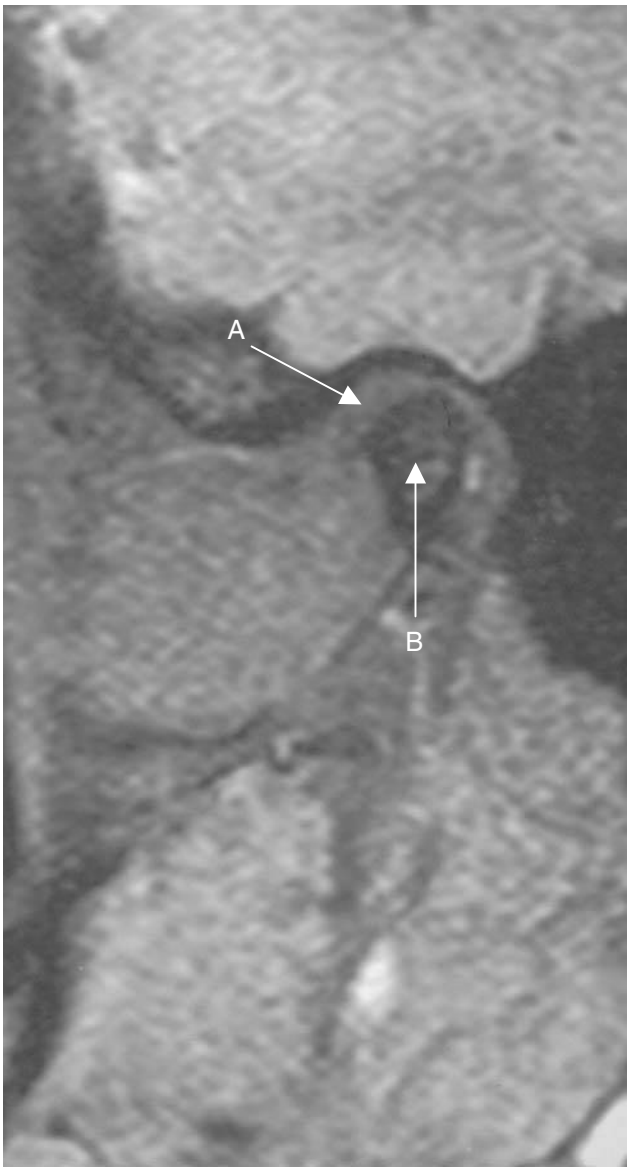

FIGURE 1. Sagittal MRI view of the left temporomandibular joint in the closed mouth position demonstrating anteriorly displaced disc (A, disc; B, condylar process).

rotation approximately 10%, bilaterally. Passive flexibility testing of the cervical muscles[9] revealed limited length of the upper trapezius bilaterally and posterior occipital muscles.

Joint play assessment of the TMJ[14] revealed limited caudal distraction and anterior glide of the mandible bilaterally. Passive physiological intervertebral mobility[20] testing indicated hypomobility of the C7-T1 and T1-T2 segments. Hypomobility was also noted at C2-C3, mildly increasing the patient's occipital headache symptoms. Unilateral and bilateral TMJ loading increased the patient's TMJ symptoms.[17]

Extraoral palpation[17] revealed tenderness of the masseter bilaterally. Palpation of the TMJ bilaterally revealed significant limitations in translation of the condyles in an anterior direction during mandibular depression. Cranial nerve function was found to be normal, based on a screening examination. Strength testing was not performed at the time of the evaluation given the patient's level of tissue irritability.

Diagnosis and Prognosis

At this stage, the initial working treatment hypothesis was temporomandibular hypomobility as a result of bilateral disc displacement without reduction. The diagnostic criteria utilized to establish our hypothesis included (1) reduced incisal edge clearance (mouth opening) of less than 35 mm, (2) MRI confirmation of anteriorly located discs in an open mouth position, and (3) prior history of clicking that progressively went away and was followed by episodes of locking.[27] The patient was classified as exhibiting preferred practice pattern musculoskeletal 4D (impaired joint mobility, motor function, muscle performance, and range of motion associated with connective tissue dysfunction), according to the *Guide to Physical Therapist Practice*, second edition.[13] Eighty percent of patients falling into this classification are expected to achieve anticipated goals within 3 to 36 visits.[13]

Outcome Measures

The measurement of physical impairment data was performed at each treatment session and included range of maximal mouth opening (MMO) and pain using the visual analog scale (VAS). Maximal mouth opening was measured with the patient in a seated position utilizing a 10-cm plastic ruler marked in millimeters. The patient was asked to "open her mouth as wide as possible without causing an increase in her pain or discomfort."[36] At the end position of MMO, the distance between the upper and lower central incisors was measured in millimeters. Intratester reliability has shown to be acceptable when measuring mandibular opening in millimeters (ICC = 0.90-0.98).[7] Only MMO was utilized as a range of motion outcome measurement in this study, as it has been demonstrated that this is the only reliable measurement of TMJ range of motion able to discriminate between patients with and without TMD.[36]

A VAS (a 10-cm line with 0 representing "no pain" and 10 representing "the worst pain imaginable") was utilized to quantify the patient's average pain level over the past 24 hours. The patient placed a mark along the line, which corresponded with the intensity of her symptoms. The VAS has been demonstrated to be a valid and reliable tool for measuring the intensity of pain.[30] Measurements for MMO and pain were recorded prior to each treatment session.

The Steigerwald/Maher TMD disability questionnaire[35] (Appendix A) was also utilized for data collection. This scale is divided into 3 components: the temporomandibular disability index, the temporomandibular symptom intensity scale, and

symptom frequency scale. A higher score is indicative of greater disability. The validity and reliability of this questionnaire has not yet been tested. The questionnaires were completed at the initial evaluation (prior to the start of the experimental procedures), at 11 days after completion of the experimental procedures consisting of 8 sessions, and at a 3-month follow-up.

Experimental Procedures

The patient came to the clinic 15 times over a 41-day period during the course of the study for either data collection or actual treatment, according to the respective phase of the study. During the 41-day study period she went through 3 phases of data collection within the A1-B-A2 single-subject design. The first baseline phase (A1) entailed 4 visits, which included the day of the initial evaluation and 3 additional visits for the purpose of data collection only. The treatment phase (B), initiated at the fourth visit, consisted of 8 physical therapy treatment sessions in addition to data collection. The second baseline phase (A2), consisted of 4 sessions of data collection only (no treatment). In an attempt to control external variables, the patient was consistently scheduled at 12:30 PM for each data collection and treatment session.

First Baseline (A1) Phase: 4 Visits Without Treatment

The first 4 baseline measurements were collected over an 8-day period. The first visit consisted of the initial evaluation, which was 1 hour in duration. No management strategies were implemented during this phase. The following 2 visits consisted of data collection only (approximately 10 to 15 minutes each). The final baseline measurement was collected on the fourth visit, just prior to the initiation of the intervention phase (B).

Treatment Phase (B): 8 Treatment Sessions

The treatment phase consisted of 8 visits over a 23-day period. Each treatment session was 30 minutes in duration. During this phase, treatment not only focused on the TMJ but also on the cervical spine. Treatment began with patient education in regard to a soft diet, teeth grinding, proper resting tongue position, and oral habits (for example, elimination of activities such as chewing gum).[14,17] Postural re-education emphasizing chin and scapula retraction[14] was also a main constituent of the education component of the treatment plan.

Manual physical therapy techniques focused on restoring arthrokinematics of the TMJ, cervical spine, and cervicothoracic junction.[14] Passive accessory intervertebral movement techniques[20] were directed at hypomobile vertebral segments. Ventral and caudal glides of the mandible were performed bilaterally (Figure 2), beginning with Grades I and II, focusing on pain management and progressing to Grades III and IV, to promote condylar mobility. Contract-relax techniques were utilized to promote tissue extensibility of the cervical musculature as well as the temporalis, masseter, and medial pterygoids.[9] Self-stretches of the aforementioned muscles were incorporated into the patient's home exercise program.[8]

FIGURE 2. Anterior glide temporomandibular joint mobilization technique.

Therapeutic exercise techniques focused on addressing flexibility of cervical musculature and muscles of mastication. As treatment progressed, therapeutic exercises were utilized for the purpose of neuromuscular re-education of the deep neck flexors,[15] scapulothoracic muscles,[10] and muscles of mastication.[15] Isometric mandibular exercises[14,32] were also incorporated for the purpose of maximizing TMJ stability. A brief description of the procedures that occurred in each phase of the research design can be found in Table 1. Specific manual therapy techniques, therapeutic exercises, and patient education utilized at each treatment session can be found in Appendix B.

Withdrawal Phase (A2) Phase: 4 Visits Without Treatment

The final 4 visits (within an 11-day period) occurred after the patient's formal discharge from therapy and served the purpose of data collection only. The final measurements were collected 11 days after withdrawal of the intervention.

In addition, longer-term follow-up data (pain, MMO, function) were collected at 3 months after discharge from therapy.

TABLE 1. General description of each phase of the A1-B-A2 design. Specific details regarding the exact interventions performed during each session can be found in Appendix B.

Phase	Interventions
A1 phase	• Evaluation and data collection only, no intervention
B phase	• Bilateral temporomandibular joint (TMJ) anterior glides and distraction[14] • Contract-relax stretching to bilateral upper trapezius, levator, and posterior occipitals[9] • Passive accessory intervertebral movements (PAIVM) to hypomobile cervical segments (C2-C3, C7-T1, T1-T2)[20] • Postural re-education seated emphasizing chin and scapula retraction • Prone scapulothoracic exercises • Neuromuscular re-education of deep neck flexors[15] • Patient education: parafunctional habits, soft diet, relaxation techniques, activity modification, tongue resting position
A2 phase	• Data collection only

Data Analysis

Both visual analysis and statistical analysis were utilized to determine the effects of manual physical therapy, therapeutic exercise, and patient education in the management of TMD in this patient. Visual analysis consists of the evaluation of variability, level, slope, and trend of data. Variability is the magnitude of fluctuation of data points.[29] Level refers to the change in magnitude between data phases and is used to determine if the intervention is effective.[28] Trend refers to the direction in which a response pattern is progressing. If it is systematically increasing, it is referred to as an accelerating trend and, if it is decreasing, it is referred to a decelerating trend.[29] Slope is described as the steepness of the data points over time.[29] Statistical analysis was performed utilizing the 2 standard deviation band method. A significant change in status is inferred if at least 2 contiguous data points fall outside the 2 standard deviation range.[28]

RESULTS

Pain

Visual analysis of the pain data collected with the VAS can be seen in Figure 3. Visual analysis of the data demonstrated a reduction in the variability of data points from the A1 to B phase, suggesting the data points in the B phase were more stable. A noticeable change in level occurred between the last data point in the A1 phase to the first point in the B phase. Although at a smaller magnitude, a change in level was again witnessed between the last data point in the B phase and the first data point in the A2 phase. The mean level of the data points changed throughout the phases from a mean of 58.8 mm in the A1 phase to 39.6 mm in the B phase to 10.0 mm in the A2 phase.

A change in trend from accelerating in the A1 phase to decelerating in the B phase occurred, suggesting a reduction in measurements obtained with the VAS during the B phase. The descending trend continues throughout the A2 phase. In addition, the slope of the descending trend is greater in the B phase than the A2 phase, indicating a greater rate of change during the treatment phase. At the time of the 3-month follow-up the patient's VAS score was 5 mm.

Statistical analysis utilizing the 2 standard deviation band method revealed 5 contiguous data points in the B phase that fell outside the −2 standard deviation line (46.0 mm), signifying a statistically significant reduction in pain following implementation of the intervention (Figure 3).

Maximal Mouth Opening

Data collected for MMO can be seen in Figure 4. Visual analysis of the data revealed that the variability of data points was greater in the treatment phase (B), compared to both the A1 and A2 phase. A change in level is noted between the last data point in the A1 phase and the B phase, and again between the last point in the B phase and the first point in the A2 phase. In addition, the mean level of the B phase (34.0 mm) was greater than that of the A1 phase (28.5 mm), suggesting a change in MMO once the intervention was implemented. An accelerating trend was consistent throughout all phases. Visual analysis does not reveal a change in slope for the trend lines during any of the phases for MMO. At the time of the patient's 3-month follow-up her MMO was recorded at 46 mm.

Statistical analysis utilizing the 2 standard deviation band method revealed that 4 contiguous data points in the B phase fell outside the +2 standard deviation line (31.1 mm), signifying a statistically significant increase in MMO following implementation of the intervention phase (Figure 4).

Function

Data collected with all 3 scales of the Steigerwald/Maher TMD disability questionnaire[35] revealed that scores prior to implementation of the intervention (day 0 and day 8) remained consistent. However, marked improvements in all 3 scales were recorded at the completion of the intervention (day 30), completion of the A2 phase (day 41), and at a 3-month follow-up (Table 2). In addition, at the time of the 3-month follow-up, the patient reported that she was able to chew steak and bagels with only occasional discomfort and often without any symptoms.

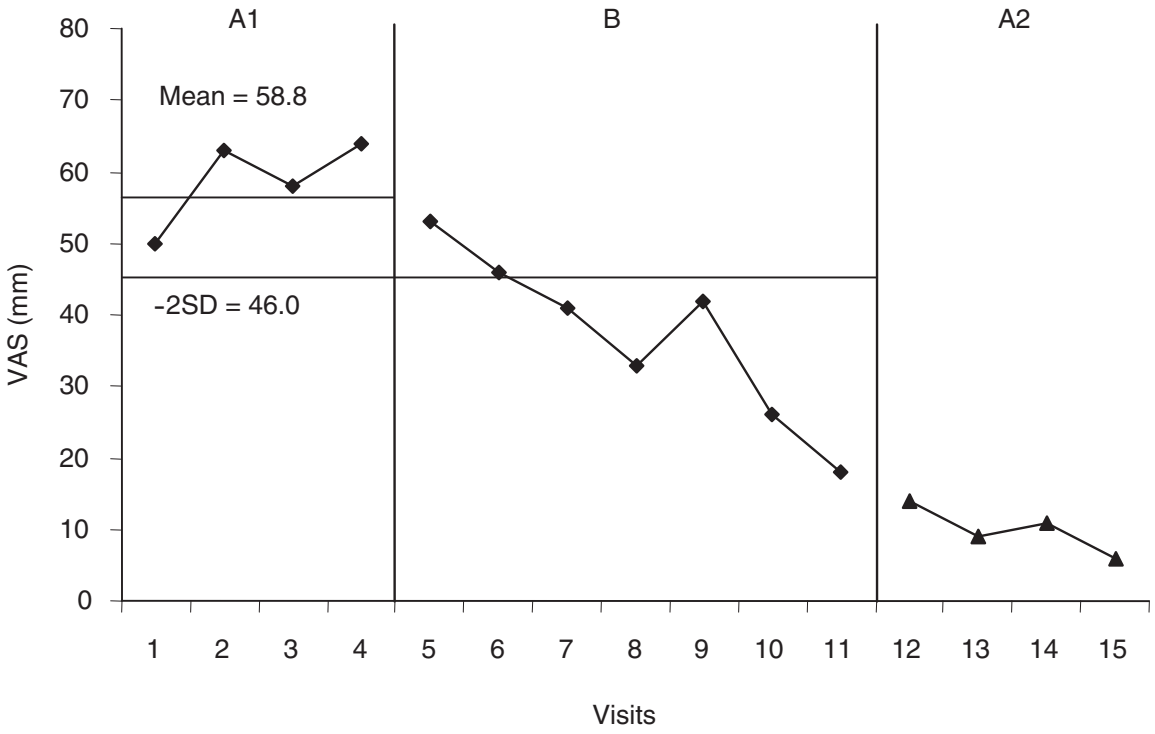

FIGURE 3. Pain data recorded with the 10-cm visual analog scale and statistical analysis using the 2 standard deviation band method. The anchors for the VAS were 0 representing "no pain" and 10 representing "the worst pain imaginable."

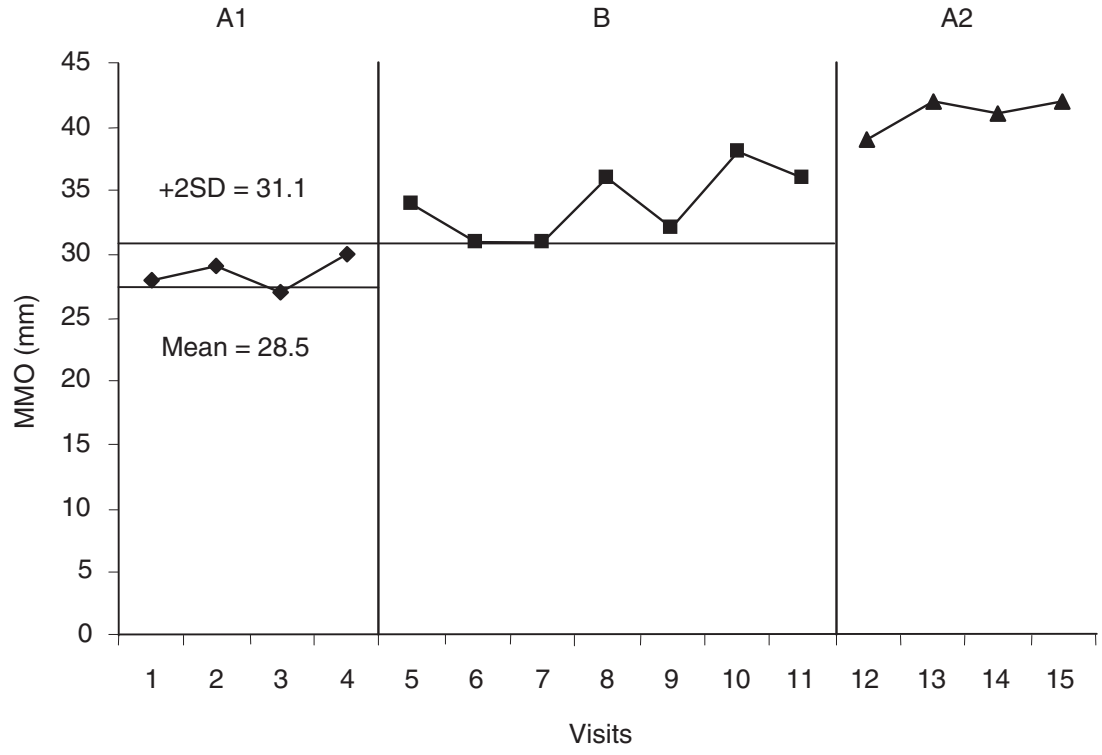

FIGURE 4. Data for measurements of maximal mouth opening (MMO) and statistical analysis using the 2 standard deviation band method.

DISCUSSION

The results of this single-case design suggest that manual therapy, therapeutic exercise, and patient education may be an effective management strategy to reduce pain and dysfunction in a patient with bilateral disc displacement without reduction. In addition, the patient demonstrated a return of MMO to within normal limits (42 mm) for a patient of her stature and age.[23] Although, the patient's pain did

TABLE 2. Data collected with the Steigerwald/Maher temporomandibular (TMD) disability questionnaire. Higher scores are indicative of greater disability. Day represents the number of days following initial evaluation. All values in percent.

	TMD Symptom Intensity Scale			
Day (phase)	Usual	Max	TMD Symptoms Frequency Scale	TMD Disability Index
0 (A1)	44.0	64.0	64.0	62.5
8 (A1)	43.0	44.0	44.0	65.0
30 (B)	8.6	16.0	8.6	35.0
41 (A2)	5.8	7.0	5.8	15.0
3 mo (follow-up)	2.9	7.0	5.8	12.5

not completely resolve during the intervention phase, she demonstrated a significant reduction in both pain and improvement in MMO, as determined by the 2 standard deviation band method of statistical analysis. Perhaps of greater relevance is the clinically meaningful change (>45-mm reduction) in pain scores as measured by the VAS. A 10- to 28-mm change in pain score, as measured by the 10-cm VAS, is considered clinically significant.[2,16]

Additionally, visual analysis revealed a positive change in level for both the VAS and MMO, indicating improvements in impairments immediately upon beginning the intervention phase. The change from an accelerating to decelerating trend recorded by the VAS during the intervention phase is again suggestive of the benefits of manual therapy, therapeutic exercise, and education in this patient. Despite the lack of documented reliability and validity of the functional questionnaire, we speculate that the association between the dramatic improvement in pain and MMO and all 3 scales of the Steigerwald/Maher TMD disability questionnaire is supportive of the effectiveness of the intervention strategies in this patient. In addition, it should be recognized that the patient had maintained the improvements in pain reduction (VAS, 5 mm), MMO (46 mm), and function at the time of the 3-month follow-up.

It is possible that fibrous adhesions between the displaced disc and articular eminence could have inhibited proper disc mechanics and blocked anterior translation of the condyles in this patient.[31] Saghafi[31] reports that clinically fibrous adhesions between a displaced disc and the articular eminence results in limited MMO to about 25 to 30 mm, which was consistent with the baseline findings in our patient (mean, 28.5 mm). It is postulated that joint mobilization may have resulted in released synovial and articular disc adhesions,[24] leading to increased MMO exhibited with our patient. We did not obtain post-treatment MRIs, therefore the position of the disc in relationship to the condyle is unknown; however, clinical success can still be achieved without knowing if the disc remains displaced or not.[24]

Cervical spine involvement often coexists with TMD and should be examined and treated in patients presenting with TMD. A few authors have suggested a correlation exists between a forward head posture and TMD.[17,26] Kraus[17] purports that the correction of cervical dysfunction (muscle or joint) can modulate type IV receptor activity of the TMJ through neurophysiological pathways. It has been demonstrated that postural awareness and self-management is superior to self-management alone in reducing symptoms associated with TMD.[37] However, the aforementioned study excluded patients with pain directly originating from the TMJ (ie, internal derangement).

There are several limitations that exist with our single-subject design. The lack of reliability and validity testing for the Steigerwald/Maher TMD disability questionnaire requires that the results be interpreted with caution. It should be considered that our study only investigated short-term (3 months) outcomes. It has been demonstrated that nearly one third of patients with disc displacements without reduction achieve a pain-free status in 12 months without treatment.[18] Perhaps the self-limiting nature may have contributed to the improvement experienced with our patient. In addition, anatomical evidence of disc displacement is not always associated with symptoms.[1] Considering this, it is possible that our patient's source of symptoms could have originated from other anatomical sources, such as the cervical spine, and might not have been directly related to the bilateral disc displacement. In addition, the patient might have had other pathoanatomical reasons for demonstrating limited mandibular depression, including a tight capsule or tight masseter/temporalis muscles.

A study by De Leeuw[4] has suggested that internal disc derangement does not lead to increased physical impairments, as compared to a control group at 30 years after diagnosis. However, the patients with internal disc derangement had received conservative intervention, which included exercise therapy. Therefore, it might be speculated that conservative intervention contributed to the equivalent physical

capacity between groups. Future clinical outcome studies are necessary to establish scientific evidence to support the use of physical therapy in a patient population with disc displacements without reduction of the TMJ.

CONCLUSION

The results of this single-case experimental design suggest manual physical therapy, therapeutic exercise, and patient education were an effective management strategy for this particular patient presenting with bilateral disc displacements without reduction of the TMJ. Perhaps these results suggest that anterior disc displacements should initially be managed with physical therapy rather than immediate surgical intervention. The successful outcome achieved in 8 visits is within the prognosis established by the *Guide to Physical Therapist Practice*.[13] However, the lack of generalizability associated with a single-case design does not provide sufficient evidence to change clinical practice patterns. Outcome studies in the form of randomized controlled trials are needed to determine the clinical utility of this treatment approach in a larger population.

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REFERENCES

1. Benson BJ, Keith DA. Patient response to surgical and nonsurgical treatment for internal derangement of the temporomandibular joint. *J Oral Maxillofac Surg.* 1985;43:770-777.
2. Bird SB, Dickson EW. Clinically significant changes in pain along the visual analog scale. *Ann Emerg Med.* 2001;38:639-643.
3. Ciancaglini R, Gherlone EF, Radaelli G. The relationship of bruxism with craniofacial pain and symptoms from the masticatory system in the adult population. *J Oral Rehabil.* 2001;28:842-848.
4. de Leeuw R, Boering G, van der Kuijl B, Stegenga B. Hard and soft tissue imaging of the temporomandibular joint 30 years after diagnosis of osteoarthrosis and internal derangement. *J Oral Maxillofac Surg.* 1996;54:1270-1280; discussion 1280-1271.
5. Di Fabio RP. Physical therapy for patients with TMD: a descriptive study of treatment, disability, and health status. *J Orofac Pain.* 1998;12:124-135.
6. Dimitroulis G. Temporomandibular disorders: a clinical update. *BMJ.* 1998;317:190-194.
7. Dworkin SF, LeResche L, DeRouen T. Reliability of clinical measurement in temporomandibular disorders. *Clin J Pain.* 1988;4:89-99.
8. Evjenth O. *Autostretching.* Alfta, Sweden: Alfta Rehab; 1997.
9. Evjenth O, Hamberg J. *Muscle Stretching in Manual Therapy. Volume II : The Spinal Column and the TM Joint.* Alfta, Sweden: Alfta Rehab; 1993.
10. Flynn TW, Whitman J, Magel J. *Orthopaedic Manual Physical Therapy Management of the Cervical-Thoracic Spine and Ribcage.* San Antonio, TX: Manipulations, Inc; 2000.
11. Friedman MH. The hypomobile temporomandibular joint. *Gen Dent.* 1997;45:282-285.
12. Gray RJ, Quayle AA, Hall CA, Schofield MA. Physiotherapy in the treatment of temporomandibular joint disorders: a comparative study of four treatment methods. *Br Dent J.* 1994;176:257-261.
13. *Guide to Physical Therapist Practice.* 2nd ed. Alexandria, VA: American Physical Therapy Association; 2001.
14. Hertling D, Dussault L. The temporomandibular joint. In: Hall CM, Brody LT, eds. *Therapeutic Exercise: Moving Toward Function.* Philadelphia, PA: Lippincott Williams & Wilkins; 1999:499-524.
15. Jull G, Barrett C, Magee R, Ho P. Further clinical clarification of the muscle dysfunction in cervical headache. *Cephalalgia.* 1999;19:179-185.
16. Kelly AM. The minimum clinically significant difference in visual analogue scale pain score does not differ with severity of pain. *Emerg Med J.* 2001;18:205-207.
17. Kraus SL. Physical therapy management in TMJ dysfunction. In: Kraus SL, ed. *TMJ Disorders Management of the Craniomandibular Complex.* New York, NY: Churchill Livingstone; 1988:139-174.
18. Linde C, Isacsson G, Jonsson BG. Outcome of 6-week treatment with transcutaneous electric nerve stimulation compared with splint on symptomatic temporomandibular joint disk displacement without reduction. *Acta Odontol Scand.* 1995;53:92-98.
19. Lundh H, Westesson PL, Eriksson L, Brooks SL. Temporomandibular joint disk displacement without reduction. Treatment with flat occlusal splint versus no treatment. *Oral Surg Oral Med Oral Pathol.* 1992;73:655-658.
20. Maitland G, Hengeveld E, Banks K, English K. *Maitland's Vertebral Manipulation.* Oxford, UK: Butterworth-Heinemann; 2001.
21. McCarty WL, Jr., Darnell MW. Rehabilitation of the temporomandibular joint through the application of motion. *Cranio.* 1993;11:298-307.
22. Merskey H, Bogduk N. *Classification of Chronic Pain.* Seattle, WA: IASP Press; 1994.
23. Mezitis M, Rallis G, Zachariades N. The normal range of mouth opening. *J Oral Maxillofac Surg.* 1989;47:1028-1029.
24. Moses JJ, Topper DC. A functional approach to the treatment of temporomandibular joint internal derangement. *J Craniomandib Disord.* 1991;5:19-27.
25. Murakami K, Hosaka H, Moriya Y, Segami N, Iizuka T. Short-term treatment outcome study for the management of temporomandibular joint closed lock. A comparison of arthrocentesis to nonsurgical therapy and arthroscopic lysis and lavage. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1995;80:253-257.
26. Nicolakis P, Erdogmus B, Kopf A, Djaber-Ansari A, Piehslinger E, Fialka-Moser V. Exercise therapy for craniomandibular disorders. *Arch Phys Med Rehabil.* 2000;81:1137-1142.

27. Nitzan DW, Dolwick MF. An alternative explanation for the genesis of closed-lock symptoms in the internal derangement process. *J Oral Maxillofac Surg.* 1991;49:810-815; discussion 815-816.
28. Nourbakhsh MR, Ottenbacher KJ. The statistical analysis of single-subject data: a comparative examination. *Phys Ther.* 1994;74:768-776.
29. Ottenbacher KJ. *Evaluating Clinical Change: Strategies for Occupational and Physical Therapists.* Baltimore, MD: Williams & Wilkins; 1986.
30. Price DD, McGrath PA, Raffi A, Buckingham B. The validation of visual analogue scales as a ratio scale measure for chronic and experimental pain. *Pain.* 1983;17:45-56.
31. Saghafi D, Curl DD. Chiropractic manipulation of anteriorly displaced temporomandibular disc with adhesion. *J Manipulative Physiol Ther.* 1995;18:98-104.
32. Santiesteban AJ. Isometric exercises and a simple appliance for temporomandibular joint dysfunction: a case report. *Phys Ther.* 1989;69:463-466.
33. Schiffman EL, Fricton JR, Haley DP, Shapiro BL. The prevalence and treatment needs of subjects with temporomandibular disorders. *J Am Dent Assoc.* 1990;120:295-303.
34. Stegenga B, de Bont LG, Dijkstra PU, Boering G. Short-term outcome of arthroscopic surgery of temporomandibular joint osteoarthrosis and internal derangement: a randomized controlled clinical trial. *Br J Oral Maxillofac Surg.* 1993;31:3-14.
35. Steigerwald DP, Maher JH. The Steigerwald/Maher TMD disability questionnaire. *Today's Chiropractic.* 1997;July-August:86-91.
36. Walker N, Bohannon RW, Cameron D. Discrimination validity of temporomandibular joint range of motion measurements obtained with a ruler. *J Orthop Sports Phys Ther.* 2000;30:484-492.
37. Wright EF, Domenech MA, Fischer JR, Jr. Usefulness of posture training for patients with temporomandibular disorders. *J Am Dent Assoc.* 2000;131:202-210.

Appendix

Appendix A

TMD Disability Index

Name _____ M/F ____ Age ____ Date _____ Score _____

Please check the statement that best pertains to you (not necessarily exactly) in each of the following categories.

1. Communication (talking).
____ I can talk as much as I want without pain, fatigue or discomfort.
____ I can talk as much as I want but it causes some pain, fatigue and/or discomfort.
____ I canít talk as much as I want because of pain, fatigue and/or discomfort.
____ I canít talk much at all because of pain, fatigue and/or discomfort.
____ Pain prevents me from talking at all.

2. Normal living activities (brushing teeth/flossing).
____ I am able to care for my gums and teeth in a normal fashion without restriction, and without pain, fatigue or discomfort.
____ I am able to care for all my teeth and gums, but I must be slow and careful, otherwise pain/discomfort, jaw tiredness results.
____ I do manage to care for my teeth and gums in a normal fashion, but it usually causes some pain/discomfort, jaw tiredness no matter how careful I am.
____ I am unable to properly clean all my teeth and gums because of restricted opening and/or pain.
____ I am unable to care for most of my teeth and gums because of restricted opening and/or pain.

3. Normal living activities (eating, chewing).
____ I can eat and chew as much of anything I want without pain/discomfort or jaw tiredness.
____ I can eat and chew most anything I want, but it sometimes causes pain/discomfort and/or jaw tiredness.
____ I canít eat much of anything I want, because it often causes pain/discomfort, jaw tiredness or because of restricted opening.
____ I must eat only soft foods (consistency of scrambled eggs or less) because of pain/discomfort, jaw fatigue and/or restricted opening.
____ I must stay on a liquid diet because of pain and/or restricted opening.

4. Social/recreational activities (singing, playing musical instruments, cheering, laughing, social activities, playing amateur sports/hobbies, and recreation, etc).
____ I am enjoying a normal social life and/or recreational activities without restriction.
____ I participate in normal social life and/or recreational activities but pain/discomfort is increased.
____ The presence of pain and/or fear of likely aggravation only limits the more energetic components of my social life (sports, exercise, dancing, playing musical instruments, singing).
____ I have restrictions socially as I canít even sing, shout, cheer, play, and/or laugh expressively because of increased pain/discomfort.
____ I have practically no social life because of pain.

5. Non-specialized jaw activities (yawning, mouth opening and opening my mouth wide).
____ I can yawn in a normal fashion, painlessly.
____ I can yawn and open my mouth fully wide open, but sometimes there is discomfort.
____ I can yawn and open my mouth wide in a normal fashion, but it almost always causes discomfort.
____ Yawning and opening my mouth wide are somewhat restricted by pain.
____ I cannot yawn or open my mouth more than two finger widths (2.8-3.2 cm) or, if I can, it always causes greater than moderate pain.

6. Sexual function (including kissing, hugging and any and all sexual activities to which you are accustomed).
____ I am able to engage in all my customary sexual activities and expressions without limitation and/or causing headache, face or jaw pain.
____ I am able to engage in all my customary sexual activities and expressions, but it sometimes causes some headache, face, or jaw pain, or jaw fatigue.
____ I am able to engage in all my customary sexual activities and expressions, but it usually causes enough headache, face or jaw pain to markedly interfere with my enjoyment willingness and satisfaction.
____ I must limit my customary sexual activities and expressions because of headache, face or jaw pain or limited mouth opening.
____ I abstain from almost all sexual activities and expression because of the head, face or jaw pain it causes.

7. Sleep (restful, nocturnal sleep pattern).
____ I sleep well in a normal fashion without any pain medication, relaxants or sleeping pills.
____ I sleep well with the use of pain pills, anti-inflammatory medication or medicinal sleeping aids.
____ I fail to realize 6 hours of restful sleep even with the use of pills.
____ I fail to realize 4 hours of restful sleep even with the use of pills.
____ I fail to realize 2 hours of restful sleep even with the use of pills.

8. Effects of any form of treatment, including, but not limited to, medications, in-office therapy, treatments, oral orthotics (e.g., splints, mouthpieces), ice/heat, etc.

____ I do not need to use treatment of any type in order to control or tolerate headache, face or jaw pain and discomfort.
____ I can completely control my pain with some form of treatment.
____ I get partial, but significant, relief through some form of treatment.
____ I don't get "a lot" of relief from any form of treatment.
____ There is no form of treatment that helps enough to make me want to continue.

9. Tinnitus, or ringing in the ear(s).

____ I do not experience ringing in my ear(s).
____ I experience ringing in my ear(s) somewhat, but it does not interfere with my sleep and/or my ability to perform my daily activities.
____ I experience ringing in my ear(s) and it interferes with my sleep and/or daily activities, but I can accomplish set goals and can get an acceptable amount of sleep.
____ I experience ringing in my ear(s) and it causes a marked impairment in the performance of my daily activities and/or results in an unacceptable loss of sleep.
____ I experience ringing in my ear(s) and it is incapacitating and/or forces me to use a masking device to get any sleep.

10. Dizziness (lightheaded, spinning and/or balance disturbance)

____ I do not experience dizziness.
____ I experience dizziness, but it does not interfere with my daily activities.
____ I experience dizziness, which interferes somewhat with my daily activities, but I can accomplish my set goals.
____ I experience dizziness, which causes a marked impairment in the performance of my daily activities.
____ I experience dizziness, which is incapacitating.

Scoring Method For the TMD Disability Index

Example:

10. Dizziness (lightheaded, spinning and/or balance disturbance)

__0 (a)__ I do not experience dizziness.
__1 (b)__ I experience dizziness, but it does not interfere with my daily activities.
__2 (c)__ I experience dizziness, which interferes somewhat with my daily activities, but I can accomplish my set goals.
__3 (d)__ I experience dizziness, which causes a marked impairment in the performance of my daily activities.
__4 (e)__ I experience dizziness, which is incapacitating.

If the patient chooses "d" a score of 3 is calculated for this first of 10 questions. The total points from the ten questions are added together and is divided by the total number possible. Maximum possible score is 40.

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TMD Symptom Intensity Scale (SIS)

Name _____ **Date** _____ **Date of birth** _____ **Age** _____

Please indicate the intensity of your symptoms as follows:

- Circle the number on the scale to indicate your most usual symptom level.
- Draw an X through the number to indicate your most severe symptom level.

1. Jaw pain	No pain	0 1 2 3 4 5 6 7 8 9 10	Most intense pain
2. Painful jaw clicking	No pain	0 1 2 3 4 5 6 7 8 9 10	Most intense pain
3. Jaw locking	No pain to open mouth	0 1 2 3 4 5 6 7 8 9 10	Can barely open mouth
4. Headaches	No pain	0 1 2 3 4 5 6 7 8 9 10	Most intense pain
5. Neck pain and/or upper shoulder muscle pain	No pain	0 1 2 3 4 5 6 7 8 9 10	Most intense pain
6. Dizziness	No dizziness	0 1 2 3 4 5 6 7 8 9 10	Most intense dizziness
7. Ringing in the ears	No ringing	0 1 2 3 4 5 6 7 8 9 10	Most intense ringing

TMD Symptom Frequency Scale (SFS)

Please indicate the frequency of your problems as follows:

- Circle the number on the scale to indicate how often you experience the following symptoms.

1. Jaw pain	Never	0 1 2 3 4 5 6 7 8 9 10	100% of the time
2. Painful jaw clicking	Never	0 1 2 3 4 5 6 7 8 9 10	100% of the time
3. Jaw locking	Never	0 1 2 3 4 5 6 7 8 9 10	100% of the time
4. Headaches	Never	0 1 2 3 4 5 6 7 8 9 10	100% of the time
5. Neck pain and/or upper shoulder muscle pain	Never	0 1 2 3 4 5 6 7 8 9 10	100% of the time
6. Dizziness	Never	0 1 2 3 4 5 6 7 8 9 10	100% of the time
7. Ringing in the ears	Never	0 1 2 3 4 5 6 7 8 9 10	100% of the time

Scoring for TMD Symptom Intensity and Frequency Scales

1. Jaw pain	No pain	0 1 2 3 4 5 6 7 8 9 10	Most intense pain
2. Painful jaw clicking	No pain	0 1 2 3 4 5 6 7 8 9 10	Most intense pain
3. Jaw locking	No pain to open mouth	0 1 2 3 4 5 6 7 8 9 10	Can barely open mouth
4. Headaches	No pain	0 1 2 3 4 5 6 7 8 9 10	Most intense pain
5. Neck pain and/or upper shoulder muscle pain	No pain	0 1 2 3 4 5 6 7 8 9 10	Most intense pain
6. Dizziness	No dizziness	0 1 2 3 4 5 6 7 8 9 10	Most intense dizziness
7. Ringing in the ears	No ringing	0 1 2 3 4 5 6 7 8 9 10	Most intense ringing

- Maximum score = 70
- Calculating patient score: Total score/maximum score possible x 100 = Final score

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Appendix B

Interventions Utilized During Each Session of the A1-B-A2 Design

Session	Interventions
1 (day 0)	• Evaluation and data collection, no intervention
2 (day 4)	• Data collection only
3 (day 6)	• Data collection only
4 (day 8), treatment 1	• Data collection, then introduction of interventions • Bilateral temporomandibular (TMJ) anterior glides and distraction Grades I-II[14] • Contract-relax stretching to bilateral upper trapezius, levator, and posterior occipitals[9] • Passive accessory movement techniques (PAIVM) Grades III-IV to hypomobile cervical segments (C2-C3, C7-T1, T1-T2)[20] • Postural re-education seated emphasizing chin and scapula retraction • Patient education: parafunctional habits, soft diet, relaxation techniques, activity modification, tongue resting position • Cryotherapy (ice pack)
5 (day 10), treatment 2	• Data collection • PAIVM Grades III-IV to hypomobile cervical segments as above • Contract-relax stretching to upper trapezius, levator, and posterior occipitals as above • Self stretches for the above muscles[8] • TMJ anterior glides and distraction Grade III as above • Gentle stretching of bilateral masseter and temporalis • Neuromuscular re-education (NMR) of deep neck flexors[15] • Patient education: parafunctional habits, soft diet, relaxation techniques, activity modification, tongue resting position • Cryotherapy
6 (day 12), treatment 3	• Data collection • PAIVM Grades III-IV to hypomobile cervical segments as above • Contract relax stretching to upper trapezius, levator, and posterior occipitals as above • TMJ anterior glides and distraction Grades III-IV as above • Gentle stretching of bilateral masseter and temporalis as above • NMR of deep neck flexors as above • Scapular retraction seated with red elastic band • Cryotherapy
7 (day 17), treatment 4	• Data collection • TMJ anterior glides and distraction Grades III-IV • Stretching of bilateral masseter and temporalis • Self stretching of the above • NMR of deep neck flexors • Prone scapulothoracic exercises: tactile facilitation as needed[10] • Cryotherapy
8 (day 19), treatment 5	• Data collection • TMJ anterior glides and distraction Grades III-IV • Stretching of bilateral masseter and temporalis • Prone scapulothoracic exercises • NMR for mandibular control in front of mirror, pain-free range of motion[14] • Cryotherapy
9 (day 24), treatment 6	• Data collection • TMJ anterior glides and distraction Grades III-IV • Stretching of bilateral masseter and temporalis • NMR for mandibular control • Mandibular isometrics • Deep neck flexor exercises • Cryotherapy
10 (day 26), treatment 7	• Data collection • TMJ anterior glides and distraction Grades III-IV • Stretching of bilateral masseter and temporalis • Prone scapulothoracic exercises • Mandibular isometrics[14,32] • Contract-relax stretching to upper trapezius, levator, and posterior occipitals • NMR of mandibular movement: opening, closing, retraction, protraction, lateral deviation • Cryotherapy

Session	Interventions
11 (day 30), treatment 8	• Data collection • TMJ anterior glides and distraction Grades III-IV • Stretching of bilateral masseter and temporalis • NMR of mandibular movement: opening, closing, retraction, protraction, lateral deviation • Review of HEP: self stretches, neuromuscular re-education, and strengthening activities
12 (day 34)	• Data collection only
13 (day 37)	• Data collection only
14 (day 39)	• Data collection only
15 (day 41)	• Data collection only
Follow-up (day 127)	• Data collection only

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1. M. Pighin, M.V. Videla, M. Barone, F. Imaz, G. Converso. 2022. Cambios en el dolor y el posicionamiento craneocervical en pacientes con trastornos temporomandibulares de origen miofascial tratados con terapia miofuncional. *Fisioterapia* **44**:3, 154-162. [Crossref]
2. Giacomo Asquini, Laurent Pitance, Ambra Michelotti, Deborah Falla. 2022. Effectiveness of manual therapy applied to craniomandibular structures in temporomandibular disorders: A systematic review. *Journal of Oral Rehabilitation* **49**:4, 442-455. [Crossref]
3. Giacomo Asquini, Alison Rushton, Laurent Pitance, Nicola Heneghan, Deborah Falla. 2021. The effectiveness of manual therapy applied to craniomandibular structures in the treatment of temporomandibular disorders: protocol for a systematic review. *Systematic Reviews* **10**:1. . [Crossref]
4. Ovidio Olivencia, Kelby Kaplan, Melissa Dreger, Michael Veloz, Alexander Kais, Katya Marlowe. 2021. Postrehabilitation Considerations for Individuals With Temporomandibular Disorders. *Strength & Conditioning Journal* **43**:6, 14-28. [Crossref]
5. M. Barone, F. Imaz, G. Converso, D. Bordachar, A. Barbero, M. Trucco, L. Intelangelo. 2021. Immediate effects of rhythmic joint mobilization of the temporomandibular joint on pain, mouth opening and electromyographic activity in patients with temporomandibular disorders. *Journal of Bodywork and Movement Therapies* **28**, 563-569. [Crossref]
6. Gabriela Fisch, Ashley Finke, John Ragonese, Lara Dugas, Mariusz Wrzosek. 2021. Outcomes of physical therapy in patients with temporomandibular disorder: a retrospective review. *British Journal of Oral and Maxillofacial Surgery* **59**:2, 145-150. [Crossref]
7. Irfan Adil Majid, Mubeen Mubeen, Fazeena Karimalakuzhiyil Alikutty. 2020. Physiotherapy and Anterior Repositioning Splint in the Treatment of Disk Displacement with Reduction - A Randomized Controlled Trial. *Journal of Evolution of Medical and Dental Sciences* **9**:52, 3926-3934. [Crossref]
8. Gopal Nambi, Walid Kamal Abdelbasset. 2020. Efficacy of Maitland joint mobilization technique on pain intensity, mouth opening, functional limitation, kinesiophobia, sleep quality and quality of life in temporomandibular joint dysfunction following bilateral cervicofacial burns. *Burns* **46**:8, 1880-1888. [Crossref]
9. Seung-Jeong Lee, Hye-Min Ryu, Su-Gyeong Kim, Eun-Jin Park, Jae-Eun Lim, Young-Jun Lee, Choon-Ho Song, Hyun-Min Yoon, Cheol-Hong Kim. 2018. The Effect of Postural Yinyang Correction of Temporomandibular Joint for Temporomandibular Disorder. *Journal of Acupuncture Research* **35**:3, 129-137. [Crossref]
10. L. Xu, B. Cai, Z. Fang. 2016. Translation and validation of a Chinese version of the Mandibular Function Impairment Questionnaire. *Journal of Oral Rehabilitation* **43**:8, 608-614. [Crossref]
11. Kenneth A. Olson. Examination and Treatment of Temporomandibular Disorders 377-409. [Crossref]
12. Katie Johnston, Lance Bird, Phillip Bright. 2015. Temporomandibular joint effusion and its relationship with perceived disability assessed using musculoskeletal ultrasound and a patient-reported disability index. *Ultrasound* **23**:2, 90-96. [Crossref]
13. Mary Lou Galantino, Melissa M. Eden, Bryan A. Spinelli, Ann Marie Flores. 2015. EDGE Task Force on Head and Neck Cancer Outcomes: A Systematic Review of Outcome Measures for Temporomandibular-related Dysfunction. *Rehabilitation Oncology* **33**:2, 6-14. [Crossref]
14. Sarah H. Stuhr, Darren H. Earnshaw, Alison M. Duncombe. 2014. Use of orthopedic manual physical therapy to manage chronic orofacial pain and tension-type headache in an adolescent. *Journal of Manual & Manipulative Therapy* **22**:1, 51-58. [Crossref]
15. Stephen M. Shaffer, Jean-Michel Brismée, Phillip S. Sizer, Carol A. Courtney. 2014. Temporomandibular disorders. Part 2: conservative management. *Journal of Manual & Manipulative Therapy* **22**:1, 13-23. [Crossref]
16. M. Al-Baghdadi, J. Durham, J. Steele. 2014. Timing interventions in relation to temporomandibular joint closed lock duration: a systematic review of 'locking duration'. *Journal of Oral Rehabilitation* **41**:1, 24-58. [Crossref]
17. Allan Kalamir, Petra L Graham, Andrew L Vitiello, Rodney Bonello, Henry Pollard. 2013. Intra-oral myofascial therapy versus education and self-care in the treatment of chronic, myogenous temporomandibular disorder: a randomised, clinical trial. *Chiropractic & Manual Therapies* **21**:1. . [Crossref]
18. Betania Mara Franco Alves, Cristiane Rufino Macedo, Eduardo Januzzi, Eduardo Grossmann, Álvaro Nagib Atallah, Stella Peccin. 2013. Mandibular Manipulation for the Treatment of Temporomandibular Disorder. *Journal of Craniofacial Surgery* **24**:2, 488-493. [Crossref]
19. Lisa T Hoglund, Brian W Scott. 2012. Automobilization intervention and exercise for temporomandibular joint open lock. *Journal of Manual & Manipulative Therapy* **20**:4, 182-191. [Crossref]

20. Anthony Delitto, Steven Z. George, Linda Van Dillen, Julie M. Whitman, Gwendolyn Sowa, Paul Shekelle, Thomas R. Denninger, Joseph J. Godges. 2012. Low Back Pain. *Journal of Orthopaedic & Sports Physical Therapy* **42**:4, A1-A57. [Citation] [Full Text] [PDF] [PDF Plus] [Supplementary Material]
21. W. Stelzenmüller, M. Griessmair, A. Čelar. 2010. Schmerzlokalisierung bei CMD-Patienten mit modifiziertem Schmerzfragebogen*. *Stomatologie* **107**:7-8, 137-145. [Crossref]
22. W. Stelzenmüller, M. Griessmair, A. Čelar. 2009. Schmerzlokalisierung bei CMD-Patienten mit modifiziertem Schmerzfragebogen. *Manuelle Medizin* **47**:5, 325-333. [Crossref]
23. W. Stelzenmüller. 2009. Physiotherapie im Wandel. *Manuelle Medizin* **47**:1, 16-22. [Crossref]
24. Janine E. Janosky, Shelley L. Leininger, Michael P. Hoerger, Terry M. Libkuman. Annotated Bibliography of Single Subject Studies 97-122. [Crossref]
25. . Temporomandibular Disorders 309-338. [Crossref]
26. Sâmia Amire Maluf, Bruno Gonçalves Dias Moreno, Patrícia Pereira Alfredo, Amélia Pasqual Marques, Graziela Rodrigues. 2008. Exercícios terapêuticos nas desordens temporomandibulares: uma revisão de literatura. *Fisioterapia e Pesquisa* **15**:4, 408-415. [Crossref]
27. M. Fink, F. Ismail, K. Heßling, M. Fischer, M. Stiesch-Scholz, A. Demling. 2007. Einsatz der physikalischen Therapie bei der Behandlung der kraniomandibulären Dysfunktion. *Manuelle Medizin* **45**:4, 255-260. [Crossref]
28. Lindsay Phipps Eisensmith. 2007. Massage therapy decreases frequency and intensity of symptoms related to temporomandibular joint syndrome in one case study. *Journal of Bodywork and Movement Therapies* **11**:3, 223-230. [Crossref]
29. Jeffrey P. Okeson. 2007. Joint Intracapsular Disorders: Diagnostic and Nonsurgical Management Considerations. *Dental Clinics of North America* **51**:1, 85-103. [Crossref]
30. Byung-Cheul Shin, Chung-Hyo Ha, Yung-Sun Song, Myeong Soo Lee. 2007. Effectiveness of Combining Manual Therapy and Acupuncture on Temporomandibular Joint Dysfunction: A Retrospective Study. *The American Journal of Chinese Medicine* **35**:02, 203-208. [Crossref]
31. Eric S. Furto, Joshua A. Cleland, Julie M. Whitman, Kenneth A. Olson. 2006. Manual Physical Therapy Interventions and Exercise for Patients with Temporomandibular Disorders. *CRANIO®* **24**:4, 283-291. [Crossref]
32. Margaret L McNeely, Susan Armijo Olivo, David J Magee. 2006. A Systematic Review of the Effectiveness of Physical Therapy Interventions for Temporomandibular Disorders. *Physical Therapy* **86**:5, 710-725. [Crossref]