12-2016

Physical Therapy Intervention For A Patient With Temporomandibular Joint Dysfunction Caused By Two Traumatic Events: A Case Study

Elyse Detweiler
University of New England

Physical Therapy Intervention for a Patient with Temporomandibular Joint Dysfunction caused by Two Traumatic Events: A Case Study

Elyse Detweiler, BS, is a Doctor of Physical Therapy student at the University of New England, 716 Stevens Ave, ME, 04103.

Address all correspondence to Elyse Detweiler: edetweiler@une.edu.

The patient signed an informed consent allowing the use of medical information, video footage, and/ photography for this report and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act.

The author acknowledges Amy Litterini, PT, DPT, for assistance with case report conceptualization, Gabe Redmond, PT, MS for supervision and assistance with video photography, and the patient for her participation as the case study participant.

ABSTRACT

Background and Purpose:

Temporomandibular disorders (TMD) are pathoanatomical dysfunctions of the temporomandibular joint (TMJ) associated with symptoms throughout the head and neck. Limited information exists regarding conservative physical therapy (PT) and post-surgical management of TMD. The dental profession is the main source of published literature specific to TMD. This paper describes a conservative and post-surgical PT plan of care (POC) for TMD.

Case Description:

A 32-year old female experienced two separate traumatic events at work resulting in TMD. She was referred to PT after the second assault because of symptoms of severe pain, limited range of motion, and jaw locking. She was unable to speak, eat, or return to work. The POC included manual therapy, therapeutic exercise, and patient education. She attended 16 total visits and she underwent two arthrocentesis procedures performed by an oral surgeon.

Outcomes:

The patient responded well to PT both pre- and post-arthrocentesis procedures in regards to ROM (Depression: 17 to 31 mm, L Lateral Excursion: 4 to 8 mm, R Lateral Excursion: 4 to 9.5 mm), numeric pain rating scale (7/10 to 1/10), and a reduction in locking symptoms. She met all her goals, which correlated with the decreasing Mandibular Functional Impairment Questionnaire results, and met most of the PT goals by discharge. She returned to a normal diet and full time work with minimal restrictions.

Discussion:

The patient had a positive outcome from her POC including conservative and surgical management of TMD. More research is needed to identify consistent indicators for individuals who would benefit from an interdisciplinary approach, and investigate the potential benefits of PT for TMD.

BACKGROUND and PURPOSE

Temporomandibular disorders (TMD) are a collection of pathoanatomical dysfunctions of the temporomandibular joint (TMJ) associated with a variety of symptoms throughout the head and neck, including jaw and cervical pain, headaches, postural changes, and various other impairments.[1-2] TMD is usually accompanied by postural abnormalities of the cervical spine; research has highlighted the importance of evaluating the TMJ and cervical spine together.[2] Moreover, a complete physical therapy (PT) initial evaluation includes a postural analysis.[2]

Scientific literature on TMD provides valuable information on the pathological condition, signs and symptoms, and background information, but there is a severe lack of supportive evidence for interventions currently used in the conservative and/or surgical treatment of TMD.[1] The literature reviews by Shaffer et al[1] and Dickerson et al[3] highlighted the majority of interventions used within physical therapy treatment of TMD where each focuses on the available supportive evidence for each intervention. Furthermore, each highlighted the variation in dosage regimes between studies, the wide variety of exercises utilized, and the inconsistent results supporting or negating the use of one type of intervention over another.[1,3]

The dental profession has provided much of the current literature on TMD, and this, again, is limited in both conservative and surgical interventions that improve symptoms.[1] Current dental literature pertaining specifically to the arthrocentesis procedure examined differs greatly in outcomes. The randomized control trial by Vos et al[4] showed arthrocentesis to be a beneficial procedure to perform initially, but the long-term outcomes for pain and functional impairments were comparable to conservative treatment. Conversely, the literature review by Monje-Gil et al,[5] showed the wide variation in variables studied and highlighted the importance for more research to determine the homogenous indicators for an arthrocentesis procedure.

Dentists are among the most common health professionals who evaluate and treat TMD,

but TMJ mobility assessments, range of motion (ROM), muscle testing, and postural assessments are most commonly performed by a physical therapists.[2] Collaborative care of TMD between dentists, oral surgeons, and physical therapists does not always occur, but should be considered best practice.

The rationale for this paper is to describe a physical therapy plan of care for TMD. The purpose is to provide information regarding conservative and post-surgical physical therapy treatment of TMD due to a traumatic mechanism of injury.

CASE DESCRIPTION

The patient signed an informed consent allowing the use of medical information, video footage, and/or photography for this case report.

KD was a 32-year-old female who worked as an education technician with adolescents with mental and behavioral problems. She initially sustained multiple blows to the head and face from one of her students at work; then approximately six months later, a different student became violent and exacerbated the original injuries to her left mandible and head with a second physical assault.

After the first incident, she received initial medical care from a physician through the worker's compensation contract with her employer and received a diagnosis of TMD. She also received care through her PCP and her dentist. No imaging was performed after the first event and she had a custom TMJ splint made by her dentist. After the second incident, the splint no longer fit, and KD was advised to discontinue use. She was referred to PT after the second assault with the chief complaint of pain of the TMJ, locking, and the inability to open her mouth to speak or eat. The pain in her face and neck was reported as sharp during movement and achy during rest. The physical therapist observed the jaw deviate to the left during mandibular

depression. KD was on no medications, except for the occasional acetaminophen when needed for pain. She had no other comorbidities and an extremely supportive family. Self-care techniques used at home included ice packs, hot packs, and rest from speaking or eating. She was on a liquid diet for the four weeks, followed by soft foods only. She described herself as frustrated with the loss of function of her jaw and the pain. Refer to Figure 1 for timeline of events.

Locking of the jaw was described during the initial PT evaluation and episodes increased during the first three weeks of PT treatment. The PCP ordered a magnetic resonance imaging (MRI) study to help determine the cause of locking. The MRI showed an anterior dislocation of the left TMJ disc and the left mandibular head did not move simultaneously with the right during depression or elevation. KD was then referred to an oral surgeon, who performed an arthrocentesis on the left TMJ and then the right TMJ two weeks later. Refer to Figure 1 for timeline.

KD's main goal was to improve ROM of the bilateral TMJ, in order to resume a normal diet, communication, and return to work. Refer to Table 3 for goals.

Clinical Impression 1

Following the subjective history and systems review, KD's problem was identified as bilateral TMD, left > right (see Table 1 for systems review results). Further tests and measures to confirm this hypothesis included: goniometry, palpation of TMJ mechanics and facial musculature, and strength measurements of the jaw. Moreover, postural assessment, sensory testing of the face, palpation of cervical spine, neck, and shoulders, and joint assessments of the cervical spine were to be assessed. Differential diagnoses included dislocation of the TMJ disc and/or fracture of the jaw; therefore, imaging was requested by the PCP after locking episodes

increased.

KD was a good candidate for a case report due to multiple traumatic injuries to the face. After the second assault, pain and tightness increased severely. She was unable to open her mouth or speak because of pain. Current literature typically describes episodes of gradual onset of TMD.[1-4] This case report examined how multiple traumatic events resulted in TMD.

Examination – Tests and Measures

Pain was assessed throughout the course of treatment using the Numeric Pain Rating Scale (NPRS).[6] Reliability and validity of the NPRS is not established for facial pain resulting from TMD, but it is a helpful tool to determine subjective information about pain and has been tested for validity and reliability for acute and chronic musculoskeletal pain.[6] Jaw motions were assessed using goniometry (Dynasplint Systems, Inc., MD), specifically in millimeters as described by Norkin and White.[9] Goniometry has been shown to be a reliable and valid form of measurement for TMJ motions according to research by Walker et al[10] that showed mandibular depression is valid in discriminating between someone with or without TMD.[10] Observation of KD's speech was used to assess whether the mandible deviated and it was observed that KD's mandible deviated to the left, but rested in a neutral position.[1]

Palpation revealed pain and clicking bilaterally. Excursion of the condyles was not equal; the left did not move smoothly and lagged behind the right. Left TMJ clicking was less pronounced but pain was reported to be more significant. Palpation assessed KD's joint mobility, which displayed hypomobility of bilateral TMJ. According to Shaffer et al,[1] palpation is helpful in providing information on symptom provocation, hypersensitivity of retrodiscal tissues, abnormalities of mandibular head motions, popping, clicking, localized tenderness, and changes in facial and cervical musculature.

The Mandibular Function Impairment Questionnaire (MFIQ) was used to calculate the perceived difficulty of tasks in comparison to jaw complaints.[9] The MFIQ score portrayed severe difficulty with everyday tasks in relation to jaw complaint. The MFIQ outcome measure has been tested and shown to be reliable by Kropmans et al[9] and others for assessing impairments in mandibular function.[11,12] Inspection of dentition showed no impairments. Cervical ROM was assessed as described by Norkin and White[10] and was within normal limits, but tightness and localized tenderness was found within the cervical and shoulder musculature. Strength of cervical and upper extremity musculature was assessed as described by Kendall[12] and found to be normal bilaterally. Refer to Table 2 for initial evaluation results.

Clinical Impression 2

Pain, locking, and muscular tightness of the facial musculature were all consistent with TMD and confirmed the initial impression. The MRI findings of anterior dislocation of the left disc, and movement abnormalities of the left mandibular head during depression and elevation, were also consistent with symptoms of locking and the pain described by KD. She remained appropriate for this case report due to the unique mechanism of injury.

Due to documented impairments ICD 10 code: M26.96 (other specified disorders of TMJ) was determined to be the most appropriate PT diagnosis.

The patient had no other comorbidities and an extremely supportive family. She was highly motivated to improve her symptoms and return to work. All these factors were considered positive prognostic indicators signifying a desirable outcome. There was no plan for referral to other health professionals. The plan for interventions was for the patient to be seen twice weekly for six weeks, focusing on manual soft tissue mobilization and therapeutic exercises.

Collaborative communication was performed with all medical personnel already working with KD. The MFIQ functional outcome measure was used every eighth visit to determine whether the patient had any subjective change in symptoms, function of the jaw, and reauthorize additional visits.[8] Testing of mandibular depression, and left and right mandibular excursions were measured every other session to determine whether there were improvements. Pain rating was assessed each session by the NPRS. Palpation was performed each session during soft tissue mobilization to determine whether musculature tightness had changed.

KD would discharged upon achievement of established PT short-term goals for ROM and pain. For short-term and long-term goals, see Table 3.

Intervention

Collaborative communication occurred regularly and documentation was provided to all medical personnel working with KD. Her POC was coordinated by a team, including her case manager, PCP, oral surgeon and physical therapist. Patient/client instruction included a home exercise program (HEP) in the form of pictures and written instructions.

Procedural interventions initially consisted of manual therapy in the form of soft tissue mobilization and manual cervical traction to improve circulation, elongate tissues, increase range of motion, and decrease pain in mandibular and cervical musculature. According to Shaffer et al[1] soft tissue mobilization is a commonly used intervention and important in the management of TMD, even with limited support in the literature.[1] Effleurage, petrissage, myofascial trigger point therapy, and cross friction massage were performed on jaw, cervical, and shoulder musculature. KD was taught to perform self-massage techniques at home for symptom management. Refer to Appendices 2 and 3 for intervention protocols, descriptions, and images. As her pain and muscular tightness decreased around session thirteen, the amount of soft tissue mobilization and

manual traction provided by the physical therapist was decreased around session thirteen, ultimately changing the focus of the treatment session to other impairments.

A dry needling intervention was performed (Myotech US Dry Needling & Physio Products, Kirkland,WA) to attempt to release the masseter muscles bilaterally. This was performed on the fourth intervention day due to limited success of soft tissue mobilization on the left masseter. KD was provided with written and verbal notification of the benefits and contraindication of the dry needling, in addition to expectations of the treatment. The dry needling intervention was performed by another physical therapist, who is certified in dry needling technique, level 2. Shaffer et al[1] supports the use of dry needling when pain can be attributed to musculature, and in this case some of the patient's pain was due to severely tight bilateral masseters.[11] The dry needling was only performed during the fourth intervention session because the patient did not feel she could tolerate another session due to a fear of needles. Because of this, soft tissue mobilization was the focus of therapy until her pain and stiffness improved around the ninth intervention day.

Mandibular ROM stretches were performed to elongate and improve circulation to the masseter, medial and lateral pterygoids, and cervical musculature each treatment session as tolerated. According to Shaffer et al[1] the use of gentle stretching is useful in reducing pain and Lateral excursion was not tolerated on the fourth, seventh, and eighth intervention days, specifically when moving to the right.

Postural exercises such as external rotation pull-outs with yellow or red resistance band and chin tucks were performed to increase postural awareness and circulation to postural muscles. Refer to Appendix 2 for sets and repetitions. These exercises were helpful to reduce the head forward and rounded shoulders posture described in the initial evaluation and by Friedman in patients with postural deviations.[2] Cervical and upper extremity exercises were incorporated to

improve circulation and strength of upper extremity and postural muscles. A Paramount Functional Trainer (Paramount Fitness Corp., St. Louis, MO) was utilized to perform resistance training including low rows, bilateral pull downs, and triceps presses, each with a resistance equal to 10 pounds initially. Progression of resistance exercises occurred by initially increasing the number of repetitions, but progressed with increased weight when patient no longer found them challenging. For ROM exercises, she performed a side bend stretch, upper trapezius stretch, and a towel/foam roller stretch to decrease pain and stiffness of the cervical and shoulder muscles for three repetitions holding for 30 seconds each time. Refer to Appendices 2 and 3 for protocol, description, and images. Shaffer et al[1] supports the use of interventions specific to the cervical spine because failing to address impairments of the cervical spine may limit a patient's rehabilitation potential with TMD.

A home exercise program (HEP) incorporating ROM and stretching of the facial and cervical musculature was given. The HEP focused on mandibular depression and lateral excursion ROM exercises and self-massage techniques because decreasing pain and increasing ROM were the focus of KD's goals. Self-massage techniques were given to improve symptoms of stiffness, fatigue, and to give the patient the ability to proactively manage her pain at home.

According to Shaffer et al[1] a multimodal approach is the most beneficial for patients with TMD. Incorporating soft tissue mobilization, gentle isometrics, guided ROM exercises, postural corrections, and relaxation techniques is an effective strategy in reducing symptoms associated with anterior disc displacement and myofascial pain dysfunction of the TMJ.[1]

KD attended two sessions each week for 8 weeks total. She reported she performed her HEP at least twice per day to help with symptoms. Re-evaluation was performed during the eighth and 16th visits according to the facility guidelines and for reauthorization for additional visits.

OUTCOME

To evaluate significant changes throughout the physical therapy treatment, the same equipment, such as the goniometer, was used at each round of testing and the MFIQ was completed. At the eighth visit re-evaluation and the 16th visit when she was discharged, she showed significant improvements in pain, ROM in all directions, and tolerance of exercises. She met all her short-term goals, in addition to achieving the long-term goal for pain at the eighth visit re-evaluation. At discharge, KD had met all her major goals. Refer to Figure 2 for specifics on when KD met each goal. Her MFIQ score changed from a 0.70 to a 0.40 at the re-evaluation, to a 0.06 at discharge, showing significant changes throughout her course of physical therapy. She could consume a normal diet, with the exception of certain sized foods that tended to over-stress the jaw. Lastly, she had returned to work full-time with some restrictions, such as not being responsible for restraining students when they became violent. Refer to Appendix 1 for test and measures comparing initial evaluation, 8th visit re-evaluation, and 16th visit discharge findings.

DISCUSSION

There is limited research to support the benefits of the current PT interventions for TMD and none specific to traumatic jaw injury. Therefore, it was difficult to develop a PT plan of care based on the current literature. The literature did, however, provide valuable information on the pathological condition, signs and symptoms, and background information that improved the physical therapist's understanding of TMD. The available literature also assisted in providing a basis for hypotheses for the patient's underlying impairments, resulting in the focus of soft tissue mobilization and a stretching program.

The patient made good progress throughout her POC with the most dramatic changes after each of the arthrocentesis procedures. This progress allowed her to return to her normal diet

and work as an education technician. Without the pain, she was once again able to communicate with her family and friends. Most importantly, KD was pleased with her progress and happy about her ability to return to the many things she enjoyed. Positive factors that contributed to KD's outcome included the collaborative care provided by her PCP, oral surgeon, and physical therapists.

More research is needed in conservative TMD treatments, specifically the efficacy for soft tissue mobilization techniques in reducing tightness in the masseter and cervical musculature. This would be helpful in determining whether these interventions could be a primary focus of treatment for reducing pain and improving range of motion. Moreover, additional research evaluating the efficacy of combined conservative and post-surgical treatments, specific to the arthrocentesis procedure combined with physical therapy would enable healthcare professionals to more successfully treat patients with TMD.

REFERENCES

1. Shaffer SM, Brismee JM, Sizer PS, Courtney CA. Temporomandibular disorders. Part 2: conservative management. *J Man Manip Ther.* 2014;22(1):13-23. Doi: 10.1179/2042618613Y.0000000061
2. Friedman MH, Weisberg J. Application of orthopedic principles in evaluation of the temporomandibular joint. *Phys Ther.* 1982; 62: 597-603.
3. Dickerson S, Weaver, J, Boyson A, Thacker J, Junak, A et al. The effectiveness of exercise therapy for temporomandibular dysfunction: A systematic review of meta-analysis. Clin Rehabil. 2016; dio: 10.1177/0269215516672275.
4. Vos LM, Huddleston Slatter JJ, & Stengena B. Arthrocentesis as initial treatment for temporomandibular joint arthropathy: a randomized controlled trial. J Craniomaxillofac

Surg. 2014; 42(5): 134-9. Doi: 10.1016/j.jcms.2013.07.0101.

5. Monje-Gil F, Nitzan D, Gonzalez-Garcia R. Temporomanidbular joint arthrocentesis. Review of the literature. Med Oral Cir Bucal. 2012; 7(4): 575-81. Dio: 10.4317/medoral.17670.
6. Santiesteban AJ. Isometric exercises and a simple appliance for temporomandibular joint dysfunction: a case report. *Phys Ther.* 1989;69:463-466.
7. Braun B, Treatment of an acute anterior disk displacement in the temporomandibular joint: a case report. *Phys Ther*. 1987;67:1234-1236.
8. Rehab Measures: Numeric Pain Rating Scale. Rehab Measures Web Site. http://www.rehabmeasures.org/Lists/RehabMeasures/PrintView.aspx?ID=891. Accessed June 12, 2016.
9. Norkin CC & White DJ. Measurements of Joint Measurement: A Guide to Goniometry. 4th ed. Philadelphia, PA: F.A. Davis Company; 2009.
10. Walker N, Bohannon RW, and Cameron D. Discriminant validity of temporomandibular joint range of motion measurements obtained with a ruler. *J Orthop Sports Phys Ther*. 2000; 30(8): 484-92. Doi: 10.2519/jospt.2000.30.8.484.
11. Kropmans TJ, Kijkstra PU, van Veen A, and de Bont LG. The smallest detectable difference of mandibular function impairments in patients with a painfully restricted temporomandibular joint. *J Dent Res*. 1999;78(8):1445-9. Doi: 10.1177/00220345990780081001.
12. Kendall FP, McCreary EK, Provance PG, Rodgers MM, Romani WA. Muscles Testing and Function with Posture and Pain. 5th ed. Baltimore, MD: Lippincott Williams & Wilcons; 2001.
13. Fernandez-Carnero J, La Touche R, Ortega-Santiago R, et al. Short-term effects of dry

needling of active myofascial trigger points in the masseter muscle in patients with temporomandibular disorders. *J Orofac Pain*. 2010;24(1):106-12.

14. TMJ Exercise Images. Oral Facial Section. http://www.hep2go.com/exercises.php?ex_type=25&ex_subtype=147&userRef=gciaake&order=default&group=all&position=-1. Accessed September 2016.

TABLES and FIGURES

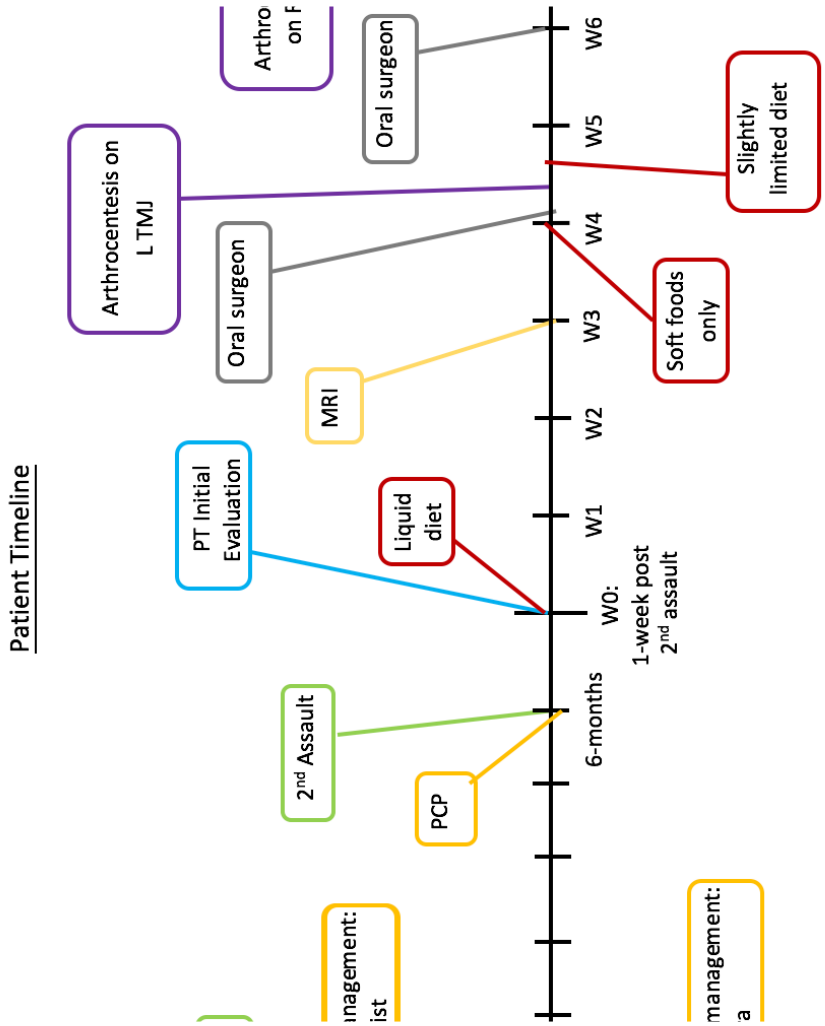


Table 1

Systems Review		
Cardiovascular/Pulmonary	○ Blood pressure: 138/86 ○ Heart rate: 84 ○ Respiration rate: 14	Unimpaired
Musculoskeletal	○ Severe tightness of the jaw, face, and cervical muscles: ○ Masseter ○ Trapezius ○ Semispinalis capitus ○ Rectus capitus posterior major and minor ○ Obliquus capitus superior and inferior ○ Temporalis ○ Left scalenes ○ Left sternocleidomastoid	Impaired

	○ The head of the mandible on the left was not moving simultaneously with the right, resulting in locking, popping, and pain.	
Neuromuscular	○ Numbness and tingling was described for the left maxilla and mandible during the initial evaluation. ○ Crude touch highlighted sensation differences on the mandible.	Impaired
Integumentary	○ No signs of bruising or abrasions ○ No redness or signs of infection ○ No swelling	Unimpaired
Communication	○ Communication was impaired due to the locking, popping, pain, and fatigue. ○ The TMJ mechanics were impaired resulting in communication limitations because speaking was extremely uncomfortable and painful. ○ She was able to communicate verbally for short periods of time, gestures, and in written form.	Impaired
Affect, Cognition, Language, Learning Style	○ Affect, cognition, language, and learning style were unimpaired. ○ Demonstrations, pictures, and verbal instructions were preferred.	Unimpaired

323

Table 2

Tests & Measures	**Initial Evaluation Results**
Goniometric Measurements	Depression: 17 mm with an increase in pain Right Lateral Excursion: 4 mm with an increase in pain Left Lateral Excursion: 4 mm with an increase in pain Cervical: Within normal limits
Strength	Facial musculature not tested at initial evaluation because of pain. Cervical and upper extremity strength normal (5/5).
Palpation of Joint Mechanics	Positive bilaterally for clicking/popping; it was felt and heard. Right and left TMJ did not move simultaneously; the left TMJ moved after the right TMJ
Sensation Crude touch:	Numbness and paraesthesia reported on left mandible; resolved within two weeks of initial evaluation
Soft Tissue Integrity	Tightness: masseter, temporalis, scalenes, SCM, trapezius, levator scapula, rectus capitus major and minor, obliques capitus major and minor, splenius capitus, longissimus capitis
Joint mobility assessment	Right TMJ: 2/6 (hypomobile) Left TMJ: 2/6 (hypomobile) Restricted bilaterally with L>R

Pain	cNPRS= 6/10 wNPRS= 9/10 bNPRS= 2/10
Observation in sitting and standing	Forward head and rounded shoulders. Pt. was able to move out of this position when cued.
Mandibular Function Impairment Questionnaire (MFIQ)	Total MFIQ RAW Score= 0.72; Q1: 1 / Q2: 2 / Q3: 4 / Q4: 4 / Q5: 1 / Q6: 1 / Q7: 0 / Q8: 3 / Q9: 3 / Q10: 3 / Q11: 3 / Q12: 4 / Q13: 4 / Q14: 4 / Q 15: 4 / Q16: 4 / Q17: 4 * Please note this is a disability index, scores are expected to decline over the course of treatment. MDC for the MFIQ = 8.6 points (CI= 90%).

Literature states to measure temporomandibular joint in millimeters; Measured in accordance to Kendall et al[9;] IE= initial evaluation; cNPRS= current Numerical Pain Rating Scale; wNPRS= worst Numerical Pain Rating Scale; bNPRS= best Numerical Pain Rating Scale; L= left; R= right; Q= question

Table 3

Goals

	Short Term Goals (4 weeks)	**Goal Achieved**	**Long Term Goals (8 weeks)**	**Goal Achieved**
Mandibular ROM Goals	Patient's mandibular depression will improve to 25 mm to improve ability to eat and speak.	8th visit	Patient's mandibular depression will improve to 50 mm week to improve ability to eat and speak.	Goal was not met; 62% of goal met at d/c
	Patient's L lateral excursion will improve to 6 mm to improve ability to eat and speak.	8th visit	Patient's L lateral excursion will improve to 10 mm to improve ability to eat and speak.	Goal not met; 95% of goal met at d/c
	Patient's R lateral excursion will improve to 6 mm to improve ability to eat and speak.	8th visit	Patient's R lateral excursion will improve to 10 mm to improve ability to eat and speak.	Goal not met; 80% of goal met at d/c
Mandibular Tightness Goal	Jaw tightness will decrease from moderate to mild to improve comfort and mobility so she is able to eat and speak comfortably.	8th visit	Jaw tightness will decrease from moderate to trace to improve comfort and mobility so she is able to eat and speak comfortably.	16th visit
Mandibular Locking Goal	Jaw locking will decrease from mild to	8th visit	Jaw locking will decrease from mild	16th visit

	minimal (<2x/week) to improve comfort and fear of eating.		to trace to improve comfort and fear of eating.	
Pain Goal	Pain rating will improve to range of 3-5/10 during all activities to improve patient's ability to socialize, communicate, and perform daily tasks.	8th visit	Pain rating will improve to range of 0-3/10 during all to improve patient's ability to socialize, communicate, and perform daily tasks.	8th visit
Work Goal	Patient will be able to return to part-time employment with some restrictions.	8th visit	Patient will be able to return to full-time employment without restrictions.	Goal not met; 90% of goal was met (patient returned to full time with some restrictions) at 15th visit.

ROM= Range of Motion; IE= initial evaluation; RE= re-evaluation; D/C= Discharge; R=Right; L=Left; mm= millimeters

APPENDICES

Appendix 1			
Tests & Measures	**Initial Evaluation Results**	**Re-evaluation: 8th Visit**	**Discharge 16th Visit**
Goniometry*	Depression: 17 mm with an increase in pain Right Lateral Excursion: 4 mm with an increase in pain Left Lateral Excursion: 4 mm with an increase in pain Cervical: Within normal limits	Depression: 23 mm with an increase in pain at end range Right Lateral Excursion: 6 mm with an increase in pain at end range Left Lateral Excursion: 6 mm with an increase in pain at end range Cervical: Within normal limits	Depression: 31 mm Right Lateral Excursion: 9.5 mm soreness at end range Left Lateral Excursion: 8 mm
Strength	Not tested at initial evaluation because of pain.	Depression: 4/5 with pain Right Lateral Excursion: 4/5 Left Lateral Excursion: 4/5 with soreness	Depression: 5/5 with pain Right Lateral Excursion: 5-/5 with some soreness at end range Left Lateral Excursion: 5/5
Retrodiscal Fad Pad Sign	Positive bilaterally with clicking/popping being felt and heard.	Negative on left Positive on right for clicking/popping being	Negative on left Positive on right for clicking/popping but

		felt	limited
Sensation Crude touch:	Numbness and paraesthesia reported on left mandible; not tested due to time constraints	Negative	Negative
Palpation	Tightness: masseter, temporalis, scalenes, SCM, trapezius, levator scapula, rectus capitus major and minor, obliques capitus major and minor, splenius capitus, longissimus capitis	Mild tightness: masseter and upper trapezius bilaterally. Moderate tightness temporalis, scalenes, SCM, trapezius, levator scapula, rectus capitus major and minor, obliques capitus major and minor, splenius capitus, longissimus capitis	Slight tightness: R<L. Mild tightness: temporalis, scalenes, SCM, trapezius, levator scapula, rectus capitus major and minor, obliques capitus major and minor, splenius capitus, longissimus capitis
Joint assessment	Right TMJ: 2/6 Left TMJ: 2/6 Restricted bilaterally with L>R	Not tested because one day post-arthocentesis	Right TMJ: 3/6 Left TMJ: 3/6 Slightly restricted but much improved from IE.
Pain	cNPRS= 6/10 wNPRS= 9/10 bNPRS= 2/10	cNPRS= 1/10 wNPRS= 3/10 bNPRS= 1/10	cNPRS= 0/10 wNPRS= 2/10 bNPRS= 0/10
Posture	Forward head and rounded shoulders. Pt. was able to move out of this position when cued.	Posture has improved and patient required less cueing to change posture.	Posture has improved and patient is able to correct posture on her own or with minimal cueing.
Mandibular Function Impairment Questionnaire (MFIQ)[9] *	Total MFIQ RAW Score = 0.72	Total MFIQ RAW Score= 0.40	Total MFIQ RAW Score= 0.06

*Measured with a goniometer (Dynasplint Systems, Inc., Western division, 800.638.6771); literature states to measure temporomandibular joint in millimeters.

* Please note this is a disability index, scores are expected to decline over the course of treatment. MDC for the MFIQ = 8.6 points (CI= 90%).

Appendix 2	
Interventions	
Rx Day 1	**Initial Evaluation** Patient Education: 5 minutes • TMJ anatomy • Treatment plan/ dry needling option • Symptom management • Exercise techniques • HEP Stretching:

	• Face Jaw Depression: 3 sets x 10 repetitions • Face Jaw Lateral Excursion: 3 sets x 10 repetitions Manual Therapy: • Cervical manual traction: 8 minutes
Rx Day 2	Warm up: • Moist heat: 8 minutes o Supine with cervical heat positioned on each TMJ Stretching: • Face Jaw Depression: 3 sets x 10 repetitions • Face Jaw Lateral Excursion: 3 sets x 10 repetitions • Jaw protrusion: 3 sets x 10 repetitions Manual Therapy: • Cervical manual traction: 8 minutes • Soft tissue mobilization: 8 minutes o Bilateral and multidirectional o Targeted masseter, temporalis, and trapezius Exercise Activities: • Chin tucks: 3 sets x 10 repetitions • Low rows: 3 sets x 10 repetitions • ER pullouts with yellow band: 3 sets x 10 repetitions
Rx Day 3	Warm up: • Moist heat: 8 minutes o Supine with cervical heat positioned on each TMJ Stretching: • Face Jaw Depression: 3 sets x 10 repetitions • Face Jaw Lateral Excursion: 3 sets x 10 repetitions • Side bend/rotation stretch: 3 sets x 30 second holds Manual Therapy: • Cervical manual traction: 5 minutes • Soft tissue mobilization: 5 minutes o Bilateral and multidirectional o Targeted masseter, temporalis, and trapezius • Mobilization with movement: 5 minutes o TMJ Exercise Activities: • Chin tucks: 3 sets x 10 repetitions • Low rows: 3 sets x 10 repetitions
Rx Day 4	Patient Education: 5 minutes • Dry needling • Symptom management • Exercise techniques Manual Therapy: • Cervical manual traction: 5 minutes • Soft tissue mobilization: 12 minutes o Bilateral and multidirectional o Targeted masseter, temporalis, and trapezius • Dry Needling Intervention: 12 minutes

	○ Education on intervention/ written and verbal consent ○ BL masseter Stretching: • Face Jaw Depression: 3 sets x 10 repetitions • Sidebend/rotation stretch: 3 sets x 30 second holds • Upper trapezius stretch: 3 sets x 60 second holds
Rx Day 5	Manual Therapy: • Soft tissue mobilization: 12 minutes ○ Bilateral and multidirectional ○ Targeted masseter, temporalis, and trapezius Patient Education: 5 minutes • Dry needling option • Symptom management • Exercise techniques Stretching: • Face Jaw Depression: 3 sets x 10 repetitions • Face Jaw Lateral Excursion: 3 sets x 10 repetitions • Side bend/rotation stretch: 3 sets x 30 second holds • Upper trapezius stretch: 3 sets x 60 second holds Exercise Activities: • Low rows: 3 sets x 10 repetitions • Bilateral pull downs: 3 sets x 10 repetitions
Rx Day 6	Manual Therapy: • Cervical manual traction: 5 minutes • Soft tissue mobilization: 15 minutes ○ Bilateral and multidirectional ○ Targeted masseter, temporalis, and trapezius • Mobilization with movement: 5 minutes ○ TMJ Patient Education: 5 minutes • Dry needling option • Symptom management Stretching: • Face Jaw Depression: 3 sets x 10 repetitions • Face Jaw Lateral Excursion: 3 sets x 10 repetitions • Side bend/rotation stretch: 3 sets x 30 second holds • Upper trapezius stretch: 3 sets x 60 second holds • Towel Stretch: 3 minute hold
Rx Day 7	Manual Therapy: • Cervical manual traction: 8 minutes • Soft tissue mobilization: 10 minutes ○ Bilateral and multidirectional ○ Targeted masseter, temporalis, and trapezius Stretching: • Face Jaw Depression: 3 sets x 10 repetitions • Door stretch: 3 x 60 seconds Exercise Activities:

	• Low rows: 3 sets x 10 repetitions • Bilateral pull downs: 3 sets x 10 repetitions • 4- Way cervical isometrics: 1 x 10 each way • Chin tucks: 3 sets x 10 repetitions • ER pullouts with yellow band: 3 sets x 10 repetitions

Rx Day 8	**Re-evaluation performed**
	Manual Therapy:
	• Cervical manual traction: 8 minutes
	• Soft tissue mobilization: 8 minutes
	  o Bilateral and multidirectional
	  o Targeted masseter, temporalis, and trapezius
	Stretching:
	• Face jaw depression: 3 sets x 10 repetitions
	• Towel stretch: 3-minute hold
	Exercise Activities:
	• Low rows: 3 sets x 10 repetitions
	• Bilateral pull downs: 3 sets x 10 repetitions
	• 4- Way cervical isometrics: 1 x 10 each way
	• Chin tucks: 3 sets x 10 repetitions
	• ER pullouts with yellow band: 3 sets x 10 repetitions

Rx Day 9	Manual Therapy:
	• Soft tissue mobilization: 8 minutes
	  o Bilateral and multidirectional
	  o Targeted masseter, temporalis, and trapezius
	Stretching:
	• Face jaw depression: 3 sets x 10 repetitions
	• Face jaw lateral excursion: 3 sets x 10 repetitions (R and L)
	• Foam roller stretch: 3-minute hold
	• Upper trapezius stretch: 3 x 60 second hold
	Exercise Activities:
	• Upper body ergometer: 3 minutes forward/ 3 minutes backward
	• Low rows: 3 sets x 10 repetitions
	• Bilateral pull downs: 3 sets x 10 repetitions
	• 4- Way cervical isometrics: 1 x 10 each way
	• Chin tucks: 3 sets x 10 repetitions
	• ER pullouts with yellow band: 3 sets x 10 repetitions

Rx Day 10	Manual Therapy:
	• Cervical manual traction: 8 minutes
	• Soft tissue mobilization: 8 minutes
	  o Bilateral and multidirectional
	  o Targeted masseter, temporalis, and trapezius
	Stretching:
	• Face jaw depression: 3 sets x 10 repetitions
	• Face jaw lateral excursion: 3 sets x 10 repetitions (R and L)
	• Foam roller stretch: 3-minute hold
	• Upper trapezius stretch: 3 x 60 second hold

	Exercise Activities: • Upper body ergometer: 3 minutes forward/ 3 minutes backward • Low rows: 3 sets x 10 repetitions • Bilateral pull downs: 3 sets x 10 repetitions • ER pullouts with yellow band: 3 sets x 10 repetitions

Rx Day 11	Manual Therapy:
	• Cervical manual traction: 8 minutes
	• Soft tissue mobilization: 8 minutes
	  o Bilateral and multidirectional
	  o Targeted masseter, temporalis, and trapezius
	Stretching:
	• Face jaw depression: 3 sets x 10 repetitions
	• Face jaw lateral excursion: 3 sets x 10 repetitions (R and L)
	• Foam roller stretch: 3-minute hold
	• Upper trapezius stretch: 3 x 60 second hold
	Exercise Activities:
	• Upper body ergometer: 3 minutes forward/ 3 minutes backward
	• Low rows: 3 sets x 10 repetitions
	• Bilateral pull downs: 3 sets x 10 repetitions
	• ER pullouts with yellow band: 3 sets x 10 repetitions

Rx Day 12	Manual Therapy:
	• Cervical manual traction: 8 minutes
	• Soft tissue mobilization: 8 minutes
	  o Bilateral and multidirectional
	  o Targeted masseter, temporalis, and trapezius
	Stretching:
	• Face jaw depression: 3 sets x 10 repetitions
	• Face jaw lateral excursion: 3 sets x 10 repetitions (R and L)
	• Foam roller stretch: 3-minute hold
	• Upper trapezius stretch: 3 x 60 second hold
	Exercise Activities:
	• Upper body ergometer: 3 minutes forward/ 3 minutes backward
	• Low rows: 3 sets x 10 repetitions
	• Bilateral pull downs: 3 sets x 10 repetitions
	• Triceps press: 3 sets x 10 repetitions
	• ER pullouts with yellow band: 3 sets x 10 repetitions

Rx Day 13	Manual Therapy:
	• Cervical manual traction: 8 minutes
	• Soft tissue mobilization: 8 minutes
	  o Bilateral and multidirectional
	  o Targeted masseter, temporalis, and trapezius
	Stretching:
	• Face jaw depression: 3 sets x 10 repetitions

	• Face jaw lateral excursion: 3 sets x 10 repetitions (R and L) • Foam roller stretch: 3-minute hold • Upper trapezius stretch: 3 x 60 second hold Exercise Activities: • Upper body ergometer: 3 minutes forward/ 3 minutes backward • Low rows: 3 sets x 10 repetitions • Bilateral pull downs: 3 sets x 10 repetitions • Triceps press: 3 sets x 10 repetitions ER pullouts with yellow band: 3 sets x 10 repetitions
Rx Day 14	Manual Therapy: • Soft tissue mobilization: 8 minutes o Bilateral and multidirectional o Targeted masseter, temporalis, and trapezius Stretching: • Face jaw depression: 3 sets x 15 repetitions • Face jaw lateral excursion: 3 sets x 15 repetitions (Bilateral) • Foam roller stretch: 3-minute hold • Upper trapezius stretch: 3 x 60 second hold Exercise Activities: • Upper body ergometer: 3 minutes forward/ 3 minutes backward • Low rows: 3 sets x 15 repetitions; 20 pound • Bilateral pull downs: 3 sets x 15 repetitions; 20 pounds • Triceps press: 3 sets x 10 repetitions; 15 pounds • ER pullouts with red band: 3 sets x 15 repetitions
Rx Day 15	Manual Therapy: • Soft tissue mobilization: 8 minutes o Bilateral and multidirectional o Targeted masseter, temporalis, and trapezius Stretching: • Foam roller stretch: 3-minute hold • Upper trapezius stretch: 3 x 60 second hold • Side bend/ rotation stretch: 3 x 60 second hold Exercise Activities: • Upper body ergometer: 3 minutes forward/ 3 minutes backward • Low rows: 3 sets x 15 repetitions; 20 pound • Bilateral pull downs: 3 sets x 15 repetitions; 20 pounds • Triceps press: 3 sets x 10 repetitions; 15 pounds • ER pullouts with red band: 3 sets x 15 repetitions • Sidelying Horizontal GH Abduction: 3 sets x 10 repetitions, 1 pound
Rx Day 16 (D/C)	Performed during HEP: (not performed during session) • Upper trapezius stretch: 3 x 60 second hold • Side bend/ rotation stretch: 3 x 60 second hold • Face jaw depression: 3 sets x 15 repetitions • Face jaw lateral excursion: 3 sets x 15 repetitions (Bilateral) Patient Education: 8 minutes • Home Exercise Program o Resisted Exercises

	• Self-mobilization technique
	Manual Therapy:
	• Soft tissue mobilization: 8 minutes
	  ○ Bilateral and multidirectional
	  ○ Targeted masseter, temporalis, and trapezius
	Stretching:
	• Foam roller stretch: 3-minute hold
	Exercise Activities:
	• Upper body ergometer: 3 minutes forward/ 3 minutes backward
	• Low rows: 3 sets x 15 repetitions; 20 pound
	• Bilateral pull downs: 3 sets x 15 repetitions; 20 pounds
	• Triceps press: 3 sets x 10 repetitions; 15 pounds
	• ER pullouts with red band: 3 sets x 15 repetitions
	• Sidelying Horizontal GH Abduction: 3 sets x 10 repetitions, 1 pound; bilateral

336

Appendix 3

Intervention Descriptions

Mandibular Depression Stretch
With tongue pushing into roof of mouth, patient performs mandibular depression.
(10 x 3 sets and progressed to 15 x 3 sets)

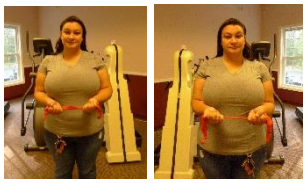
Mandibular Lateral Excursion Stretch
With tongue pushing into roof of mouth, patient performs mandibular left or right lateral excursion.
(10 x 3 sets and progressed to 15 x 3 sets)

Upper Trapezius Stretch
Patient sat with neutral posture, tilted head to one side until she felt a strong but gently stretch. Held stretch for 60 seconds, 3x per each side.

Side Bend / Rotation Stretch
Patient sat with neutral posture with upper extremities placed at sides with palms up, she then look toward her opposite pocket until she felt a strong, but gentle stretch. Held stretch for 60 seconds, 3x per side.

Foam Roller Stretch
Placed roller in between shoulder blades, open arms out to side with palms up and knee bent.
1 minute and progressed to 3 minutes

Upper Body Ergometer (UBE)
6 minutes on the UBE: 3 minutes forwards and 3 minutes backwards.



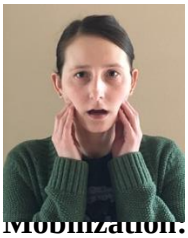
External Rotation with Theraband
(The Hygienic Corporation, Ohio)
Arms at sides with elbows bent at 90 degrees, with band in hands facing the ceiling. Bring shoulder blades towards the spine and pulling band laterally.
10 x 3 sets and progressed to 15 x 3 sets
Started with no band, progressed to yellow (a lighter resistance) and then red band (greater resistance).

Low Rows
Patient started with elbows straight, then pull back, bending elbows and squeezing shoulder blades together. Then slowly returned to starting position.
10 x 3 sets and progressed to 15 x 3 sets

Bilateral Symmetrical Pull Downs
Patient started with elbows straight, then pull back, bending elbows and squeezing shoulder blades together. Then slowly returned to starting position.
10 x 3 sets, progressed to 15 x 3 sets, then 20 x 3 sets

Triceps Press
Patient started with elbows at sides, then extended arms, straightening elbows bring hands to the floor. Then slowly returning to original position with elbows bent.
10 x 3 sets, progressed to 15 x 3 sets, then 20 x 3 sets

Sidelying Horizontal Abduction

(1-pound weight in photo) Patient was positioned in sidelying with arms extended, hands resting on top of one another. Perform horizontal abduction with top arm without allowing hips to move, allowing the chest to open. 10 x 3 sets and progressed to 15 x 3 sets	**Chin Tucks**[14] Patient was instructed to sit in neutral posture and slowly draw her head backwards, as if there was a string attached to the base of her skull. 10 x 3 sets and progressed to 15 x 3 sets,
 **Resisted Depression**[14] Patient sits with jaw slightly open for correct alignment. Depresses mandible while hand provides mild resistance. Holds for 5-10 seconds.	 **Resisted Lateral Excursion**[14] Patient sit and opens jaw slightly for correct alignment. Move mandible to side while using hand to give mild resistance. Holds 5-10 seconds.
 **Soft Tissue Mobilization: Masseter**[14] Patient finds localized tenderness, applies moderate pressure and then opens the jaw. 3-4 repetitions for discomfort or as needed	

337