ELECTROMYOGRAPHY
in Physical Therapy and Dentistry

7 Protocol for use of EMG and Tactile Biofeedback in Treatment of Temporomandibular Disorders and Myofacial Pain

Paul Canavan, PhD, PT, ATC, CSCS
Assistant Professor
Department of Physical Therapy
Northeastern University
Boston, Massachusetts

Jessica Capurso, SPT
Student, Doctorate of Physical Therapy
Northeastern University
Boston, Massachusetts

Introduction:
Temporomandibular disorders (TMDs) are a group of problems characterized by a dull, deep orofacial pain typically in front of the ear, the muscles of mastication, the masseter in particular, or the temporomandibular joint (TMJ). People with a TMD might also complain of other facial pain, tension-type headaches, neck, shoulder, or back pain[1-7]. The pain associated with TMDs can result in decreased function. TMD patients might also present with a variety of jaw problems, such as difficulty in maximally opening the jaw, locking in the open or closed position, clicking, popping or grating noises, due to abnormal position of articular disc. Degenerative disorders that lead to erosion and flattening of the condoyle, as well as bone spurs or other undesirable growths on the condoyle adversely affect the TMJ. The symptoms presented by TMD patients can mimic a variety of disorders, and patients may seek care from several different healthcare providers. Forty percent of TMD patients who were referred to a tertiary dental care center had previously consulted a physician for the problem. The varied symptomatology of TMD patients, resulting in consultations with several health care providers may account in part for the significantly greater 2-year cost of treating TMD patients compared to patients without TMDs[1].

Incidence and Prevalence:
In a survey of 45,711 American households by Lipton et al, 22% of the general population or 40 million Americans over 18 years of age experienced some form of orofacial pain. TMJ pain accounted for 7% of those who reported orofacial pain in this

survey[6]. Studies estimate that 3.6-7.0% of individuals in North America have significant signs and symptoms of TMDs that require healthcare intervention. There are no racial or ethnic differences regarding the prevalence of TMDs. There is a significant gender difference: the prevalence of TMDs in males is 3.2-10% and the prevalence in females is 6.3-14%. The highest incidence of complications of TMDs is in their reproductive years and a significant decline of incidence after the age of 45. In addition, women are more likely to experience disability due to TMDs, and they represent over 80% of the patients who receive treatment of TMDs[3]. Other sources estimate that 20% of the population is affected by TMDs and 10-20% of those seek medical attention[7].

Objective:

Currently, there is a lack of consensus among researchers regarding the etiology, diagnosis, and management of this disorder. Noninvasive, conservative treatments generally provide improvement or relief of symptoms and are recommended in the initial management of TMDs[7]. Conservative treatment of individuals with TMDs can be discouraging; however, the use of electromyography (EMG) as an adjunct to and in conjunction with other therapy interventions may be beneficial. The goal of this article review is to use an evidence based approach to present a novel treatment protocol for treatment of pain associated with TMDs. This innovative approach integrates the use of visual auditory feedback from EMG supplemented with the use tactile feedback from self-palpation to re-educate patients to volitionally relax the muscles of mastication.

In 1971, J. Adams developed his closed-loop theory of motor learning emphasizing feedback. Adams believed that all movements are made by comparing the ongoing feedback from the body to a reference of correctness that is learned during practice[8]. Biofeedback involves developing patients' ability to alter a particular physiological response by providing them feedback about the response they are attempting to control[4]. The use EMG biofeedback provides concurrent visual and auditory feedback of the muscle tension of the muscles of mastication. The data compiled from the EMG device when the muscle tested is at a state of optimal rest serves as a reference of correctness to maintain the least amount of tension.

This method of treatment utilizes complex control of various closed loop systems that compare visual and auditory feedback from the EMG device and tactile sensations to the patients' optimal state of relaxation. To increase efficacy, additional visual feedback can be obtained by using a mirror to monitor the patient's performance. This collaboration of knowledge of performance allows the patient to cognitively train the masticatory muscles in relaxation. Upon progression of treatment, an autogenic open loop relaxation of the targeted muscles is established, providing alleviation and future prevention of the increased muscle tension that causes pain and dysfunction associated with TMDs.

Efficacy of treatment methods:

The use of EMG biofeedback has been shown to be successful in lessening myofacial pain due to primary or secondary temporomandibular disorders. Crider and Glaros concluded that a variety of biofeedback interventions, including the use of EMG

biofeedback collectively demonstrate treatment efficacy[2]. A meta-analysis of the efficacy of biofeedback-based treatments of TMDs investigated 13 studies of EMG biofeedback treatment of TMDs, including 6 controlled, 4 comparative treatment, and 3 uncontrolled trials. The outcome variables examined were patient pain reports, clinical exam findings, and ratings of global improvement. Five of the six controlled trials found EMG biofeedback treatments of TMDs to be superior to no treatments or psychologic placebo controls for at least one of the three types of outcomes. Patients treated with EMG biofeedback methods showed improved and/or symptoms free post-treatment outcomes in 69% of patients, as compared to 35% of patients treated with a variety of placebo interventions. There were no findings of apparent deterioration at follow-up assessments[1]. These conclusions suggest successful results with retention.

Dental and other health professions recognize psychosocial and emotional factors as playing key roles in the etiology, maintenance, and treatment of TMDs. An emerging biopsychosocial approach creates a role for biofeedback as part of the treatment plan for TMDs. Pain is a complex behavior and not merely a pure sensory experience; biofeedback is the most beneficial for patients when used as one adjunctive component of an interdisciplinary pain management program[4]. The use of tactile sensation bilaterally over the TMJ is an effective treatment tool that has been used by the authors fro several years to provide feedback on normalization of TMJ arthrokinematics, decreased pain, and improved quality of life.

EMG Biofeedback and Treatment Protocol:

The first objective of the protocol is to orient the patient with proper use of the MyoTrac™ EMG equipment[9]. A basic explanation of relationships between prolonged masticatory muscle contraction and perceived orofacial pain is critical for the success of the rehabilitation. This explanation provides the patient with information regarding the efficacy of the methods of treatment. A rationalization of the implementation of EMG and tactile biofeedback for reduction in this heightened muscle activity provides the patient with an understanding of the pain associated with TMDs, and therefore an improved sense of control. This improved sense of control helps to relieve stress, anxiety and depression[5], which increases compliance with home exercise programs, and it aids in patients' retention of proper motor patterns, and TMJ arthrokinematics. This sustained motor learning displays the transition to an open loop learned response from the use of several closed loop feedback systems, which is the primary objective of this treatment protocol.

At the start of treatment, begin by measuring the amount of mandibular opening and note any abnormalities of the motion (i.e. S-curve, J-curve). Record observations in Data Table #1. Next, gently palpate the patient's TMJ bilaterally while he/she slowly opens and closes that mandible. This component allows for a tactile sense as well as a visual analysis of arthrokinematic abnormalities. Repeat three times. Allow patient to apply the tactile component to his/her own TMJ while opening the mandible. Repeat three times. Finally place patient in front of a mirror to visually display mandibular deviations to the patient. During this process of explaining the protocol, instruct the patient to self correct

any deviations to consciously normalize mandibular movement in using the various types of feedback.

Exercises	Description of motion	Alteration for Progression
Exercise #1: ***Mandibular Opening***	Start at neutral mandible position. Slowly perform sub-maximal mandibular opening through a count of 2 seconds: ➢ 1 set of 5 repetitions.	Increase amount and speed of mandibular opening.
Exercise #2: ***Tongue to Roof of Mouth***	Start with lips closed with jaw and teeth in a relaxed state. Bring tip of tongue to roof of mouth and hold for 3 seconds: ➢ 1 set of 5 repetitions.	Decrease the time for holding tongue to roof of mouth.
Exercise #3: ***Mandibular Protrusion***	Use starting position from Phase #2. Protrude tongue. Bring lateral sides of tongue up and together, forming a cylindrical-like configuration. Let sides of tongue down to neutral position and bring tongue back into mouth: ➢ 1 set of 5 repetitions.	Increase speed of motion.

Table 1: *Rehabilitation protocol using tactile cues in adjunct with EMG biofeedback for the treatment of TMDs.*

Once the patient is oriented and comfortable with the introduction to the treatment, electrode sensors of a single channel MyoTrac^{TM} EMG device are to be placed upon the midsubstance of the masseter muscle belly, in line with muscle fibers. Since the device used in this treatment is a single channel EMG unit, chose TMJ that has the most palpable deviation. Be sure to ensure proper electrode placement, as defined by Figure 1. Instruct the patient to relax the facial muscles, keeping lips closed. Record average EMG activity at this relaxed state for 1-2 minutes. This establishes a baseline level of muscle relaxation to use as a reference of correctness.

Once a baseline threshold is established, instruct patient to palpate TMJ region, apply tactile component, and perform Exercise #1 of the rehabilitation protocol, as defined in Table 1. Allow for patient to reach baseline threshold once Exercise #1 is completed, then complete Exercise #2. Follow same steps for Exercise #3.

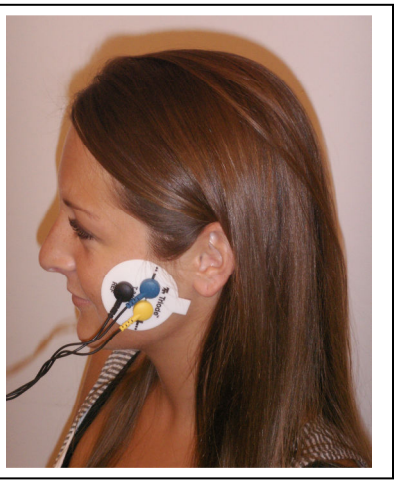

Figure 1: *Proper electrode placement of single channel MyoTrac™ EMG device. Ensure the sensor portion of the electrode lies parallel to masseter muscle fibers.*

Outcomes Measured:

The outcomes of this treatment protocol measured are patient pain reports at rest and after treatment using Visual Analog Scale (VAS) and a quantitative assessment in centimeters of maximal mandibular opening before and after treatment. The pattern, extent, and frequency of lateral deviations and incidence of clicking, popping, or other irregular noises are observed and noted as well.

Many activities of daily life can have negative effects on Normal TMJ arthrokinematics. Table 2 provides suggestions about how to avoid pain and positions that aggravate or lead to complications associated with TMDs.

Actions and Positions to Avoid[5]

- Clenching jaw or teeth
- Chewing gum for prolonged time
- Eating tough food or candy
- Stressful stimuli
- Resting chin, jaw, or side of face in the palm of hand
- Yawning with wide open mouth
- Biting nails
- Forced closed lips
- Licking lips or teeth
- Prolonged chewing
- Any deviation of jaw from neutral position.
- Biting into food with front teeth
- Lying on one side of the face

Table 2: *Actions and positions to avoid for the treatment and prevention of TMDs.*

Phase of Treatment	Lowest uV Left	Lowest uV Right	Average uV Left	Average uV Right	Difference Left-Right
Phase #1: *Mandibular Opening*					
Phase #2: *Tongue to Roof of Mouth*					
Phase #3: *Mandibular Protrusion*					

Measurable Outcome	Before treatment	After treatment
Measurement of Mandibular Opening		
Patient Pain Reports using VAS		
Other Observations (i.e. S-curve, J-curve)		

Table 3: ***To record data and observations before and after treatment.***

Summary:
The use of EMG biofeedback supplemented with visual and tactile components of biofeedback can be an effective approach in treatment of the pain and dysfunction associated with TMDs. By establishing an autogenic relaxation and normal muscle firing of the masticatory muscles through practice and integrating several forms of closed-loop feedback, this technique can result in long term relief of TMD symptoms. Other areas of concern relating to TMD are the effects of ergonomics of work station and cervical spine and associated musculature. These areas of concern should be addressed in addition to direct TMD treatment.

REFERENCES

1. Crider A, Glaros AG. A meta-analysis of EMG biofeedback treatment of temporomandibular disorders. *Journal of Orofacial Pain.* 1999; 13(1): 29-37.

2. Crider A, Glaros AG, Gervirtz RN. Efficacy of biofeedback based treatments for temporomandibular disorders. *Applied Psychophysiology and Biofeedback.* 2005; 30(4): 333-345.

3. DeRossi SS, Stoopler ET, Sollecito TP. Temporomandibular disorders and migraine headaches: co-morbid conditions? *The Internet Journal of Dental Science.* 2005: 2(1).

4. Gatchel RJ. Biofeedback as an adjunctive treatment modality in pain management. *Pain Clinic Perspectives.* 2004; 14(4).

5. Hudzinski LG, Walters PJ. Myofacial pain and TMJ: the use of electromyographic biofeedback for the treatment of facial pain. *Electromyography in Physical Therapy and Dentistry.* 1993:1-4.

6. Lipton JA, Ship JA, Larach-Robinson D. Estimated prevalence and distribution of reported orofacial pain in the United States. *J Am Dent Assoc.* 1993; 124: 115-121.

7. Medlicott MS, Harris SR. A systematic review of the effectiveness of exercise, manual therapy, electrotherapy, relaxation training and biofeedback in the management of temporomandibular disorders. *Physical Therapy.* 2006; 86(7):955-973.

8. Schmidt RA, Lee TD. *Motor Control and Learning: 4th edition.* Champaign: Human Kinetics; 1999.

9. Thought Technology Ltd. Montreal, QC, Canada. www.thoughttechnology.com