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USE OF GUM CHEWING AND ELECTROMYOGRAPHY IN THE CONSERVATIVE TREATMENT OF UNILATERAL MASSETER MUSCLE HYPERACTIVITY

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ABSTRACT

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It is estimated that up to 10% of the American public has some form of Temporomandibular Joint Disorder (TMD), of whom perhaps 5 % may seek or need treatment. The purpose of this study is demonstrate that chewing gum for 5 minutes on the involved side at levels less than maximal contraction will decrease resting muscle tone in the masseter muscle as demonstrated through surface electromyography.

This study examined 40 normal subjects as well as 6 people diagnosed with TMD. The results showed that there was a siginificant decrease in masseter output after the intervention.as measured by EMG in the normals. There was not enough data in the TMD population from which to make conclusions.

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CHAPTER 1

INTRODUCTION

WHAT IS TMD?

The term temporomandibular disorders (TMDs), also known as myofacial pain dysfunction syndrome or temporomandibular joint pain dysfunction syndrome, refers to a group of clinical problems that involve the temporomandibular joint (TMJ) or joints, the masticatory musculature (mainly masseter and temporalis), or both. Such disorders are considered to be a subclassification of musculoskeletal disorders and are a major source of non-dental pain in the orofacial region. It is estimated that up to 10 percent of the American public has some form of TMD, of whom perhaps five percent may seek or need treatment (Kraus, 1994).

TMDs involve many different diseases and the diagnoses are mainly of a musculoskeletal character. However, the signs and symptoms of these diseases have many features in common. TMDs are characterized by pain and discomfort in the joints and masticatory muscles, often associated with joint sounds, TMJ pain, masticatory muscle pain or tenderness, restricted mandibular movement, joint locking, and dislocation (Katz, Rugh, Hatch, Langlais, Terezhalmy, & Borcherding, 1989; Dalen, Elertsen, Espelid, & Gronningsaeter, 1986; Palla, & Ash, 1981; McNeill, 1991). Research shows a significant correlation between muscle activity, especially in the jaw-closing muscles, and TMD symptoms (Kumai, 1993). Symptoms include continuous muscle activity (spasm), muscle hyperactivity in natural chewing, and psychic tension or emotional stress closely associated with abnormal muscle activity (Kumai, 1993; Katz et al., 1989; Gay, Maton, Rendell, & Majourau, 1994; Solberg, 1986; Kawazoe, Kotani, & Hamada, 1979).

ANATOMY AND PHYSIOLOGY OF TMD

A brief description of the functional anatomy of the TMJ complex is presented toclarify the subject of this study. The TMJ is one of the most frequently used joints in the body, but it probably receives the least amount of attention. The joints are paired structures which allow the mandible to move, as a single unit, in function. The mandible is set in motion by the attached voluntary musculature after this musculature is suitably stimulated by nervous impulses to produce functional movements. The range of these various movements are controlled, guided, and limited by teeth, joint structures, nerves, muscles and ligaments (Perry, 1957). Practitioners of dentistry and medicine have long been aware that the TMJs are among the few joints in the body that, like the vertebral joints, function as a unit in a sliding-gliding action. However, the many intricacies of the TMJ are just beginning to be appreciated.

The skeletal and muscular architecture of the masticatory system is designed to perform efficient ingestion and deglutition. In function, force is transmitted from the teeth to the alveolar processes, sustained by the symphysis and external oblique ridges, then in a direct line to the condylar heads. Masticatory force is transmitted to the cranium via the cranial attachments of the muscles of mastication, the maxillary teeth, and the craniomandibular articulation.

The mandible forms a diarthrosis with the temporal bone spanned by suspensory ligaments containing a synovial lining that secretes synovial fluid. The suspensory ligaments (capsular and lateral) restrain the functional movements of the mandible.

The disc of the TMJ is a fibrocartilaginous, intra-articular structure that separates the condylar head from the mandibular fossa. Tightly bound to the capsular ligaments, the disc is thickest superiorly, medially, and laterally to stabilize condylar movements. Synovial fluid is contained in both the superior and inferior joint spaces and retrodiscal connective tissue is located in the posterior joint space.

The muscles of mastication are the paired masseter, temporalis, medial pterygoid, and lateral pterygoid. Of these, the masseter muscles are the focus of this study. The masseter muscle is a thick and powerful muscle advantageously placed to produce maximum masticatory force for complete clench in the molar region. It is a quadrilateral muscle innervated by the trigeminal nerve consisting of three superimposed layers blending into superficial and deep bellies.

Muscular contractions, both isometric and isotonic, eventually fatigue when contracted for prolonged periods during exercise. A muscle fatigues when a strong contraction strangulates the blood flow through the tissue. This subsequent lack of oxygen changes the aerobic metabolism to an anaerobic one, the end product of which is mainly lactic acid. Because of the negligible blood flow this by-product is not washed out, and thus creates a lowered intracellular pH. Consequently, fiber conduction velocity is decreased and the shape of the action potential is changed, giving rise to changes in muscle activity (EMG) (Lindstrom, Magnusson, & Petersen, 1970).

CURRENT PT PRACTICES WITH TMD PATIENTS

In the treatment of TMD, physical therapy (PT) currently employs conservative treatment methods such as heat, cold, diathermy, ultrasound, interferential therapy, stretching, mobilizations, and exercise. Conservative treatment has been found to be effective for the great majority of patients with the pain dysfunction syndrome. PT as a whole has been reported to have a positive effect on many signs and symptoms of TMD, but the assessments have been uncontrolled and the application of these methods is almost entirely empirically based (Dahlstrom, 1992). In addition, the completion of more research related to functional home programs may improve the quality, and quantity, of life for TMD individual.

USE OF EMG IN TMD ANALYSIS

Investigators are divided into two broad camps of opinion as to whether craniomandibular muscles exhibit resting electromyographic (EMG) activity in subjects who are not using their mandible in an oral function such as chewing. One group expounds the position that subjects sitting upright in a relaxed position do not demonstrate muscle activity as assessed by EMG. The second group has supported the viewpoint that the resting skeleton requires active recruitment of selected regions of specific muscles (Naeije, 1988). The importance of this problem is the lack of current research and functional exercise programs designed for home use with TMD individuals.

Abnormal muscular activity of the jaw-closing muscles is a significant factor in TMD symptoms. EMG recordings can be used to determine resting muscle tone of the masseter after chewing gum on the involved side for five minutes compared to pre-exercise levels.

PURPOSE OF THE STUDY

The purpose of this study is to demonstrate that chewing gum on the involved side at levels less than maximal contraction for five minutes will decrease resting muscle tone and spasticity in the masseter muscle as demonstrated through surface EMG.

CHAPTER 2

LITERATURE REVIEW

The temporomandibular joint (TMJ) is often overlooked as one of the most complicated joints in the human body. The bilateral TMJs are used everyday for talking, swallowing, and chewing. Furthermore they are in close contact with the skull (actually articulating with it). Thus lends more interest in the TMJ because everything the TMJ does affects the head. Furthermore, pain in the joint can be referred to the face and cranial areas.

BACKGROUND OF TMD

In temporomandibular disorders (TMD) the leading etiological factors believed to be responsible for the dysfunction of the masticatory muscles are muscle hyperactivity, tension, and spasm (Chong-Shan, & Hui-Yun, 1989). The term "craniomandibular dysfunction" (CMD), which is synonymous with TMD, covers a wide range of abnormal and pathologic conditions caused by physical strain of the muscle of mastication, i.e. the masseter and temporalis, and the TMJs. These conditions are accompanied by headache, orofacial pain, and impaired function (Bakke, 1993). The term myofascial pain dysfunction (MPD) will also be used for "craniomandibular dysfunction" (CMD).

PHYSICAL THERAPY RESEARCH

There is little physical therapy research dealing with craniomandibular dysfunction treatment. The treatment modalities used by physical therapists are not specific to the TMJ and they include moist heat, cold, ultrasound (US), spray and stretch techniques, electrical stimulation, joint mobilizations, and exercise. These treatments are sometimes used in conjunction with dental therapies such as occlusal splints, medications, intraarticular injections, and joint surgery (Bradley, 1987; Sheikholeslam, Moller, & Lous, 1982). The treatments usually just deal with the symptoms of pain, muscle spasm, and tenderness rather than the causative factor of muscle hyperactivity.

The use of biofeedback as a treatment for the CMD/MPD has been proven to be valuable in decreasing the muscle spasm or hyperactivity and also helps the patient regain proper function to the affected joint or joints (Kopp, 1982). The patient can visually see the tension in the muscle and then try to decrease the tension which leads to a reduction in their symptoms and an improved functional state.

USE OF EMG

As has been stated, the major causative factor in MPD or CMD is muscle hyperactivity, tension, and spasm. Before reviewing the work done on muscular hyperactivity and fatigue the use of electromyography (EMG) will be discussed because electromyography is a common method used to quantify muscle activity. EMG is the procedure of recording muscular action potentials produced by muscle fibers or bundles to the electrodes that monitor activity (Bakke, 1993). The basic unit in the nerve-muscle interaction is the motor unit, which is the nerve and all the muscle fibers it innervates. Action potentials are nerve impulses that stimulate muscle to contract; the recorded potentials are summed from several motor units (Bakke, 1993). EMG uses two different types of electrodes to pick up the muscular activity: invasive needle electrodes and non-invasive surface electrodes. The needle electrodes are inserted into the muscle to be recorded, while the surface electrodes pick up the myoelectric activity through the skin. The needle electrodes, because they are inserted into a specific muscle, are generally regarded as better for electromyographic studies.

Physical therapists traditionally do not use invasive techniques such as the insertion of needle electrodes into a muscle. Therefore, physical therapists have relied on the usage of surface electrodes (SE) in electromyographic studies of muscles. The masticatory muscles usually involved in EMG of the TMJ are not large and therefore lend themselves well to the use of surface electrodes. Surface electrodes are generally regarded as satisfactory for recording general activity, but they also pick up activity from surrounding muscles (Wood, 1987). Even so, surface electrodes have been shown to be effective for recording from both the superficial and deep masseter muscles (Wood, 1987).

EMG studies use a variety of methods for quantifying data in order to objectify the electromyographic data. These methods include power spectrum, amplitude, and duration. The power spectrum is synonymous with the muscle output (force). The amplitude is the measure of the maximum value of current with reference to the baseline. Amplitude is synonymous with intensity, which deals with the height of the action potentials, i.e. the nerve impulses. The duration deals with the time phase of the conduction velocity of the nerve impulse to the muscle (how quickly the impulse arrives to the muscle). These techniques for objectifying data from the EMG allow studies to demonstrate the effects of exercise on the masseter muscle's resting muscle tone (Chong-Shan, & Hui-Yun, 1991).

EMG & HYPERACTIVITY

The masseter muscle tends to be more susceptible to hyperactivity (increased resting muscle tone) than the temporalis muscle (Moller, Sheikholeslam, & Lous, 1984). For a particular muscle, hyperactivity is considered to be a quantity relative to its maximal strength. Therefore, the effect of hyperactivity and its sequelae in terms of pain and tenderness may depend on the particular muscle's strength (Sheikholeslam, Moller, & Lous, 1980). When healthy, normally innervated voluntary muscle is at rest there are no or low signs of activity recorded by surface electrodes (Perry, 1957). The masseter muscle, in TMDs and occlusal disharmonies, constantly exhibit low-grade electrical activity even when the jaw is in the rest position (Perry, 1957). This study is based on the foundation that the masseter muscle is in a hyperactive state and that this condition leads to the pain and spasm associated with the dysfunction.

According to Dahlstrom (1989), the studies of basic EMG activity consistently show increased rest activity in the masseter and temporalis muscles when recorded in groups of patients with CMD. The frequency, intensity (amplitude), and duration of masseter muscle activity appeared to greater in patients than in healthy individuals. The hyperactivity associated with the masticatory musculature is closely related with the concept of muscle fatigue.

MUSCLE FATIGUE & EMG

Muscle fatigue can be defined as a transient loss of work capacity resulting from preceding work regardless of whether or not the current performance is affected (Bigland-Ritchie, Cafarelli, & Vollestad, 1986). The muscle during fatigue cannot maintain the level of initial force. During fatigue several electromyographic events occur. There is a shift to lower frequency muscle activity which is due to the decrease in conduction velocity of the action potentials of the muscle fibers. This leads to a longer duration of the motor unit action potentials. The fatigue is found to cause the conduction velocity to decrease as well as the integrated EMG signal (Palla, & Ash, 1981; Lindstrom, Magnusson, & Petersen, 1970). There is an initial increase in myoelectric signal amplitude during fatiguing contractions. This initial increase in amplitude is needed to maintain the same level of force and involves the recruitment of more low frequency regions of the muscle; the high frequency regions of the muscle are recruited less. The initial increase does significantly decrease as the fatiguing process progresses. Therefore, due to a patient's inability to maintain endurance in the masticatory muscles, there is an overall decrease in the EMG amplitude (Hagberg, 1981; Lindstrom et al., 1970; Kroon, & Naejie, 1992).

Another EMG signal that decreases in patients with CMD is the power spectrum data. This is the muscle's output or strength and it shows a lower level of strength during maximum biting as compared to healthy subjects (Sheikholeslam et al., 1982; Bakke, & Moller, 1992). There is a consistent relationship between the fatiguing process of the masticatory muscles and the decrease in the mean frequency of the power density spectrum (Maton, Rendell, Gentil, & Gay, 1992).

Lund and Widmer (1989) have suggested that the jaw muscles are extremely fatigue resistant. They point out that subcutaneous tissues and the prevalence of bruxism (grinding teeth) have not been factors that are considered in the data collection using power spectral analysis in the diagnosis of jaw muscle fatigue, and that these factors could prove the use of EMG in diagnosis of muscular fatigue should not be accepted without more careful research. This article downplayed the importance of EMG and its relation to objectifying muscular fatigue.

Muscular fatigue is a physiological and biochemical phenomenon that causes muscles to tire and, therefore, lose their initial level of contraction force. As stated above, previous EMG studies of muscle fatigue find a decrease in the conduction velocity or power frequency due to the shift of the power spectrum to lower frequencies. There is an initial increase in low frequency amplitude in order to maintain the level of muscle force. Finally there is a decrease in the muscular output (force) due to fatigue.

The nature of muscle fatigue has been discussed by many investigators. The consensus on masseter muscle fatigue is that, due to muscular contractions of the masseter muscle the blood flow through the muscle is stopped. The blocked vascularization at these high contraction levels results in the pooling of blood in the muscle. This leads to the switching of aerobic activity to anaerobic activity and the accumulation of lactic acid. Since the blood flow is decreased the lactic acid is not washed out and creates an acidic intracellular environment for the muscle fibers (Kroon, Naeije, & Hansson, 1986; Naeije, 1984; Naeije, & Zorn, 1981; Palla et al., 1981; Lindstrom et al., 1970; Sheikholeslam et al., 1982; Hagberg, 1981). The increased metabolic waste due to the decreased blood flow causes the conduction velocity to decrease as well as the shape of the action potentials of the motor units. In addition, the muscle is painful, tender and has a decreased function. In this study the goal is to decrease the resting tone by chewing gum, which will cause the muscle to fatigue. Most of the fatigue EMG studies used maximal clenching as the means to bring about fatigue, we hope to use intermittent submaximal contractions to do the same without increasing the patient's pain.

USE OF CHEWING GUM

In 1990 Kawada studied the effects of gum chewing on fatigue and the recovery rate. This is the only published study found that used intermittent isometric motion and EMG measurements. The patients, all asymptomatic for MPD/TMD/CMD, chewed gum for 30 seconds at maximal masticatory power. EMG power spectrum was taken and the masseter muscles had lost 16.4-18.9% of their power. The duration of the conduction also decreased (by 5.0-8.2%) due to fatigue. The conclusion was that the work of mastication creates fatigue. Kawada stated the muscle fatigue from the chewing appeared to cause the decrease of excitement at the neuromuscular junction (NMJ). This would account for the decreased electromyographic data obtained in the experiment. The normal subjects with a normal resting tone did, indeed, become fatigued after chewing gum. This fatigue decreased the muscular electric output and showed up on the EMG as a decrease in muscular output and a decrease in contraction duration (endurance).

The goal of this study is to demonstrate how to decrease the abnormally high resting tone in the masseter muscle and how to make this a functional activity. There are no functional treatments for the TMJ or for CMD. Most, if not all, other joints have treatments that are functionally based (eg. walking for the lower extremity and activities of daily living (ADL) for the upper extremity). There are no such treatments for the TMJ. Many researchers agree that therapeutic motion is the key to restoring and promoting musculoskeletal function (Solberg, 1986; Armstrong, 1984; McCarty, & Darnell, 1993). The strength-pain relationship points to muscular exercise as an alternative measure to eliminate muscle pain and tenderness (Sheikholeslam et al., 1980).

The exercise utilized in this investigation is the chewing of gum. Gum chewing is usually not recommended by practitioners. Usually when people chew gum, they do so for long periods of time (between 1-2 hrs). This length of time would aggravate patient's pain and cause the patient's muscles to go into protective spasm, which would cause more pain. It is a vicious cycle of pain-spasm-pain-spasm. This current study would only suggest that five minutes of gum chewing would decrease resting muscle tone. The gum gives the motion resistance and chewing is a functional exercise which involves dynamic activity in opening and closing motions as well as isometric submaximal activity in the occlusal (teeth together) phase (Bakke, 1993). This form of exercise gives motion to the joint, fatigues the masseter muscle, and also allows for anaerobic waste products (lactic acid) to be removed due to its dynamic phase. Therefore the data obtained from the EMG will demonstrate that gum chewing, as an exercise for the masseter muscle, fatigues the muscle. This will allow patients to perform the exercise, at their leisure, to decrease the spasm and pain associated with the dysfunction.

The rhythm of chewing should not change during gum chewing (Kawada, 1990), because this will impact on how the waste materials are cleared. It is noted that rest periods of as short as 2 seconds enhanced the endurance of a muscle (Hagberg, 1981). The rest periods for the muscle would occur just prior to the occlusal phase of chewing. They would allow for more endurance of the muscle, but the exercise by itself will still fatigue the muscle. The pain and tenderness associated with the maximal voluntary contraction would be limited by the dynamic phase of the exercise. Physical exercises should be used as an adjunct therapy to relax the masticatory muscles (Kopp, 1982).

In the Kawada (1990) study, gum was used for its size and consistency. Its size and consistency do not change during chewing and the gum does not initiate swallowing (Plesh, Bishop, & McCall, 1986). The hardness of the gum affects the masseter muscle in a few ways. The masseter stays active longer when chewing hard gum, also the mean peak amplitude is greater when chewing hard gum. Also the length of the open-close-clench cycle is longer when chewing hard gum as opposed to soft gum (Plesh et al., 1986).

CHEWING SIDE

The final aspect of this study deals with on which side to chew the gum. EMG activity on the working side, especially in the masseter was greater than that of the balancing side (Kumai, 1993). Although the masseter activity starts on the contralateral side, it shows the greatest activity (strength) on the ipsilateral side (Balkhi, Tallents, Katzberg, Murphy, & Proskin, 1993). During chewing on the molar teeth, which occurs during gum chewing, the working side superficial masseter has greater muscle activity than the balancing side (Throckmorton, Groshan, & Boyd, 1990). Chewing gum is a dynamic exercise which will fatigue the muscles working the hardest---the masseter muscle on the working side.

The masseter muscle is the major muscle used with the teeth contacting one another and during chewing on the working side, as in grinding or crushing motions (Bakke, 1993). The superficial layer is more active on the working side , while the deep layer is more active on the balancing side during unilateral mastication. According to Bakke (1993) and in accordance with Throckmorton et al. (1990) the working side masseter generally shows more myoelectric activity than the balancing side masseter, often as much as two times more. During natural chewing the preferred side seems to depend on the occlusal support in the intercuspal position (Bakke, 1993). In a Kumai (1993) study, he suggested the hyperactivity on the dysfunctional side in TMD patients may be the result of habitual unilateral chewing. He later stated that most TMD patients with unilateral pain try to chew on the involved side and theorizes that this is due to less pressure on the working side condyle than the balancing side condyle. Kuami (1993) concluded that the preferred side in unilateral chewing was the side with the stronger muscle activity, but this was not necessarily contralateral to the dysfunction.

HYPOTHESIS

The hypothesis of this study is that chewing gum will fatigue the masseter muscle and, therefore, decrease the patient's muscle tone, as quantified by EMG data.

RESEARCH QUESTION

The question this study will answer is: Can gum chewing be used to decrease the hyperactive tone of the masseter muscle as measured by electromyography?

Chapter 3

Methodology

Study Design

This study followed the pre-test, post-test, control group design utilizing one experimental and one control group. Measurements for the control group were taken within intervals that match those of the experimental group (Portney & Watkins, 1993). The independent variable, a gum chewing exercise, had two levels: a treatment and a control.

Advantages and Limitations of Study Design

This design had strong internal validity because the pre-test and post-test scores provided a basis for establishing the initial equivalence of the treatment and control groups. History, maturation, testing, and instrumentation affected all groups equally in both the pre-test and post-test groups (Portney & Watkins, 1993).

External validity was susceptible to a potential interaction of treatment and testing (Portney & Watkins, 1993). This translated into a possible reaction to the pre-test by the study groups that could have elicited a different outcome if the variable (gum chewing) was used without the pre-test (obtaining an electromyograph baseline). We advised clinicians that if the research evolved into a form of treatment, they were to include an objective measurement of their subjects progress by monitoring them with an electromyograph (EMG). This forewarned clinicians to the possibility of the variable interacting with the pre-test. By limiting the study to one testing session, there was no chance of losing subjects to follow-up. A major limitation of the sampling design was the potential bias of self-selection. By strictly monitoring the inclusion and exclusion criteria, those who demonstrated a myofacial pain disorder (MPD) pathology were excluded.

Study Site and Subjects

The study site was a clinical lab at GVSU equipped with adjustable plinths and a TV monitor in Allendale, MI. All studies on normal subjects took place at GVSU. The EMG machine was provided by Memorial Hospital of South Bend, IN. The Wrigley Co of Chicago, IL, provided the chewing gum. Subjects were solicited by posting a sign-up form at Grand Valley State University at the Allendale, MI, campus.

Six subjects with pain related to the temporomandibular joint (TMJ) were studied at a dental office in Holland, MI, with comparable equipment. These subjects had sought treatment by a Holland, MI dentist who agreed to refer his patients to our study. These subjects were solicited by the dentist after they completed their initial dental exam. The subjects had both arthrogenous and myogenous sources of pain, and were classified as a "pathological" group.

This study used a population of normal subjects who had never been diagnosed with a myofacial pain disorder (MPD). These subjects sought out a sign-up form posted at GVSU. The subjects did not have arthrogenous pain, painful clicking, or surgeries related to the temporomandibular joint (TMJ), cranial, or cervical structures. Those candidates on medications that affected masseter muscle physiology were excluded (see Appendix A for detailed information).

The sampling procedure was a non-probability convenience sample. As potential subjects voluntarily signed-up over a defined period of time (Jan. 15, 1995 - Feb. 13, 1996), they were selected and asked to participate after meeting the inclusion criteria. At that time, they were placed in experimental and control groups, one at a time, in series, to get matching numbers of experimental and control groups. Each subject was assigned a number at this time for data collection and anonymity purposes.

Limitations

Other than decreases in EMG activity in the masseters of normal subjects, other conclusions about the effects of gum chewing on the muscles of the face cannot be drawn via this study. This study did not allow for gum chewing to be used in a strengthening exercise program or to increase endurance of the facial muscles. In addition, this paper did not account for systemic effects that may result from gum chewing with a pathological TMJ. Furthermore, the effects of gum chewing in conjunction with subjects using various medications must be approached with caution. A MPD is a often a unique disorder that differs by individual. We were not proposing that gum chewing was beneficial for all subjects that fit into the MPD diagnosis. The test maneuver was designed around decreasing muscle tone of the masseter to promote pain relief in the masseter muscles.

Arthrogenous cause and effect relationships were not drawn from this study. We did not make inferences concerning the health of or healing of the TMJ. This study did not provide for adaptations of the pathological TMJ to long term treatments of gum chewing. While this paper may have appeared somewhat limited in scope, it provided three points to consider. One, a functional, closed kinetic chain exercise (gum chewing) may be possible for the TMJ patient. Second, this study provided a basis from which to perform further investigations involving a functional, closed kinetic chain exercise for the TMJ. Finally, gum chewing for five minutes did not increase any subject's masseter EMG activity - on the side that gum was chewed - for up to thirty minutes after chewing (both pathological and nonpathological, and those subjects that were excluded).

Instruments

Electromyograph

The measuring device was the Autogenics HT-1 biofeedback EMG and HT-10 digital integrator (Berkeley, CA). The instruction manual was not available for the HT-1. We used one from an Autogen 1700, which is an upgraded model with visual and audio feedback. The myograph controls were exactly the same for the two models. (see appendix G). The HT-1 and HT-10 have an absolute accuracy rating of $\pm 1\%$. The biofeedback EMG and the digital integrator were calibrated by Stoelting-Autogenics, South Holland, IL. The machines combined error margins of both the biofeedback EMG and the digital integrator were .3 uV at the 100 uV testing scale used on all subjects. Technical support help was available from the Bio-Com department of Memorial Hospital (South Bend, IN). The standard EMG electrode assembly consisted of permanent reusable electrodes 11 mm in diameter, and were a standard accompaniment of the HT-1.

Chewing Gum

Our intervention was accomplished with Wrigley's Extra sugarless, peppermint flavored gum (Wm. Wrigley Jr. Company, Chicago, IL). Wrigley's advised us against using non-flavored gum since it may have affected subject participation and comfort throughout the experiment. The gum was of equal densities and had the same processing and packaging dates to guarantee consistency in gum characteristics. Each subject was allowed to keep their pack of gum if they chose. Gum similarities could have been in question (i.e. freshness and packaging dates would be changed via using gum opened on a previous day) if opened packs of gum were used on different testing days.

Procedure

Subjects were solicited by a sign up form posted at the GVSU science complex. Subjects were then phoned or contacted in person to schedule one testing session. If subjects passed the inclusion criteria (as described in Appendix E), they completed informed consent forms (see Appendix B) and demographics questionnaires(see Appendix F). Subjects were asked to participate in one, one-hour session. Subjects laid relaxed and inclined on a plinth at a 50° angle using a pillow for head support. Subjects were instructed to watch a video playing during the session (for distraction). Subjects were asked to make no head or body movements during the task other than mandibular movements. Subjects were not allowed to speak within a one minute interval of the time a reading was taken, and they were instructed to speak minimally if necessary (speaking during readings accounted for most subjects being excluded). They were instructed to chew on either side of their mouth, without changing sides, at a pace of their choice, at an intensity of their tolerance, and on their back teeth (molars) only. Subjects were allowed to swallow as needed.

The subjects' skin was cleaned with alcohol and a cotton ball prior to electrode placement. Electrodes were placed 34 mm apart, center to center, in line with the masseter fibers. Three electrodes were placed unilaterally on the side the subject planned to chew (two on the masseter and a reference electrode on the frontal ridge of the skull). These placements were standardized by locating the midpoint of the electrodes in an area 1/2 way between the inferior border of the zygomatic arch at the zygomaticotemporal suture to the goinal angle (Gay, Maton, Rendell, & Majourau, 1994, 848). The subjects were given two minutes to acclimate to the environment with all the equipment in place before EMG readings were taken. EMG readings were taken prior to chewing (three times, 20 sec apart, meaned and averaged) and after gum chewing (at completion, one minute, three minutes, five minutes, fifteen minutes, and thirty minutes).

The control group was set up the same. However, they performed rhythmic stabilizations exercises in resisted opening, lateral deviation (both directions), and resisted protrusion in place of gum chewing. Subjects resisted movements with their own hand providing the resistance. Subjects held resisted opening 10 seconds, and then rested for 5 seconds. Subjects then proceeded to right and then left lateral deviation, and finished with resisted protrusion. These exercises were repeated for five minutes. Subjects were asked to resist at 60-80% of their maximal strength (Kisner & Colby, 1990, 70). Maximal strength was defined as a subjective estimate of the maximum amount of muscle force that could be generated by the subject. Masseter outputs were measured after the completion of exercise.

Procedure for Pathological Subjects

Since the goal of most clinical studies is to promote improvement in patient care, this study demonstrated a preliminary examination of the gum chewing intervention on subjects who have been diagnosed with the MPD pathology. In the duration of our study, we were able to find six pathological subjects that consented to be studied. The study would have benefited most by finding forty or more subjects to examine. However, data collected here may benefit future studies.

All procedures for the pathological subjects took place at the dentist's office in Holland, MI. All necessary equipment was relocated to the Holland office. Subjects were solicited by the dentist after the dentist addressed the patient's complaint. Subjects completed their dental exam with the dentist and then began the experiment. Pathological subjects completed a demographics questionnaire and completed informed consent procedures. All of these subjects received the gum chewing intervention. These subjects were instructed to chew like the normal subjects and data was collected similarly.

Protection of Study Participants

Study participants were protected to the largest extent possible. The EMG unit was grounded and used DC current, and there was virtually no danger of electrical shock if the equipment was set up properly. If subjects experienced increases in jaw pain during gum chewing that was intolerable, subjects were immediately allowed to stop the procedure. Subjects who were interrupted were allowed to finish the study if they desired, but their results were marked and excluded from the study with notation. All intensities of gum chewing were at the subject's tolerance. An unpreventable hazard was that gum chewing may create TMJ pain or make existing pain worse. In this case, we would have aided subjects in seeking immediate medical attention with a dentist or physician of their choice.

Data Analysis

Data analysis for this thesis employed repeated measures of analysis of variance (ANOVA). These tests determined statistical significance between the initial reading and each of the post maneuver measures. The analysis compared the rate of decrease between control and experimental groups, the rate of decrease of experimental and control groups versus time, and the rate of decrease in output between males and females in each group, A 10% decrease in muscle tone from the baseline was estimated to be clinically significant.

Data was collected on the demographics of the normal and pathological populations during the study. Summaries of this information is reported in the results (also see appendix E).

Data collection occurred before, during, and after the experiment (see Appendix D). Data was coded according to subject group (treatment or control). Baseline EMG readings were taken before the intervention. At each designated time, three readings were taken twenty seconds apart and the median of these readings was recorded. Medians of the readings were taken opposed to averages to reduce the chance of one extreme EMG skewing the average result. Individual scores were recorded by subject code number. Subjects were coded immediately upon inclusion into the study (data collection parameters are described in procedures). Statistical consultation and data analysis was contracted with GRAMEC (Grand Rapids, MI).

Chapter 4

Results

Techniques

Complete EMG data was collected on 22 gum chewing subjects and 18 controls. Average masseter EMG outputs decreased over time when compared to the average initial (i.e. resting or baseline) values in both groups. The gum chewing or exercise intervention took place after the initial EMG readings were obtained. Subjects were then monitored for 30 minutes after the intervention.

There were 48 subjects who participated in the study. Eight of those were excluded from the study for reasons including two for speaking during data collection, one for coughing during data collection, one subject fell asleep, one wore a dental appliance, and three reported after the study that they failed to meet inclusion criteria (smoking, drinking caffeine, and excessive lateral deviation). No subjects had previous diagnoses involving the TMJ, cervical spine, and nerves and muscles of the head and neck.

Demographics Summary

Demographic information was collected on all forty subjects who completed the data collection process. No demographic information was reported on pathological subjects. There was a large variability in the pathological demographic reports. Also, this study does not make inferences as to significance of gum chewing as a treatment for the pathological group.

There were twenty-six females and fourteen males. Of these, fifteen females were gum-chewers and eleven were exercisers. There were seven male gum-chewers and seven exercisers. The average age of subjects was 25.9 years. Eleven males were right-sided chewers, four were left-sided. Eighteen females were right-sided chewers, seven were left-sided.

Twenty-six subjects admitted to chewing gum four times in the last month and sixteen of those reported chewing eight times or more. Sixteen people chewed gum for approximately 60 minutes and eight claimed they chewed gum for longer than 60 minutes. Thirty-six people reported one or more sources of stress (see Appendix E) in their lives and five reported greater than four stressors. Sixteen people reported one or more parafunctional habits (see Appendix E), and seven people reported that they believed they bruxed at night.

Hypothesis/Research Question

The study was designed to show that gum chewing would fatigue the masseter muscle and that the fatiguing process would decrease the resting muscle tone of the masseter. It can be seen in Table (2) and Figure (1) that there was a significant decrease in resting muscle tone after the intervention in both groups. Although gum chewing is not significantly different from isometric exercise in decreasing the resting muscle tone, there was no evidence that chewing gum was ineffective. There was an initial increase in amplitude after the exercise, this was followed by a significant drop in amplitude as measured by an EMG. These results are in accordance with previous studies performed on the masseter muscle and using EMG as the data collecting source (Lindstrom et al., 1970; Kroon et al., 1992; Chong-Shan et al., 1991; Dahlstrom, 1989).

Data Analysis

Average masseter outputs, medians, and standard deviations for several time periods are listed for the control (C), experimental (E), and pathological (P) groups in Table 1. Pathological data is shown for comparison only and no inferences should be masde from this information. Average masseter EMG outputs are compared in Figure 1. Initial EMG values were calculated by averaging the three initial readings taken for each group. All readings are recorded in microvolts and have an error margin of .3 microvolts.

Table 1

Masseter EMG Output Values at Specific Times after Exercise

	Initial EMG	0 sec	1 min	3 min	5 min	10 min	15 min	20 min	25 min	30 min
Average (C)*	6.62	6.89	6.67	6.23	5.30	4.80	4.53	5.32	4.40	4.43
Average (E)**	6.61	6.98	5.60	5.20	5.02	4.70	4.87	4.75	4.39	4.54
Average (P)***	8.57	9.50	8.75	8.45	7.85	7.85	7.80	7.75	8.40	8.60
Median (C)		5.70	5.40	5.55	4.35	4.35	4.20	4.20	3.90	4.05
Median (E)		7.05	5.55	4.80	4.65	4.50	4.35	3.90	4.20	4.35
Stand Dev (C)		2.83	3.54	2.48	2.25	1.63	1.43	2.86	1.57	1.50
Stand Dev (E)		2.57	1.84	1.82	1.89	1.70	1.55	2.11	1.28	1.51

* (C) = control (isometric exercise) population
** (E) = experimental (gum chewing) population
*** (P) = pathological population

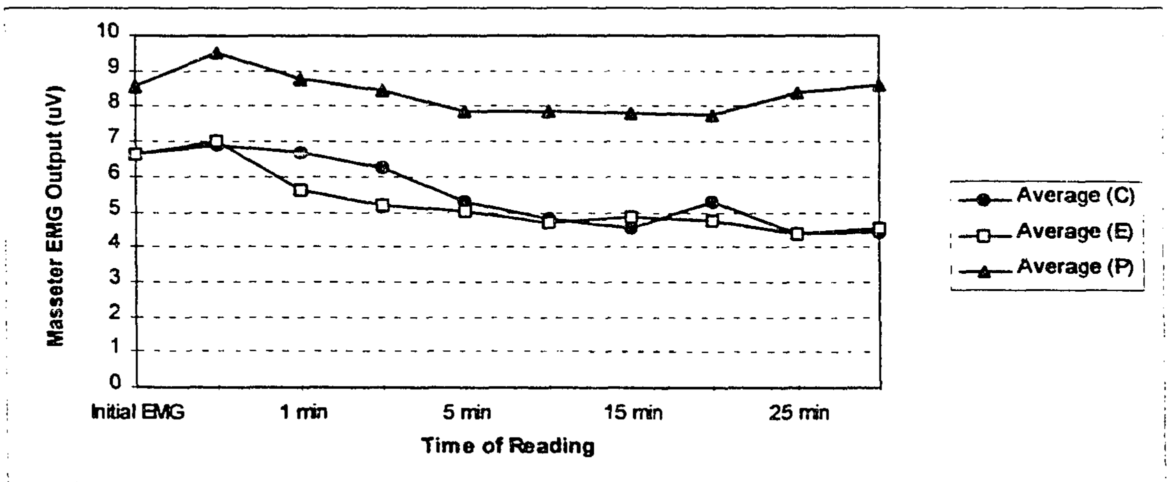
Table 2.

Repeated Measures ANOVA on Times, Experimental/Control, Gender, and Time

	SS	DF	MS	F	P Value
Within+Residual	**69.71**	**36**	**1.94**		
Times	80.20	1	80.20	41.42	0.00
Experiment/Control By Times	**0.42**	**1**	**0.42**	**0.22**	
Gender By Times	0.00	1	0.00	0.00	0.968
Experiment By Gender By Times	**1.75**	**1**	**1.75**	**0.90**	**0.348**

Figure 1

Baseline and Post Exercise Average Masseter EMG Values



(C) = control population
(E) = experimental population
(P) = pathological population

Statistical analysis of data obtained from the control and experimental groups are shown in Table 2. Statistical significance of decreasing EMG values was set at $P < .05$. The high F value for times (12.12) shows that masseter EMG output values decrease significantly within subjects by time.

CHAPTER 5

DISCUSSION

Discussion of findings

Several areas noted in our literature review, as well as our data and subjective observations during trials, may have significant impact on further research. Our study was one attempt to devise a functional exercise for the treatment of myogenous jaw discomfort. The data revealed a significant decrease in masseter muscle tone over time in both the exercising and gum chewing groups. These results indicated that gum chewing may be used as a functional alternative to traditional exercise. However, there was no statistical significance between the two groups. Our results support the hypothesis that gum-chewing does decrease resting muscle tone in the masseter as measured by surface EMG in our sample population.

In the analysis of variance, gender by times involving within-subject effect (P=0.968) was measured and was found not to be significant No statistical difference was found between male and female subjects in either group. These findings may suggest there was no difference in amplitude between male and female at the same submaximal level of tension.

One area of relative significance was analysis of variance of experiment by time, measured from zero seconds to 30 minutes. Although not statistically significant (P=0.348), this analysis did demonstrate a decrease in resting muscle tone following gum chewing. This decrease was similar to that of the control group, but as seen in Figure 1, there was a more rapid decline.

Previous literature (Kawazoe et al., 1979; Naeije, 1984; Maton et al., 1992; Bingland-Ritchie et al., 1986; Gay et al., 1994; Naeije et al., 1981) propose an initial increase in EMG amplitude during maximal and submaximal contraction of the masseter muscle. This increase was due to recruitment of motor units taking place to compensate for the decrease in force of contraction occurring in the fatigued muscle fibers. This correlates with our findings that amplitude decreases following submaximal contraction for a short chewing duration as a result of an increased number of recruited muscle fibers. Therefore, if the masseter is already in a hyperactive state, it may be inferred that dynamic exercise will recruit additional muscle fibers resulting in greater relaxation following fatigue.

Another significant area was that the fatiguability of muscle depends on the types of fibers stimulated. Type I fibers contain low ATPase activity that typically correlate with long contraction times (slow twitch) and resistance to fatigue whereas type II fibers contain high ATPase activity correlating with rapid contraction times (fast twitch) and fatiguability (Bakke, 1992). Considerable controversy persists in the muscle fiber type of the masseters.

Major jaw-closing muscles (Lund et al., 1989) contain several compartments that differ in the proportion of slow, fast, and intermediate muscle fibers they contain. This implies that the compartments have different functional roles. Based on the premise that the masseter contains type II fibers, this study hypothesized that the masseter muscle will fatigue following submaximal gum chewing based on a decreased EMG amplitude following exercise. This coincides with Naeije's (1984) findings in a study comparing human leg and masseter muscle. He implied that the muscles with a higher percentage of fast-twitch (FT) fibers (and thus shorter endurance time) have a stronger EMG signal with a lower frequency content, a more rapid shift to lower frequencies during fatigue, and a frequency content which is strongly contraction dependent. Further findings have shown that in the human masseter muscle the FT muscle fibers, which are recruited at the higher contraction levels, have a tendency to result in higher surface-EMG amplitudes.

Naeije and Zorn (1981) report that the fiber type I ranged in percentage distribution from 9-55 per cent. Therefore, variation in fiber type, together with the assumption that the FT fibers were activated during our experiment, may explain the variability in endurance times we found.

An additional area of significance was revealed on the side of chewing. The dominant side of the mouth was used in this study to infer a hyperactive or overutilized muscle in comparison to a pathological population. It appears reasonable to assume that the dominant side is used more frequently in the chewing cycle, thus increasing the susceptibility to fatigue, as would be the case with a hyperactive masseter muscle following exercise. There is no literature to support the premise that a hyperactive muscle will become hypertrophied. Throckmorton et al. (1990), Kumai (1993), and Kraus (1988) reported that differences exist between working- and balancing-side levels of muscle activity with higher activity in the working-side masseter during chewing of gum. The masseter muscle consists of 50 to 60 percent type IIB fibers. It is therefore capable of a strong rapid contration but fatigues readily. Further testing with larger sample sizes and myogenous pain population could lend support and perhaps offer further explanation regarding the side of chewing and its effectiveness on fatiguing the masseter muscle.

Finally, another area of significance was the limited research supporting active motion of the jaw in relieving hyperactivity. In regards to physical therapy treatment, nothing functional exists for relieving myogenous muscle pain. Traditional empirically-based treatment consists of thermal modalities for pain-relief, electrical stimulation for muscle fatigue, and isometric exercises for reducing hyperactivity and strengthening. The clinical reports (Dahlstrom, 1992) on exercise therapy as the only form of treatment have been positive, both subjectively and clinically, but are also uncontrolled. No current literature exists reporting active range of motion exercise as a contraindication to myogenous masseter pain. Travell and Simons (1983) reported that when dealing with muscles that contain myofascial pain, the movement associated with an isotonic exercise was preferred to the fixed position of the isometric exercise. However, it may be assumed by practitioners that because it involves the TMJ, active exercise might potentially exacerbate existing conditions. Based on the literature review concerning masseter fiber type and physiology involved with fatigue, these may be aberrant assumptions.

There was literature, however limited, supporting mandibular motion as a method of treatment. This objective was accomplished by minimizing functional demands, avoidance of wide opening of the mouth, consuming a mechanically soft diet, and rest with gentle motion (Solberg, 1986). Kroon and Naeije (1991) further state that if muscle soreness is a consequence of chronic disuse of masticatory muscles, then exercise training of progressively increasing intensity is indicated. The patient should be restricted to movement within painless limits, but all function should not be eliminated. This will improve the general physical condition of the patient and will teach them to cope better with their bodily sensations. One may conclude from this study, as well, that active functional exercise may indeed result in decreased pain and muscle hyperactivity in masseter dysfunctions.

Applications to Practice

Considering that the masseter muscles are used for necessary functions of survival, namely feeding, mobility of these muscles are critical. In conjunction with other orofacial musculature, they allow one to talk, chew, whistle, and change facial expressions. An almost perfect synergy of the orofacial musculature is required to perform these necessary functional activities. Thus hyperactivity of the muscle groups needs to be decreased especially in the masseter(s) because they function as primary masticatory structures.

There are three main implications to gum-chewing for treating hyperactivity in contrast to traditional physical therapy. First is the cost of treatment. If traditional therapy is implemented, the patient is required to seek treatment in an outpatient setting for a predetermined length of time. This requires manipulation of personal schedules on a weekly basis to receive treatment that cannot be performed at home. Furthermore, the patient is charged for each visit. In retrospect, implementing a gum-chewing program that fits the patient's needs requires purchasing a few packs of gum and one follow-up visit following the initial evaluation. This could have a significant impact on the cost of health care from both the patient and provider level.

Second is function involved in chewing gum. Traditional therapy offers no activities that might be included in daily activities. These treatment methods require time to perform and oftentimes materials to implement. Gum chewing, conversely, requires performing jaw exercises used in various activities of daily living. Chewing gum incorporates muscular movement coinciding with feeding motions.

Finally, the third benefit is psychological. Gum chewing therapy provides the patient with a sense of control over their problem. Gum may be chewed at a rate and for a period that is conducive to the patient. The patient has complete control over pain and discomfort, terminating the treatment when relief is attained. Another aspect is the patient may chew gum whenever painful symptoms arise. The benefits are apparent since they don't have to wait to see a therapist. Furthermore, this treatment can be performed anywhere at any time of the day. Finally, gum chewing does not require additional preparation (e.g. time, positioning). The patient may perform the treatment while carrying out daily activities, avoiding excessive chewing that may exacerbate symptoms Although not inclusive, these applications present benefits that far outweigh the traditional approach of modalities, splinting, and manual exercises.

Limitations

This study of decreasing masseter muscle tone through the chewing of gum, though successful, had limitations. The position of the person on the plinth and the cervical posture was defined in the protocol. This position did not change with every person, and could have been uncomfortable for people with a different resting posture. The purpose of the protocol was to make people comfortable and take out the effect of cervical muscles on the EMG data of the masseter muscle. Cervical posture, swallowing, talking, and body movements can increase the EMG data of masticatory muscles (Tsolka & Preiskel, 1990). The study could not control for the factors of swallowing, talking, and body movement, but these activities were minimized as best as possible.

A second limitation was the use of a video as a distraction to the exercise used in the study. Many people who watched the video suggested that the video was a large source of relaxation and made people rest more than normal. The study was designed to show that gum chewing decreased muscle tone, the fact that people rested while watching the video was a fact that we could not change.

A third limitation was that the treatment cannot be generalized for its effectiveness after 30 minutes. Since the design was to measure muscle output up to 30 minutes, the treatment does not have any reliability past that time duration.

A fourth limitation was in regard to the placement of electrodes on the subjects. This interexperimenter reliability was subject to scrutiny, but the protocol used was specific in regards to where the electrodes would be placed. The protocol stated that electrodes were to be placed 1.7cm from the midpoint (proximally and distally) of the zygomatic arch and the gonial angle of the mandible. The specificity of the protocol decreases the possibility of error on behalf of the experimenters.

A fifth limitation during the experiment was that the adhesives used for the electrodes were used up. Due to the insufficient amount of the first adhesive, a second, similar adhesive was used. The two adhesives differed by no more than .2 cm in diameter.

A sixth limitation was that subjects were recruited in a non-random selection process. Subjects were requested to sign up for participation. Phone calls were made to set up a time period when the person would be available to perform in the study. This selection process was convenient for the student group, but a more random sample would have been preferred.

A seventh limitation of this study was the fact that some people did not know on which side they chewed. Some chewed on both sides, when this occurred they were able to choose which side the electrodes were to be placed. This is a limitation because the study was design to research the dominant side masseter output. If the side chosen was not the dominant chewing side, then the data would misrepresent the true value of the dominant side masseter.

The final limitations dealt with how vigorously people performed the isometric exercises and where chewing occurred. Subjects in the isometric exercise group were asked to give 60-80% of there maximum contraction during the exercise. A maximum contraction of the masseter muscle would occur with maximal clenching (teeth together). There was no way to monitor the amount of the contraction, so it was left up to the person's discretion. Subjects in the gum chewing group were asked to chew on the side they preferred, which was the side the electrodes were placed, and were asked to chew on their molar teeth. There was no way to monitor if either of these conditions occurred.

Suggestions for Further Research

This study represented the first known project to implement isotonic exercise in the treatment of myogenous TMD patients. Some suggestions for further research include the use of multiple interventions of gum chewing per day, and also the use of gum chewing versus a control group of sitting, resting with no intervention. This latter approach would help identify whether resting with no intervention is responsible for a decrease in resting muscle tone.

Other research study could identify whether needle EMG to the masseter and/or the temporalis muscles would get a more specific result due to the more specific nature of the needle EMG procedure. Other studies could change the duration of chewing and also the densities or hardness of the gum being chewed.

A significant research project would be to perform the same or a similar experiment but using pathological patients. This current study did perform the gum chewing exercise on a few pathological patients, but no conclusions were made. An experiment using people with pathology would be better to generalize to the myogenous TMD population. During the experiment the opposite side masseter could be monitored by a dual channeled EMG machine in order to identify any abnormal response of the isotonic exercise on it.

A final suggestion would be to use the gum chewing exercise in conjunction with the other therapy treatments. The isotonic gum chewing exercises used with moist heat, ultrasound, patient education, massage, bite splints, and stress relieving techniques could go a long way in improving a TMD patient's quality of life and function.

Conclusion

This study addressed a previously uninvestigated area--functional chewing to decrease masseter muscle tone. An interesting finding in our research was that gum chewing on the dominant side decreased resting muscle tone, and that this occurred at a faster rate than when performing isometric exercise. Generalizations from this data, however, should be avoided because of our normal patient population. Further research is needed to investigate whether similar results would be obtained from a patient population with specific masseter muscle hyperactivity.

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APPENDIX A

INCLUSION & EXCLUSION CRITERIA

Study Subject Inclusion and Exclusion Criteria

Studies have indicated that the development of a craniomandibular disorder (CMD) with mainly muscular problems at the onset may be followed by increased engagement of the joint structures (Naeije & Hansson, 1986). The structure of the joint, the condyle, the temporal component, the disc and their arrangement in constituting a functional unit becomes disturbed (Naeije, 1988). If any component of the unit is disturbed, the unit becomes dysfunctional, and symptoms of a CMD may become present.

A proper working diagnosis requires a careful history and a thorough clinical examination. In this respect, objective diagnostic tools are often essential in the examination of joint and muscle structures. Techniques to examine the temporomandibular joint structures radiographically are well developed. However, objective tools to examine the muscles of mastication are scarce. This is suprising, as in 80% of the CMD patients, pain is originating from the muscles (Naeije, 1988). This study utilized careful questioning of potential subjects and a simple objective exam that can be interpreted by a graduate physical therapy student.

Inclusion Criteria

Forty-eight subjects were accepted from the sign-up form for our study. Those potential subjects then completed a demographics questionnaire designed to signal a possible pathological subject or a subject that may have responded abnormally to the experimental maneuver (e.g. subject on muscle relaxers). Those subjects excluded still received their pack of gum.

The simple objective examination consisted of the following tests to screen for a possible MPD. Potential subjects must have had greater than 35 mm of mandibular opening that was pain free. Subjects must not have deviated greater than 5 mm in observed opening. Subjects must not have had an underbite (Koidis, Zarifi, Grigoriadou, & Garefis, 1993). Subjects did not have palpable tenderness of the masseter muscles (Buchner, Van Der Glas, Brouwers, & Bosman, 1992). Finally, subjects may not have had visible facial paralysis.

Subjects must also have met the following inclusion criteria asked verbally by the investigator on the day of the experimental session. Subjects must have been pain free before, during, and after chewing. Subjects not have had a headache, earache, or facial pain with opening to end of range and with chewing on the day of testing. Subjects also had complete dentition save wisdom teeth removal over one year previously.

Exclusion Criteria

Patients may not have arthrogenous pain, painful clicking, or surgeries related to the temporomandibular joint, cranial, or cervical structures. Patients were within the ages of 18-55 years. Patients must have had posterior support in the mouth and did not have dentures.

Subjects did not participate if they were currently diagnosed any disorder that may mask MPD symptoms (see Appendix B) (Mohl & Ohrbach, 1992; Greene, 1992). A subject may not have been currently diagnosed with a psychological or emotional disorder. Subjects did not have a known history of neurologic or proprioceptive disorders; stomatognathic, deglutition, or masticatory disorders (Tzakis, Dahlstrom, & Haraldson 1992); dentofacial deformities, or have experienced acute trauma to the TMJ. Subjects with extensive dental restorations or those undergoing active dental treatment were excluded (Throckmorton & Dean, 1993). Finally, pregnant subjects did not participate.

Patients on medications that affect the masseter muscle physiology were excluded. Patients were included into the study if their medication regimen was terminated early enough to allow for clearing of the specified drug by the body with no remedial side effects.. Patients on medications such as muscle relaxers (e.g. FLEXERIL, PARAFON FORTE, etc.), steroidals (DECADRON, etc.), mood elevators (ELAVIL, XANAX, etc.), antipsychotics (HALDOL, PROZAC, etc.), antiepileptics (TEGRETOL, CLONOPINE, etc.), and narcotic analgesics (CODEINE, TYLENOL #3, etc.) were excluded. Moreover, drugs that mimic the effects of the above (antiarrythmics, respiratory drugs, central nervous system inhibitors, etc.) were treated similarly. Patients taking over-the-counter medications and limited prescription analgesics (MOTRIN) were included after further investigation and consultation with the referring physician.

APPENDIX B

INFORMED CONSENT

GRAND VALLEY STATE UNIVERSITY RESEARCH CONSENT FORM

Title of Project: Treatment of the painful mandibular muscle
Principle Investigators: Marc Maday, SPT, Nathan Tear, SPT, and Ben Rentfrow, SPT

PURPOSE OF RESEARCH

I have been informed that this study will determine that exercise may be used to gently fatigue the two large clenching muscles of the jaw (masseters) so that they are less likely to involuntarily contract for long periods of time. Exercise is unique because it allows the jaws to be treated in a natural way without the use of medications, surgery, or specialized medical instruments that control pain. It is also a very low-cost procedure that patients, insurance companies, and medical personnel can appreciate. This study will help physical therapists better understand the use of physical therapy services in the management of the painful jaw muscles.

PROCEDURE

I will be expected to attend one physical therapy treatment session. I am aware that the procedures include using surface EMG sensing electrodes in which I will not feel the electric current, and exercising to my tolerance for five minutes. Furthermore, I understand that the EMG will be used during the five minute treatment, immediately after exercise, one, three, five, 10, 15, 20, 25, and 30 minutes after the treatment. Three readings will be taken for each time interval.

RISKS AND DISCOMFORTS

I understand that I may experience some discomfort during or after my treatment. The procedures of this study are not expected to exaggerate possible preexisting conditions or pathologies.

BENEFITS

I understand that my participation in the study will have no direct benefit. The major potential benefit is to find out if this conservative treatment decreases resting muscle tone in individuals without muscle pathology. The potential benefit may lead to research on pathological subjects with TMD.

ALTERNATIVES

There are other physical therapy techniques, medication, psychological consultations, surgery, and/or dental appliances that may be offered as alternatives for this treatment.

CONFIDENTIALITY

I understand that the information obtained from this study will be confidential and used only for research. My data results will be stored in the investigators research file and identified only by a code number.

If the data are used for publication in the medical literature or for teaching purposed, no names will be used, and other identifiers, such as EMG recordings, will be used only with my special written permission. I understand that I may see the EMG recordings before giving this permission.

REQUEST FOR MORE INFORMATION

I understand that I may ask more questions about the study at any time. Ben Rentfrow at 791-8848, Marc Maday at 453-7603, and Nathan Tear at 785-1586 are available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during and following the course of this study which might influence my continued participation.

If during the study, or later, I wish to discuss my participation in or concerns regarding this study with a person not directly involved, I am aware that the GVSU faculty (895-3356) is available to talk with me. A copy of this consent form will be given to me to keep for careful rereading.

REFUSAL OR WITHDRAWAL OF PARTICIPATION

I understand that my participation is voluntary and that I may refuse to participate or may withdraw consent and discontinue participation in the study at any time. I also understand that Marc Maday, Nathan Tear, and/or Ben Rentfrow may terminate my participation in this study at any time after they have explained the reasons for doing so and has helped arrange for my continued care by my own physician or physical therapist, if this is appropriate.

INJURY STATEMENT

I understand that in the unlikely event of injury to me resulting directly from my participation in this study, if such injury were reported promptly, then medical treatment would be available to me, but no further compensation would be provided by Grand Valley State University. I understand that by my agreement to participate in this study I am not waiving any of my legal rights.

I have explained to ____________________________ the purpose of the research, the procedures required, and the possible risks and benefits to the best of my ability.

_____________________ _____________

Investigator Date

I confirm that Marc Maday, Nathan Tear, and/or Ben Rentfrow has explained to me the purpose of the research, the study procedures that I will undergo, and the possible risks and discomforts as well as benefits that I may experience. Alternatives to my participation in the study have also been discussed. I have read and I understand this consent form. Therefore, I agree to give my consent to participate as a subject in this research project.

_____________________________ _______________

Participant Date

_____________________________ _______________

Witness to Signature Date

APPENDIX C

DEMOGRAPHICS QUESTIONNAIRE

DEMOGRAPHIC QUESTIONNAIRE

1. Age______ 2. Sex M___ F___

3. Education Level (please circle): High School College Graduate School Post Grad Other

4. Occupation: ____

5. How many times have you chewed gum in the past 30 days? (please circle) 0 1-2 3-4 5-6 7-8 8+

6. If you circled anything other than zero (0) for question #5, how long do you chew the gum?

   ____1-5 minutes ____15-30 minutes
   ____5-10 minutes ____30-60 minutes
   ____10-15 minutes ____60+ minutes

7. Are you currently on any medications, including over-the-counter medications? Y___ N___

   If yes, please list:

   ____
   ____
   ____

8. Please check any category below that may be a source of additional stress in your life:

   ____children ____spouse
   ____occupation ____ change in sleeping pattern
   ____change in eating pattern ____ finances
   ____school ____ pain
   ____ other family members ____ health status
   ____ other (please specify)____________________

9. Have you ever experienced jaw discomfort in the past? Y____ N____

   If yes, briefly describe your jaw discomfort (type, when, how long):

   ____
   ____
   ____

10. Was your jaw discomfort caused by a traumatic experience? Y____ N____

    If yes, briefly describe how it happened:

    ____
    ____
    ____

11. Are you currently being treated for dental abnormalities? Y____ N____

12. Have you ever seen a dentist regarding your jaw discomfort, other than on this occasion?

    Y____ N____

    If yes, how many times?__________

13. Have you ever seen a physical therapist regarding your jaw discomfort? Y____ N____
If yes, for how long?__________
What did your treatment consist of ? ______________________________

14. Have you ever had surgery because of your current jaw problems? Y____ N____
If yes, what procedure(s) were performed?______________________________

15. Do you wear dentures? Y____ N____
If yes, do you wear them while you sleep? Y____ N____

16. Do you have any missing teeth? Y____ N____

17. Do you feel like your bite is off, or like it has changed? Y____ N____
If yes, how?______________________________

18. Do you have any discomfort when you maximally open your mouth? Y____ N____

19. Do you have any nervous habits you are aware of? Y____ N____
(e.g. gum chewing, smoking, snuff, biting finger nails, crunching ice, chewing pens or pencils, etc.)

20. Do you chew on: Right_____ Left_____ side of your mouth?

21. Do you experience tenderness when you touch any part of your jaw? Y____ N____

22. Have you ever been diagnosed with one or more of the following diseases?
Please check each one that applies.

____ pulpalgia	____ migraine headache
____ pericoronitis	____ rheumatoid arthritis
____ otitis media	____ osteoarthritis
____ sinusitis	____ degenerative joint disease
____ parotiditis	____ fibromyalgia
____ temporal arteritis	____ gout
____ neuralgia	____ lupus
____ Eagle's syndrome	____ malignant disease

23. Does your jaw deviate to either the left or right when opened? Y____ N____

24. Do you clench or grind your teeth while sleeping? Y____ N____

25. Are you currently experiencing a psychological or emotional disorder? Y____ N____

26. Do you currently have mouth and jaw, swallowing, chewing, or speaking dysfunctions?
Y____ N____
If yes, please specify:______________________________

27. Briefly describe any appliances and/or modalities such as heat or cold that you have used to relieve your jaw discomfort:
____
____

28. Are you pregnant? Y____ N____

I, ________________________________, understand that the information contained within this form will be kept strictly confidential by the researchers of this study. I also understand that this information will be used by the researchers solely for the purpose of determining my eligibility for acceptance into this research study, and that should I be found to have any illness or previous injury that could have a potentially negative influence on by health during this study, my participation will be terminated, effective immediately after said determination.

By signing this form, I am agreeing that all information presented on this form is true and correct to the best of my knowledge.

____________________________ ____________

Signature of Participant Date

____________________________ ____________

Signature of Researcher/Witness Date

APPENDIX D

RAW DATA TABLE

Experimental/Normal	Subject Code	Gender	Initial EMG (1)	Initial EMG (2)
E	1	F	7.8	5.4
E	3	F	5.7	5.1
E	9	F	4.2	4.2
E	11	F	7.5	7.8
E	13	F	5.1	4.2
E	15	F	3.3	3
E	17	F	3.9	5.7
E	19	F	4.8	3.9
E	23	F	13.2	12
E	29	F	6.6	6.6
E	33	F	9	9.3
E	37	F	12.3	15.3
E	39	F	9	6.6
E	43	F	7.2	8.1
E	45	F	4.5	3.9
E	21	M	3.6	3.6
E	25	M	8.1	7.5
E	27	M	6.3	4.5
E	31	M	8.4	9.3
E	35	M	9.3	9.9
E	41	M	3.3	3
E	47	M	8.4	8.4
Average			6.89	6.70
Mean			6.9	6.15
Standard Dev			2.75	3.15
N	2	F	5.4	5.7
N	8	F	7.2	6.9
N	10	F	6.9	4.8
N	20	F	3.9	3.6
N	30	F	5.4	4.8
N	38	F	9.3	8.7
N	40	F	11.1	11.1
N	42	F	8.7	3.6
N	44	F	4.8	7.2
N	46	F	4.5	4.5
N	48	F	6.9	4.2
N	4	M	8.4	10.2
N	14	M	6.3	6
N	16	M	2.7	4.2
N	22	M	9.9	10.5
N	24	M	9.9	6.9
N	26	M	3.9	3.9
N	36	M	9.6	9
Average			6.93	6.43
Mean			6.9	5.85
Stand Dev			2.48	2.51

Initial EMG (3)	O Sec	1 min	3 min	5 min
3.9	7.5	4.5	4.5	4.2
4.8	7.5	5.4	5.7	5.4
4.2	7.5	6	4.2	3.9
10.5	8.7	6.9	5.7	5.1
4.2	3.9	3.9	4.2	6.6
4.5	3.6	3.3	3.6	3
6.3	8.4	6.9	5.7	6
4.2	9.6	4.5	3.9	3.3
10.8	12	4.8	4.2	9
6.3	6.6	6	5.1	5.1
9.3	5.4	6.9	6	5.7
8.4	6.3	6.6	5.1	4.2
6.3	5.1	6	5.7	5.4
4.8	9.6	6.6	8.7	5.4
3.9	4.2	3.6	3.9	3.3
3.6	4.2	3.9	3.9	3.6
7.8	6.3	5.7	3.9	3.6
4.5	4.8	4.5	4.2	4.2
8.4	8.1	7.5	6.6	6.9
10.2	12.9	11.4	11.1	10.2
3.3	3.9	3	3	2.7
6.9	7.5	5.4	5.4	3.6
6.23	6.98	5.60	5.20	5.02
5.55	7.05	5.55	4.8	4.65
2.44	2.57	1.84	1.82	1.89
4.8	5.4	3.9	5.7	4.5
6.9	8.1	6.9	6.3	5.1
4.5	9.6	5.7	3.6	3.6
5.1	6	4.2	3.9	3.3
5.1	4.2	3.6	3.9	4.2
9.6	13.8	12.6	11.4	10.2
10.5	10.8	11.1	10.2	10.2
6.3	4.8	3.6	3.9	3.9
7.5	10.8	9.9	9.9	8.4
4.2	4.2	4.2	4.2	4.2
4.2	3.6	15.3	7.8	3.9
6.6	6.3	5.7	4.8	4.8
5.7	8.4	9	7.8	3.3
4.2	5.4	5.1	3.3	3.9
10.5	7.7	7.6	7.1	7.5
8.1	4.5	3.9	7.8	4.8
4.2	5.1	3.3	5.1	3.6
9	5.4	4.5	5.4	6
6.50	6.89	6.67	6.23	5.30
6	5.7	5.4	5.55	4.35
2.23	2.83	3.54	2.48	2.25

10 min	15 min	20 min	25 min	30 min
3.9	4.2	3.6	3.6	3.6
6.9	6.9	4.5	4.2	4.5
3	3.3	3.3	2.7	2.7
4.2	6.9	4.2	4.8	6.3
4.8	7.8	11.1	4.5	3.3
3.3	3.3	3.3	3.3	3
7.5	6.3	5.7	6.6	5.7
3	3.6	3	5.1	3.3
4.2	4.2	3.9	4.2	4.2
4.5	4.8	4.5	4.8	4.8
5.1	8.1	7.2	5.1	6.6
8.7	4.5	4.2	3.3	6
4.5	5.7	8.4	6.2	5.1
3.6	3.6	3.9	3.6	3.3
2.4	3.3	3.3	3.3	3
3.3	3.6	3.3	3.3	3
5.4	3.9	3.3	3.6	6.6
4.5	3.6	3.3	3.9	3.6
7.8	5.7	6.9	6	5.7
4.8	5.1	6.9	7.5	7.8
2.7	3	3	2.7	2.7
5.4	5.7	3.6	4.2	5.1
4.70	4.87	4.75	4.39	4.54
4.5	4.35	3.9	4.2	4.35
1.70	1.55	2.11	1.28	1.51
3.6	4.5	3.6	3.9	3.3
5.4	3.3	3	4.8	4.2
3.3	4.5	3.3	3.3	3.6
3.3	3	3.3	3	3
3.9	3.6	3.9	4.5	4.5
8.4	7.2	3.9	9	6.6
8.1	6.3	13.2	5.7	8.1
5.4	4.2	3.6	3.6	3.3
4.8	4.2	6	5.4	4.5
3.6	3.6	4.2	4.2	3.6
3.6	3.3	4.5	2.7	3.3
6.3	5.1	6.3	3.9	3.9
3.3	3	3	3	2.7
3	4.5	4.2	3.6	4.2
5.1	3.9	5.7	5.7	4.2
5.1	8.1	6.9	3.6	3.9
3.9	3.9	5.4	3	7.2
6.3	5.4	11.7	6.3	5.7
4.80	4.53	5.32	4.40	4.43
4.35	4.2	4.2	3.9	4.05
1.63	1.43	2.86	1.57	1.50

Side of Mouth	Error Margin	Comments
R	0.3	1 Passerby walked in to visit
R	0.3	Had to warn subject to stop talking after 5 min
R	0.3	
L	0.3	
R	0.3	
R	0.3	
R	0.3	Did not enjoy video: bored/anxious
L	0.3	
L	0.3	Coughed at 5 min reading
R	0.3	
R	0.3	wears permanent retainer
R	0.3	
R	0.3	
R	0.3	
R	0.3	
R	0.3	
R	0.3	Anxious to get to class
L	0.3	
L	0.3	
L	0.3	
R	0.3	
L	0.3	
R	0.3	received 7 sec rest during 1 ex
R	0.3	
R	0.3	1st initial taken at 3.5' 2' to loose input wire
R	0.3	
L	0.3	
R	0.3	Interruption at 25' reading
R	0.3	
R	0.3	
R	0.3	
R	0.3	
R	0.3	
R	0.3	Subject sat up once between readings
R	0.3	
R	0.3	
R	0.3	EMG scale set incorrectly, excluded
R	0.3	
R	0.3	
R	0.3	

APPENDIX E

DEMOGRAPHICS DATA SHEET/SUMMARY

Exp/Cntrl	Code	Gender	Age	X Chewed	Time Chew	Meds?	Type Med
0	16	1	29	4	60.01	0	0
0	36	1	24	4	5	0	0
1	37	2	37	0	0	0	0
1	15	2	44	4	15	0	0
1	39	2	38	2	30	1	Pamelar
0	38	2	53	2	10	1	Erythromycin
0	40	2	22	8.1	60	0	0
1	47	1	10	8.1	60	0	0
0	46	2	19	2	60	0	0
1	27	1	24	8.1	60.01	0	0
1	29	2	25	4	60.01	1	Bactrum
0	30	2	26	8.1	60.01	0	0
1	35	1	25	0	0	0	0
0	24	1	23	8.1	30	0	0
1	25	1	19	10000	10000	1	acne med
1	43	2	24	8	30	0	0
0	26	1	22	2	60	0	0
1	21	1	26	4	10	0	0
0	22	1	28	4	15	0	0
1	23	2	20	8.1	15	0	0
1	17	2	25	8.1	30	0	0
1	19	2	29	4	60	0	0
0	20	2	24	8.1	60.01	1	aphredid
0	10	2	24	2	60	0	0
1	11	2	25	8.1	60	0	0
1	13	2	30	8.1	60	0	0
0	14	1	25	8	30	0	0
1	9	2	23	8	60	1	ovcon-28,erythromycn
0	8	2	24	2	5	1	tylenol prn
0	4	1	25	2	60	0	0
0	2	1	31	0	0	0	0
1	3	2	24	0	0	0	0
0	44	2	20	8.1	60	1	BirthControl
1	41	1	41	8.1	60.01	0	0
1	1	2	24	8.1	60.01	0	0
0	48	2	23	8.1	60.01	1	Beconase-Allergy
1	45	2	18	2	60	0	0
1	33	2	21	8.1	60	0	0
2	42	2	23	8.1	60	0	0
1	31	1	20	4	30	0	0
24	0	65	1037	10201.6	11575.08	9	0
	25.85	1.625	25.925	255.04	289.377	0.225	0

Stress #	Children	Occupation	Eating	School	Otr Fam	Spouse	Sleeping	Finances
1	0	0	0	1	0	0	0	0
0	0	0	0	1	0	0	0	0
1	0	1	0	0	0	0	0	0
4	1	1	0	1	0	0	0	0
0	0	0	0	0	0	0	0	0
2	0	1	0	0	0	0	1	0
3	0	0	0	1	0	1	0	1
0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	1	0	0
1	0	0	0	1	0	0	0	0
3	1	0	0	1	0	0	0	1
2	0	0	0	1	0	0	1	0
3	0	0	0	1	0	0	0	1
2	0	1	0	1	0	0	0	0
3	0	0	0	1	1	0	0	1
2	0	0	0	1	0	0	0	1
3	0	1	0	1	0	1	0	0
0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	0
4	0	1	0	1	0	0	1	1
2	0	0	0	1	0	1	0	0
1	0	0	0	1	0	0	0	0
1	0	0	0	1	0	0	0	0
4	0	0	1	1	0	0	1	1
2	0	0	0	1	0	0	1	0
1	0	0	0	1	0	0	0	0
2	0	0	0	1	0	0	0	1
1	0	0	0	1	0	0	0	0
2	0	0	0	1	0	0	0	1
2	0	0	0	1	0	0	0	0
1	0	0	0	1	0	0	0	0
3	0	1	0	1	0	0	0	1
5	1	0	0	1	1	1	0	0
3	0	0	0	1	0	0	0	1
1	0	0	0	1	0	0	0	0
1	0	0	0	1	0	0	0	1
1	0	0	0	1	0	0	0	0
4	0	0	0	1	1	0	1	1
2	0	0	0	1	0	0	0	0
76	3	7	1	34	3	5	6	13
1.9	0.075	0.175	0.025	0.85	0.075	0.125	0.15	0.325

Health	Other	Past JD	Type	When	How Long	Treated	SubTeeth
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	1	Ache	CG/run	10000	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0
0	girlfriend	1	ooj	constant	2	0	0
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	1	tmj	10000	15ya	10000	0
0	0	0	0	0	0	0	0
0	0	1	soreness	10000	1or2days	0	1
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	move caree	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	0	1	jaw	cg	10000	0	0
0	friends	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0
0	personal rel	0	0	0	0	0	1
1	1	5	0	20000	20002	10001	4
0.025	0.0277778	0.125	0	540.54054	526.36842	250.025	0.1

Bite Off	HowB	Habits	GumChew	Smoking	NailBite	Icecrunch	Chewpen	OtherH
0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	1
1	High Cap	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	1
0	0	2	0	0	1	1	0	0
0	0	0	0		0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0
1	overbite	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	1
0	0	1	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	1	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	overbite	1	0	0	0	0	0	0
0	0	2	0	0	1	0	1	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	3	1	1	1	0	0	0
1	10000	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	10000	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
0	0	1	0	0	0	0	0	1
5	20000	20	2	1	4	1	3	5
0.125	540.54054	0.5	0.05	0.025641	0.1	0.025	0.075	0.125

SideChew	Tendernes	#disease	OM	Sinusitis	Migraine	SideDev	Bruxism	NoPain
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	1	0	1	0	0	0	0
1	0	0	0	0	0	0	0	0
1	0	2	1	1	0	0	1	1
1	0	0	0	0	0	1.1	0	0
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	0
2	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	1	0	1	1
2	0		0	0	0	0	0	0
1	0	0	0	0	0	1.1	0	1
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	0
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1
1	0	1	1	0	0	0	0	0
1	0	0	0	0	0	0	1	0
1	0	0	0	0	0	0	0	0
1	0	1	0	1	0	0	0	0
1	1	0	0	0	0	1.2	1	0
1	0	0	0	0	0	0	1	0
1	0	0	0	0	0	0	0	0
1	0	1	0	1	0	0	0	0
1	0	1	0	1	0	0	0	0
2	0	0	0	0	0	0	0	0
51	1	7	2	5	1	3.4	7	4
1.275	0.025	0.1794872	0.05	0.125	0.025	0.085	0.175	0.1

NoPainH				
Heat				
0				
0				
0				
0				
0				
0				
0				
0				
0				
0				
0				
0				
0				
0				
frap+brace				
0				
massage				
0				
0				
0				
0				
0				
0				
retainer				
0				
0				
0				
0				
0				
0				
0				
0				
0				
0				
0				
0				

Demographics Summary

I. There were 22 experimental subjects and 18 controls.

- Of these, there were 26 females and 14 males.
- The Average age was 25.9 years.
- 10 males were R sided chewers, 4 were L sided.
- 22 females were R sided chewers, 4 were L sided.
- There were 15 female chewers and 11 female exercisers.
- There were 7 male chewers and 7 male exercisers.

II. 26 people chewed gum 4x or more in the last month.

- 16 people chewed gum more than 8x in the last month.
- 14 people chewed gum for up to 60 min.
- 8 people chewed gum for longer than 60 min.

III 8 people were on medications: birth control (2), Antibiotics (2), Acne medication (2).

IV. 36 people reported 1 or more sources of stress in their lives.

- Average number of sources of stress per person: 1.01.
- # of people with > 4 stress sources: 5.

- 34 people reported school as a source of stress, 13 reported finances, 7 reported occupation, 6 reported change in sleeping pattern, 5 reported spouse, 3 reported children, 3 reported other family members as a stress source.

V. 5 people reported past jaw discomfort.

- 2 people reported pain when they chewed gum too long.
- 2 people reported previous trauma that's presently asymptomatic.
- 1 claimed "TMJ" 15 years ago but no longer has symptoms.

VI 4 people were missing some original teeth but had currently had full dentition.

- 5 people felt their bite was "off": 2 described this as overbite.

VII 16 people reported 1 or more parafunctional habits: 5 people reported habits other than the choices given, 4 reported biting nails, 3 reported pen chewing, 2 reported gum chewing.

VIII. 6 people reported being diagnosed previously with one or more of the following diseases that have been known to mask TMJ.

- 2 people reported otitis media.
- 5 people reported sinusitis.

IX. 7 people believed that they were bruxers.

X. 4 people had used heat or cold modalities to relieve symptoms in the past.

APPENDIX F

DATA COLLECTION SHEET

Data Collecton Form

Patient Code:
Patient Name:
Date Tested:
Gender:
(-) Tone:
(+) Tone:
Initial EMG (1):
Initial EMG (2):
Initial EMG (3):
Avg Initial:
0 sec (3):
1 min (3):
3 min (3):
5 min (3):
10 min (3):
15 min (3):
20 min (3):
25 min (3):
30 min (3):
Side of Mouth:
Error Margin: