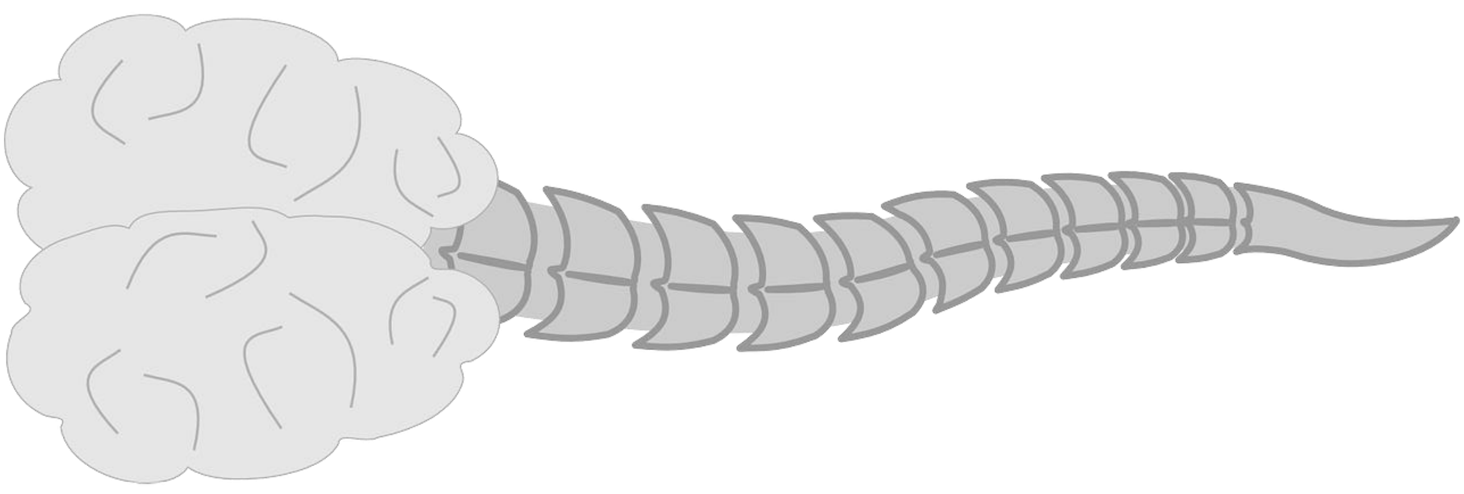
FLEX CEUs

TMJ Overview and Jaw Dysfunctions Associated with the Cervical Spine



TMJ DISORDERS

Temporomandibular joint and muscle disorders, commonly called "TMJ," are a group of conditions that cause pain and dysfunction in the jaw joint and the muscles that control jaw movement. We don't know for certain how many people have TMJ disorders, but some estimates suggest that over 10 million Americans are affected. The condition appears to be more common in women than men.

For most people, pain in the area of the jaw joint or muscles does not signal a serious problem. Generally, discomfort from these conditions is occasional and temporary, often occurring in cycles. The pain eventually goes away with little or no treatment. Some people, however, develop significant, long-term symptoms.

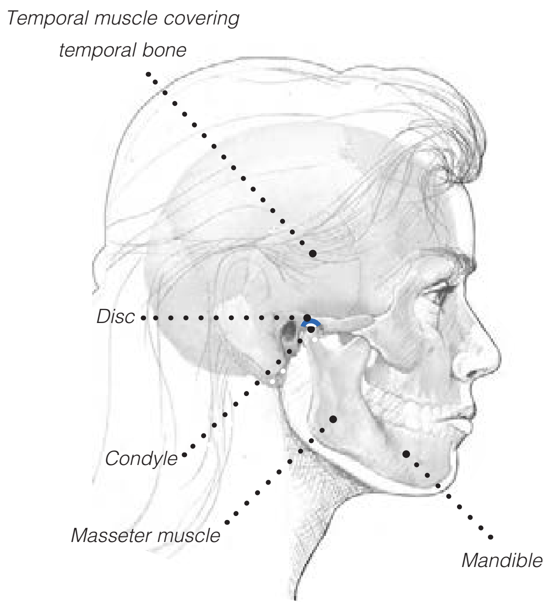
If you have questions about TMJ disorders, you are not alone. Researchers, too, are looking for answers to what causes these conditions and what the best treatments are. Until we have scientific evidence for safe and effective treatments, it's important to avoid, when possible, procedures that can cause permanent changes in your bite or jaw. This booklet provides information you should know if you have been told by a dentist or physician that you have a TMJ disorder.

WHAT IS THE TEMPOROMANDIBULAR JOINT?

The temporomandibular joint connects the lower jaw, called the mandible, to the bone at the side of the head—the temporal bone. If you place your fingers just in front of your ears and open your mouth, you can feel the joints. Because these joints are flexible, the jaw can move smoothly up and down and side to side, enabling us to talk, chew and yawn. Muscles attached to and surrounding the jaw joint control its position and movement.

When we open our mouths, the rounded ends of the lower jaw, called condyles, glide along the joint socket of the temporal bone. The condyles slide back to their original position when we close our mouths. To keep this motion smooth, a soft disc lies between the condyle and the temporal bone. This disc absorbs shocks to the jaw joint from chewing and other movements.

The temporomandibular joint is different from the body's other joints. The combination of hinge and sliding motions makes this joint among the most complicated in the body. Also, the tissues that make up the temporomandibular joint differ from other load-bearing joints, like the knee or hip. Because of its complex movement and unique makeup, the jaw joint and its controlling muscles can pose a tremendous challenge to both patients and health care providers when problems arise.



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WHAT ARE TMJ DISORDERS?

Disorders of the jaw joint and chewing muscles—and how people respond to them—vary widely. Researchers generally agree that the conditions fall into three main categories:

1 Myofascial pain involves discomfort or pain in the muscles that control jaw function.

2 Internal derangement of the joint involves a displaced disc, dislocated jaw, or injury to the condyle.

3 Arthritis refers to a group of degenerative/inflammatory joint disorders that can affect the temporomandibular joint.

A person may have one or more of these conditions at the same time. Some people have other health problems that co-exist with TMJ disorders, such as chronic fatigue syndrome, sleep disturbances or fibromyalgia, a painful condition that affects muscles and other soft tissues throughout the body. These disorders share some common symptoms, which suggests that they may share similar underlying mechanisms of disease. However, it is not known whether they have a common cause.

Rheumatic disease, such as arthritis, may also affect the temporomandibular joint as a secondary condition. Rheumatic diseases refer to a large group of disorders that cause pain, inflammation, and stiffness in the joints, muscles, and bone. Arthritis and some TMJ disorders involve inflammation of the tissues that line the joints. The exact relationship between these conditions is not known.

How jaw joint and muscle disorders progress is not clear. Symptoms worsen and ease over time, but what causes these changes is not known. Most people have relatively mild forms of the disorder. Their symptoms improve significantly, or disappear spontaneously, within weeks or months. For others, the condition causes long-term, persistent, and debilitating pain.

WHAT CAUSES TMJ DISORDERS?

Trauma to the jaw or temoromandibular joint plays a role in some TMJ disorders. But for most jaw joint and muscle problems, scientists don't know the causes. Because the condition is more common in women than in men, scientists are exploring a possible link between female hormones and TMJ disorders.

For many people, symptoms seem to start without obvious reason. Research disputes the popular belief that a bad bite or orthodontic braces can trigger TMJ disorders.

There is no scientific proof that sounds—such as clicking—in the jaw joint lead to serious problems. In fact, jaw sounds are common in the general population. Jaw noises alone, without pain or limited jaw movement, do not indicate a TMJ disorder and do not warrant treatment.

WHAT ARE THE SIGNS AND SYMPTOMS?

A variety of symptoms may be linked to TMJ disorders. Pain, particularly in the chewing muscles and/or jaw joint, is the most common symptom. Other likely symptoms include:

- radiating pain in the face, jaw, or neck,
- jaw muscle stiffness,
- limited movement or locking of the jaw,
- painful clicking, popping or grating in the jaw joint when opening or closing the mouth,
- a change in the way the upper and lower teeth fit together.

HOW ARE TMJ DISORDERS DIAGNOSED?

There is no widely accepted, standard test now available to correctly diagnose TMJ disorders. Because the exact causes and symptoms are not clear, identifying these disorders can be difficult and confusing. Currently, health care providers note the patient's description of symptoms, take a detailed medical and dental history, and examine problem areas, including the head, neck, face, and jaw. Imaging studies may also be recommended.

You may want to consult your doctor to rule out other known causes of pain. Facial pain can be a symptom of many conditions, such as sinus or ear infections, various types of headaches, and facial neuralgias (nerve-related facial pain). Ruling out these problems first helps in identifying TMJ disorders.

HOW ARE TMJ DISORDERS TREATED?

Because more studies are needed on the safety and effectiveness of most treatments for jaw joint and muscle disorders, experts strongly recommend using the most conservative, reversible treatments possible. Conservative treatments do not invade the tissues of the face, jaw, or joint, or involve surgery. Reversible treatments do not cause permanent changes in the structure or position of the jaw or teeth. Even when TMJ disorders have become persistent, most patients still do not need aggressive types of treatment.

Conservative Treatments

Because the most common jaw joint and muscle problems are temporary and do not get worse, simple treatment may be all that is necessary to relieve discomfort.

Self-Care Practices

There are steps you can take that may be helpful in easing symptoms, such as:

- eating soft foods,
- applying ice packs,
- avoiding extreme jaw movements (such as wide yawning, loud singing, and gum chewing),
- learning techniques for relaxing and reducing stress,
- practicing gentle jaw stretching and relaxing exercises that may help increase jaw movement. Your health care provider or a physical therapist can recommend exercises if appropriate for your particular condition.

Pain Medications

For many people with TMJ disorders, short-term use of over-the-counter pain medicines or nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen, may provide temporary relief from jaw discomfort. When necessary, your dentist or physician can prescribe stronger pain or anti-inflammatory medications, muscle relaxants, or anti-depressants to help ease symptoms.

Stabilization Splints

Your physician or dentist may recommend an oral appliance, also called a stabilization splint or bite guard, which is a plastic guard that fits over the upper or lower teeth. Stabilization splints are the most widely used treatments for TMJ disorders. Studies of their effectiveness in providing pain relief, however, have been inconclusive. If a stabilization splint is recommended, it should be used only for a short time and should not cause permanent changes in the bite. If a splint causes or increases pain, or affects your bite, stop using it and see your health care provider.

The conservative, reversible treatments described are useful for temporary relief of pain – they are not cures for TMJ disorders. If symptoms continue over time, come back often, or worsen, tell your doctor.

Botox

Botox® (botulinum toxin type A) is a drug made from the same bacterium that causes food poisoning. Used in small doses, Botox injections can actually help alleviate some health problems and have been approved by the Food and Drug Administration (FDA) for certain disorders. However, Botox is currently not approved by the FDA for use in TMJ disorders.

Results from recent clinical studies are inconclusive regarding the effectiveness of Botox for treatment of chronic TMJ disorders. Additional research is under way to learn how Botox specifically affects jaw muscles and their nerves. The findings will help determine if this drug may be useful in treating TMJ disorders.

Irreversible Treatments

Irreversible treatments that have not been proven to be effective – and may make the problem worse – include orthodontics to change the bite; crown and bridge work to balance the bite; grinding down teeth to bring the bite into balance, called "occlusal adjustment"; and repositioning splints, also called orthotics, which permanently alter the bite.

Surgery

Other types of treatments, such as surgical procedures, invade the tissues. Surgical treatments are controversial, often irreversible, and should be avoided where possible. There have been no long-term clinical trials to study the safety and effectiveness of surgical treatments for TMJ disorders. Nor are there standards to identify people who would most likely benefit from surgery. Failure to respond to conservative treatments, for example, does not automatically mean that surgery is necessary. If surgery is recommended, be sure to have the doctor explain to you, in words you can understand, the reason for the treatment, the risks involved, and other types of treatment that may be available.

Implants

Surgical replacement of jaw joints with artificial implants may cause severe pain and permanent jaw damage. Some of these devices may fail to function properly or may break apart in the jaw over time.
If you have already had temporomandibular joint surgery, be very cautious about considering additional operations. Persons undergoing multiple surgeries on the jaw joint generally have a poor outlook for normal, pain-free joint function. Before undergoing any surgery on the jaw joint, it is extremely important to get other independent opinions and to fully understand the risks.

IF YOU THINK YOU HAVE A TMJ DISORDER...

Remember that for most people, discomfort from TMJ disorders will eventually go away on its own. Simple self-care practices are often effective in easing symptoms. If treatment is needed, it should be based on a reasonable diagnosis, be conservative and reversible, and be customized to your special needs. Avoid treatments that can cause permanent changes in the bite or jaw. If irreversible treatments are recommended, be sure to get a reliable, independent second opinion.

Because there is no certified specialty for TMJ disorders in either dentistry or medicine, finding the right care can be difficult. Look for a health care provider who understands musculoskeletal disorders (affecting muscle, bone and joints) and who is trained in treating pain conditions. Pain clinics in hospitals and universities are often a good source of advice, particularly when pain continues over time and interferes with daily life. Complex cases, often marked by prolonged, persistent and severe pain; jaw dysfunction; co-existing conditions; and diminished quality of life, likely require a team of experts from various fields, such as neurology, rheumatology, pain management and others, to diagnose and treat this condition.

RESEARCH

The National Institute of Dental and Craniofacial Research (NIDCR), one of the National Institutes of Health (NIH), leads the federal research effort on temporomandibular joint and muscle disorders. In a landmark study, NIDCR is tracking healthy people over time to identify risk factors that contribute to the development of these conditions. Preliminary results from this study have identified a series of clinical, psychological, sensory, genetic and nervous system factors that may increase the risk of having chronic TMJ disorders. These new findings expand our scientific understanding of the onset and natural course of TMJ disorders and may lead to new diagnostic and treatment approaches.

Additionally, researchers are using data from a TMJ implant registry and repository that collected health information from patients who received implants and from those who had implants removed. Recent studies using the data have helped researchers plan for new pain medication trials and other research projects.

Pain Studies

Because pain is the major symptom of these conditions, NIH scientists are conducting a wide range of studies to better understand the pain process, including:

- understanding the nature of facial pain in TMJ disorders and what it may hold in common with other pain conditions, such as headache and widespread muscle pain,
- exploring differences between men and women in how they respond to pain and to pain medications,
- pinpointing factors that lead to chronic or persistent jaw joint and muscle pain,
- examining the effects of stressors, such as noise, cold and physical stress, on pain symptoms in patients with TMJ disorders to learn how lifestyle adjustments can decrease pain,
- identifying medications, or combinations of medications and conservative treatments, that will provide effective chronic pain relief,
- investigating possible links between osteoarthritis and a history of orofacial pain.

Replacement Parts

Research is also under way to grow human tissue in the laboratory to replace damaged cartilage in the jaw joint. Other studies are aimed at developing safer, more life-like materials to be used for repairing or replacing diseased temporomandibular joints, discs, and chewing muscles.

HOPE FOR THE FUTURE

The challenges posed by TMJ disorders span the research spectrum, from causes to diagnosis through treatment and prevention. Researchers throughout the health sciences are working together not only to gain a better understanding of the temporomandibular joint and muscle disease process, but also to improve quality of life for people affected by these disorders.

Correlation between TMD and Cervical Spine Pain and Mobility: Is the Whole Body Balance TMJ Related?

Temporomandibular dysfunction (TMD) is considered to be associated with imbalance of the whole body. This study aimed to evaluate the influence of TMD therapy on cervical spine range of movement (ROM) and reduction of spinal pain. The study group consisted of 60 patients with TMD, cervical spine pain, and limited cervical spine range of movements. Subjects were interviewed by a questionnaire about symptoms of TMD and neck pain and had also masticatory motor system physically examined (according to RDC-TMD) and analysed by JMA ultrasound device. The cervical spine motion was analysed using an MCS device. Subjects were randomly admitted to two groups, treated and control. Patients from the treated group were treated with an occlusal splint. Patients from control group were ordered to self-control parafunctional habits. Subsequent examinations were planned in both groups 3 weeks and 3 months after treatment was introduced. The results of tests performed 3 months after the beginning of occlusal splint therapy showed a significant improvement in TMJ function ($P > 0.05$), cervical spine ROM, and a reduction of spinal pain. The conclusion is that there is a significant association between TMD treatment and reduction of cervical spine pain, as far as improvement of cervical spine mobility.

1. Introduction

Recent years have seen a significant increase in the number of patients suffering from temporomandibular disorders (TMD) [1]. According to various sources, 8 out of 10 patients coming to the dentist are found to have bruxism or TMD [2].

The issue of relationships between temporomandibular disorders and body posture is still a source of speculations. The knowledge about connections between distant body districts has to be proven by appropriate diagnostic procedures and instruments.

TMD are musculoskeletal disorders needing a multidisciplinary effort to manage with other professionals (e.g., neurologist, laryngologist, and psychiatrist) [3].

Because of the variety of TMD symptoms, many patients had a history of multiple treatments and medications and were treated previously by laryngologists, neurologists, or physiotherapist, but the therapy did not bring the expected, long lasting results. According to currently prevailing theories, temporomandibular dysfunction is considered to be associated with imbalance of the whole body [4].

In addition, the body as a whole operates on the principle of compensation, when it comes to disturbances in the upper quarter, such as increased muscle tension; this will lead to compensatory changes within the muscle tension in the spinal region so as to force the correct position/posture. These adaptive changes occur at all levels, within tolerance of the body [5, 6].

When the body capacity to compensate for the pathological changes progressing in given areas is exceeded, however, imbalance sets in and pathological symptoms will appear. Each individual, obviously, has a unique compensation limit beyond which such symptoms are triggered off.

It was pointed out by many authors that pain in the upper quarter and masticatory motor system may be caused by cervical spine disorders (generally by dysfunction of muscular origin) and vice versa [7–9].

It could be explained by specific functional and morphological connections between the cervical and temporomandibular regions.

2. Materials and Methods

The sample was comprised of 60 individual (30 female, 30 male, age 18–40) and was divided into two groups with randomization. Study and control groups both consisted of 30 people with TMD, cervical spine pain, and limited cervical spine range of movements (ROM). Subjects were directed from Cooperating Orthopaedic Service.

Groups were not different regarding age and gender.

Patients from both groups met the criteria for inclusion and exclusion of studies (Table 1).

Patients from both groups were recruited from cooperating clinics and previously diagnosed by an orthopaedist who excluded morphological and degenerative changes of cervical spine. Cervical spine pain was diagnosed by an orthopaedist according to the Neck Pain Task Force recommendations [10].

Each patient had to have had cervical spine pain for at least 12 months in multiple episodes at a frequency of at least once a week. Patients were included in the study if having pain in the area between occiput and C7.

Subjects gave written consent to participate in the study. The study was approved by the Ethics Committee of the Medical University of Silesia (number KNW/0022/KB1/6/I/10 from 16.03.2010).

Each patient was examined three times. At the 3-week and 3-month evaluations, symptoms of TMD and cervical spine pain and mobility were studied.

The examination included the following:

(1) medical history and physical examination, based on a survey card (according to RDC/TMD);

(2) analysis of pain, using the visual analogue scale (VAS) and the cervical Oswestry scale for the cervical spine;

(3) TMJ functional evaluation by JMA device;

(4) cervical spine motion evaluation with the MCS device.

In order to describe individual TMD symptoms, the entire sample filled out a questionnaire according to research diagnostic criteria for TMD, the translated Polish version (RDC/TMD axis I). The questionnaire focuses on symptoms specifically in the jaw-face, neck, shoulder girdle, intensity of spinal pain, and any other complaints of TMD and spinal origin. Presence of symptoms was marked according to duration, frequency, and intensity. The survey card was completed by each patient 3 times during three consecutive examinations which enabled a comparison of symptoms between groups according to treatment provided in treated group.

On a questionnaire, patients indicated the intensity of spinal pain experienced at the time of examination on a 100 mm visual analogue scale (VAS). Additionally, subjects described symptoms of pain and reduced mobility of cervical spine by filling in the cervical Oswestry scale.

Table 1: Inclusion and exclusion criteria of studies.

Inclusion criteria	Exclusion criteria
(1) Spinal pain	(1) After spine surgery
(2) Women, men	(2) Congenital or degenerative changes of the spine confirmed radiologically
(3) Age between 18 and 40	(3) Neuropathy
(4) Functional changes of the spine, muscle-related	(4) Ongoing medication or physiotherapy
(5) Temporomandibular joint disorder/bruxism	(5) TMJ internal derangement
(6) Patient agreement	

Clinical examination was performed according to RDC/TMD guidelines, too.

Previously trained examiner assessed face symmetry, dentition, and occlusion, as far as "upper quarter" muscle tenderness to palpation with an emphasis on the masticatory muscles, trapezius muscles, suprahyoid muscles, infrahyoid muscles, sternocleidomastoid muscles, and neck muscles in the region of the linea nuchae. Each time the muscle tension was examined by the same examiner.

Mandibular motion was recorded using jaw motion analyzer (JMA) from Zebris, (GmbBH) and the software provided (WinJaw) [11]. The device allows recording mandibular position and movements.

The subjects were provided with an explanation as to the objective of the axiographic examination and its course as well as what types of mandibular movements should be made and how. For each examination, it was necessary to make a paraocclusal clutch mounted on the vestibular surface of the lower teeth and fitted with an electronic sensor. The tool was made of light-cured Multitray (Espe).

The study was based on the performance of patients' movements: opening and closing of the mandible, lateral movements, protrusion, and retrusion. To avoid bias, all subjects performed each trials three times. For each movement, the baseline position was the mandibular rest position. It seems that the rest position should be the starting point when assessing the motor function of the stomatognathic system using instrumental techniques (Figure 1).

The advantages of this system are the ease of use and a positional accuracy of about 100 micrometers. Software allowed creating data report, which consists of graphic diagrams of TMJ function (e.g., Condyle path, maximal opening, and Bennett angle).

Afterwards, the MCS (Zebris, GmbH) ultrasonic-based device was used to collect external kinematic data of the cervical spine movements. Patients with a neutral (comfortably seated) position performed maximal head movements: flexion, extension, rotation to the right and left side, and lateral flexion movements. Each movement was repeated three times in order to minimise measurement errors. The system was calibrated before each measurement. Data were monitored in a real time (Figure 2).

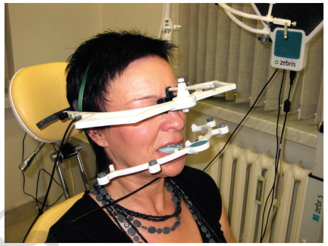

Figure 1: Patient during the mandibular movements' examination (JMA).

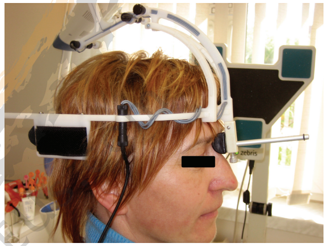

Figure 2: Patient during the cervical spine movements' examination.

Thanks to the repeatable measurements, values were found describing the cervical spine ROMs, presented in the form of relevant graphs.

After the subjects' examination, data containing information about the quality and range of movement in both the TMJ and cervical spine were stored on a personal computer.

After the first examination, each patient selected for the treated (experimental) group was supplied with an occlusal splint. Every patient suffered from TMD of muscular origin (RDC/TMD axis I); therefore, subjects were supplied with an occlusal splint SVED (Sagittal Vertical Extrusion Device). SVED is a removable, flat-plane appliance which makes contact only with the anterior teeth in the opposing arch [12]. It disengages the posterior teeth and thus eliminates their influence in the function of the masticatory system by changing the input signal from proprioceptive fibres contained in the periodontal ligament of the posterior teeth (Figure 3).

The SVED appliance is used in case of hyperactivity of masticatory muscles, without the occlusal reason of TMD [13]. It is usually used to promote jaw muscle relaxation in patients with stress related pain symptoms like headache or neck pain of muscular origin. The splint also obliges the patient to find a new mandibular position, which results in a muscular balance. Patients were ordered to wear the occlusal splint during sleep, but not more than 8–10 hours per day.

Table 2: Characterization of the sample according to age and gender.

Gender	Group		Total
	Treated	Controls	
Female	16	14	30
Male	14	16	30
Mean age in years	32,65	34,87	33,76

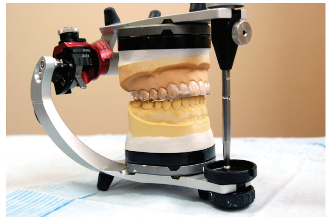

Figure 3: SVED appliance.

According to many researchers, there is no ideal way to handle the problem of control treatment, especially in splint studies. The use of a placebo control group can balance the nonspecific effects in the treatment group and allow for independent assessment of the real treatment effect [14]. In our study control, subjects were instructed to self-control clenching and other parafunctional habits.

The statistical analysis of the results was performed using the statistical package STATISTICA 9.0 (StatSoft). The test probability of $P < 0.05$ was assumed to be significant while the test probability of $P < 0.0001$ was highly significant.

3. Results

60 subjects were examined: 30 belonged to the treated group and 30 to the control group. Patients were randomly admitted to groups. The characteristics of age and gender for both groups are shown in Table 2.

All patients were simultaneously assessed by the same examiner.

3.1. RDC/TMD Diagnoses. Referring to TMD research diagnostic criteria, in patients from both treated and control groups myofascial pain (I) or disc displacement with reduction (DDR, IIa) was diagnosed.

After a three-month therapy with an occlusal splint considerable improvements of TMJ function were found in the experimental group, with 78% of the subjects reporting no DDR symptoms or acoustic phenomena like clicks during mandible movements; the abduction path of the mandible was symmetrical, and there was no pain during the movements (Table 3).

Most interestingly, however, there were changes on the condyle path in the TMJ during the measurements made

Table 3: Symptoms of DDR and myofascial pain during 3 examinations.

	Myofascial pain (treated/control)		Disc displacement with reduction Left side (treated/control)		Disc displacement with reduction Right side (treated/control)	
Examination 1	27	29	13	11	15	12
Examination 2	19	26	8	11	10	12
Examination 3	4	25	3	10	6	12

with a JMA. Deviations within the condylar path which had been noticeable in the first examination (such as lack of symmetry between the length of the path in the right and left TMJ) became reduced in 28 subjects as a result of the treatment, and during the third measurement, the graphs of the condylar paths were asymmetrical on both sides in as few as four subjects. In 24 subjects, there were considerable improvements, which also improved the TMJ function.

In the control group, no changes in the TMJ function were observed in the clinical examination or instrumental check with a JMA in successive examinations.

Muscle tension was examined by palpation by the same examiner. In all subjects, upper quarter muscle tenderness (masticatory muscles, semispinalis muscles, trapezius muscles, sternocleidomastoideus muscles, suprahyoid muscles, and neck muscles in the region of the linea nuchae) was diagnosed during three consecutive examinations. The presence of muscle pain and tenderness during palpation was registered in both experimental and control groups.

During the third examination, the muscle tension of the subjects in the experimental group lowered considerably and they reported lack of pain in the examination by palpation. Out of the 27 subjects in whom intensified tension of the examined muscles had been found, 22 reported no complaints during the third examination. No significant changes were found in the control group.

3.2. Spinal Pain. The whole group showed cervical spine pain. Cervical spine pain according to VAS scale in a treated group significantly improved during three-month therapy (Figure 4).

During treatment, cervical spine pain diminished and after 3 weeks it occurred in 39% of subjects and after 3 months pain was only in 8% subjects from treated group (2 subjects).

The difference between treated and control groups was statistically significant ($P < 0.0001$).

3.3. Cervical Spine ROM. During the first examination, cervical limited ROM at least during one of the tested movements was reported in 60 subjects.

For each measurement, a relevant physiological standard was established, to which the cervical spine ROM results were referred [15]. The norm assumed was dependent on the gender and age of the subject.

Many authors claim that in the ROM examinations of the cervical spine it is not correct to treat an imposed and inflexible range of values within which the ROM should be included as the only indicator. As the resultant data are

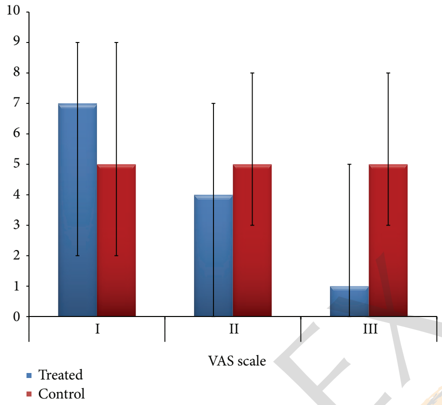

Figure 4: The VAS scale score according to groups during three examinations.

dependent on too many additional factors, in the study we placed special emphasis on the comparison between the results from the first, second, and third examinations and on the assessment whether they have been changed or improved, not merely whether they fell within the standard.

After introducing the occlusal splint therapy, cervical spine mobility improved.

The highest improvement was seen during the flexion movement, which, on the 1st examination only in 22% of patients, was within normative values. During the 3rd examination in 70% of patients from treated group flexion movement conformed the norm (Figure 5).

For the anteflexion movement, the improvement of the results was highly significant ($P = 0.0006$); that is, there were more subjects in the experimental group with the result conforming to the norm.

Likewise, for the retroflexion movement, the results were improved by a highly significant factor ($P = 0.0082$); that is, there were more subjects in the experimental group with the result conforming to the norm.

In the control group, no significant ($P > 0.05$) changes were found; that is, there was no ROM improvement in the cervical spine towards the values in the norm.

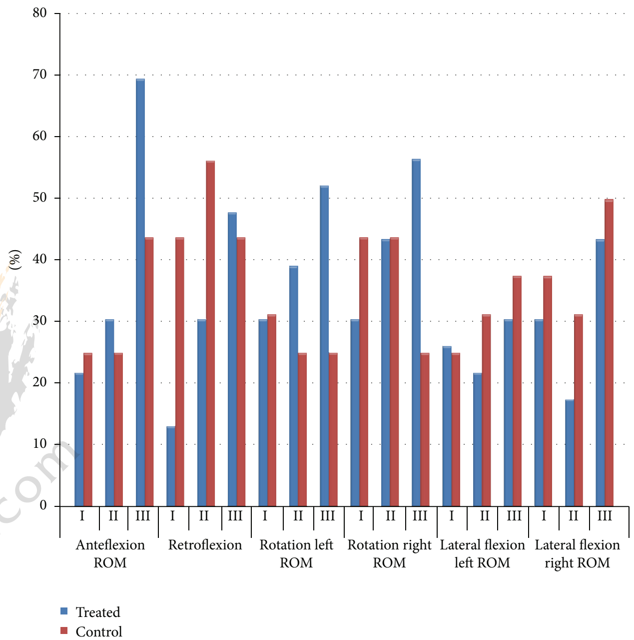

Figure 5: Cervical spine mobility results.

The results of improving the mobility and reduction of cervical spine pain influenced the cervical Oswestry scale score. The average score on the first examination in a treated group was 9.22 points and during therapy, after 3 months, the average score changed to 3.71.

4. Discussion

The results obtained have confirmed a correlation between the pathologies and the positive impact of treatment within the motor aspect of the stomatognathic system on the alleviation of spine pain, even in subjects experiencing such pain for many years.

It is important to understand the complex interrelations between the stomatognathic system and pain and dysfunctions in other areas of the body in order to be able to treat patients more efficiently and effectively at the initial stage, when painful symptoms appear and when curing them is possible as well as much swifter and more efficient. To be able to make successful therapeutic interventions, dental surgeons should cooperate in an interdisciplinary fashion with neurologists, orthopaedists, or laryngologists. They all should also take such interdependencies into account in their diagnostic work with their own patients.

Scientists often note the importance of a holistic approach to therapy. There are many voices in favor of this approach that symptoms of the disorder are usually not isolated and the dysfunction of one region of the body also applies to other regions [16–20].

Although the etiology of cervical spine pain very often remains unexplained, medical specialists in many cases report the comorbidity of dysfunctions in the stomatognathic system and the pain syndrome in the cervical spine [4]. Numerous scientific reports confirm that many researchers have embarked on the examination of the impact of disorders in the "upper quarter" on body posture and pain experienced in various areas of the body [21]. In studies conducted thus far, however, the focus has been mainly to prove the presence or absence of dependence between dysfunction of the stomatognathic system and pain in the cervical spine. The most commonly applied methodology was questionnaires with questions concerning cervical spine pain and complaints of the motor aspect of the stomatognathic system [22]. On that basis, researchers would look for a link between the dysfunction in the motor aspect of the stomatognathic system and the pain felt in the cervical spine. Our study, however, included a therapy with an occlusal appliance, with no other invasive treatment methods used. By applying treatment with an occlusal splint in the experimental group, a vast majority of the subjects reported improvements and the total disappearance or considerable alleviation of cervical spine pain and TMD symptoms, while the mobility of the cervical spine improved considerably as well.

In case of TMD, there are often large discrepancies between therapists concerning type of occlusal splint most appropriate to use. Many types of splints can be distinguished, for example, stabilization splint, repositioning splint, relaxation splint, or splints only for protecting oral tissues. SVED splint, which is a typical relaxing appliance, was used because of its influence on jaw muscles. No studies about different types of splints used in patients with both TMD and spinal pain were found [23].

5. Conclusions

Our studies as well as the clinical followup suggest that TMD is very frequently present along with pain in the cervical spine. The key aspect of the studies described here is the considerable ROM improvement in the cervical spine and the elimination of cervical spine pain felt there by the subjects in the experimental group. Taking into account the results of our study, it seems obvious that interdisciplinary cooperation between orthopedist, laryngologist, neurologist, and dentist is necessary and essential.

Jaw Dysfunction Is Associated with Neck Disability and Muscle Tenderness in Subjects with and without Chronic Temporomandibular Disorders

Purpose. Tender points in the neck are common in patients with temporomandibular disorders (TMD). However, the correlation among neck disability, jaw dysfunction, and muscle tenderness in subjects with TMD still needs further investigation. This study investigated the correlation among neck disability, jaw dysfunction, and muscle tenderness in subjects with and without chronic TMD. *Participants*. Forty females between 19 and 49 years old were included in this study. There were 20 healthy controls and 20 subjects who had chronic TMD and neck disability. *Methods*. Subjects completed the neck disability index and the limitations of daily functions in TMD questionnaires. Tenderness of the masticatory and cervical muscles was measured using an algometer. *Results*. The correlation between jaw disability and neck disability was significantly high ($r = 0.915$, $P < 0.05$). The correlation between level of muscle tenderness in the masticatory and cervical muscles with jaw dysfunction and neck disability showed fair to moderate correlations ($r = 0.32$–0.65). *Conclusion*. High levels of muscle tenderness in upper trapezius and temporalis muscles correlated with high levels of jaw and neck dysfunction. Moreover, high levels of neck disability correlated with high levels of jaw disability. These findings emphasize the importance of considering the neck and its structures when evaluating and treating patients with TMD.

1. Introduction

Temporomandibular disorders (TMD) are a musculoskeletal disorder affecting the masticatory muscles, the temporomandibular joint (TMJ), and associated structures. Evidence suggests that TMD are commonly associated with other conditions of the head and neck region, including cervical spine disorders and headache. Presence of neck pain was shown to be associated with TMD 70% of the time [1, 2]. Neuroanatomical and functional connections between masticatory and cervical regions are discussed as explanations for concomitant jaw and neck symptoms [3, 4]. The presence of pain in the masticatory system, especially related to myogenic TMD, could be caused by dysfunctions in the cervical column, or vice versa, showing the intrinsic relationship between the different structures [1, 5].

Although the association of cervical spine disorders and TMD has been studied by different authors, it is far from being exhaustively explained [6, 7]. Most of the studies agree that symptoms from the cervical spine can be referred to the stomatognathic region through the trigeminocervical nucleus. Several studies have examined the presence of signs and symptoms in the cervical region of patients suffering with TMD and that the presence of tender points in the cervical area of these patients is very common [8–13]. de Laat et al. [11] found that, on palpation, 23–67% of the patients with TMD had neck muscle tenderness in the sternocleidomastoid and upper trapezius as well as other cervical and shoulder muscles, which was only rarely present in the control group. Recently, Greenspan et al. [14] measured pressure pain threshold (PPT) in the center of the temporalis, masseter, and trapezius muscles in subjects with and without TMD. They showed that patients with TMD were more sensitive to a wide range of mechanical and thermal pain tests than control subjects, including not only the orofacial area, but also the trapezius muscle.

Muscle tenderness in the cervical spine and jaw was shown to be associated with increased levels of jaw and neck disability. For example, one study by our team revealed a strong relationship between neck disability and jaw disability ($r = 0.82$). A subject with a high level of TMD disability (grade IV) had an increase of about 19 points in the NDI when compared with a person without TMD disability [15]. Disability associated with jaw and neck pain interferes greatly with daily activities and can affect the patient's lifestyle which declines the individual's ability to work and interact in a social environment [6, 8].

Muscle tenderness is the most common sign [8, 16–18] and muscle pain is the most common symptom [19] found in patients with TMD, and their evaluation is still one of the most important methods of establishing a clinical diagnosis of TMD [17, 20], being of particular interest to clinicians treating orofacial pain. Treatment strategies such as exercises, manual therapy, stretching, and education can be targeted to painful and sensitive muscles in order to reduce pain in the orofacial region [8, 20–22].

Although several studies have evaluated neck tenderness in subjects with TMD, none of these studies have evaluated the relationship between the level of tenderness and jaw dysfunction. Moreover, most studies that investigated muscle tenderness in subjects with TMD used palpation techniques, which are difficult to quantify and standardize [10, 11].

There is a great interest on the knowledge for further relationship between stomatognathic system and cervical spine. If further relationship is established, new clinical strategies that target both regions should be considered and, therefore, the need of a multidisciplinary approach should be reinforced in the management of patients with alterations of the stomatognathic system, including TMD patients. In order to further investigate this relationship, the objective of this study was to determine the correlation among neck disability, jaw dysfunction, and muscle tenderness in subjects with chronic TMD. We hypothesized that the higher the level of neck disability, the higher the level of jaw dysfunction and the higher the level of muscle tenderness.

2. Methods

2.1. Subjects. A convenience sample of 20 female subjects diagnosed with chronic TMD (at least 3-month duration) and 20 healthy female subjects participated in this cross-sectional study. Subjects were recruited from the TMD/Orofacial Pain Clinic at the University of Alberta and by using advertising around the university and on the local television news. Sample size calculation was based on bivariate correlation. Based on a moderated and conservative correlation ($r = 0.4$, effect size) and using $\alpha = 0.05$, $\beta = 0.20$, and power = 80%, approximately 37 subjects were needed for this study [23].

Subjects with TMD were classified with either myogenous TMD (mainly muscle complaints) or mixed TMD (myogenous and arthrogenous) and presented concurrent neck disability. The subjects were excluded if they presented arthrogenic TMD only, a medical history of neurological, bone, or systemic diseases, cancer, acute pain or dental problems other than TMD, or a history of trauma or surgery to the upper quarter within the last year or if they had taken any pain medication or muscle relaxants less than 4 hours before the diagnostic session.

The healthy group included subjects with no pain or clinical pathology involving the masticatory system or cervical spine for at least one year prior to the start of the study. Exclusion criteria included previous surgery, neurological problems, any acute or chronic musculoskeletal injury, or any systemic diseases that could interfere with the procedure and taking any medication such as pain relieving drugs, muscle relaxants, or anti-inflammatory drugs.

After obtaining consent, all subjects were examined clinically using the research diagnostic criteria for temporomandibular disorders (RDC/TMD) [24] by a physical therapist specialized in TMD. Neck disability was evaluated using the Neck Disability Index (NDI) [25]. The TMD group should score more than 4 points on the NDI in order to be classified as presenting neck disability. To measure their level of jaw disability, all subjects completed the Limitations of Daily Functions in the TMD Questionnaire (LDF-TMDQ) [26]. The healthy group had to score less than 4 points on the Neck Disability Index in order to be considered as having no neck dysfunction.

This study was approved by the Ethics Review Board from the University of Alberta, where the study was conducted.

2.2. Questionnaires. The "Limitations of Daily Functions in TMD Questionnaire" (LDF-TMDQ) was used to measure the jaw function of all the subjects in this study. The LDF-TMDQ is multidimensional and includes specific evaluations for TMD patients [26]. The LDF-TMDQ consists of 10 items and 3 factors and these factors are extracted by exploratory factor analysis. The first factor is named "limitation in executing a certain task" and is composed of five items including several problems in daily physical and psychosocial activities; the second factor is called "limitation of mouth opening" which is composed of three items, and the third factor, "limitation of sleeping," is composed of two items. The internal consistency of the questionnaire was calculated using Cronbach's alpha which was 0.78 for the 10 items, 0.72 for "limitation in executing a certain task," 0.73 for "limitation of mouth opening," and 0.77 for "limitation of sleeping," indicating good consistency. The LDF-TMDQ was tested for concurrent validity with the dental version of the McGill Pain Questionnaire and the authors found correlations ranging between 0.49 and 0.54 [26].

The NDI is a questionnaire designed to give information about how neck pain affects the ability of the subject to manage her everyday life [25, 27–30]. The NDI includes 10 items—7 items are associated with activities of daily living, 2 are linked to pain, and 1 is related to concentration [25, 29]. Each item is scored from 0 (no pain or disability) to 5 (severe pain and disability), and the total score is expressed as a percentage (total possible score = 100%), with higher scores corresponding to greater disability [25, 29]. Depending on the score, the patient was classified as having neck disability or not (0–4 = no disability; 5–14 = mild disability; 15–24 = moderate disability; 25–34 = severe disability; >35 = complete disability) [27]. The NDI has proven to be valid and reliable in measuring neck disability, allowing its use as a guide for clinical-decision making [28–30].

2.3. Pressure Pain Threshold (PPT) Measurements. The manual pressure algometer (force dial) was used to measure the muscle tenderness in both groups by one investigator, blinded to the subjects' group allocation. Muscle tenderness was measured bilaterally in the following muscles: masseter (i.e., deep masseter, anterior, and inferior portions of the superficial masseter), temporalis (i.e., anterior temporalis, medial temporalis, and posterior temporalis), sternocleidomastoid, and upper trapezius (i.e., occipital region and half way between C7 and acromion) in a supine position for all muscles but trapezius muscle which was evaluated in seating [17, 31, 32]. These muscles were selected for investigation because previous studies reported that patients with TMD tended to develop tenderness in these muscles [31, 32]. Furthermore, these muscles were easy to evaluate because of their anatomic position, which avoided confusion with other anatomic structures such as joints, ligaments, and other muscles.

The pressure pain threshold (PPT) was defined in this study as the point at which a sensation of pressure changed to pain. At this moment, the subject said "yes," the algometer was immediately removed, and the PPT was noted [33]. Before the test was performed, the procedure was demonstrated on the investigator's hand and a practice trial was performed on the subject's right hand [33]. During the test, the algometer was held perpendicular to the masticatory (i.e., masseter and temporalis) and neck muscles (i.e., sternocleidomastoid and upper trapezius). Figure 1 shows the sites in which the muscles were measured. The measurements were repeated 3 times at each site, with 30-second intervals with pressure rate of 1 Kg/sec for the neck muscles and 0.5 Kg/sec for the masticatory muscles [34, 35]. Since the first PPT of a session is usually higher than consecutive measurements, the first PPT measurement was discarded and the mean of the other two PPT measurements was considered to be the final pressure threshold of the sites tested [34].

Pressure rates were decided based on previously studies that showed the most reliable rates to use on cervical and facial muscles [18, 36–38].

2.4. Statistical Analysis. Muscle tenderness data for all analyzed muscles, jaw, and neck disability levels were analyzed descriptively. A paired t-test was performed to verify whether there were any differences between right and left sides in each pair of muscles. Spearman's rho was used to determine

Figure 1: PPT points evaluated (♦ temporalis muscle, ■ masseter muscle, ▲ sternocleidomastoid muscle, and X upper trapezius muscle).

whether there was a correlation among neck disability, jaw dysfunction, and muscle tenderness. The criteria used to interpret the correlation coefficient were as follows: 0.00–0.25: little correlation, 0.26–0.49: low correlation, 0.50–0.69: moderate correlation, 0.70–0.89: high correlation, and 0.90–1.00: very high correlation. The correlation was considered important when the correlation coefficient value was higher than 0.70. The reference values to make this decision were based on values reported by Munro [39].

Level of significance for all statistical analyses was set at $\alpha = 0.05$. The SPSS (SPSS Inc., Chicago), Statistical Program version 18.0 (Statistical Package for the Social Sciences), was used to perform the statistical analysis.

3. Results

3.1. Subjects Demographics. Mean age for TMD group was 31.05 (SD = 6.9) and for the healthy group was 32.3 (SD = 7.2). Thirteen subjects were classified as having mixed TMD and 7 were classified as having myogenic TMD. The range of neck disability ranged from 0 to 31 (no to severe disability) and the range of jaw dysfunction ranged from 10 to 50 (no to severe disability) among all subjects included in this study.

3.2. Correlation between Level of Muscle Tenderness and Jaw Dysfunction and Neck Disability. The correlations (Spearman's rho) between level of muscle tenderness and jaw dysfunction (LDF-TMDQ) as well as between level of muscle tenderness and neck disability (NDI) ranged from low to moderate correlations. Spearman's rho ranged from 0.387 to 0.647 for muscle tenderness and jaw dysfunction and Spearman's rho ranged from 0.319 to 0.554 for muscle tenderness and neck disability (Table 1).

3.3. Correlation between Neck Disability and Jaw Dysfunction. It was found that the correlation (Spearman's rho) between jaw disability and neck disability was significantly high ($r = 0.915$, $P < 0.001$). The coefficient of variation was 0.82

Table 1: Correlation between muscle tenderness (PPTs) and neck disability and jaw dysfunction.

		Spearman's rho	
Side	Muscle	Jaw dysfunction	Neck disability
Right	Temporalis	**−0.585**	**−0.517**
	Masseter	**−0.512**	−0.443
	Sternocleidomastoid	−0.387	−0.319
	Upper trapezius	−0.408	−0.352
Left	Temporalis	**−0.646**	**−0.554**
	Masseter	**−0.595**	−0.48
	Sternocleidomastoid	−0.426	−0.374
	Upper trapezius	**−0.647**	**−0.518**

indicating that approximately 82% of the variance of jaw disability is explained by the neck disability in this population. Thus, subjects who had no or low levels of jaw disability (evaluated through the JDI) also presented with no or low levels of neck disability (evaluated through the NDI).

4. Discussion

This study investigated the correlation among neck disability, jaw dysfunction, and muscle tenderness in subjects with and without chronic TMD.

The main results of this study were that jaw dysfunction and neck disability were strongly correlated, showing that changes in jaw dysfunction might be explained by changes in neck disability and vice versa. Also, the results showed that the higher the level of muscle tenderness in upper trapezius and temporalis muscles is, the higher the level of jaw and neck dysfunction the subject will have. These results add to the body of knowledge in this area providing new information regarding these associations. Furthermore, they corroborated the importance of looking at cervical spine and stomatognathic system as a functional entity when evaluating and treating subjects with TMD, neck pain, and muscle tenderness. Another study that is corroborated to this association was the study by Herpich and colleagues [40], where head and neck posture was found to be different between patients with bruxism and controls. They also found a relationship between posture alterations and the TMD severity.

The discussion will focus on each of the results separately, as well as highlighting the strengths and limitations of this study.

4.1. Correlation between Level of Muscle Tenderness of Masticatory and Cervical Muscles and Jaw Dysfunction and Neck Disability. Several studies examined the presence of signs and symptoms in the cervical area of patients suffering with TMD and they have been showing that the presence of tender points in the cervical area of TMD's patients is quite common, which is in line with the findings of this study [8–13]. Both upper trapezius and temporalis muscles had a moderate correlation with jaw dysfunction and neck disability. This finding indicates that increased levels of tenderness in these two muscles were related to higher levels of dysfunction in patients having TMD with concurrent neck disability. Therefore, assessing temporalis and upper trapezius muscles in patients with TMD and concurrent neck disability may allow physical therapists to have a better understanding of the level of dysfunction of these patients and to consider the need of managing these patients as a whole. However, although these results show a trend, moderate correlations just indicate association between levels of dysfunction in patients having TMD and concurrent neck disability with levels of muscle tenderness in both upper trapezius and temporalis muscles [23].

Muscle tenderness is only one factor among multiple factors that could contribute to maintaining or perpetuating a level of dysfunction in people with TMD either in the jaw or in the neck. Usually, jaw dysfunction and neck disability are both related to gender, psychological factors, and social factors. For example, studies have shown that the presence of muscle tenderness is more commonly found in women than in men suffering with signs and symptoms of TMD [8, 41–44]. Females' hormones seem to play a possible etiologic role, since there is a higher prevalence of signs and symptoms of TMD in women than in men as well as a lower prevalence for women in the postmenopausal years [41]. Increased rates of occurrence of TMD have been shown during specific phases of the menstrual cycle and possible adverse effects of oral contraceptives have been cited in the literature [41, 45]. Sherman et al. [45] showed significant differences in terms of pressure pain threshold during different phases of a woman's menstrual cycle. Women who have TMD and have not been using oral contraceptives showed lower pressure pain thresholds during menses and midluteal phases, while women with TMD and using oral contraceptives had stable pressure pain threshold throughout menses, ovulatory, and midluteal phases, with increased intensity at the late luteal phase [45]. Fluctuations in estrogen levels during the menstrual cycle may be related to the level of pressure pain in women [45]. The authors speculated that TMD patients, when exposed to experimental pain stimuli, might benefit from the use of oral contraceptives, since these patients did not experience the same intensity of estrogen depletion levels throughout late luteal and menses phases of the menstrual cycle nor the wide swings in estrogen levels during the ovulation [45].

"Pain is a complex phenomenon influenced by both biologic and psycologic *[sic]* factors" [46] (pp. 236). Younger et al. [47] found several limbic abnormalities in subjects suffering with TMD, showing that these patients had alterations not only in the sensory system, but also within the limbic system. The authors found alterations in the basal ganglia nuclei, which contain neurons responsive to nociceptive input and serve the function of preparing behavioral responses to noxious stimuli. They also found alterations in the anterior insula of patients with TMD. These alterations have been reported to be responsible for the integration of emotional and bodily states [47]. According to the authors, alterations in the anterior insula region appear to be very important in the emotional awareness of internal states and the emotional aspects of the pain experience and anticipation of sensation. It is important to note that pain is also perceived differently by different people, since factors such as fear, anxiety, attention, and expectations of pain can amplify the levels of pain experience [46]. On the other hand, self-confidence, positive emotional state, relaxation, and beliefs that pain is manageable may decrease the sensation of pain [46]. Studies have shown that psychosocial factors are significantly associated with both jaw pain and neck pain [48–50]. Vedolin et al. [50], for example, showed that the PPTs of jaw muscles of patients with TMD were lower throughout a natural stressful event (i.e., academic examination), showing a relationship between stress and anxiety levels with level of muscle tenderness. Another study by Mongini et al. [32] also showed a high relationship between jaw and neck muscle tenderness with the prevalence of anxiety and depression among patients suffering from TMD. Increased levels of stress, anxiety, and depression could enhance sympathetic activity and the release of epinephrine at sympathetic terminals, leading to an increase in acetylcholine activity at the motor endplate. This could start a cascade of events, causing a decreased pressure pain threshold in the muscles [50]. The results of these studies suggest that a more integrated treatment approach including psychosocial assessment is important when treating patients with TMD. Factors that might be related to the development of jaw dysfunction or neck disability were not evaluated in this study, so further conclusions regarding social, emotional, and psychological factors are beyond the scope of this specific study.

4.2. Correlation between Neck Disability and Jaw Dysfunction. The correlation (Spearman's rho = 0.915) between jaw disability and neck disability was significantly high in this study. This means that the variance of jaw dysfunction is highly dependent on the neck disability (approximately 82%). Thus, subjects who had high levels of jaw disability (evaluated through the JDI) also presented with high levels of neck disability (evaluated through the NDI) and vice versa. Recently, the study by Armijo-Olivo and colleagues [15] was the first to show the relationship between jaw disability and neck disability. As in the present study, a high correlation between jaw disability and neck disability was found. Until now, the association between neck and jaw was always reported in terms of signs and symptoms, but the authors showed the importance of assessing the impact that the level of disability can have on patients suffering with TMD.

Disability is a complex concept, since it involves more than accounting for the individual signs and symptoms alone. It also includes the perception of the patient about his or her condition as an important factor [15]. The International Classification of Functioning, Disability and Health from the World Health Organization is helping health professionals to understand the importance of viewing chronic pain patients from different perspectives such as body, individual, societal, and environmental [51]. The impact that the disability has on patient's body functions, body structures, activities, and participation shows a more realistic vision of how the disease is impacting an individual's quality of life [15, 51]. TMD patients are a good example of how signs and symptoms can be perceived differently by different individuals. Sometimes severe TMD signs and symptoms may only have a small impact on the quality of life of a patient, while mild signs and symptoms may greatly interfere in other patients' lives. Therefore, assessing the level of disability of patients suffering with TMD is important to have a better view of how this condition is affecting these patients and which treatment approach is best for each situation [15].

The fact that jaw disability and neck disability are strongly related also shows that one has an effect on the other, which provides further information about the importance of assessing and treating both regions when evaluating chronic TMD patients. Assessment of the neck structures such as joints and muscles as well as the disability of patients with TMD could direct clinicians to include the cervical spine in their treatment approach. In addition, if patients with TMD have neck disability in addition to jaw disability, or vice versa, physical therapists and dentists should work together to manage these patients.

As strong correlation between jaw disability and neck disability does not indicate a cause and effect relationship, longitudinal studies where subjects with TMD are followed up to determine the appearance of neck disability are still necessary to determine any cause and effect connection.

4.3. Clinical Relevance. This study showed that the higher the level of muscle tenderness, mainly in upper trapezius and temporalis muscles, the higher the level of jaw and neck disability. Therefore, when clinicians assess higher levels of muscle tenderness either in the jaw and/or in the neck regions, they should infer that this could be possibly related to higher levels of jaw and neck disability. This information will guide health professionals to consider new clinical strategies that focus on both masticatory and cervical regions to improve patients' outcomes. Jaw dysfunction and neck disability were strongly correlated, showing that changes in jaw dysfunction might be explained by changes in neck disability and vice versa. This provides further information about the importance of assessing and treating both the jaw and neck regions as a complex system in TMD patients.

4.4. Limitations. The convenience sample used increased the potential subject self-selection bias. It was difficult to recognize what characteristics were present in those who offer themselves as subjects, as compared with those who did not, and it was unclear how these attributes might have affected the ability to generalize the outcomes [32]. Although probability samples would have been ideal for this type of study, having accessibility to the general population of TMD patients was limited in this study. Furthermore, even with random selection, not all of the TMD patients who could have been invited to participate in the study would give their consent.

5. Conclusions

High levels of muscle tenderness were correlated with high levels of jaw and neck disabilities. Furthermore, jaw dysfunction and neck disability were strongly correlated, showing that changes in jaw dysfunction may be explained by changes in neck disability and vice versa in patients with TMD. This study has highlighted the importance of assessing TMD patients not only at the level of the jaw, but also including the neck region. Muscle tenderness, however, is only one aspect of the TMD. TMD is a complex problem and involves many factors such as gender, levels of anxiety and stress, and the level of socialization of the patient. Future studies investigating the association between neck and jaw should also include factors other than muscle tenderness which are still needed.