

# Cervical pain in individuals with and without temporomandibular disorders

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## Abstract

The objective of this study was to evaluate the association of the Temporomandibular Disorder (TMD) with the presence of pain in the cervical region, as well as to evaluate the involvement of Sternocleidomastoid (SCM) muscle during the activity of the temporal and masseter muscles during dental clenching. 40 female volunteers aged between 18 and 41 years, distributed into a control group and TMD group were enrolled in this study. Clinical examinations of the craniomandibular system and of the neck were performed. Myoelectric activity of the temporalis, masseter and SCM muscle was registered during the mandibular rest position and during the contraction in maximal intercuspal position. The results show to the existence of association between the groups and the presence of cervical pain. It was registered bigger myoelectric activity in SCM muscle during the contraction in maximal intercuspal position than mandibular rest position. The results of this study indicate that individuals with TMD present more pain in the cervical region. The presence of compensatory strategies represents a mechanism necessary to find stability for the mandibular and cervical region during the mandibular movements.

## Key Words:

masticatory muscles, physical examination, pain, electromyography

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## Introduction

Temporomandibular Disorder (TMD) is considered a set of articular and muscular disorders in the orofacial region, characterized mainly by pain, joint noises, and an irregular mandibular function<sup>1</sup>. It includes disorders related to the joint and masticatory and cervical muscular system. Clinical studies show that the symptoms associated with the temporomandibular joint (TMJ) pain and dysfunction syndrome are due to hyperfunction and/or dysfunction of the masticatory muscles, rather than to degenerative or inflammatory changes of the TMJ, or inadequate occlusion of the teeth<sup>2</sup>.

The TMD also is related with the cervical region disorder. Many studies make reference about the existence of the functional connection of the mandibular motor system (trigeminal nerve) and the cervical motor system (spinal nerves), influencing mandibular and cervical movements<sup>3-6</sup>. The trigeminal system conveys most of the sensory information from the face, conjunctiva, oral cavity, and dura mater, as well as the motor innervation of the muscles responsible for mastication<sup>7</sup>. Connection patterns between the trigeminal system and the vestibular nuclei suggest that sensory inputs from the face can influence the vestibular control of eye and head movements<sup>8</sup>.

According to Browne et al., many studies support the concept of the interdependence between the cervical and trigeminal motor sensorial system. Disease in one system may induce pain and/or dysfunction in the other system through the central command or the reflected connectivity between the two anatomic areas<sup>9</sup>. The association was observed between the pain of the cervical muscles and patients with symptoms of TMD<sup>10-11</sup>.

The alterations in the position of the head and neck influence the trajectory of the mandibular movements<sup>12</sup>. The mandibular and cervical movements must be balanced for increase functional effectiveness. Normally, on the intervention of the TMD, the different methods of treatment are based only on the analysis of directly involved skeletal muscle system, without evaluating the posture control and the corporal balance. Thus, the objective of this study was to evaluate the association of the TMD with the presence of pain in the cervical region, as well as to evaluate the involvement of SCM muscle during the activity of the temporal and masseter muscles during dental clenching.

## Material and Methods

### Subjects

40 female volunteers aged between 18 and 41 years, distributed into a control group (n=20) and TMD group (n=20) were enrolled in this study. The inclusion criterion for the control group was no signs or symptoms of TMD according to the Research diagnostic criteria (RDC) for TMD (RDC/TMD)<sup>13</sup>. The inclusion criterion for the TMD group

was one or more TMD diagnoses according to the RDC/TMD. For both groups, the exclusion criteria were volunteers with dental flaws; a history of trauma in face, temporomandibular articulation and cervical spine; systemic illnesses; those using analgesic and anti-inflammatory medicines and those using braces.

The Research Ethics Commission of Campinas University approved this study, under protocol number 116/2003 and all the volunteers signed a term of assisted consent following clarification and agreement to participate in the study.

### Clinical Examination

The clinical examination was carried through to distinguish the groups, that is, volunteers with and without TMD and to distinguish volunteers with and without pain in the cervical region. With this objective it was used, respectively, the TMD diagnostic system (RDC/TMD)<sup>13</sup> and a combination of tests for cervical region<sup>14</sup>.

The RDC/TMD<sup>13</sup> examination protocol included the assessment of the following signs and symptoms: range of jaw motion, TMJ sounds, and muscle and joint palpation for tenderness. The RDC/TMD<sup>13</sup> classified the clinical diagnostic data into three mutually exclusive groups: I) Muscle diagnoses (either myofascial pain or myofascial pain with limited range of motion, but not both); II) Disc displacements (with reduction, without reduction and with limited opening, without reduction and without limited opening); III) Arthralgia, osteoarthritis, osteoarthrosis. A subject can be assigned from zero diagnoses to five diagnoses (one muscle diagnosis plus one diagnosis from group II and one from group III for each joint). The diagnosis was made on the basis of clinical and history criteria only.

The presence of pain in the neck/shoulder region of all the volunteers was also evaluated through a physical examination<sup>14</sup> which included the palpation of the cervical region, passive and active movements of the cervical spine and dynamic and static tests of the cervical spine. The palpation of the cervical region was performed of the trapezius muscle, splenius capitis muscle, levator scapulae muscle and SCM muscle, bilaterally. In the active and passive movements of the cervical spine the volunteers were asked to bend the head forward, backward, sideward to the right and the left, to rotate the head to the right and left side, and movements of the high cervical region. During the dynamic and static tests of the cervical spine the same movements had been carried through with light manual resistance and, immediately afterwards, with high manual resistance. Volunteers were classified as having a CP when they complained of pain or tenderness in the neck/shoulder region during the clinical examination. When no pain complaints in the neck/shoulder region were present, that volunteer was classified as not suffering from a CP.

### Electromyography

Myoelectric activity of the temporalis, masseter and SCM muscle was registered using an Electromyography Myosystem I® of 12 channels, with 12 bits of resolution analogical/digital converter board to a 2000 Hz sampling frequency and with a high pass filter of 10 Hz and low pass filter of 500 Hz.

The electrical activity of the muscles was bilaterally detected using Medi-Trace Kendall-LTP surface electrodes with a between-electrodes center-to-center distance of 25mm, connected to pre-amplifiers model PA 1010-VA with 20 times gain. The impedance was  $10^{12} \Omega$  and a minimum Common Mode Rejection Relation of 112 dB. The electrical impedance of the skin was reduced, by cleaning the site with hydrophilic cotton soaked in an alcohol at 70%. Muscle function test was performed before electrode placement. For temporalis anterior (vertically along the anterior margin of the muscle) and masseter (2cm above of the external angle of the jaw) muscles the electrodes were positioned on muscle belly (parallel to muscular fibres) that was located during dental clenching. For the SCM muscles, the volunteer was asked to bend the head forward and the examiner applied a manual resistance; the electrodes were positioned parallel to muscular fibres at a distance of 1/3 rostral between the mastoid process and the sternum<sup>15</sup>. The reference electrode was placed on the sternum.

To make comparisons of the electromyographic signal among the individuals, the Root Mean Square (RMS) values were normalized by voluntary isometric activity during a submaximal contraction, the reference voluntary contraction (RVC). The RVC for temporalis and masseter muscles was recorded during the contraction in maximal intercuspal position. For the SCM muscles, the volunteer was positioned in supine lying and combined movement of cranio-cervical and cervical flexion to slightly lift the head and isometrically support it<sup>16</sup>. Each RVC was sustained for 5s to temporalis and masseter muscles and 10s to SCM, was repeated three times with an interval of 1 min between repetitions. For normalization, the EMG potentials were expressed as a percentage of a maximum 1s RMS value obtained across the three repetitions of the RVC for each muscle, subject and day.

During the experimental protocol, myoelectric signals were detected in two different mandibular postures in biped stance: the mandibular rest position (MRP) (10s); and the contraction during maximal intercuspal position (MIP) (5s). Each volunteer carried out three repetitions with an interval of 1 min between repetitions. During the contraction in the MIP, Parafilm "M" material was folded 15 times (1.5cm by 3.5cm) and placed bilaterally on the mandibular first and second molars.

The female volunteers remained in an upright position during the test and were positioned barefoot on a platform with

their feet placed at 30°, with their arms relaxed against the body and eyes open and directed towards a target of 5cm in diameter placed at eye level, 2.20m in front of them. A short training period was carried out prior to beginning the tests to better orientate the volunteers about the proposed activities. To reduce the data variability, all the experimental protocol and the protocol for the normalization were repeated during three days, that is to say, the data from each test day was normalized by a RVC on the same day, with the electrodes positioned in the same place. The tests were carried out within a maximum interval of 1 week and with the necessary care to ensure that they were done in the same period of the day.

The SCM data from 5 subject of normal group and 8 subject of TMD group were excluded from the analysis because of the errors in data acquisition.

### Statistical Analysis

The difference between the age average between the control group and the group with TMD was analyzed through Student's t-test. In order to verify the existence of association between the Control and TMD groups and the presence of cervical pain was calculated by the Qui-Square test. To quantify the risk of the presence of pain in the cervical region in TMD patients was calculated Odds Ratio (OR) and its confidence interval of 95% (CI).

The descriptive data was given as mean and 95% confidence interval for mean, calculated of three repetitions carried out by each volunteer in each mandibular posture during the three-day test period. Differences in EMG activity between the control group and the TMD group and between the different mandibular postures were analyzed with repeated measures analyses of variance (PROC MIXED, ReML estimation method) with *group* (Control and TMD) as the between-subject factor and *mandibular posture* (MRP and MIP) as the within-subject factor in a *RMS* dependent variable (temporalis, masseter and SCM).

Analyses were performed using Statistical Analysis Software (SAS Institute, Inc.) and the significance level of 5% ( $p < 0.05$ ) was adopted for all the procedures.

### Results

The average age of the control group was  $26.32 \pm 4.00$  years whilst the average age of the TMD group was  $27.3 \pm 4.47$  years (*t*-test:  $p > 0.10$ ). Among the female volunteers of the control group ( $n=20$ ), 6 had CP (30%) and 14 had not CP (70%). Among the female volunteers in the TMD group ( $n=20$ ), 13 had CP (65%) and 7 had not CP (35%) (fig.1). The Qui-square test shows to the existence of association between the groups and the presence of cervical pain ( $p < 0.05$ ). The relative risk indicates that pain in the cervical region is 2,16 times most likely in TMD group in relation to the Control group. In 95% of the cases, the repetition of this study will lead to greater possibilities of cervical pain in

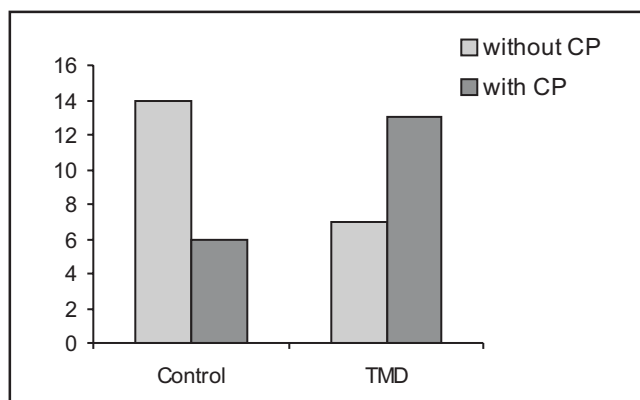


Fig. 1. Distribution of frequencies related to the cervical pain (CP) with regard to the control (n=20) and DTM (n=20) group.

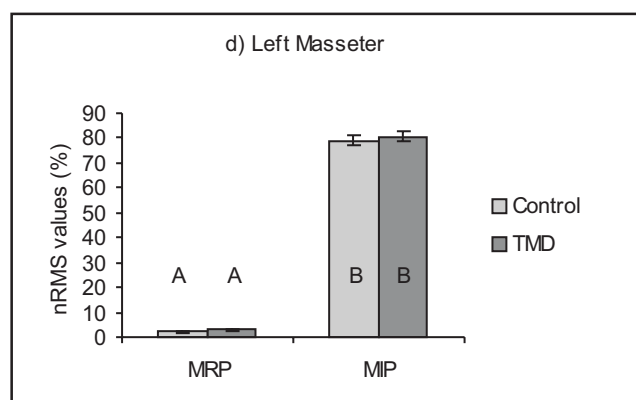


Fig. 2d

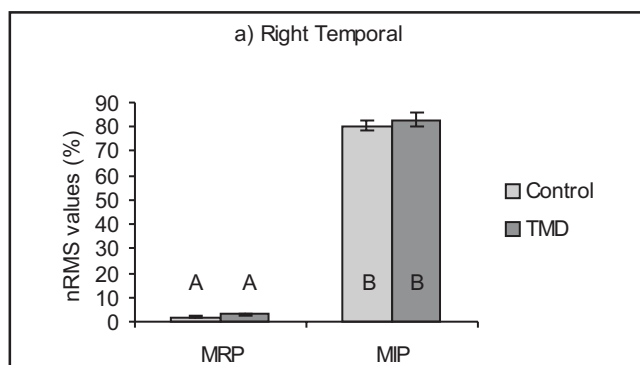


Fig. 2a

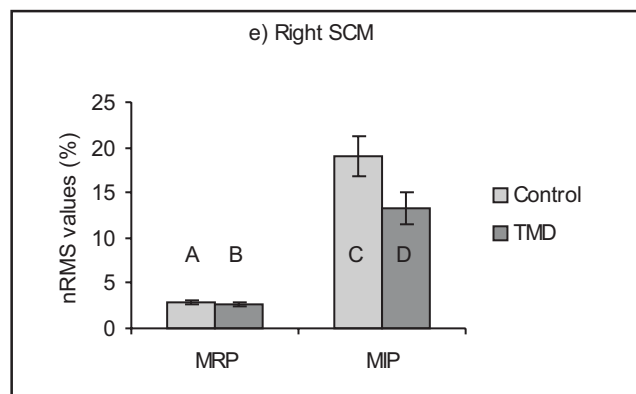


Fig. 2e

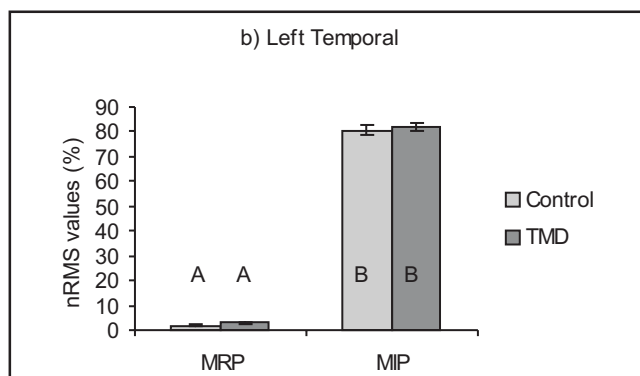


Fig. 2b

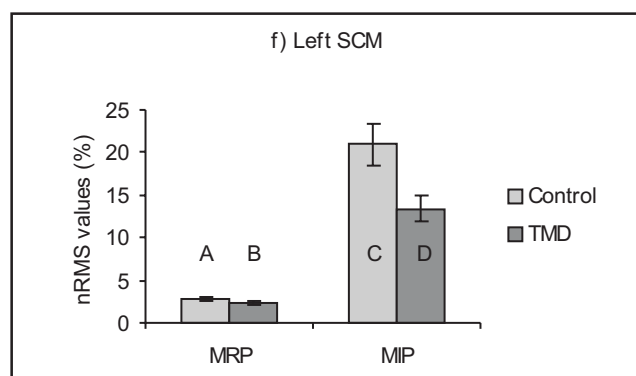


Fig.2 - Mean  $\pm$  95% confidence interval for mean of the normalized root mean square (nRMS) obtained for Right Temporal (a), Left Temporal (b), Right Masseter (c), Left Masseter (d), Right Sternocleidomastoid (e) and Left Sternocleidomastoid (f) muscles in control and patient groups during mandibular rest position (MRP) and the contraction during maximal intercuspal position (MIP). Data with equal letters in columns are not significantly different.

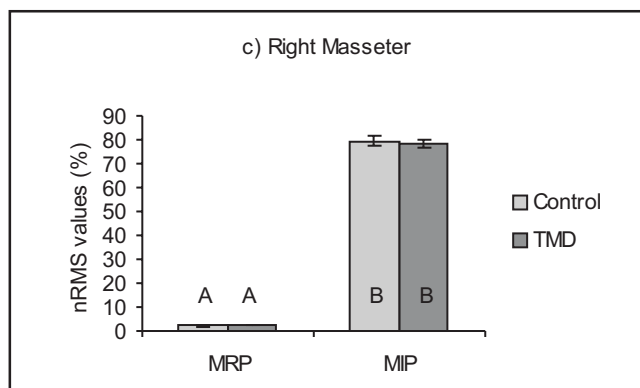


Fig. 2c

TMD group in relation to the Control group, between 1,03% and 4,55%.

The means values of the normalized RMS of Right Temporal (fig.2a), Left Temporal (fig.2b), Right Masseter (fig.2c), Left Masseter (fig.2d), Right SCM (fig.2e) and Left SCM (fig.2f) are reported during different mandibular positions in control

and TMD groups. Utilizing the variance analysis of the repeated measures with the Control and TMD groups as an inter-subjects factor, no significant group effects were found for Right Temporal ( $F=1.84$ ;  $p>0.10$ ), Left Temporal ( $F=1.21$ ;  $p>0.10$ ), Right Masseter ( $F=0.13$ ;  $p>0.5$ ) and Left Masseter ( $F=1.52$ ;  $p>0.1$ ). Analysis of the SCM data, showed a significant difference in EMG activity between control and TMD group for Right SCM ( $F=22.96$ ;  $p<0.001$ ) and Left SCM ( $F=77.47$ ;  $p<0.0001$ ). Significant mandibular posture effect (MRP and MIP) was found for Right Temporal ( $F=4128.28$ ;  $p<0,001$ ), Left Temporal ( $F=8632.17$ ;  $p<0,001$ ), Right Masseter ( $F=5135.17$ ;  $p<0,001$ ), Left Masseter ( $F=7601.64$ ;  $p<0,001$ ), Right SCM ( $F=440.95$ ;  $p<0.0001$ ) and Left SCM ( $F=989.63$ ;  $p<0.0001$ ) muscles. Significant interactive effect was found between the mandibular positions and the groups for Right SCM ( $F=18.66$ ;  $p<0.001$ ) and Left SCM ( $F=58.75$ ;  $p<0.0001$ ), but not for Right Temporal ( $F=0.33$ ;  $p>0.10$ ), Left Temporal ( $F=0.01$ ;  $p>0.10$ ), Right Masseter ( $F=0.46$ ;  $p>0,5$ ), Left Masseter ( $F=0.28$ ;  $p>0.5$ ) muscles.

## Discussion

Patients with pain in the craniomandibular region also presents more pain in the region of the cervical column<sup>17-18</sup> suggesting a tension increase that could be related to a lesser balance in the activity of these muscles in the volunteers with TMD. The increase of the frequency of cervical pain in TMD group suggests the presence of compensatory strategies to find stability for the mandibular and cervical system.

It was registered bigger amplitude EMG in SCM muscle during the contraction in maximal intercuspal position than mandibular rest position. These results had confirmed previous studies that had demonstrated its action during the contraction in maximal intercuspal position<sup>4,19-20</sup> and during maximal voluntary clenching in retrusive occlusal contact position<sup>10</sup>. The SCM activity was related to the effort of the occlusal force with the reduction of the area of occlusal contact<sup>21</sup>. The involvement of the cervical muscles also was observed through the variation of the vertical dimension of the occlusion that provoked EMG alteration in the basal tonic activity of SCM muscle<sup>22</sup>.

The muscles of the neck present great number of proprioceptors and are important in the balance and the general postural control<sup>23</sup>. SCM muscle participates in the stabilization of the head during the contraction in MIP. In the study of the masticatory cycle of rabbits<sup>5</sup> it was observed that sternocleidomastoid muscle was active in the jaw closing and opening phases during the respective head flexor and extensor movement. The sternocleidomastoid activity in the opening phase disappeared in the head fixed preparation. The activation of the masticatory muscles could trigger linked structures, such as the platysma, which would in turn increase the activity of the digastric and sternocleidomastoid

muscles<sup>19</sup>.

Small asymmetries of the visual, somatosensorial, vestibular system can cause small compensatory asymmetries, many times not perceived for the individual<sup>24</sup>. Some inquiries show that the position of the head influences the kinematics of the jaw trajectory. In five postures of the head were registered different mandibular movements that can be related to stretching and/or elongation of the muscles and of other soft tissues involved in this movement, and to the varying influence of the force of gravity upon the mandible<sup>25</sup>. In inverse way, the modification of the interocclusal distance, with the use of an occlusal device, cause extension of the head and modification of cervical bending<sup>26</sup>. The mandibular movements are the result of the association of mandibular and cervical movements<sup>27</sup>. The interactions between the trigeminal and cervical nervous system can allow the trigeminal system to modulate the head and neck movements during feeding<sup>5</sup>.

Many times the TMD patients add many other complaints as headache and the presence of tension in the cervical region<sup>2,28</sup> suggesting associations with alterations in the activity of the cervical muscles. The TMJ dysfunction was correlated with the forward inclination of the upper cervical spine and an increased craniocervical angulation<sup>29</sup>. The alteration of the position of the head has been related with pain in the cervical region, scapular girdle and TMJ. An inadequate head, neck and shoulders postures with sensitive points were proportionally higher according to the severity of TMD<sup>30</sup>.

However, in other studies, had not been observed significant differences in the head posture between normal volunteers and with TMD<sup>31</sup>, or with cervical alterations<sup>32</sup>. Postural alterations in cervical region can not be observed, but pain appears when it has muscular unbalance giving to origin to postural adaptations and muscular compensations of the musculoskeletal system.

The results of De Wijer *et al.* show that orthopedic tests of the cervical column are of lesser importance to discriminate between TMD or with cervical disorder patients<sup>33</sup>. The functional examination of the stomatognathic system is a better discriminator between TMD and cervical disorder, but the cervical evaluation must be incorporated in this examination to better understand and better treat the TMJ disorders.

The cervical disorder is common in the general population and the association between signals and symptoms of TMD with signs and symptoms of cervical disorder many times is small<sup>18</sup>. The differentiation between the two disorders is not easy and signs and symptoms of disturbance in cervical and stomatognathic muscles may be also seen in TMD groups as well as in patients with cervical disorder<sup>33</sup>.

EMG activity of SCM muscle during the contraction in maximal intercuspal position suggests the presence of

compensatory strategies to find stability for the mandibular and cervical region during the mandibular movements. The complexity of the TMD demands the necessity to integrate professionals of different areas to an interdisciplinary treatment.

The results of this study indicate that individuals with TMD presents more pain in the cervical region, showing that the alterations of the mandibular motor system are related with alterations in the cervical system. The cervical column would have to be involved in the clinical evaluation of the TMD. The muscular compensations represent a mechanism necessary to find stability for the mandibular and cervical system during the masticatory function.

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