Analysis of the postural stability in individuals with or without signs and symptoms of temporomandibular disorder

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Abstract: The objective of this study was to evaluate the stability and the distribution of weight of individuals with TMD (Temporomandibular Disorder) when placed in an orthostatic position. Forty female volunteers, participating in this study, were distributed into a control and a TMD group. Clinical examinations of the craniomandibular system and of the neck were performed. Postural stability was evaluated using a stabilographic platform. Through this system, the sway index (SI), the maximum medial-lateral distance (MMLD), the maximum anterior-posterior distance (MAPD) and the medial-lateral symmetry (MLS) could be determined. Tests were performed in the mandibular rest position and during isometric and isotonic contraction. The variables were analyzed through repeated measures ANOVA. The level of significance was $p < 0.05$. The results of this study indicate that individuals with TMD present more pain in the cervical region ($p < 0.05$). The group with TMD showed a significant reduction in SI ($p < 0.05$), MMLD ($p < 0.05$) and MLS ($p < 0.01$). Individuals with TMD presented greater postural asymmetry, and cervical pain demonstrated a potential link with an increase in postural stability.

Descriptors: Posture; Masticatory muscles; Temporomandibular joint disorders.

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Introduction

The mechanism of postural control requires information of the proprioceptive, vestibular, and visual receptors, and any disturbance in the sensorial information is compensated by postural synergies.[1] Many studies have shown the functional connection between the mandibular motor system and the cervical motor system[2-4] that can possibly allow the trigeminal system to modulate the cervical movements during mastication.[3]

Disease in one system may induce pain and/or dysfunction in the other system through the central command or by way of the reflex connectivity between the two anatomic areas.[5] The etiology of TMD is multifactorial[6] and is related to functional disorders of the cervical spine.[7] Pain and cervical muscular fatigue can affect postural control.[8] Many studies have been carried out to analyze the relation between different patterns of mandibular movements and the corporal position.[9-12]

There is great interest in the relation between postural alterations and the physiopathology of the temporomandibular joint (TMJ). Mandibular movements related to cervical movements through postural synergies become interconnected through the entire body. This interconnection raises a question: Do individuals with TMD present alterations in stability and in the distribution of weight in the orthostatic position?

Material and Methods

Subjects

Forty female volunteers participated in this study, and were distributed into a control group (20) and a TMD group (20). The inclusion criterion for the control group was that there were no signs or symptoms of TMD according to the "Research Diagnostic Criteria for Temporomandibular Disorder" (RDC/TMD).[13] The inclusion criterion for the TMD group was that there were one or more TMD diagnoses according to the RDC/TMD. The following conditions were considered as exclusion criteria: volunteers with a reduction in the number of total teeth in both upper and lower jaws; history of trauma in the face, temporomandibular articulation or cervical spine; individuals with systemic illnesses; individuals using analgesic and/or anti-inflammatory medicines; and individuals with braces.

The presence of pain in the neck/shoulder region of the volunteers was also evaluated through a physical examination,[14] which included palpation of the cervical region, passive and active movements of the cervical spine and dynamic as well as static tests of the cervical spine. Volunteers were classified as "having pain in the cervical region" when they complained of pain or tenderness in the neck/shoulder region during the clinical examination.

The research project was approved by the Research Ethics Committee, State University of Campinas, in accordance with Resolution n. 196/96 - CNS, under protocol number 116/2003. All the volunteers signed an informed consent form.

Experimental procedure

The System of Chattecx Balance (Chattanooga Group, Tennessee, USA) was used to provide data on sway index, maximum anterior/posterior movement (A/P), and left/right (L/R) movement, in centimeters, away from the subject's center of balance, and also the percental load difference between the right and left lower limbs. The reliability and validity of data measured through the Chattecx balance system has previously been argued. Comparisons between this system and the Kistler platform demonstrated a strong correlation in oscillation parameter measurements.[15,16]

The experimental procedure consisted of an evaluation of the stabilographic variables in three mandibular positions[17] while standing erect: a) during the mandibular rest position (REST) (10 s); b) the isometric contraction during maximal intercuspal position (ISOM) (5 s); c) the isotonic contraction during non-habitual chewing cycle (ISOT) (10 s). During ISOM and ISOT, Parafilm "M" material (American National Can, Chicago, IL, USA) was folded 15 times (1.5 cm by 3.5 cm) and placed bilaterally on the first and second molars of the mandible. While in ISOM position, a verbal command was given to stimulate maximum contraction. ISOT was coordinated by a metronome (Wittner-Taktell Picolo, Germany) with 80 beats per minute.

During the test, the volunteers were positioned barefooted on a platform with their feet placed at 30°, arms relaxed at their sides, eyes opened and directed towards a target of 5 cm in diameter placed at eye level, 2.20 m in front of them. The stabilographic data were collected after the volunteer remained 20 s standing in the erect position, which is considered an acceptable period of time for adaptation to the position without causing fatigue of the mandibular muscles.[10,18] A short training period was carried out prior to beginning the tests to improve the volunteer's orientation concerning the proposed activities. At least one practice trial for each test was used to confirm understanding of verbal instructions.

With the objective of diminishing variability of the data, the volunteers carried out three repetitions of each mandibular position with an interval of 1 min between them. The experimental protocol was repeated in three days within a maximum period of 1 week and with the necessary care to ensure that they were done during the same period of the day. To prevent interobserver variability, all the clinical and stabilographic procedures were performed by the same operator.

Data analysis

MLS (medial-lateral symmetry) was calculated by means of the Excel software (Microsoft Corp., Redmond, WA, USA) using the value of the percental difference between the loads on the right and left lower limbs. This index was assessed by means of the formula:

$$MLS = abs\,[1 - (a - b) / (a + b)] \times 100$$

where:

abs = absolute value (or modulus)

a is the total weight on the right foot

b is the total weight on the left foot

If the weight distribution is symmetrical, MLS is 100%.

Statistical analysis

The difference in age average between the control group and the group with TMD was analyzed through Student's *t*-test. To assess the existence of an association between the Control and TMD groups and the presence of cervical pain (CP), the Chi-Square test was used.

The descriptive data was given as mean and 95% confidence intervals, calculated for three repetitions carried out by each volunteer in each mandibular posture during the three-day test period.

The variables were analyzed with a repeated measures analysis of variance (PROC MIXED, ReML estimation method) with *group* (Control and TMD) as the between-subject factor and *mandibular position* (REST, ISOM and ISOT) as the within-subject factor in a dependent variable (SI-sway index, MMLD-maximum medial-lateral distance, MAPD-maximum anterior-posterior distance, MLS-media-lateral symmetry). In the case of a significant result, *post hoc* comparisons were then made using the *t*-test.

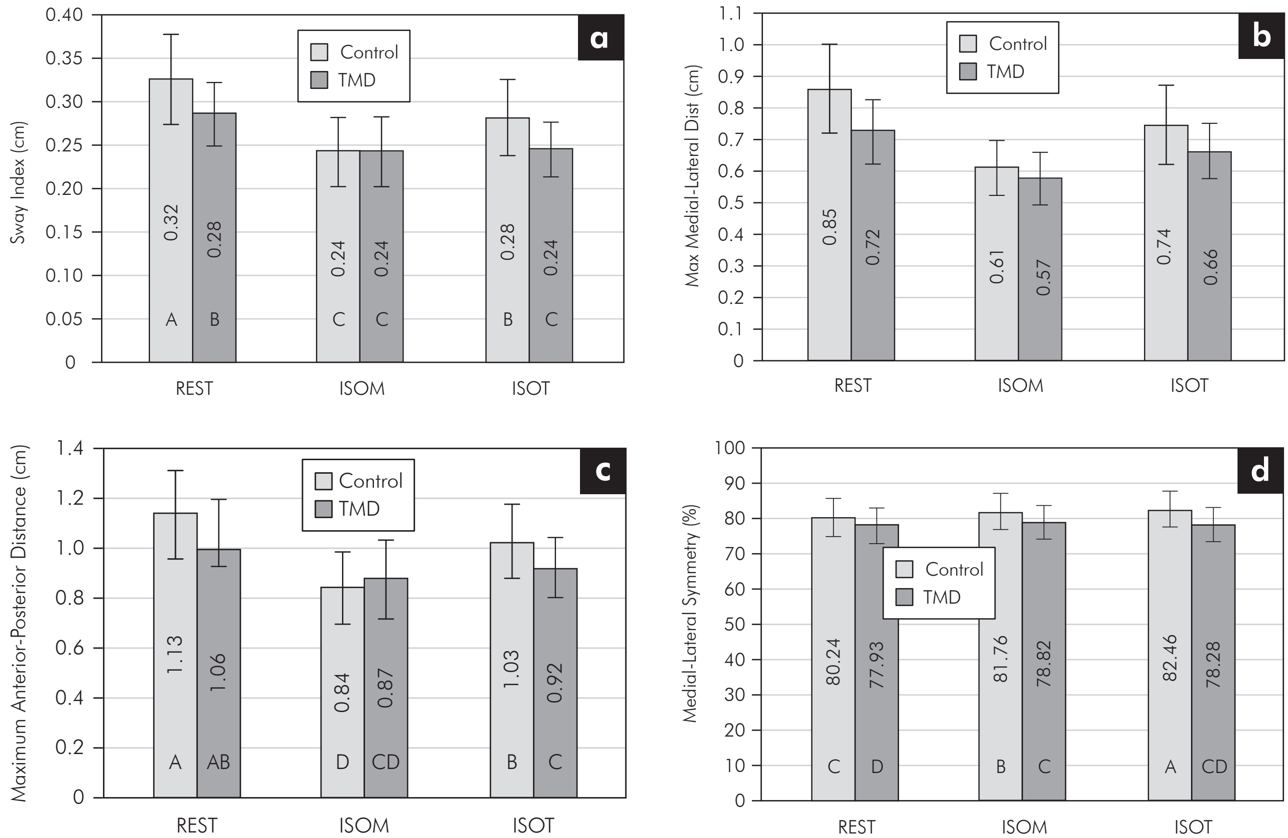
Analyses were performed using the SAS System, release 9.1 (SAS Institute, Inc., Cary, NC, USA) and the significance level of 5% ($p < 0.05$) was adopted for all the procedures.

Results

The average age of the control group was 26.32 ± 4.00 years while the average age of the TMD group was 27.3 ± 4.47 years (*t*-test: $p > 0.10$). Among the volunteers of the control group (n = 20), 6 were with CP (30%) and 14 were without CP (70%). Among the female volunteers in the TMD group (n = 20), 13 were with CP (65%) and 7 were without CP (35%). The Chi-square test showed the existence of an association between the groups and the presence of cervical pain ($p < 0.05$).

Using repeated measures analysis of variance with the Control and TMD groups as an inter-subjects factor, the TMD group expressed a significantly smaller difference compared to the Control group in SI ($F = 6.29$; $p < 0.05$), in MMLD ($F = 7.75$; $p < 0.05$) and in MLS ($F = 11.88$; $p < 0.01$). MAPD was smaller in the TMD group, although the difference was not significant ($F = 2.19$; $p > 0.10$). Graph 1 shows the average values of SI, MMLD, MAPD and MLS.

A significant mandibular position effect was found for SI ($F = 24.94$; $p < 0.001$), MMLD ($F = 35.04$; $p < 0.001$), MAPD ($F = 27.37$; $p < 0.0001$)



Graph 1 - Mean and 95% confidence intervals of: (**a**) sway index (cm); (**b**) maximum medial-lateral distance (cm); (**c**) maximum anterior-posterior distance (cm) and (**d**) medial-lateral symmetry (%) of the control (n = 20) and TMD (n = 20) groups in mandibular rest position (REST), isometric contraction (ISOM) and isotonic contraction (ISOT). Data with equal letters in columns are not significantly different by the *t*-test at 5%.

and MLS (F= 9.47; $p < 0.01$). The results from the *t*-test for SI showed that the significant difference was between REST vs. ISOM ($p < 0.001$), REST vs. ISOT ($p < 0.001$) and ISOM vs. ISOT ($p < 0.05$). The *t*-test for MMLD showed a significant difference between REST vs. ISOM ($p < 0.001$), REST vs. ISOT ($p < 0.01$) and ISOM vs. ISOT ($p < 0.001$). The *t*-test for MAPD showed a significant difference between REST vs. ISOM ($p < 0.001$), REST vs. ISOT ($p < 0.01$) and ISOM vs. ISOT ($p < 0.001$). In the case of MLS, the *t*-test did not confirm a significant difference; this was made evident by the repeated measures analysis of variance.

The analysis showed a significant interactive effect between the mandibular positions and the groups for SI (F= 3.96; $p < 0.05$), for MAPD (F= 3.69; $p < 0.05$) and for MLS (F= 5.84; $p < 0.05$). However, for the MMLD there were no significant interactive effects between the mandibular positions and the groups (F= 2.05; $p > 0.10$).

Discussion

Postural instability is connected to an increase in body oscillation.[19] During the different mandibular positions a significant difference in the values of SI, MMLD and MAPD was observed, showing greater postural stability in ISOM and lesser stability during rest, in the two evaluated groups. Due to the functional relationship between the mandibular and the head-neck motor systems, an active repositioning of the head in the vertical position was exhibited during mandibular movements.[20] The cause of said activity could be instability. However, during ISOM and ISOT, it was observed that the corporal position remained more stable as a preparatory activity to allow for the occlusion work.

The kinesthetic sensation is more accurate during extreme amplitudes of movement, during the intercuspal position and at maximum jaw opening.[21] The greater the kinesthetic acuity, the greater the improvement in postural adjustments, cervical stability and postural stability observed through the minor indices of SI, MMLD and MAPD during isometric contraction.

During the control of the upright posture, a cognitive task can also diminish the postural sway.[22] Concentration is needed in order to execute tasks requiring Isotonic and isometric contractions. This concentration can generate the greatest restriction on postural oscillation as a security mechanism during the time that the attention is given to another task.[22] Keeping the focus on a secondary task has a strong influence on postural control.[23]

In other studies, an improvement in postural stabilization was observed when the dental occlusion was adjusted into a centric relation[11], and after unilateral anesthesia of the trigeminal nerve, a postural deviation was observed.[24] The trigeminal and cervical nervous system may have strong interactions and connections[3,5] and this modulating mechanism can explain the results observed in the present study. This study observed that different mandibular positions indicated significant differences in postural stability.

Analysis of the indices SI, MMLD and MLS showed significantly greater values for the control group. The MAPD index was also greater in the control group, but the difference was not significant. These results show that the TMD group presents greater postural stability and asymmetry in its distribution of weight in the frontal plane. Other researchers have not observed a significant difference in the oscillation of the center of pressure between the control and the TMD groups[10] and between the control and the unilateral posterior cross bite groups.[12]

The presence of cervical pain, significantly greater in the TMD group, and the alterations of the stomatognathic system seem to be factors that influence postural stability. It was assumed that disorders in TMJ and the cervical region would show a concomitant postural disequilibrium due to the alterations of the whole muscular chain. This postural disequilibrium was confirmed by the increase in asymmetry in the medial-lateral distribution of weight in the TMD group. However, in relation to stability, the TMD group presented a more stable position.

It must be considered that individuals with TMD present minor muscular activity during the maximal intercuspal position, which can be a protective effect to minimize TMJ movement.[25] The increase of cervical pain in the TMD group also seems to have an influence in reducing oscillation.

In relation to the distribution of weight in the frontal plane, it was observed that the Control group was significantly more symmetrical than the TMD group in all of the mandibular positions. These results do not confirm the studies of postural symmetry in the frontal plane by Ferrario *et al.*[10] (1996). In another study, the significant difference in the index of symmetry between the control and the unilateral posterior cross bite group was not observed.[12]

However, Bracco *et al.*[9] (2004), keeping the mandibular relation in a myocentric position (which is a right-left muscular equilibrium position), observed improvement in the postural symmetry.[9] In an analysis of the electric activity of the temporalis, masseter and sternocleidomastoid muscles, a greater asymmetry in the TMD group was observed.[26] The activity of the muscles involved in the chewing movement of the mandible, during the postural symmetry evaluation, may explain the results of this study.

Conclusions

Individuals with TMD present greater postural asymmetry and their cervical pain can be related to the reduction in oscillation and the consequent increase in postural stability.

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