

# THE RELATIONSHIP BETWEEN TEMPOROMANDIBULAR DYSFUNCTION AND HEAD AND CERVICAL POSTURE

Ricardo Alves MATHEUS<sup>1</sup>, Flávia Maria de Moraes RAMOS-PEREZ<sup>2</sup>, Alynne Vieira MENEZES<sup>2</sup>,  
Gláucia Maria Bovi AMBROSANO<sup>3</sup>, Francisco HAITER-NETO<sup>1</sup>, Frab Norberto BÓSCOLO<sup>1</sup>, Solange Maria de ALMEIDA<sup>1</sup>

1- PhD, Oral Radiology, Dental School of Piracicaba, State University of Campinas, Piracicaba, SP, Brazil.

2- DDS, Msc, Oral Radiology, Dental School of Piracicaba, State University of Campinas, Piracicaba, SP, Brazil.

3- PhD, AGR ENG, Department of Community Dentistry, Dental School of Piracicaba, State University of Campinas, Piracicaba, SP, Brazil.

**Corresponding address:** Flávia Maria de Moraes Ramos-Perez - Oral Radiology, School of Dentistry of Piracicaba, UNICAMP - Av. Limeira, 901-Areão- 13414-018 - Piracicaba/SP, Brazil - Phone: 55 19 2106-5327 - e-mail: [flavia\\_radio@hotmail.com](mailto:flavia_radio@hotmail.com)

**Received:** May 31, 2008 - **Modification:** September 21, 2008 - **Accepted:** November 9, 2008

## ABSTRACT

**O**bjective: This study aimed to evaluate the possibility of any correlation between disc displacement and parameters used for evaluation of skull positioning in relation to the cervical spine: craniocervical angle, suboccipital space between C0-C1, cervical curvature and position of the hyoid bone in individuals with and without symptoms of temporomandibular dysfunction. Material and Methods: The patients were evaluated following the guidelines set forth by RDC/TMD. Evaluation was performed by magnetic resonance imaging for establishment of disc positioning in the temporomandibular joints (TMJs) of 30 volunteer patients without temporomandibular dysfunction symptoms and 30 patients with symptoms. Evaluation of skull positioning in relation to the cervical spine was performed on lateral cephalograms achieved with the individual in natural head position. Data were submitted to statistical analysis by Fisher's exact test at 5% significance level. To measure the degree of reproducibility/agreements between surveys, the kappa (K) statistics was used. Results: Significant differences were observed between C0-C1 measurement for both symptomatic ( $p=0.04$ ) and asymptomatic ( $p=0.02$ ). No statistical differences were observed regarding craniocervical angle, C1-C2 and hyoid bone position in relation to the TMJs with and without disc displacement. Although statistically significant difference was found in the C0-C1 space, no association between these and internal temporomandibular joint disorder can be considered. Conclusion: Based on the results observed in this study, no direct relationship could be determined between the presence of disc displacement and the variables assessed.

**Key words:** Temporomandibular joint. Temporomandibular joint disc. Magnetic resonance imaging. Craniofacial pain.

## INTRODUCTION

The etiology, diagnosis and treatment of temporomandibular disorder (TMD) are a controversial subject. According to Mehta, et al.<sup>9</sup> (1984) the system can be divided in three main areas termed the "triad of dysfunction", which accounts for the majority of patients complaints: 1. myofascial pain and dysfunction; 2. internal derangement of the temporomandibular joint (TMJ) and 3. cervical spine dysfunction (CSD).

The guidelines of the American Academy of Orofacial Pain pointed out a correlation of TMD and cervical spine. The cervical spine is intimately related to the cranium and masticatory system via specific joint articulations, muscle attachments, and neural and vascular innervations and the relation of postural balance among them is of fundamental importance to maintain the functionality of the system formed by these structures<sup>13</sup>.

More and more clinicians are recognizing the presence

of signs and symptoms of CSD in many of their patients with TMD, however this exact relationship between CSD and TMD is still unclear<sup>2</sup>. Munhoz, et al.<sup>10</sup> had already demonstrated a predisposition for individuals with more severe TMD to exhibit cervical spine hyperlordosis.

Some studies support the connection between head and cervical posture and TMD<sup>7,11,14</sup>, while others do not<sup>3,16</sup>. Due to the great controversy about the causative factors of TMD this study investigated the possibility of association between head and cervical posture and internal derangement. The space existent between the base of the occipital bone and posterior arch of the first vertebra, C1-C2 distance, the craniocervical angle and the position of the hyoid bone were used as parameters.

## MATERIAL AND METHODS

The sample of the present study consisted on 60 volunteers (47 women and 13 men, mean age 34.2 ). The study protocol was approved by the Research Ethics Committee of the Dental School of Piracicaba, São Paulo, SP, Brazil (020/2002).

The clinical examination included the evaluation of signs (mandibular trajectory and movement during mouth opening, TMJ sounds) and symptoms (TMJ and muscle tenderness determined by palpation) following the guidelines set forth by RDC/TMD axis I<sup>12</sup>. The main components of RDC/TMD include determination of painful muscle sites, painful joint palpation, painful mandibular function, and range and trajectory of mandibular opening<sup>12</sup>. All patients were examined by using magnetic resonance imaging (MRI) and telerradiographs.

The MRI was obtained with a 1.5 T magnetic resonance unit (Sigma, GE, Milwaukee Wisconsin, USA) using high-resolution bilateral spools for assessing the position and function of the articular disc. The protocol for image acquisition was based on Hollender, et al.<sup>6</sup> (1998), which is initially constituted by axial cuts, and from these, oblique sagittal images were obtained, perpendicular to the long axis of the condyle. After that, coronal images were performed. Images were obtained at closed-and open-mouth positions in the sagittal plane and at the closed-mouth position in the coronal plane. The parameters for the sagittal and coronal

images were as follows:

Repetition time (TR), 2500 ms; echo time (TE), 24 ms; field of view, 12 cm, number of excitations, 2. We used a slice thickness of 3 mm for the sagittal images and 2 mm for the coronal acquisitions and a matrix of 512 x 512 pixels. Scanning time was 2 min and 45 s for the closed-and open-mouth sagittal images and 1 minute and 55 s for the closed-mouth coronal images. Initial localizers (TR= 300 ms, TE= 8 ms) were used for planning sagittal images. The coronal images were planned by using sagittal images on each side as an orientation for perpendicular to the disc and posterior slope of the articular eminence. The complete exam was initially composed of a sequence of 15 axial slices, followed by a sequence of 8 sagittal images at closed-mouth of each TMJ. Eight coronal images also at closed-mouth and finally a sequence of 8 sagittal images at open-mouth position of each TMJ. All images were recorded on CD for later analysis and interpretation by a specific computer program called eFilm Workstation version 1.5.3.

Two experienced radiologists who made a consensus evaluation of all images without any clinical information performed MRI image evaluation. The antero-posterior position of the disc relative to the condyle was determined by closed-and open-mouth sagittal images; and lateral and medial disc displacements were interpreted by coronal images. Functional positions of the articular discs were assessed in accordance with the classification proposed by Tasaki, et al.<sup>15</sup> (1996), in which they classify as normal

<p>Suboccipital space between vertebrae C0-C1: This space was measured by tracing a perpendicular line from the base of the occipital bone (point 0) to the postero-superior point (Point A) of the first cervical vertebra. Values between 4 and 9 mm were considered normal. Distances of less than 4 mm may be related to a posterior rotation of the cranium; Distances over 9 mm may be associated to an anterior rotation of the cranium.</p>
<p>C1-C2 distance: This measurement shows the perpendicular distance between the posterior arch of atlas and the spinous process of C2. The landmarks are the most inferior and posterior point of the posterior arch of the atlas and the most superior and posterior point of the spinous process of axis.</p>
<p>Cranio Cervical Angle: The cranio cervical angle is formed by the McGregor Plane (tangent from the base of the occipital bone until it reaches the posterior nasal spine on the hard palate) and the Pdontoideum Plane (which starts from the apex of the odontoid process of C2 up to the most anterior and inferior point of the body of C2). This angle is used to assess the antero-posterior position of the cranium in relation to the cervical spine. Values between 96 and 106°, are considered normal. Values lower than 96° suggest an extension of the head and values higher than 106° are indicative of a flexion position of the head, causing it to be in an anterior position.</p>
<p>Position of the Hyoid Bone: The hyoid tracing involves planes between the cervical spine and the mentonian symphysis. A triangle is formed when the following cephalometric points are joined. First the retrognath (RGn) is determined. Next, a line is traced between the inferior-anterior angle of C3 up to point RGn, and points C3-H and H-RGn are joined to obtain the hyoid triangle. Four situations are considered as regards the position of the Hyoid bone.</p> <ol style="list-style-type: none"> <li>1) Negative hyoid triangle, when the hyoid bone is located above the line traced between points C3-RGn;</li> <li>2) Absence of the hyoid triangle, when the hyoid bone is located on C3-RGn line;</li> <li>3) Positive hyoid triangle, when the hyoid bone is located up to 5 mm below the line traced between points C3-RGn, this position being considered normal; and</li> <li>4) Markedly positive hyoid triangle, when the hyoid bone is located more than 5 mm below C3-RGn line.</li> </ol>

FIGURE 1- Parameters assessed by means of Lateral Teleradiography

position, anterior disc displacement with reduction and anterior disc displacement without reduction.

The lateral teleradiographs (Siemens, São Paulo, SP, Brazil) were taken of the cranium and cervical spine in order to evaluate the head and cervical posture. Exposure factors varied in accordance with the biotype of each subject in the study. In order to interpret the relation of the cranium with the cervical spine, the radiograph was taken with the patient in the self-balanced position as recommended by Rocabado (1984)<sup>13</sup>. The cephalometric analyses as described by Rocabado (1984)<sup>13</sup> for measuring the suboccipital space (C0-C1 distance), atlas-axis distance (C1-C2 distance), craniocervical angle (CCA) and position of the hyoid bone widths were performed (Figure 1). The measurements were done by the same two evaluators, who did not have knowledge about the diagnostic obtained by MRI. To evaluate the reliability of each examiner, 10 radiographs were chosen randomly to repeat the measurements.

Data were submitted to statistical analysis by Fisher's exact test at 5% significance level. Kappa (K) statistics was used to assess the degree of reproducibility and agreement between surveys.

## RESULTS

Table 1 presents the distribution and classification of symptomatic and asymptomatic individuals with and without articular disc displacement in relation to the C0-C1 space. It was observed that most individuals symptomatic for TMD presented disc displacement, and these were related to a normal suboccipital space (4 to 9 mm). The main findings observed in symptomatic individuals were painful masseter muscle, painful joint palpation and painful mandibular function. Asymptomatic individuals with normal positioning of the disc were associated with normal values of the space between C0-C1, comprising 57% of the individuals. Fisher's exact test showed statistically significant difference ( $p < 0.05$ ) between disc position and C0-C1 space measurement for both symptomatic ( $p = 0.04$ ) and asymptomatic ( $p = 0.02$ ) individuals.

There were no statistically significant difference ( $p > 0.05$ ) for C1-C2 space, craniocervical angle and hyoid bone position. Tables 2 to 4 show the distribution and classification of symptomatic and asymptomatic individuals with and without articular disc displacement according to the above parameters.

The K value for inter-observer agreement was used to

**TABLE 1-** Distribution and classification of symptomatic and asymptomatic individuals, with and without articular disc displacement, in relation to the values referring to the suboccipital space

Patients	CO-C1 space	Normal disc	Disc displacement
Symptomatic	< 4	0	0
	4 to 9 mm	1 (20%)	18 (72%)
	> 9	4 (80%)	7 (28%)
Asymptomatic		5	25
	< 4	0	0
	4 to 9 mm	12 (57%)	9 (100%)
	> 9	9 (43%)	0
		21	9

Fisher's exact test ( $p < 0.05$ ); symptomatic ( $p = 0.04$ ) and asymptomatic ( $p = 0.02$ ).

**TABLE 2-** Distribution and classification of the TMJs of symptomatic and asymptomatic individuals, with and without articular disc displacement, in relation to the values referring to the C1-C2 space

Patients	C1-C2 space	Normal disc	Disc displacement
Symptomatic	< 4	1 (20%)	4 (16%)
	4 to 9 mm	2 (40%)	19 (76%)
	> 9	2 (40%)	2 (8%)
Asymptomatic		5	25
	< 4	1 (5%)	3 (33%)
	4 to 9 mm	17 (81%)	6 (67%)
	> 9	3 (14%)	0
		21	9

Fisher's exact test ( $p > 0.05$ ); symptomatic ( $p = 0.08$ ) and asymptomatic ( $p = 0.09$ ).

**TABLE 3-** Distribution and classification of the TMJs of symptomatic and asymptomatic individuals, with and without articular disc displacement, in relation to craniocervical angle values

Patients	CCA	Normal disc	Disc displacement
Symptomatic	< 96°	0	2(8%)
	96 to 106°	2(40%)	9(36%)
	> 106°	3(60%)	14(56%)
Asymptomatic		5	25
	< 96°	2(9.5%)	2(22%)
	96 to 106°	5(24%)	5(56%)
	> 106°	14(66.5%)	2(22%)
		21	9

Fisher's exact test (p>0.05); symptomatic (p=1.00) and asymptomatic (p=0.07).

**TABLE 4-** Distribution and classification of the TMJs of symptomatic and asymptomatic individuals, with and without articular disc displacement, in relation to the values referring to the hyoid bone position

Patients	Hyoid bone position	Normal disc	Disc displacement
Symptomatic	normal (below to 5mm)	0	7(28%)
	same line	0	0
	above	2(40%)	6(24%)
	below (over to 5mm)	3(60%)	12(48%)
Asymptomatic		5	25
	normal (below to 5mm)	10(48%)	4(44.4%)
	same line	2(9%)	1(11.1%)
	above	4(19%)	2(22.2%)
	below (over to 5mm)	5(24%)	2(22.2%)
	21	9	

Fisher's exact test (p>0.05); symptomatic (p=0.05) and asymptomatic (p=1.00).

evaluate the reproducibility. Overall, these values indicated a good to almost perfect agreement (0.81 to 1).

**DISCUSSION**

When assessing symptomatic patients for disc displacement with reduction, Armijo Olivo, et al.<sup>1</sup> (2001) found values considered normal for the C0-C1 space in 48% of them. In this study, the CO-C1 space was the only one that showed a significant difference between groups and considering the normal values for the C0-C1, it was observed that 20% of symptomatic individuals and 57% of the asymptomatic subjects showed normal disc position. Disc displacement diagnosis performed by Armijo Olivo, et al.<sup>1</sup> (2001) was based only on clinical signs and symptoms, which may lead to a false-positive diagnosis for disc position. Differently, in the present study, the clinical diagnosis was associated with MRI.

As mentioned by Rocabado<sup>13</sup> (1984), the maintenance of the space between CO-C1 prevents compression of the neurovascular elements and altered spaces could produce articular hypomobility, muscular tension and local pain. However, the greater prevalence of TMJs with disc displacement, presenting normal CO-C1 space may lead to think that the symptomatology

observed in these individuals should be related to intra-articular factors.

Regarding the craniocervical angle, no relation was found between TMD and craniocervical dysfunction. No statistically significant difference was found between normal disc position and disc displacement in both groups. In this research, the majority of disc displacements (56%) were related to craniocervical angles higher than 106° in individuals with TMD complaints, agreeing with Lee, et al.<sup>8</sup> (1995). Differently, Armijo Olivo, et al.<sup>1</sup> (2001) found 80% of symptomatic individuals with disc displacement presenting altered craniocervical angle. Most of them (60%) presented values compatible with a posterior rotation of the head in relation to the spinal column. Nevertheless, it should be emphasized that according to the cited literature<sup>1,8</sup> the diagnosis of disc displacement was based on a clinical assessment and the presence of symptoms only does not necessarily indicate an altered disc position.

Angles lower than 96° lead to an exaggerated posterior rotation of the head that may cause a lot of alterations, such as reduction of the suboccipital space with signs of craniofacial pain and strong tension in the supra and infra hyoidea musculature. On the other hand, angles higher than 106° are implicated with anterior rotation of the head that cause increase in the suboccipital space, inversion of the physiological

curvature (kyphosis) and exaggerated tension in posterior craniocervical soft tissues<sup>13</sup>. A direct relationship between the anterior position of the head and TMD has been investigated by different authors and different opinions have been proposed. Sonnesen, et al.<sup>14</sup> (2001) reported that the presence of TMD signs is more prevalent in patients that presented an anterior head position, but could not affirm if these signs were the cause or the consequence of this position. However, Visscher, et al.<sup>16</sup> (2001), when making a similar comparison to assess both patients and asymptomatic volunteers did not find any relationship between the presence of craniocervical dysfunction symptoms, temporomandibular dysfunction and the abnormal position of the head.

Considering the hyoid triangle, it was observed that the majority of the symptomatic patients with normal disc position presented the hyoid below the C3-RGn line more than 5 mm, while the majority of the asymptomatic volunteers showed the hyoid in the normal position. The presence of negative hyoid triangle (above the C3-RGn line) was observed in 40% of symptomatic individuals with normal disc position and in 19% of asymptomatic volunteers. This condition was observed in 36.6% of individuals assessed by Fuentes, et al.<sup>3</sup> (1999) and in 11.2% of the sample observed by Henríquez, et al.<sup>5</sup> (2003). Both<sup>3,5</sup> conducted the studies in completely asymptomatic individuals for temporomandibular or cervical problems while in the present study we considered both asymptomatic and symptomatic individuals, as well as the disc position.

Thus, based on the results observed in this study, no direct relationship could be determined between the presence of disc displacement and the assessed variables. From the results regarding the four parameters used to assess the presence of craniocervical dysfunction, no association between them and internal disorder of the TMJs was considered, even though, statistically significant difference have been found in one of them (C0-C1space).

Halbert's<sup>4</sup> (1958) statement may explain the results of the present study. According to him, there is a close anatomic-functional relationship between the masticatory system and the cervical region and scapular centric, and the postural alteration of the head leads to a disadvantage to muscular biomechanics. Therefore, the relationship between craniocervical disorder and TMD may be stronger related to the muscular component rather than the articular component.

## CONCLUSION

Although the alterations in the parameters that diagnose craniocervical dysfunction are not related to disc displacement, further studies should be conducted in order to achieve a final conclusion. This study alone could not affirm that there is relation between craniocervical dysfunctions and temporomandibular disorders. Furthermore, it is important to note that TMD is not related only to the position of the articular disc, but also to other signs and symptoms.

## ACKNOWLEDGEMENTS

This work was supported by FAPESP and CNPq, Brazil.

## REFERENCES

- 1- Armijo Olivo S, Frugone Zambra R, Wahl FV, Gaete JV. Alteraciones teleradiográficas craneocervicomandibular en pacientes con desplazamiento anterior de disco con reducción. *Kinesiología*. 2001;64:82-7.
- 2- Clark GT, Green EM, Dorman MR, Flack VF. Craniocervical dysfunction levels in a patient sample from a temporomandibular joint clinic. *J Am Dent Assoc*. 1987;115(2):251-6.
- 3- Fuentes R, Freesmeyer W, Henríquez J. Influencia de la postura corporal en la prevalencia de las disfunciones craneomandibulares. *Rev Med Chil*. 1999;127(9):1079-85.
- 4- Halbert R. Electromyographic study of the head position. *J Can Dent Assoc*. 1958;24(1):11-23.
- 5- Henríquez J, Fuentes R, Sandoval P, Muñoz A. Análisis de la estabilidad ortostática craneocervical en adultos jóvenes mapuches. *Int J Morphol*. 2003;21(2):149-53.
- 6- Hollender L, Barclay P, Maravilla K, Terry V. A new coronal imaging plane for magnetic resonance imaging of the temporomandibular joint disc. *Dentomaxillofac Radiol*. 1998;27(1):48-50.
- 7- Huggare JA, Raustia AM. Head posture and cervicovertebral and craniofacial morphology in patients with craniomandibular dysfunction. *Cranio*. 1992;10(3):173-9.
- 8- Lee WY, Okeson JP, Lindroth J. The relationship between forward head posture and temporomandibular disorders. *J Orofac Pain*. 1995;9(2):161-7.
- 9- Mehta NR, Forgione AG, Rosenbaum RS, Holmberg R. "TMJ" triad of dysfunctions: a biologic basis of diagnosis and treatment. *J Mass Dent Soc*. 1984;33(4):173-6,212-3.
- 10- Munhoz WC, Marques AP, Siqueira JTT. Radiographic evaluation of cervical spine of subjects with temporomandibular joint internal disorder. *Braz Oral Res*. 2004;18(4):283-9.
- 11- Nicolakis P, Nicolakis M, Piehlinger E, Ebenbichler G, Vachuda M, Kirtley C, et al. Relationship between craniomandibular disorders and poor posture. *Cranio*. 2000;18(2):106-12.
- 12- Pereira FJ Jr, Favilla EE, Dworkin S, Huggins K. Critérios de diagnóstico para pesquisa das disfunções temporomandibulares (RDC/TMD): tradução oficial para a língua portuguesa. *J Bras Clin Odontol Int*. 2004;8(47):384-95.
- 13- Rocabado M. Analisis biomecanico craneocervical a traves de una teleradiografia lateral. *Rev Chil Ortodod*. 1984;1(1):42-52.
- 14- Sonnesen L, Bakke M, Solow B. Temporomandibular disorders in relation to craniofacial dimensions, head posture and bite force in children selected for orthodontic treatment. *Eur J Orthod*. 2001;23(2):179-92.
- 15- Tasaki MM, Westesson PL, Isberg AM, Ren YF, Tallents RH. Classification and prevalence of temporomandibular joint disc displacement in patients and symptom-free volunteers. *Am J Orthod Dentofacial Orthop*. 1996;109(3):249-62.
- 16- Visscher CM, Lobbezoo F, Boer W, van der Zaag J, Naeije M. Prevalence of cervical spinal pain in craniomandibular pain patients. *Eur J Oral Sci*. 2001;109(2):76-80.