ANALYSIS OF MANDIBULAR POSITION USING DIFFERENT METHODS OF LOCATION

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ABSTRACT

There has been much discussion regarding the ideal position of the condyle in the mandibular fossa. Although the centric relation position (CR) is used as a reference, some authors do not believe that it is physiologic. Thus, the aim of this study was to evaluate in a group of asymptomatic individuals the position of the condyle in the mandibular fossa at maximum intercuspation (MI), with a occlusal splint and with a Lucia jig between the teeth. It was analyzed by means of magnetic resonance imaging (MRI), transcranial radiography imaging and analysis of horizontal axis of rotation from casts mounted on an articulator. The results showed that even if patients had mandibular displacement in positions of CR, habitual maximum intercuspation and with the occlusal splint, confirmed by means of the analysis of the horizontal axis of rotation, the images showed no statistically significant differences among condylar positions. It can therefore be concluded that the positions analyzed were similar and that transcranial radiography seems to be a reliable method for analyzing condylar position.

Key words: condylar position, magnetic resonance imaging, centric relation.

ANÁLISE DA POSIÇÃO MANDIBULAR ATRAVÉS DE DIFERENTES MÉTODOS DE LOCALIZAÇÃO

RESUMO

Muito se discute sobre a posição ideal que o côndilo deve ocupar dentro da fossa mandibular. Apesar da Relação Cêntrica (RC) ser usada como uma referência, alguns autores não concordam que esta posição seja fisiológica. Sendo assim, o objetivo deste estudo foi avaliar a posição do côndilo dentro da fossa mandibular em um grupo de indivíduos assintomáticos nas posições de máxima intercuspidação (MI), com placa estabilizadora e com o Guia de Lucia, interposto entre os dentes. A análise foi realizada por meio de imagem por ressonância nuclear magnética, da radiografia transcraniana; e análise do eixo horizontal de rotação, a partir de castos montados em articulador. Os resultados mostraram que, apesar de os pacientes possuírem deslizes mandibulares entre as posições de RC, máxima intercuspidação habitual e com a placa estabilizadora, confirmados por meio da análise do eixo horizontal de rotação, as imagens não mostraram diferenças estatisticamente significantes entre as posições condilares. Assim, pode-se concluir que as posições analisadas foram similares e que a radiografia transcranial parece ser um método confiável para análise da posição condilar.

Palavras chave: posição condilar, imagem por ressonância magnética, relação cêntrica.

INTRODUCTION

The position of the condyle in the mandibular fossa and its clinical importance are fundamental in restorative procedures. Some authors relate this position to certain temporomandibular disorders and alterations in the structures of the temporomandibular joint structures[1,2].

The centric relation position, which has long been used, has been defined in two different ways over the years. The first is by authors who recommend a more retruded position of the condyle[3,4]. Currently, however, researchers maintain that the condyles are in a more superior and anterior position in relation to the posterior surface of the temporal bone[5-7]. Nevertheless, TMJs are highly mobile joints, allowing great capacity for adaptation and change in the position of the horizontal axis of rotation[5,8]. Moreover, studies have shown that it is not a physiologic position because the muscles and ligaments comprised in the system would be overloaded[9,10]. Other authors, such as Weinberg[11], believe that the condyles should be centred in the fossa. Anatomical studies by Sicher[12] show that the condyle should not compress the retrodiscal area because it is profusely innervated and vascularized.

When the condyle is positioned further back in the mandibular fossa, it compresses the posterior edge of the disc and can produce morphological alterations

by thinning it[13]; during this stage, anatomical conditions favour displacement of the disc towards the anterior region[14]. Depending on the structural tolerance of the retrodiscal tissues, small compressions, which are not always able to produce morphological alteration of the disc, may cause inflammation and trigger local pain or pain referred to correlative sites[8]. When it is concluded that function is not normal, a diagnostic image is essential to assess why the habitual bite is not the most functional bite. Diagnostic imaging has several advantages: it allows reversible diagnosis, helps evaluate dental contacts and the response of the system to the new condition as time goes by, and enables it to be determined whether the new treatment position is better for the patient than his/her habitual maximum intercuspation (HMI)[15].

Scientific literature has also shown that centric relation (CR) and centric occlusion (CO) positions rarely coincide, i.e. when the mandible closes in CR, in most people there is not a maximum number of contacts between teeth[16].

Several methods are used for studying condylar position. The most important of these include transcranial radiography[17], computer assisted tomography and magnetic resonance imaging[2]. However, studies on this issue have produced controversial results.

In view of the importance of the position of the condyle in the fossa and the controversy in the literature, the aim of this study was to assess the position of the condyle in the mandibular fossa in a group of asymptomatic patients, when teeth are at maximum intercuspation (MI), with a occlusal splint and with a Lucia jig placed between the teeth, by analyzing the horizontal axis of rotation in casts mounted on an articulator, and by transcranial radiography and magnetic resonance imaging.

MATERIALS AND METHODS

This study was conducted on six young female adults aged 19 to 25 years, who were free from signs or symptoms of temporomandibular disorders and had full dentition and Angle's class I molar relation. Three casts (two for the maxillary arch and one mandibular) were made for each patient in special stone plaster (Durone, Dentsply, Petrópolis, Rio do Janeiro). One of the maxillary casts was used to make the occlusal splint, while the other two were used to determine the positions of the horizontal axis of rotation using a semi-adjustable articulator.

To make the occlusal splint, a sheet of PVC 1.5 mm thick was adapted to the maxillary cast under vacuum; the occlusal surface was rebased with self-polymerizable resin (Artigos Odontológicos Clássico, São Paulo) directly in the mouth of the patient, and adjusted in order to distribute bilateral contacts among all the teeth, and anterior disocclusion guides in eccentric movements.

Patients were instructed to wear it 24 hours a day. Further adjustments of occlusion were made every 48 hours until mandibular equilibrium was achieved, identified by the maintenance of the occlusal contact points on the occlusal splint.

The casts were mounted on a semi-adjustable articulator, with the help of the facial arch and interocclusal record in the CR position. To do this, a Lucia jig was made from self-polymerizable resin (Duralay, Reliance Dental Manufacturing, Worth, Illinois) on the maxillary central incisors to prevent contact between antagonistic teeth while the CR position was being recorded, according to the technique described by Bezzon & Orsi[18].

To analyze the horizontal axis of rotation, after mounting the casts, an acrylic resin guide was made to maintain the centric relation position between the casts. To do so, a Buhnergraph[19] for locating the horizontal axis of rotation graphically was adapted to the lower member of the articulator (Fig. 1).

Statistical analysis (analysis of variance for paired samples with one

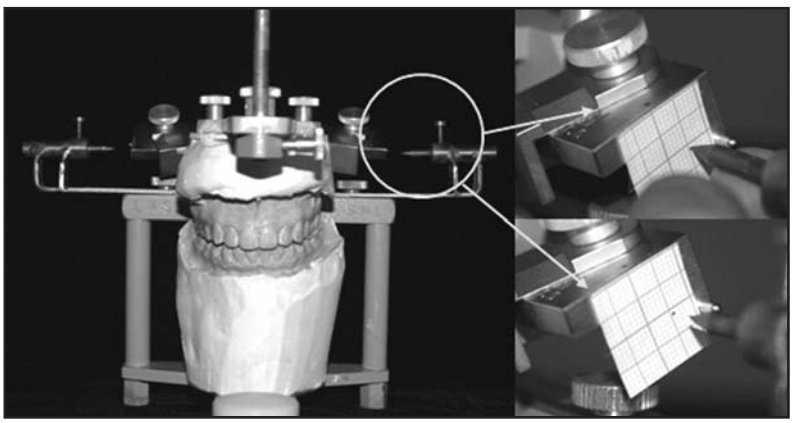

Fig. 1: Buhnergraph adapted on the lower member and graph paper positioned in the condylar device of the articulator while recording the horizontal axis of rotation in the centric relation position.

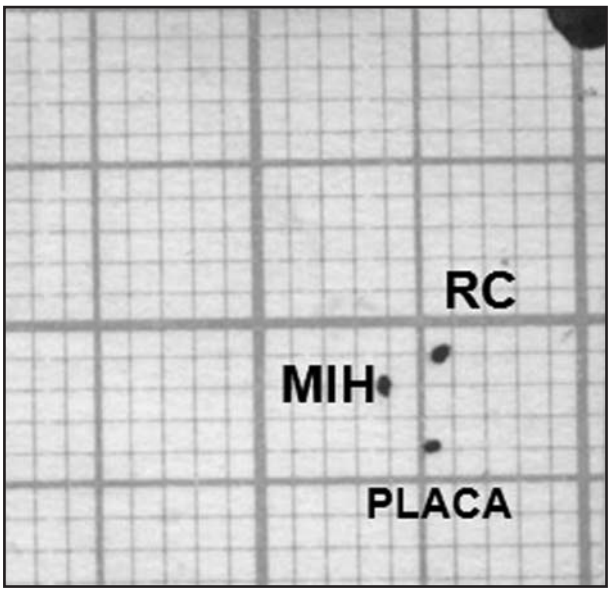

Fig. 2: Graph paper used for marking the points recorded for the horizontal axis of rotation with the articulated casts in centric relation position (CR), habitual maximum intercuspation (MIH) and with occlusal splint in position (PLACA).

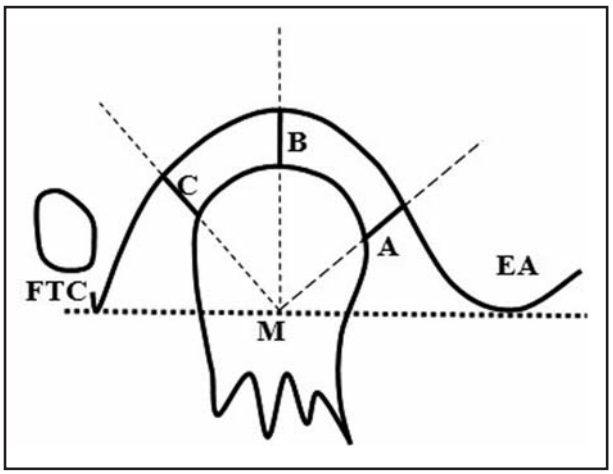

Fig. 3: Diagram of a TMJ. (EA) Articular eminence; (M) midpoint of the line between the squamotympanic fissure (FTC) and the articular eminence; (A) distance from the front of the condyle to the posterior surface of the articular eminence; (B) distance from the top of the condyle to the roof of the fossa; (C) distance from the condyle to the posterior surface of the mandibular fossa.

Fig. 4: Patient positioned in the device used for magnetic resonance imaging imaging of the left TMJ.

variation factor) was done by comparing the differences between the right and left sides for the distances corresponding to the CR and MI points and with the occlusal splint.

When the device was ready, graph paper was fixed to the lateral region of the condylar cavity, to mark the horizontal axis of rotation in the CR position with ink. Then the resin guide was removed and the casts juxtaposed manually in the MI position. Another point was marked in a different colour, corresponding to the mandibular horizontal axis of rotation in the MI position. Finally, the occlusal splint was placed on the maxillary cast and juxtaposed to the mandibular cast, allowing a third point to be marked, corresponding to the horizontal axis of rotation when the occlusal splint was in place (Fig. 2). The distance between the three points was measured using the software AutoCAD 2000 (Autodesk Inc., USA).

Updegrave's technique[20] was then used to obtain images of the TMJs with the occlusal splint installed, with the Lucia jig in position (centric relation) and teeth in the HMI position. The radiographs were scanned using AutoCAD 2000 software to analyze the condylar position. A straight line was drawn from the articular eminence (EA) to the squamotympanic fissure (FTC) on the digitalized TMJ image. Another line was drawn from the highest point of the roof of the mandibular fossa, perpendicular to the first, producing segment B. The intersection of the two lines was called point M. Bisectors were drawn from point M into the anterior space, producing segment A, and into the posterior space, producing segment C (Fig. 3).

The position of the condyle in the fossa was evaluated according to distances A, B and C (Fig. 4).

Magnetic resonance images were made using a Picker Polaris machine with a 1.0 Tesla magnetic field, repetition time (RT) 450 to 500 milliseconds and echo time (ET) 20 milliseconds. The patient was positioned and a unilateral surface coil located over the joint to be examined (Fig. 4).

Table 1: Difference in millimetres (mm) between mandibular positions of the horizontal axis, between right (R) and left (L) sides of the patients (PAT), analyzed using the semi-adjustable articulator.

PAT.	CENTRIC RELATION TO MAXIMUM INTERCUSPATION (MI)		CENTRIC RELATION TO OCCLUSAL SPLINT		OCCLUSAL SPLINT TO MAXIMUM INTERCUSPATION (MI)	
	R	*L*	*R*	*L*	*R*	*L*
1	1.9	0.9	1.3	2.0	1.8	1.6
2	1.3	0.6	0.7	0.6	1.7	1.4
3	0.8	0.8	0.0	0.0	0.8	1.2
4	1.4	1.3	1.3	1.8	1.8	1.6
5	0.6	0.9	1.2	0.9	1.0	0.9
6	0.8	0.5	1.5	0.9	1.2	0.8
MEANS	**1.1**	**0.8**	**1.0**	**1.0**	**1.4**	**1.3**

Three sequences of sagittal T1 weighted sections 2 mm thick were made on each side of the patient, providing a total six sequences for each patient studied: two (one on each side), with the mouth closed and the occlusal splint held between the teeth; two with the Lucia jig and two with the teeth in HMI. The digital images were analyzed with the AutoCAD 2000 software following the same methodology as for radiographic images, and the mean value was used for analysis.

The data were analyzed statistically using analysis of variance for paired data because they were from the same patients and had two variation factors, namely:

a) the imaging technique (resonance and transcranial radiography)

b) the position in which the image was taken (with occlusal splint, with Lucia jig, and maximum intercuspation).

Each position (A, B and C) and each side (right and left) of the patient was analyzed separately. Initially, no comparison was made between right and left sides or between the distance from the anterior region of the condyle of the fossa (Distance A) and the middle and anterior regions (Distances B and C respectively).

Student's "t" test for paired samples was used to compare the imaging of the patients' right and left sides.

RESULTS

Table 1 shows the distances of the horizontal axis of rotation between positions CR, MI and with the occlusal splint, as well as the differences between right and left sides and the result of the statistical analysis.

Table 2 and Fig. 5 show the mean distances (A, B and C) obtained by the radiographic method for patients' right and left sides.

Table 3 and Fig. 6 show the mean distances (A, B and C) obtained by magnetic resonance imaging for patients' right and left sides.

The results of the "t" test for paired simples showed that there were no statistically significant differ-

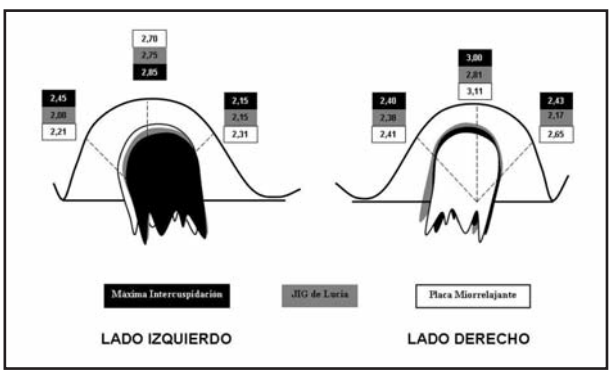

Fig. 5.

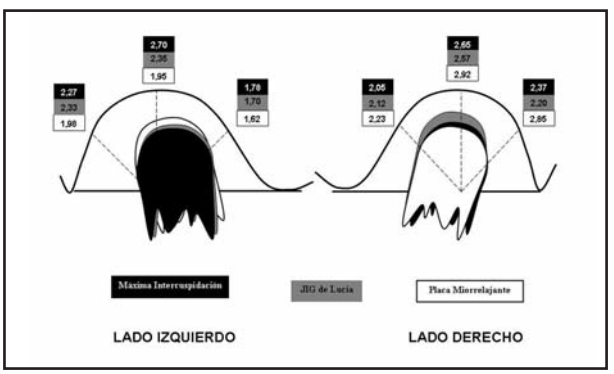

Fig. 6.

Table 2: Sizes and means (M), in millimetres, of the distances between the condyle and the posterior surface of the temporal bone (A); between the condyle and the roof of the mandibular fossa (B) and between the condyle and the posterior surface of the mandibular fossa (C) for right side (RS) and left side (LS) of patients (P) in the different positions analyzed – Transcranial radiography.

TRANSCRANIAL RADIOGRAPHY																		
P	*Maximum Intercuspation*						*Occlusal Splint*						*Lucia Jig*					
	RS			*LS*			*RS*			*LS*			*RS*			*LS*		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1	2.2	4.4	3.6	2.2	4.4	3.7	2.3	4.4	3.5	2.9	4.3	4.0	2.4	4.4	3.6	2.5	4.4	4.0
2	1.9	2.1	3.2	1.5	2.2	2.9	1.7	1.7	2.8	1.6	1.7	2.4	1.8	1.7	2.7	1.5	1.6	2.2
3	3.5	3.3	2.0	3.4	2.9	2.0	3.2	3.2	2.2	3.2	3.1	1.5	3.2	3.2	2.5	3.1	3.2	1.5
4	1.7	3.1	1.9	2.0	2.7	1.9	2.0	3.0	1.4	1.9	2.5	1.4	1.9	2.9	0.7	1.9	2.6	0.9
5	3.1	3.0	1.5	2.2	3.4	2.2	3.3	4.3	3.6	2.7	3.1	2.0	3.0	2.6	1.0	2.3	3.2	2.0
6	2.0	2.1	2.4	1.6	1.5	2.0	2.0	2.1	2.4	1.6	1.5	2.0	2.0	2.1	2.5	1.6	1.5	1.9
M	2.40	3.00	2.43	2.15	2.85	2.45	2.41	3.11	2.65	2.31	2.70	2.21	2.38	2.81	2.17	2.15	2.75	2.08

Table 3: Sizes and means (M), in millimetres, of the distances between the condyle and the posterior surface of the temporal bone (A); between the condyle and the roof of the mandibular fossa (B) and between the condyle and the posterior surface of the mandibular fossa (C) on the right side (RS) and left side (LS) of the patients (P) in the different positions analyzed. – Magnetic Resonance Imaging (MRI).

MAGNETIC RESONANCE IMAGING (MRI)																		
P	*Maximum Intercuspation*						*Occlusal Splint*						*Lucia Jig*					
	RS			*LS*			*RS*			*LS*			*RS*			*LS*		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1	1.6	3.8	3.0	1.6	3.8	3.0	2.1	4.0	3.3	1.0	1.1	1.2	2.0	4.0	2.9	1.6	2.4	1.6
2	2.1	1.6	2.7	2.0	2.7	2.7	3.0	2.1	2.9	2.1	2.4	3.2	2.6	1.7	2.8	1.5	2.1	1.5
3	2.6	2.2	1.7	1.7	1.8	1.8	2.3	2.0	2.1	1.6	1.8	2.0	2.2	2.5	1.8	1.6	2.0	1.6
4	2.2	2.4	2.4	2.0	2.9	2.1	2.0	3.3	2.0	2.0	2.2	1.7	2.0	2.3	1.7	2.0	3.3	2.0
5	1.8	3.0	2.0	2.0	3.2	2.5	1.8	3.1	3.3	1.6	2.8	1.8	2.0	2.9	2.0	2.0	2.9	2.0
6	2.0	2.9	2.4	1.4	1.8	1.5	2.2	3.0	3.5	1.4	1.4	2.0	1.9	2.0	2.0	1.5	1.4	1.5
M	2.05	2.65	2.37	1.78	2.70	2.27	2.23	2.92	2.85	1.62	1.95	1.98	2.12	2.57	2.20	1.70	2.35	1.70

ences among the imaging techniques used, either for distance A (t=0.02%), or distances B (t=2.46%) and C (t=5.88%). Thus, statistically significant differences were found between patients' right and left sides for measurements A and B.

DISCUSSION

The position of the condyle in the mandibular fossa for prosthetic work endeavouring to make the occlusal condition re-establish mandibular equilibrium is still a matter of much controversy[11]. Some studies show that the position of the condyle in the mandibular fossa is important[5,21], and it seems to be one in which the condyle is in a more superior and anterior position than the posterior surface of the temporal bone.

Two different conditions need to be considered regarding the position of the condyle. The first is the position for mounting casts on the articulator in order to make full dentures when the patient has lost all dental references. in this case, the preferred position is centric relation, which can be reproduced.

The other condition is when occlusion is being rehabilitated in dentate or partially dentate patients. In these cases, considering anatomical concepts, it is best to mount the casts in a position of mandibular equilibrium, which can match maximum intercuspation and is equal to the centric relation position when gothic arch tracing is used in the determination. In the position of mandibular equilibrium, joint structures must be anatomically correctly positioned, the disc must be juxtaposed to the condyle, and the condyle-disc assembly is placed against the posterior surface of the temporal bone, in agreement with the results of the muscular forces of the elevator muscles[8]. Thus,

there must be enough space between the condyle and the posterior surface of the fossa to hold the retrodiscal area, which is rich in vessels and nerves. In addition, the masticatory muscles must be in harmony with the position, in which their fibres exert force without producing alterations in the metabolism of the muscle cells. To achieve this, the vertical dimension of occlusion needs to maintain the ideal muscle length for the functions which require force, such as crushing food. Finally, teeth must be in harmony with these anatomical relations, with adequate overjet y overbite to allow maximum intercuspation.

Our results showed that there is no statistically significant difference between sides of a patient when mean values for the horizontal axis of rotation position are compared between casts mounted in centric relation and with occlusal splint. Even though the positions are not very similar, they position the mandible in equilibrium. However, when compared to habitual maximum intercuspation, greater numerical differences are found between sides, suggesting that it is a position of mandibular imbalance. Our results thus suggest that although patients were asymptomatic, they had some lateroprotrusive deviation, shown by the differences between axes recorded in CR and MI positions, indicating a slight orthopaedic imbalance, though it was not enough to trigger temporomandibular disorders, probably due to high physiological tolerance, as explained by Okeson[8].

In addition to the position of the condyle, there is much discussion regarding the methods and techniques used for analysis. This study showed no significant difference between transcranial radiography and magnetic resonance imaging techniques for analyzing the position of the condyle. These techniques may assist the clinician in complex restorative procedures, such as cases of patients with some temporomandibular disorder, with occlusion as a predisposing factor. However, the fact magnetic resonance imaging is expensive and that some patients suffer claustrophobia may limit its use, and transcranial radiography may be a more practical choice.

The techniques differ in that magnetic resonance imaging shows slightly smaller spaces between the condyle and the temporal bone (articular space), as it measures the real articular space, i.e. the space between the soft tissues of the surfaces of the condyle and the temporal bone[22]. In contrast, transcranial radiography shows the distance between the compact bone tissue of the condyle and temporal bone structures[23]. The difference between the space shown by transcranial radiography and magnetic resonance imaging in MI position, particularly the anterior space (0.35 and 0.37 mm respectively for right and left sides) found in this study might indicate the thickness of the soft tissue, which is variable, as shown in the study by Hansson et al.[24]. and explanations by Mohl[7]: the thickest lining tissue is located at the anterior region of the condyle and the posterior surface of the temporal bone, where the highest incidence of forces occurs during function. In this context, the distance between the condyle and the posterior surface of the temporal bone, analyzed by means of the two imaging techniques, showed that the condyles are usually closer to the surface of the temporal bone.

The anterior position of the condyle in the fossa suggests that anterior displacement to the position of maximum intercuspation occurs when the mandible closes in centric relation. In this case, if the deviation is of the lateral protrusive type, it will position the condyle further back on one side and further forward on the other. This condition is found in most patients on analyzing the size of spaces A, B and C. However, after using the occlusal splint, theoretically this difference should no longer exist. This does not happen in any of the conditions used for positioning the condyles in the mandibular fossa, even though no significant difference was found.

Statistical differences were found only between sides when distances A and B were compared, which may have been due to asymmetry between sides in patients. Similarly, in the equilibrium position, the condyle is positioned in front of the centre of the mandibular fossa, against the posterior surface of the temporal bone, as verified by Garcia[21], and maintains a posterior space for the retrodiscal tissues, avoiding compression and inflammation[8] or alterations of the posterior edge of the disc[13], which favour anterior displacement of the disc[14].

When a occlusal splint is placed between the teeth, there is decompression of the TMJ, as shown by Kirk[25]. However, radiographic and resonance imaging did not show statistically significant differences. This was to be expected in view of the fact that asymptomatic patients without temporomandibular disorders were selected. In these patients it was assumed that occlusion, TMJ and muscles were in orthopaedic balance, and that after the procedures employed, no alterations would be observed.

Thus, the choice of mandibular position for occlusal treatment of the patient will depend on whether or not there are teeth and temporomandibular disorders. If the patient is asymptomatic, like the ones selected for the study, the treatment can be conducted in the habitual maximum intercuspation position. However, if the patient has some disorder it is advisable to initially re-establish mandibular equilibrium by means of a occlusal splint, to find out whether the occlusal condition is harmonious with the resulting muscular forces.

When occlusal discrepancy is great, it is advisable to adjust the occlusion, enabling the teeth to occlude in the maximum intercuspation position, which, in our opinion, is an adequate condition of mandibular balance for the treatment. Subsequently, the casts can be juxtaposed or the position of the mandible recorded for mounting in MI position in order to rehabilitate the teeth.

CONCLUSION

Based on the results obtained from the techniques proposed in this study, it can be concluded that:

a) The analysis of the horizontal axis of rotation, when the centric relation position was compared to the position recorded with the occlusal splint and at maximum intercuspation, showed symmetrical differences between the means for the two sides of the patient.

b) The analysis of radiographic and magnetic resonance images showed statistically significant difference in the position of the condyle with relation to the posterior surface of the temporal bone, roof and posterior surface of the mandibular fossa, for both sides of the patient.

c) Although the transcranial radiography analyzes the lateral pole region, it seems to be a reliable method for analyzing the position of the condyle in the mandibular fossa.

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