

# Mandibular Condyle Position in Maximum Mouth Opening. A Magnetic Resonance Imaging Evaluation

Posición Condilar en Apertura Oral Máxima.  
Una Evaluación con Imágenes de Resonancia Magnética

\*Katharina Fernandes Juca; \*\*Iván Claudio Suazo Galdames & \*\*\*Antonio Sergio Guimarães

---

JUCA K. F.; SUAZO, G. I. C. & GUIMARÃES, A. S. Mandibular condyle position in maximum mouth opening. A magnetic resonance imaging evaluation. *Int. J. Morphol.*, 27(3):867-871, 2009.

**SUMMARY:** The purpose of this study was to analyze the condylar position in the maximum mouth opening in a group of individuals with and without temporomandibular joint disorders (TMD) using corrected magnetic resonance imaging (MRI). It was analyzed the MRIs of 200 temporomandibular joint (TMJ) of 100 adults (25 males and 75 females). The images protocol of the MRIs were in corrected sagittal plane T1, with the patient kept at a maximum mouth opening without pain. All the images were obtained parallel to the Frankfurt plane. The images were split by two lines parallel to the upper base of the image which was obtained parallel to the Frankfurt plane, tangential to the articular tubercle and the condyle of each TMJ, and set along the discrepancy of the condylar position on both sides and the position with regard to the articular tubercle. The discrepancy was 45% overall, the most common condylar position types were 5 and 6 on the right and left sides in both the male and female TMJ patients. In this regard, the highest mean values were found for the maximum mouth opening. Our results support the hypothesis that the condylar position is not directly related to the magnitude of the oral opening.

**KEY WORDS:** Temporomandibular joint; Oral opening; Maximal opening mouth; Condylar position; Temporomandibular dysfunction; Articular hypermobility.

---

## INTRODUCTION

The evaluation of the maximal mouth opening is frequently used as a clinical indicator of the TMJ pathology in an increased maximal mouth opening, and is usually an argument for the diagnosis of articular hypermobility or dislocated condylar fractures (Maruyama *et al.*, 1984).

This relationship has been strongly questioned by some authors who have analyzed the condylar position at a maximum opening mouth. Through images at varying degrees of condylar excursion, without clinical signs of joint dislocation or subluxation, authors suggest that the position of the condyle in the maximum mouth opening is not directly related to the magnitude of the TMJ condyle movement (Meti, 2002; Muto *et al.*, 1994; Yang *et al.*, 1999).

The purpose of this study was to analyze the condylar position at the maximum mouth opening using the magnetic

resonance imaging (MRI), in individuals with and without temporomandibular joint disorders (TMD).

## MATERIAL AND METHOD

By non-probability convenience sampling, were selected 200 temporomandibular joints MRIs of 100 adults (25 males and 75 females, between 20 and 50 years old) The patients were analyzed at Computed Tomography Center – Samaritan Hospital - São Paulo - Brazil. The examinations were requested by different clinical problems for various reasons or as evaluation pre orthodontics or orthognatic surgery. It was not included those with a history of the closed lock or locking in wide mouth opening phase, disc adherence, trauma or study of the evaluation in pre- and postoperative

\* Dental Research Institute Sao Leopoldo Mandic, Rua José Rocha Junqueira, 13, code: 13045-755, Campinas, Brazil.

\*\* Department of Anatomy, Universidad de Talca, Talca, Chile.

\*\*\* Head of TMD department, Dental Research Institute Sao Leopoldo Mandic, Rua José Rocha Junqueira, 13, code: 13045-755, Campinas, Brazil.

TMJ surgery. The study was welcomed by the ethics committee of the graduate center São Leopoldo Mandic, Campinas, São Paulo, Brazil and Samaritan Hospital. Patients were all informed of the nature of the study and they agreed to voluntarily participate by providing a written record of their acceptance.

**Analysis of the images:** MRIs of the TMJs were obtained parallel to Frankfurt plane in a corrected sagittal plane in T1 acquisition used for the anatomical study of the TMJs (Westesson, 1993). The images were obtained at a maximum mouth opening without pain. From the images a straight line was drawn (A) parallel to the upper board of the image (considered parallel to Frankfurt plane), tangential to the

lowest point of the curvature in the articular tubercle (point A) called fixed, while a second line parallel to line A was draw in tangent to the upper portion of the condyle (point B) called mobile (Fig.1).

The relations between the points A and B were established in the vertical and horizontal plane according to the position of point B, and were classified into seven types that are shown in Figure 2.

**Evaluation of the maximal mouth opening phase:** Patients were asked to conduct maximum mouth opening without pain, and the interincisal distance was measured using a millimeter ruler.

**Statistical analysis:** Discrepancies in the condylar position in the left and right sides and the descriptive statistics for the values of the oral opening in the different condylar positions were calculated using statistical software SPSS 15.0 for Windows. By t-test, samples were compared according to the values of maximum mouth opening in males and females in the horizontal plane and posterior condylar position (Types 1, 2 and 3) with anterior (Types 5, 6 and 7), and the vertical plane and superior condylar position (Types 2 and 6) with inferior (Types 1, 4 and 5). Statistical significance was established with  $p < 0.05$ .

## RESULTS

In 45 of the analyzed TMJ's images, a discrepancy was found in the condylar positions when the right side is compared to the left, so that the overall discrepancy was

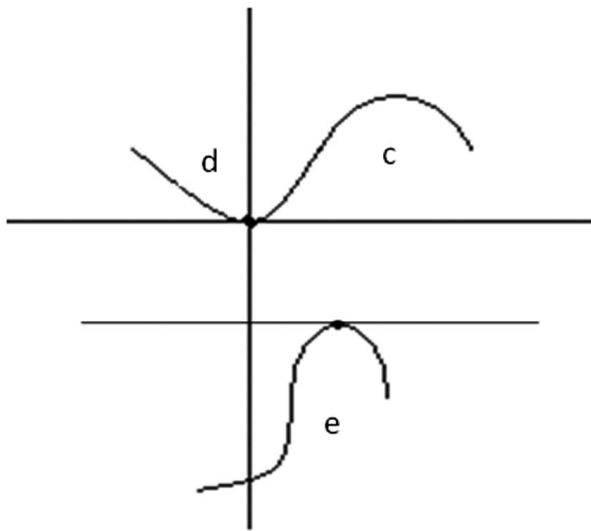


Fig. 1. Outline of the route used to observe the relationship between the articular tubercle and the mandibular head. c = mandibular fossa; d = articular tubercle; e = mandibular head.

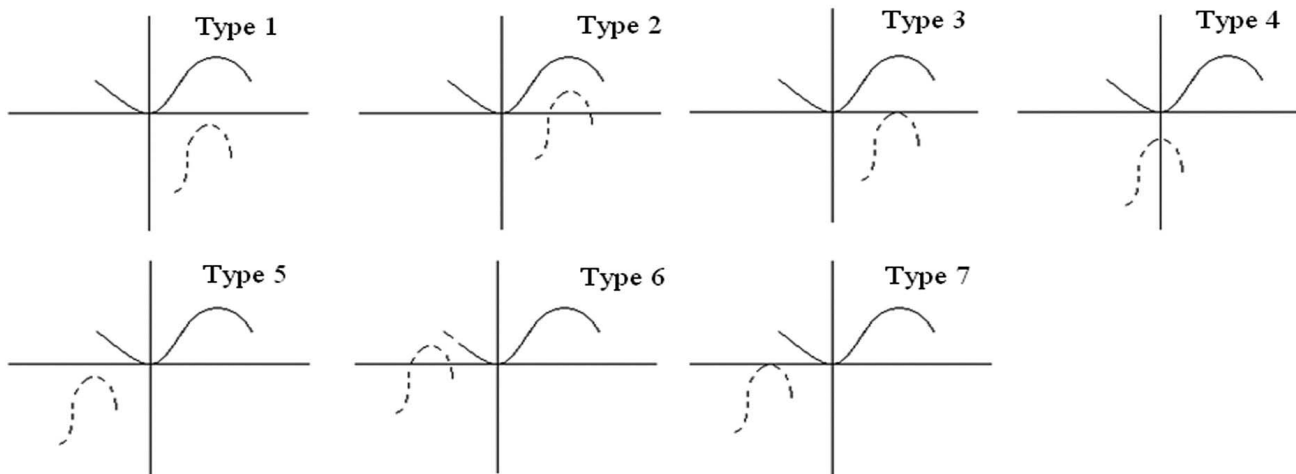


Fig. 2. Outline of the possible positions of the mandibular head in relation to the articular tubercle. Type 1: posterior-inferior; Type 2: posterior-superior; Type 3: posterior and at the same level; Type 4: inferior; Type 5: anterior-inferior; Type 6: anterior-superior; Type 7: anterior and at the same level.

45%. There were 11 and 34 TMJ's positions in males and females, respectively that did not coincide. The most frequently condylar positions found were of types 5 and 6 on the right and left sides in both male and female TMJs, and in these were found the highest mean of the maximum mouth opening. Details of the results of maximum opening at different condylar positions are given in Table I.

In the horizontal plane, the female group had the highest values, which was found in the maximal mouth opening, when the condyle was placed in the anterior position of the articular tubercle both on the right and left sides of the TMJ. These differences were significant in most of the cases.

In the vertical plane, the female patients showed lower values of the maximal mouth opening, when the condyles were located in a superior position, to the depth of the mandibular fossa; however, if the condyles were at a superior plane but anterior to the tuberosity (Type 6), the values were significantly higher than those located in the inferior quadrants.

In males, only the mean of the maximal mouth opening comparison between Types 4 and 6 from the right side presented a significant difference that was higher than Type 6.

Details of differences in the mean value with their statistical significance are shown in Table II.

## DISCUSSION

In the literature and in clinical communications, it is common to see the relationship between the maximal mouth opening and the position of the mandibular condyle: it is traditionally accepted that when the maximal mouth opening

is wide, the mandibular head shifts towards the anterior, and that if the oral opening exceeds normal ranges then the condyle is located anterior to the articular tubercle. In patients with openings over the normal ranges, the former was considered a factor of articular instability ((Maruyama *et al.*).

We analyzed the TMJ through MRI with various dimensions of the mouth opening. In general, the extent of the movement of the condyle is related more to the horizontal plane than the vertical plane. Patient's in which the condyle adopted an anterior position to the articular tubercle also presented the highest values of the mouth opening. This is reasonable because during the moment of opening, the mandibular head rotates and moves to the anterior in a simultaneously rot translation movement until it gets the maximal mouth opening position, to slip into the slope over the articular tubercle ((Isberg & Westesson, 1998; Muto & Kanazawa, 1996). This anterior displacement enables morphological determination of joint surface characteristics, and is the most important characteristic of the articular tubercle, which has a greater flattening in subjects with excessive horizontal overjet. Characteristics of the form and dimensions of the mandibular fossa seem to be of minor importance (Muto *et al.*) in decisive functional neuromuscular control corresponding to the rotation of the mandible. Obwegeser *et al.* (1987) explain that interindividual variations in these determinants are important anatomical aspects in establishing the normal character of the condylar position in the maximal mouth opening. Thus, diagnosis of TMJ subluxation or dislocation cannot rest solely on imaging observations.

With regard to condylar position in the vertical plane, it was found that the values of the oral openings are not related. It is important to cite here that while low values have been obtained, they are within the normal values of the oral opening in patients with Type 2 relations.

Table 1. Descriptive statistics of maximum aperture on different types of condylar positions on both sides in males and females.

	Females						Males									
	Right			Left			Right			Left						
	n	%	Maximum	n	%	Maximum	n	%	Maximum	n	%	Maximum				
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Type	11	14.47	38.27	8.06	11	14.47	35.27	5.06	3	13	48.3	12.5	1	4	35	
Type	10	13.16	31.8	11.8	9	11.84	29.22	12.5	0	0			0	0		
Type	6	7.89	27.5	7.94	6	7.89	31.16	7.3	0	0			0	0		
Type	12	15.79	39.4	6.5	5	6.58	37	7.58	5	21	39.2	4.08	6	25	45.16	8.77
Type	17	22.37	46.82	8.55	25	32.89	45.76	9.1	8	33	47.1	6.9	7	29	44	9.5
Type	17	22.37	48.05	6.16	14	18.42	47.7	5.99	6	25	50.16	8.56	7	29	45.7	6.9
Type	3	3.95	45	13.22	6	7.89	48.33	4.08	2	8	37.5	3.53	3	13	53.3	6.1
	76	100.00		76	100.00			24	100			24	100			

		Mean differences	SD	Sig (bilateral)
		<b>Female right</b>		
Horizontal	Type 1 - Type 5	-7.000	8.509	.021*
	Type 1 - Type 6	-7.455	10.820	.045*
	Type 1 - Type 7	-6.667	12.583	.456
	Type 2 - Type 5	-13.500	14.293	.015*
	Type 2 - Type 6	-13.500	14.199	.015*
	Type 2 - Type 7	-20.000	20.664	.236
	Type 3 - Type 5	-15.500	14.869	.051*
	Type 3 - Type 6	-18.833	7.985	.002**
	Type 3 - Type 7	-15.000	15.000	.225
Vertical relationship	Type 1 - Type 2	6.500	15.651	.222
	Type 1 - Type 6	-7.455	10.820	.045*
	Type 2 - Type 4	-7.400	15.306	.161
	Type 4 - Type 6	-7.500	7.775	.007**
	Type 2 - Type 5	-13.500	14.293	.015*
	Type 5 - Type 6	-1.235	11.851	.673
		<b>Female left side</b>		
Horizontal	Type 1 - Type 5	-7.273	8.308	.016*
	Type 1 - Type 6	-11.818	5.510	.000**
	Type 1 - Type 7	-12.500	5.244	.002**
	Type 2 - Type 5	-13.889	12.820	.012*
	Type 2 - Type 6	-16.222	13.700	.007**
	Type 2 - Type 7	-22.833	11.179	.004**
	Type 3 - Type 5	-12.167	11.548	.049*
	Type 3 - Type 6	-14.500	9.182	.012*
	Type 3 - Type 7	-17.167	8.931	.005**
Vertical relationship	Type 1 - Type 2	5.444	15.331	.318
	Type 1 - Type 6	-11.818	5.510	.000**
	Type 2 - Type 4	-12.400	16.196	.162
	Type 4 - Type 6	-9.800	6.140	.023*
	Type 2 - Type 5	-13.889	12.820	.012*
	Type 5 - Type 6	-6.786	9.496	.019*
		<b>Male right side</b>		
Horizontal	Type 1 - Type 5	-4.333	9.292	.504
	Type 1 - Type 6	2.667	2.517	.208
	Type 1 - Type 7	5.000	14.142	.705
	Type 1 - Type 6	2.667	2.517	.208
	Type 4 - Type 6	-10.600	6.986	.027*
	Type 5 - Type 6	-2.833	13.014	.617
		<b>Male left side</b>		
Vertical relationship	Type 4 - Type 6	.500	14.209	.935
	Type 5 - Type 6	-1.714	12.120	.721

Table 2. Oral opening mean differences when comparing the condylar positions in the horizontal and vertical plane for males and females.

Another interesting finding is the high percentage of discrepancies in the relationship of the condyle with the articular tubercle on both sides (45%), as these differences relate more to functional adjusting positions or the presence of antalgic positions, which have real asymmetries in the craniomandibular relationship (Kropmans *et al.*, 2000).

Our results support the hypothesis that the condylar position is not directly related to the magnitude of the mouth opening. Pi (1985) reports that the anterior-superior position of the condyle, over the articular tubercle in maximal mouth opening respond to physiological conditions or operational positions, but not to TMJ subluxations or dislocations.

**JUCA .K. F; SUAZO, G. I. C. & GUIMARÃES, A. S.** Posición condilar en apertura oral máxima. Una evaluación con imágenes de resonancia magnética. *Int. J. Morphol.*, 27(3):867-871, 2009.

**RESUMEN:** El propósito de este estudio fue analizar mediante resonancia nuclear magnética (RNM) la posición condilar en apertura máxima en pacientes sin alteraciones de la articulación temporomandibular (ATM). Se utilizaron 200 imágenes de 100 individuos adultos (25 hombres y 75 mujeres) observadas en plano sagital corregido en T1 con el paciente en apertura máxima sin dolor, la región de la ATM se dividió mediante dos líneas perpendiculares entre sí, tangentes a la cabeza mandibular y al tubérculo articular y se estableció la discrepancia de la posición condilar en ambos lados y la posición condilar con respecto al tubérculo articular. La discrepancia general fue del 45%, las posiciones condilares más frecuentes fueron los tipos 5 y 6 en los lados derecho e izquierdo en ATM de hombres y de mujeres, en esta relación se encontraron los mayores valores medios de apertura oral máxima. Nuestros resultados apoyan la hipótesis que la posición condilar no se encuentra en relación directa con la magnitud de la apertura oral.

**PALABRAS CLAVE:** Articulación temporomandibular; apertura oral; posición condilar; disfunción temporomandibular; hipermovilidad articular.

## REFERENCES

- Isberg, A. & Westesson, P. L. Steepness of articular eminence and movement of the condyle and disk in asymptomatic temporomandibular joints. *Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod.*, 86:152-7, 1998.
- Kropmans, T.; Dijkstra, P.; Stegenga, B.; Stewart, R. & de Bont, L. Smallest detectable difference of maximal mouth opening in patients with painfully restricted temporomandibular joint function. *Eur. J. Oral Sci.*, 108:9-13, 2000.
- Maruyama, T.; Kotani, M.; Ozaki, H.; Sumida, N.; Akanishi, M. & Kuroda, T. A study on the condylar position of temporomandibular joint in the dysfunction of the stomatognathic system using tomography. *J. Osaka Univ. DentSch.*, 24:89-96, 1984.
- Meti, M. Position of mandibular condyle at maximal mouth opening in symptom free subjects. *Indian J. Dent. Res.*, 13:135-41, 2002.
- Muto, T. & Kanazawa, M. Linear and angular measurements of the mandible during maximal mouth opening. *J. Oral Maxillofac Surg.*, 54:970-4, 1996.
- Muto, T.; Kohara, M.; Kanazawa, M. & Kawakami, J. The position of the mandibular condyle at maximal mouth opening in normal subjects. *J. Oral Maxillofac. Surg.*, 52:1269-72, 1994.
- Obwegeser, H. L.; Farmand, M.; Al-Majali, F. & Engelke, W. Findings of mandibular movement and the position of the mandibular condyles during maximal mouth opening. *Oral Surg. Oral Med. Oral Pathol.*, 63:517-525, 1987.
- Pi, X. A study on the physiologic range of the forward movement of the condyle. *Zhonghua Kou Qiang Ke Zhi.*, 20:234-5, 1985.
- Westesson, P. L. Reliability and validity of imaging diagnosis of temporomandibular joint disorder. *Adv. Dent. Res.*, 7(2):137-51, 1993.
- Yang, D.; Han, K. & Zhou, S. A study of the maximal mouth opening movement of normal subjects. *Zhonghua Kou Qiang Yi Xue Za Zhi.*, 34:373-5, 1999.

Correspondence to:  
Prof. Dr. Antonio Sergio Guimarães  
Dental Research Institute São Leopoldo Mandic,  
Rua José Rocha Junqueira, 13  
Code: 13045-755  
Campinas  
BRAZIL

Email:sergio@asgadm.com

Received: 23-02-2009

Accepted: 30-06-2009

