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CLINICAL SCIENCE

Cone-beam tomography assessment of the condylar position in asymptomatic and symptomatic young individuals

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ABSTRACT

Statement of Problem. Studies of the condyle-mandibular fossa relationship are common, although the role of this relationship in the development of a temporomandibular disorder remains controversial.

Purpose. The purpose of this study was to quantitatively evaluate the condyle-mandibular fossa relationship in young individuals with intact dentitions and compare it to that between individuals with and without symptoms of temporomandibular disorder.

Material and Methods. Volunteers were classified as asymptomatic (n=20) or symptomatic (n=20) according to research diagnostic criteria for temporomandibular disorders. Each participant underwent 2 cone beam-computed tomography scans of the middle and lower third of the face: 1 scan of the maximum intercuspation position and 1 of the centric relationship position. The distance between the condyle and mandibular fossa was measured on frontal and lateral images of the temporomandibular joint. The condylar position was compared across groups (asymptomatic, symptomatic) by using the Mann-Whitney *U* test (α=.05). Within each group, the condylar position was compared across maximum intercuspation and centric relationship positions by using the Mann-Whitney *U* test (α=.05).

Results. No statistically significant differences were found in condylar positions between centric relationships and maximum intercuspation in either asymptomatic or symptomatic young adults, and no significant differences were found between asymptomatic and symptomatic young adults.

Conclusions. The condyle-mandibular fossa relationships of these young adults were similar in the centric relationships and maximum intercuspation positions when evaluated by computed tomography. The presence or absence of temporomandibular disorder was not correlated with the condyle position in the temporomandibular joint. (J Prosthet Dent 2015;114:420-425)

Studies of condyle-mandibular fossa relationships in the centric relationship (CR) and maximum intercuspation (MI) positions have been controversial.[1-15] Two-dimensional radiographic imaging studies[1,4] and dental cast studies[2,7,10,11,13] have shown discrepancies in condylar position between the CR and MI mandibular positions, with some investigators identifying these discrepancies as a causative factor in temporomandibular disorders (TMDs).[11,13]

Although recent investigations using 3-dimensional imaging in asymptomatic individuals confirm a high incidence of discrepancies in condylar position between the CR and MI mandibular positions, they showed no statistically significant differences between the 2 positions, indicating a spectrum of adaptive variability in humans.[9,14,15] Similarly, comparison of the condyle-mandibular fossa relationships in these mandibular positions between asymptomatic and symptomatic

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Clinical Implications

Results of this study question the need for widespread use of computed tomography scans to evaluate the condyle-mandibular fossa relationship. Likewise, the use of condylar repositioning splints for symptomatic or asymptomatic young adults should be reevaluated.

individuals has generated dubious results, increasing the controversy surrounding this topic, with some studies suggesting that changes in condylar position may be in part responsible for TMDs[16-18] and others suggesting that a discrepancy in condylar position has only a synergistic relationship with the causative agents of TMDs.[19-22]

The purpose of this study was to quantitatively evaluate and compare the condyle-mandibular fossa relationship in asymptomatic and symptomatic young adults, in both the CR and MI positions, by using cone beam computed tomography (CBCT). We hypothesized that no significant differences would be found between the condyle-mandibular fossa relationship in young adults with TMDs and those without TMDs.

MATERIAL AND METHODS

Study participants and design

Forty young adult volunteers took part in this study, which was approved by the Ethics Committee of the Federal University of Uberlandia (No. 669/11). Criteria for inclusion were 18 to 25 years of age; all teeth present and healthy; a balanced maxilomandibular relationship (based on analysis of facial proportions); no previous orthodontic treatment or occlusal adjustments; and no previous craniofacial trauma. Exclusion criteria were myospasms, myositis, muscle contracture, polyarthritis, acute traumatic injuries, and infections in the temporomandibular joint (TMJ).

Volunteers were classified as asymptomatic or symptomatic according to Research Diagnostic Criteria (RDC) for TMD (Axis I).[23] The asymptomatic group was composed of 20 participants without signs and symptoms related to TMD (8 men and 12 women), such as clicking, deviation during mouth opening with or without reduction, limited mouth opening, and tenderness of the lateral regions of the TMJ and masticatory muscles (masseter, temporal, medial pterygoid, and lateral pterygoid). According to the classification described by Andrews,[24] this group consisted of 5 individuals with normal occlusion, 5 individuals with class I malocclusion, 5 individuals with class II malocclusion, and 5 individuals with class III malocclusion. The symptomatic group consisted of 20 participants with signs and symptoms of TMD (5 men and 15 women), according to the RDC for TMD. According to the classification described by Andrews,[24] this group consisted of 10 individuals with class I malocclusion, 6 individuals with class II malocclusion, and 4 individuals with class III malocclusion.

The study was divided into 2 parts. In part 1, a clinical survey was carried out to identify the occlusal features of each participant. The mandible was manipulated, and an anterior deprogramming device[25] was used to record the CR position. This device was fabricated using chemically activated acrylic resin (Duralay; Reliance Dental Mfg Co). The first contact between the maxillary and mandibular arches corresponding to the TMJ in the CR position was identified for the purpose of maintaining a CR position during the tomographic examination. Next, the palatal slope of the device was adjusted until this first occlusal contact was obtained. A standardized channel leading to the CR position was made with acrylic resin, to be used as a stable occlusal position during the tomographic examination performed in the CR position.[14,26]

Part 2 was conducted by an oral and maxillofacial radiologist and by the operator (E.R.L.) who carried out part 1. Each volunteer underwent 2 CBCT examinations of both TMJs, the first in the MI position and the second in the CR position. Lateral and vertical CBCT scans were obtained with a gantry tomography unit (NewTom 3G; Quantitative Radiology srl). Marks made on the participant's face with a ballpoint pen were used to standardize the participant's head position under the laser positioner of the tomograph device across the 2 scans. For the first scan, the participant was instructed to stabilize his or her occlusion in the MI position, and for the second scan, the participant was instructed to open his or her mouth so that the operator could adjust the deprogramming device in the region of the maxillary central incisors. Primary reconstructions of the images were immediately performed by software (QRNNT v2.00; Quantitative Radiology srl), which was coupled to the gantry tomography machine.

Image selection and measurements

After the same methodological sequence was used to scan the left and right TMJs in the CR and MI positions for each participant, the radiologist acquired lateral and frontal sections to obtain secondary reconstructions. Four lateral image slices and 4 frontal image slices were selected for each participant: right lateral MI, right lateral CR, left lateral MI, left lateral CR, right frontal MI, right frontal CR, left frontal MI, and left frontal CR.

The distance between the condyle and mandibular fossa was measured with software (Basic 3G; Quantitative Radiology srl) coupled to the gantry tomography unit. The same radiologist performed all measurements. For the 4 lateral images, measurements were made as shown in Figure 1. Reference line 1 was placed tangentially to the lowest posterior and anterior extremities of the mandibular fossa. Reference line 2 was placed over

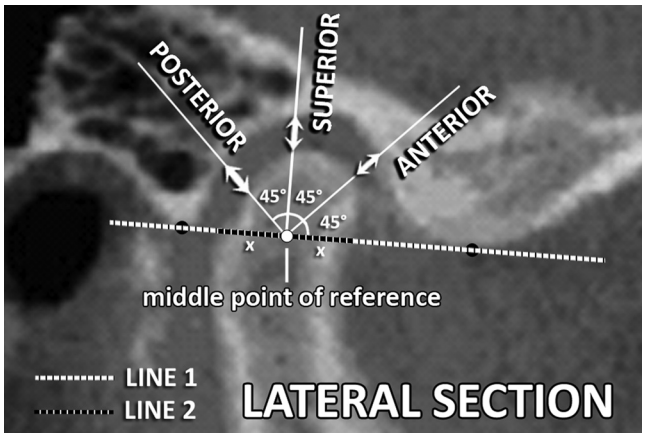

Figure 1. Superior, posterior, and anterior distances to condyle-fossa measured on lateral images.

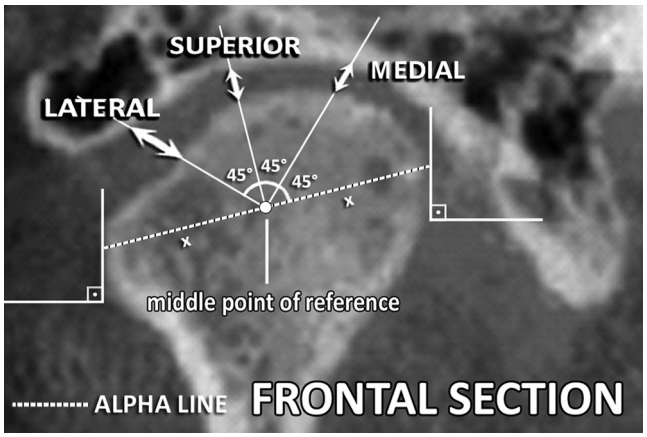

Figure 2. Superior, lateral, and medial distances to condyle-fossa measured on frontal images.

line 1 so that it covered the portion of line 1 that overlapped the condylar process. The halfway point of line 2 was termed the middle point of reference. The superior line was drawn from this point at an angle of 90 degrees to reference line 1, and the anterior and posterior lines were drawn from this point at an angle of 45 degrees to reference line 1 (Fig. 1). Three measurements were made from the image: distance between the outermost point of the condyle and the closest point of the mandibular fossa overlapping the superior line; the anterior line; and the posterior line (Fig. 1).

For the 4 frontal images, measurements were made as shown in Figure 2. The most medial and lateral points of the condylar process were connected to produce reference line alpha. The halfway point of this line was called the middle point of reference. The superior line was drawn from this point at an angle of 90 degrees to reference line alpha, and the medial and lateral lines were drawn from this point at an angle of 45 degrees to reference line alpha (Fig. 2). The superior, medial, and lateral measurements were obtained in the same manner as the superior, anterior, and posterior measurements in the lateral images (Figs. 1, 2).

Twenty days after the measurement session, and before the statistical analysis was performed, an intraexaminer reliability test was conducted. Ten participants and 2 variables were selected for the reliability analysis. Measurements did not differ from those performed in the primary measurement session, confirming the reliability of the results (measurement 1, P=.968; measurement 2, P=.991; intraclass correlation coefficient at P<.01).

Three measurements were made for each lateral image: superior, anterior, and posterior distances. These 3 measurements were made for images obtained in the CR position and for images obtained in the MI position and were compared between CR and MI positions by using the Mann-Whitney U test. These comparisons were performed separately for the left and right side (right lateral CR versus right lateral MI; left lateral CR versus left lateral MI) and separately for each group (symptomatic and asymptomatic). Similarly, 3 measurements were made for each frontal image: superior, medial, and lateral distances. These 3 measurements were made for images obtained in the CR position and

Table 1. Measurements obtained for symptomatic participants (n=20) in MI and CR positions

Measurement	Position	Mean (mm)	Standard Deviation (mm)	Mann-Whitney U Test	P[a]
Right lat post	MI	1.91	0.519	-1.629	.103
	CR	1.58	0.456		
Right lat sup	MI	2.38	0.652	-0.693	.489
	CR	2.27	0.600		
Right lat ant	MI	2.15	0.782	-0.109	.914
	CR	2.21	0.925		
Right front lat	MI	2.05	0.784	-0.948	.343
	CR	1.85	0.699		
Right front sup	MI	2.59	0.672	-1.906	.057
	CR	2.27	0.579		
Right front med	MI	2.57	0.903	-1.112	.266
	CR	2.27	0.884		
Left lat post	MI	1.85	0.670	-1.697	.090
	CR	1.48	0.544		
Left lat sup	MI	2.63	0.803	-0.625	.532
	CR	2.37	0.870		
Left lat ant	MI	1.79	0.993	-0.542	.588
	CR	1.89	0.902		
Left front lat	MI	2.38	0.944	-0.678	.498
	CR	2.22	0.902		
Left front sup	MI	2.63	0.905	-0.747	.455
	CR	2.46	0.818		
Left front med	MI	2.58	1.102	-0.976	.329
	CR	2.25	0.963		

ant, anterior; CR, centric relationship; lat, lateral; med, medial; MI, maximum intercuspation; sup, superior.
[a] P values are from Mann-Whitney U tests.

Table 2. Measurements obtained for asymptomatic participants (n=20) in MI and CR positions

Measurement	Position	Mean (mm)	Standard Deviation (mm)	Mann-Whitney *U* Test	*P*[a]
Right lat post	MI	1.87	0.512	-0.644	.644
	CR	1.89	0.684		
Right lat sup	MI	2.32	0.787	-0.734	.734
	CR	2.37	0.731		
Right lat ant	MI	1.92	0.935	-0.797	.797
	CR	1.98	0.808		
Right front lat	MI	2.09	0.900	-0.818	.818
	CR	2.16	0.925		
Right front sup	MI	2.47	0.838	-0.989	.989
	CR	2.51	0.930		
Right front med	MI	2.52	0.986	-0.607	.607
	CR	2.69	1.098		
Left lat post	MI	1.98	0.630	-0.447	.447
	CR	1.89	0.597		
Left lat sup	MI	2.57	0.811	-0.978	.978
	CR	2.56	0.806		
Left lat ant	MI	2.02	0.930	-0.694	.694
	CR	1.95	0.883		
Left front lat	MI	2.26	0.741	-0.968	.968
	CR	2.23	0.749		
Left front sup	MI	2.82	0.827	-0.828	.828
	CR	2.80	0.899		
Left front med	MI	2.84	0.915	-0.871	.871
	CR	2.84	0.956		

ant, anterior; CR, centric relationship; lat, lateral; med, medial; MI, maximum intercuspation; sup, superior.
[a]*P* values are from Mann-Whitney *U* tests.

Table 3. Measurements obtained for asymptomatic and symptomatic participants in maximum intercuspation position

Measurement	Group (*n*=20/group)	Mean (mm)	Standard Deviation (mm)	Mann-Whitney *U* Test	*P*[a]
Right lat post	Symp	1.91	0.519	-0.947	.343
	Asymp	1.87	0.512		
Right lat sup	Symp	2.38	0.652	-0.872	.383
	Asymp	1.91	0.935		
Right lat ant	Symp	2.15	0.782	-1.192	.233
	Asymp	2.31	0.786		
Right front lat	Symp	2.05	0.784	-0.115	.908
	Asymp	2.09	0.900		
Right front sup	Symp	2.59	0.672	-0.190	.849
	Asymp	2.47	0.838		
Right front med	Symp	2.57	0.903	-0.765	.444
	Asymp	2.52	0.986		
Left lat post	Symp	1.85	0.670	-0.815	.415
	Asymp	1.98	0.629		
Left lat sup	Symp	2.63	0.803	-0.928	.353
	Asymp	2.01	0.930		
Left lat ant	Symp	1.79	0.993	-0.612	.541
	Asymp	2.56	0.811		
Left front lat	Symp	2.38	0.944	-0.399	.690
	Asymp	2.26	0.741		
Left front sup	Symp	2.63	0.905	-0.342	.732
	Asymp	2.82	0.827		
Left front med	Symp	2.58	1.102	-0.928	.354
	Asymp	2.84	0.915		

Asymp, asymptomatic; ant, anterior; lat, lateral; med, medial; sup, superior; Symp, symptomatic.
[a]*P* values are from Mann-Whitney *U* test.

for images obtained in the MI position and were compared between CR and MI positions by using the Mann-Whitney *U* test. In addition to within-group comparisons between the CR and MI positions, each of the 24 variables (3 measurements for lateral images in CR and MI and 3 measurements for frontal images in CR and MI on the left and the right side) was compared between symptomatic and asymptomatic volunteers, using the Mann-Whitney *U* test (α=.05). A nonparametric statistical test was used because the distribution of the scores did not present the normal distribution pattern.

RESULTS

According to the RDC for TMD, 100% of participants in the symptomatic group showed displacement of the articular disk, 40% had associated muscle disorder, and 25% had concomitant arthralgia. For each volunteer, 12 comparisons were made between CR and MI, giving 240 pairwise comparisons across the 2 groups. Of the 240 comparisons between MI and CR performed in the symptomatic and asymptomatic groups, 83.4% and 85.0% of the measures, respectively, were different for a given individual. However, when the measurements were statistically compared between MI and CR, no differences (all *P*>.05) were found in the symptomatic group (Table 1) or asymptomatic group (Table 2). Also, no significant differences were found between the symptomatic and asymptomatic participants in any measure in the MI (Table 3) or in the CR (Table 4) position (all *P*>.05).

DISCUSSION

In this study, most measures were different between MI and CR. These results corroborated those of several authors who have reported discrepancies between MI and CR positions,[6,10-12] including 1 study that found discrepancies in greater than 90% of individuals.[6] However, these differences were not statistically significant in either frontal or lateral plane images (Tables 1, 2). The condylemandibular fossa relationship was also not significantly different between groups (Tables 3, 4), contradicting the existing literature.[6,10-12,16,17]

These differences may have been a result of the increased accuracy of the imaging method used in this study compared with those of other methodologies. Previous studies using articulators,[2,6,7,11,13] which ignore the presence and anatomic variability of existing soft tissue in the TMJ, have shown a low level of

Table 4. Measurements obtained for asymptomatic and symptomatic participants in centric relationship position

Measurement	Group (*n*=20/group)	Mean (mm)	Standard Deviation (mm)	Mann-Whitney *U* Test	*P*[a]
Right lat post	Symp	1.58	0.456	-1.399	.162
	Asymp	1.89	0.684		
Right lat sup	Symp	2.27	0.600	-0.380	.704
	Asymp	1.98	0.808		
Right lat ant	Symp	2.21	0.925	-0.928	.354
	Asymp	2.36	0.731		
Right front lat	Symp	1.85	0.699	-1.170	.242
	Asymp	2.15	0.925		
Right front sup	Symp	2.27	0.579	-0.606	.544
	Asymp	2.51	0.930		
Right front med	Symp	2.27	0.884	-1.221	.222
	Asymp	2.69	1.097		
Left lat post	Symp	1.48	0.544	-1.952	.051
	Asymp	1.89	0.597		
Left lat sup	Symp	2.37	0.870	-0.488	.626
	Asymp	1.95	0.882		
Left lat ant	Symp	1.89	0.902	-0.373	.709
	Asymp	2.55	0.805		
Left front lat	Symp	2.22	0.902	-0.164	.870
	Asymp	2.23	0.749		
Left front sup	Symp	2.46	0.818	-0.993	.321
	Asymp	2.80	0.899		
Left front med	Symp	2.25	0.963	-1.797	.072
	Asymp	2.84	0.956		

Asymp, asymptomatic; ant, anterior; lat, lateral; med, medial; sup, superior; Symp, symptomatic.
[a]*P* values are from Mann-Whitney *U* test.

reproducibility for the measurement of the condyle-mandibular fossa mandibular relationship.[3,6,8] Similarly, studies that have used radiographs[1,4,20] usually show images under varying degrees of magnification and are restricted to a 2-dimensional plane.[27] Alternatively, the differences may be due to differences in the study sample. We studied adults aged 18 to 25 years with all their permanent teeth present in the oral cavity (except third molars). By contrast, some other studies have been conducted without considering the age of participants and have included participants with several missing teeth in their samples.[16] It is possible that because our participants were young individuals with intact dentition, they had not had enough time to develop significant changes in the spatial condyle-mandibular fossa relationship.

Although some authors believe that the altered position of the condyles is a triggering factor for TMDs,[16-18] a spatial change in the condyle-mandibular fossa relationship is not a prerequisite for TMD.[19-22] According to previous work,[14] there seems to be a spectrum of normal variations in the condylar position, characterized by individual adaptive capacity.

According to the RDC, all volunteers in the symptomatic group had disk displacement. Because of this, we hypothesized that the condyles would be positioned higher and more posteriorly in volunteers with anterior disk displacement and asymmetrically in volunteers with medial deviation. Our results did not support these hypotheses, which is in agreement with recent studies[19,22] in which the condylar position did not predict a diagnosis of a TMD, possibly because of the high interindividual variability.[19,20] Another aspect to be considered is the fact that in adult individuals, spatial changes that have occurred have had enough time for the occurrence of compensatory mechanisms of craniofacial growth that can normalize the condyle-mandibular fossa relationship.

If subsequent work confirms our finding that changes in condylar positioning and TMD are not necessarily interdependent, there is the need to question 2 aspects of TMD treatment: 1 involving the diagnosis and the other the related therapeutic field. If it is not necessary to assess condylar position for a diagnosis of TMD, there is no longer an advantage to using CT relative to conventional imaging. From a therapeutic standpoint, these results could lead to a reduction in the use of devices for condylar repositioning in individuals with TMD.

CONCLUSIONS

According to our results, the condyle-mandibular fossa relationship in young adults was similar in the CR and MI positions when evaluated by CBCT. The presence or absence of TMD was not associated with the position of the condyles in the TMJs.

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