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Anteroposterior condylar position: A comparative study between subjects with normal occlusion and patients with Class I, Class II Division 1, and Class III malocclusions

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Background: The present study aimed to determine and compare the anteroposterior position of the condyle in the mandibular fossa between groups of asymptomatic subjects with normal occlusion and asymptomatic subjects with Class I, Class II Division 1, and Class III malocclusions.

Material/Methods: Thirty persons with normal occlusion, 30 with Class I malocclusion, 30 with Class II Division 1, and 30 with Class III had computed tomography scans of their temporomandibular joints. The anterior joint space/posterior joint space (AJS/PJS) ratio was determined for the right and left joints. The paired t test was used to analyze the AJS/PJS ratio between both sides for each group. The ANOVA test was applied to verify the differences between the groups for the measurements of the right and left sides. In case the ANOVA test confirmed significance, the Dunnett's t test was performed to compare the groups of malocclusion with that of normal occlusion.

Results: The paired t test between the AJS/PJS relationships in the right and left sides showed the following p values: Class I (0.168), Class II Division 1 (0.662), Class III (0.991), and normal occlusion (0.390). The ANOVA test showed a p value of 0.445 for the comparisons of the right side and 0.040 for the left side. The Dunnett's t test demonstrated a statistically significant difference between the Class II group and the normal occlusion group (p value of 0.026) in the joints of the left side.

Conclusions: Bilateral symmetry and lack of condyle centralization were common characteristics among all groups. The greatest condylar decentralization was observed in the Class II group, whereas the least condylar decentralization was found in the normal occlusion group.

Key words: **temporomandibular joint • computed tomography • morphology**

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Background

Between 1960 and 1990, several studies evaluated the relationship between the shape and function of the temporomandibular joints (TMJs) and concluded that they were intimately related; therefore, eventual functional loads applied to them exert considerable influence on their morphology. However, the role of occlusion on articular morphology is still not completely elucidated [1–3]. Katsavrias and Halazonetis [3] suggested that both the condyle and the mandibular fossa differ in shape among patients with various types of malocclusion. Several studies showed a significant relationship between occlusal factors and joint morphology [1,2,4,5] whereas others failed to demonstrate a correlation [6–8]. Burley [6] evaluated the TMJ structures in Class I, Class II, and Class III malocclusions and showed that these malocclusions do not produce functional stimuli capable of altering the contour of the anterior wall of the mandibular fossa. Pullinger et al. [9] did not find a concentric position of the mandibular condyles in Class II malocclusion.

Most of these pioneer studies used conventional radiographic examination, which have limited ability to accurately demonstrate the anatomic characteristics of TMJs. This is because the TMJ is a small joint with complex morphology and is surrounded by osseous tissues that produce superimposition of images, particularly the petrous region of the temporal bone, the mastoid process, and the articular eminence [10,11]. The development of computed tomography (CT) techniques has improved the diagnosis of TMJ pathologies because it is an accurate, efficient, noninvasive, and fast diagnostic procedure. This is the method of choice for obtaining images of bone structures [12]. The use of CT scans in TMJ studies allows real and precise measurements of the structures under analysis [13].

Some CT studies were performed with the purpose of evaluating the symmetry between the condyles and to compare the condyle-fossa relationship between the right and left sides in samples with specific types of malocclusion [14–18]. In a sample of normal occlusion, Vitral et al. [14] demonstrated that the largest mediolateral diameter of the mandibular condylar processes and the posterior joint spaces showed a statistically significant difference between the right and left sides. In the Class I group, Rodrigues et al. [15] found that only the posterior articular space had a statistically significant difference between the right and left sides. There was a higher mean for posterior articular space on the right temporomandibular joint. In the Class II Division 1 malocclusion sample, the distance of condylar process/midsagittal plane and posterior articular space showed a significant difference between the right and left sides [16]. In the Class III and Class II subdivision samples [16–18] there was no significant difference between both sides.

One important conclusion that can be drawn from those studies is that in all samples the evaluation of the concentric position of the condyles in their respective mandibular fossae showed a non-centralized position for the right and left sides, demonstrating a statistically significant anteriorly positioned condyle [14–16,18]. Although recent papers have demonstrated that condylar centralization is not observed in most samples studied, a matter not yet completely resolved is whether this condylar positioning differs between groups with different occlusal characteristics. A correct comparison of the condylar centralization in the articular fossa between distinct groups should use a relative or proportional measurement, which is the ratio between the anterior and the posterior joint spaces.

A representative number of studies concerning the adequate condyle-fossa relationship have been published and some researchers stated that there was a direct relationship between internal derangements of the TMJ and condylar position [19–22]. Studies on the ideal position of the condyles have suggested that the healthiest condyle-fossa relationship is that in which the condyle is centralized anteroposteriorly in the mandibular fossa [23–26]. Most of these studies were carried out at a time in which CT scans were not yet available. In addition, there was no specific analysis of the relationship between the variables, symptomatology, occlusion, and condylar position.

The present study aimed, therefore, to determine and compare the position of the condyle in the mandibular fossa between asymptomatic subjects with normal occlusion and asymptomatic subjects with Class I, Class II Division 1, and Class III malocclusions.

Material and Methods

The present study included CT scans of the TMJs of 30 persons with normal occlusion, 30 with Class I, 30 with Class II Division 1, and 30 with Class III malocclusion. The participants of the sample were selected among individuals who sought dental treatment involving images of the craniofacial region. The study was been approved by the Federal University of Juiz de Fora, Human Research Ethics Committee. Exam results are available at the archives of the Department of Orthodontics of the Federal University of Juiz de Fora

All participants met the following requirements: all permanent teeth erupted, except third molars; and no functional mandibular deviations, crossbites (except for the Class III sample), open bites, evident facial asymmetry, or symptoms of temporomandibular disorders.

In the normal occlusion group, the following additional requirements were included: first molars and canines in Class

Figure 1. CT image: ajs (anterior joint space), pjs (posterior joint space).

I relationship, canine guidance without working or nonworking side interferences on lateral excursions, anterior guidance with no posterior interferences, normal overbite and overjet, and no crossbite.

The CT images were obtained with the patients in maximum dental intercuspation and their heads were positioned so that the Frankfort and midsagittal planes were perpendicular to the floor. The helicoidal/multislice CT was performed with a Somatom Spirit device (Siemens, Xangai, China) at 120 kV and 160 mA. We obtained 1-mm thick slices spaced at 1 mm intervals, using the helicoidal technique. Because this procedure provides images on the axial plane, it was reformatted to produce images sagittally. The selected imaging slices were processed with the same equipment.

The following measurements were assessed on the sagittal plane:

1. Anterior joint space: expressed by the shortest distance between the most anterior point of the condyle and the posterior wall of the articular tubercle (Figure 1, ajs).
2. Posterior joint space: represented by the shortest distance between the most posterior point of the condyle and the posterior wall of the mandibular fossa (Figure 1, pjs).

Statistical analysis

For the subjects of the 4 groups, the anterior/posterior (A/P) joint space ratio was calculated by dividing the anterior joint space by the posterior joint space. An A/P ratio of 1.0 indicated a concentric condyle. An A/P ratio of greater than 1.0 represented a posterior condylar position, whereas an A/P ratio of less than 1.0 represented an anteriorly displaced condyle. The further the value from 1, the greater the decentralization of the condyle in the mandibular fossa.

The following tests were applied:

1. Paired t test for the relationships between the right and left sides for each group.

2. ANOVA test between the measurements of the right side for all groups and also between the measurements of the left side for all groups. In case of statistically significant difference, the Dunnett's t test was applied, which treated normal occlusion as the control, and compared all other groups against it.

Results

Table 1 shows the mean and standard deviation for the AJS/PJS relationships of each group for the right and left TMJs, as well as the result of the paired t test between the AJS/PJS relationships of the right and left sides for the normal occlusion (p value 0.390), Class I (p value 0.168), Class II, Division 1 (p value 0.662) and Class III (p value 0.991) groups

Table 2 shows the result of the ANOVA test with p value of 0.445 for the comparisons of the right side and p value of 0.040 for the left side. The Dunnett's t test was performed and a statistically significant difference was found, on the left side, between the Class II group and the normal occlusion group (p value 0.026)

Discussion

The morphology and relationship of TMJ structures in different occlusal conditions, as well as the role of condylar position on TMJ internal derangements have been studied during the last decades [1–4,8,19–25,] but several questions are yet to be completely elucidated and findings from various studies are contradictory.

As for the analysis of the condyle position within the articular fossa, and thus evaluating condylar centralization, the resulting images from the CT scans were reformatted sagittally. Since CT scans allow the acquisition of different cutting planes, the one that showed the greatest anteroposterior diameter of the condylar processes was selected.

In the studies mentioned previously [14–18] in which the same technique for image acquisition was used, it can be noted that the evaluation of the anteroposterior position of the condyles in the different groups was made through the comparison between absolute measurements of the anterior and posterior joint spaces and was expressed in millimeters. However, for an adequate comparison to be made, condylar centralization in the mandibular fossa between the right and left sides or between distinct groups should be evaluated by means of a proportionality ratio between the posterior and anterior joint spaces, instead of simple linear measurements.

Table 1. Mean and standard deviation for the AJS/PJS relationships for the right and left TMJs and the comparisons between sides.

	Right side (AJS/PJS)		Left side (AJS/PJS)		P value*
	Mean	SD	Mean	SD	
Normal occlusion	.770	.504	.860	.492	.390
Class I malocclusion	.721	.353	.809	.411	.168
Class II Division 1 malocclusion	.613	.324	.581	.375	.662
Class III malocclusion	.660	.326	.660	.252	.991

* Paired t test.

Table 2. ANOVA test between the right and left sides for all groups and the Dunnett's t-test comparing all malocclusion groups against normal occlusion group.

	ANOVA	Comparison with normal occlusion group*		
		Class I malocclusion	Class II Division 1 malocclusion	Class III malocclusion
Right side	0.445	0.936	0.290	0.720
Left side	0.040	0.936	0.026	0.277

* Dunnett t-tests treat normal occlusion as a control, and compare all other groups against it.

By analyzing the AJS/PJS ratio, it can be observed that condylar decentralization has occurred in both the right and left TMJs in all groups, showing an anterior joint space smaller than the posterior joint space. However, there was no statistically significant difference between the sides for the paired t test, what suggests anteroposterior condylar symmetry in the normal occlusion and malocclusion samples.

The lack of centralization of the condylar processes has been reported in both normal occlusion and malocclusion samples in CT studies [14–18], which is in agreement with the results obtained in this study, despite the different mathematical criteria used for such determination. From the results obtained, it is possible to verify that the use of simple morphologic criteria for classifying malocclusions does not seem to influence the sagittal relationship of the condyle in the mandibular fossa. Similar results were found by Ikeda and Kawamura [27] in patients with optimal joints without displacement using cone beam computed tomography.

In the present study, an increasing decentralization can be noted in the following order when groups are compared: normal occlusion (right AJS/PJS 0.770, left AJS/PJS 0.860), Class I (right AJS/PJS 0.721, left AJS/PJS 0.809), Class III (right AJS/PJS 0.660, left AJS/PJS 0.660), and Class II Division 1 (right AJS/PJS 0.613, left AJS/PJS 0.581). In spite of that, the ANOVA and Dunnett's t test did not show statistically significant differences between the groups of malocclusions and the normal occlusion group in the right TMJs. In the left side, a significant

difference was found only between the normal occlusion and the Class II groups, which showed the least and the greatest decentralization, respectively.

Most previous observations were of morphological character. From a clinical standpoint, it appears that, contrary to what was observed in the results of studies conducted in the 1970's and 1980's [23–26], centralization of the condyles was not a characteristic found in the asymptomatic samples of this study. Such a finding is probably due to the different image acquisition techniques that were used, and the arbitrarily selected amplitude of variation accepted for a condyle to be considered centralized in those studies. Modern CT techniques allow precise and reliable evaluation of condylar position. Even more important than condylar centralization, symmetric condylar relationships, as shown in Table 1, may play a relevant role in the articular balance and, consequently, in the absence of TMD [28,29]. In all groups evaluated in this study, in both normal occlusion and malocclusion samples, a symmetrical condylar relationship was a common characteristic when the right and left sides were compared.

Conclusions

1. The lack of centralization of the condylar processes in their respective mandibular fossae was a common characteristic in the asymptomatic normal occlusion group, as well as in all asymptomatic malocclusion groups. A statistically significant

- difference was found in the left TMJs between the normal occlusion group and the Class II Division 1 group.
- The greatest condylar decentralization was observed in the Class II group.
 - The normal occlusion group showed the least condylar decentralization.

- There was no statistically significant difference between the sides for the paired t test, which suggests bilateral condylar symmetry in the normal occlusion and malocclusion samples.

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