Original Article

Three-dimensional positional assessment of glenoid fossae and mandibular condyles in patients with Class II subdivision malocclusion

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ABSTRACT

Objectives: To test the null hypotheses that the positions of the glenoid fossae and mandibular condyles are identical on the Class I and Class II sides of patients with Class II subdivision malocclusion.

Materials and Methods: Retrospective three-dimensional (3D) assessments of the positions of the glenoid fossae and mandibular condyles were made in patients with Class II malocclusion. Relative to a fiducial reference at the anterior cranial base, distances from the glenoid fossae and condyles were calculated in pretreatment cone beam computed tomographic scans of 82 patients: 41 with Class II and 41 with Class II subdivision malocclusions. The 3D distances from glenoid fossae to sella turcica in the X (right-left), Y (anterior-posterior), Z (inferior-superior) projections were calculated.

Results: Patients with Class II malocclusion displayed a symmetric position of the glenoid fossae and condyles with no statistically significant differences between sides ($P > .05$), whereas patients with Class II subdivision showed asymmetry in the distance between the glenoid fossae and anterior cranial base or sella turcica ($P < .05$), with distally and laterally positioned glenoid fossae on the Class II side. ($P < .05$). Male patients had greater distances between glenoid fossae and anterior cranial fossae ($P < .05$). The condylar position relative to the glenoid fossae did not differ between the two malocclusion groups nor between males and females ($P > .05$).

Conclusions: The null hypotheses were rejected. Patients with Class II subdivision malocclusion displayed asymmetrically positioned right- and left-side glenoid fossae, with a distally and laterally positioned Class II side, although the condyles were symmetrically positioned within the glenoid fossae. (*Angle Orthod.* 2017;87:847–854.)

KEY WORDS: Angle Class II malocclusion; Temporomandibular joint; Class II subdivision

INTRODUCTION

The distal positions of the glenoid fossa relative to the cranial base and of condyles in glenoid fossae have been associated with the etiology of Class II malocclusion.[1,2] However, in asymmetric cases such as those of Class II subdivision, it remains unclear how the temporomandibular joint's (TMJ) anatomic position influences the occlusal pattern. Early investigations into the dentoskeletal components of Class II subdivision, typically based on two-dimensional (2D) images, detected no association between clinically visualized occlusal asymmetry and skeletal abnormalities.[3–6] Accordingly, dentoalveolar changes were associated with the etiology of a Class II subdivision malocclusion;

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however, despite their historic importance, 2D exams have inherent limitations of reliability.[7,8]

Research has shown that to evaluate facial skeletal asymmetries, three-dimensional (3D) imaging is mandatory.[9] Indeed, with the increased use of cone beam computed tomography (CBCT), studies have found results contrasting those of previous 2D investigations. Recent 3D evidence has shown that a Class II subdivision malocclusion might be associated not only with asymmetric occlusal pattern but also with skeletal components,[9–11] and 3D studies show great potential to aid in the visualization of the skull and TMJ structures.[9–12] Minich et al.[10] compared Class II subdivision patients with Class I controls, and although they found significant skeletal and occlusal differences between the groups, dental components contributed to two-thirds of all asymmetry. Li et al.,[11] who also compared Class II subdivision and Class I malocclusions, showed that asymmetric patterns contributed majorly to the distal positioning of glenoid fossae.

Given the challenge of treating Class II subdivision patients, primarily because the diagnosis of asymmetry is frequently difficult based on clinical examination alone, studies that can provide clinicians with epidemiological data about the components of Class II subdivision are necessary. However, previous reports on the topic remain contradictory, and evidence about changes in the position of glenoid fossae is lacking. At present, the literature also reveals a gap in the comparison between Class II subdivision and Class II patients themselves. Improvements in the diagnosis of the position and morphology of TMJ structures can help achieve more accurate orthodontic diagnoses and increase the effectiveness of treatment.[2,10,13]

Therefore, the aim of this retrospective CBCT investigation was to evaluate patients with Class II subdivision and skeletal Class II malocclusion with mandibular deficiencies based on facial analysis. The null hypothesis was that the position of glenoid fossae and condyles is identical between the Class I and II sides of patients with Class II subdivision.

MATERIALS AND METHODS

The Institutional Review Board at the Pontifical Catholic University of Minas Gerais approved this retrospective study based on pretreatment orthodontic records. Based on the standard deviation of 2.149 mm reported by Li et al.[11] for the primary outcome of the current research (ie, sagittal position of the glenoid fossa), an alpha significance level of 0.05 and a power of 0.80 to detect differences between groups greater than 1.3 mm, a sample size of 41 patients per group was adopted. The sample consisted of 82 orthodontic patients (49 male and 33 female), all aged 12 to 17 years.

A total of 41 patients presented with Class II subdivision malocclusion (C2SD), and 41 with Angle Class II malocclusion (C2). Inclusion criteria were permanent dentition, presence of Class II subdivision malocclusion (ie, in the C2SD group), or Angle Class II (ie, in the C2 group), and the availability of CBCT scans at the beginning of orthodontic treatment. Patients with syndromes, dentofacial deformities, temporomandibular disorders, or histories of orthodontic treatment were excluded.

All C2SD patients and 19 of the C2 patients had CBCT performed as a component of pretreatment records at Case Western Reserve University, Cleveland, Ohio (CB MercuRay, Hitachi Medical Systems America Co., Twinsburg, Ohio), and 22 C2 patients had CBCT scans acquired as part of the pretreatment routine of orthodontic record taking at Pontifical Catholic University of Minas Gerais, Belo Horizonte, Brazil (i-CAT, Imaging Sciences International, Hartfield, Pa). Images with the CB MercuRay were taken with a field of view of 20.3 cm, 0.37 mm voxel size, and custom settings of 2mA, 120 kVp, and a 9.5-second exposure. The i-CAT images were taken with a field of view of 17 $\times$ 22 cm, 0.3 mm voxel dimension, 5mA, 120 kV, and 40 seconds of exposure. All patients were instructed to bite into maximum intercuspation during scan capture.

Measurement

Tomographic images were processed using Dolphin Imaging software version 11.7 (Dolphin Imaging & Management Solutions, Chatsworth, Calif). Before measurements, patients' heads were oriented along three planes of space so that measurements could be taken with all patients in the same position according to previously reported criteria.[14]

Angular and linear measurements were assessed using a voxel dimension of 1 mm to ensure better sharpness and standardization. From the topographic sagittal view, a modification of the fiduciary cranial base reference point of the fronto-maxillo-nasal (FMN) suture, located as described for 2D cephalometry,[2,15] was selected for measuring the spatial relationships of the TMJ. From the sagittal view of the FMN point, a vertical reference line was drawn that, from a 3D perspective, defined the coronal plane tangent to the FMN point dubbed the *stable plane* (Figure 1).

The selection of the standardized axial cross-section was based on the first section of the mandibular condyle, from top to bottom, which included the largest medial–lateral condylar measurement. Cross-sections were selected independently for the left and right sides

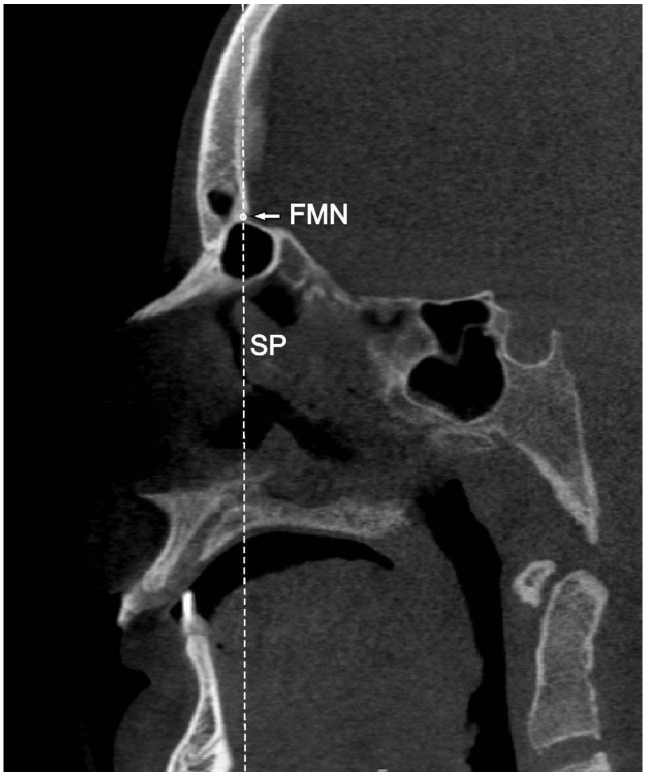

Figure 1. Identification of the stable plane (SP). A vertical dashed line tangent to the front–maxillo–nasal point is drawn. In a three-dimensional perspective, the coronal plane is tangent to SP. The straight line is the axial plane perpendicular to the SP.

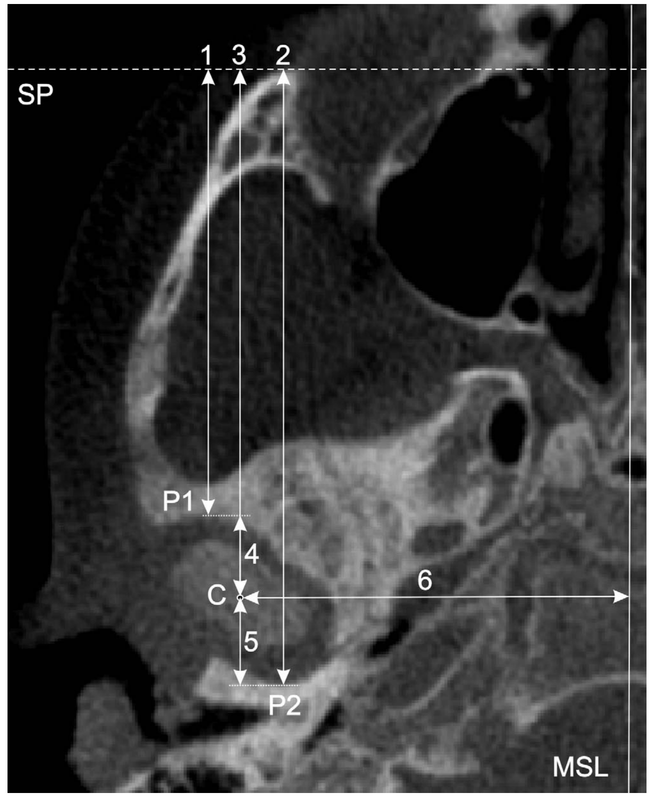

Figure 2. Landmarks and measures. (1) P1 to front–maxillo–nasal; (2) P2 to front–maxillo–nasal; (3) C to front–maxillo–nasal; (4) C to P1; (5) C to P2; (6) C to mid-sagittal line (MSL).

(Figure 2). In the axial sections, three landmarks (P1, P2, and C) were marked. P1 was located in the most anterior internal contour of the glenoid fossa anterior wall; P2 was located in the most posterior internal contour of the glenoid fossa posterior wall; and C was the geometric center of the condyle. From the three landmarks, orthogonal linear measurements were taken relative to the stable plane and mid-sagittal line (MSL), both on the right and left sides of all patients.

From the axial view, the coronal plane was positioned tangentially to the geometric center of the right and left condyles. From coronal views, the angular inclinations of the right and left glenoid fossae (A1) were calculated using the line constructed from the most medial and lateral poles of the fossae walls and the axial plane tangentially to the most superior aspect of the glenoid fossae (Figure 3).

To assess the 3D spatial position of the glenoid fossae, the anterior wall of sella turcica was designated as the intersection of all three Cartesian planes and given a 0.0.0. coordinate. Coordinates for the most superior point of the glenoid fossae were extracted to assess X (right–left), Y (anterior–posterior), Z (superior–inferior), and 3D Euclidean displacement relative to sella turcica.

Statistical Analysis

The reliability of measurements (ie, intraexaminer repeatability and interexaminer reproducibility) was tested with the intraclass correlation coefficient. For all linear and angular measurements, intraexaminer intraclass correlation coefficient was calculated with the remeasurement of 42 randomly chosen individuals

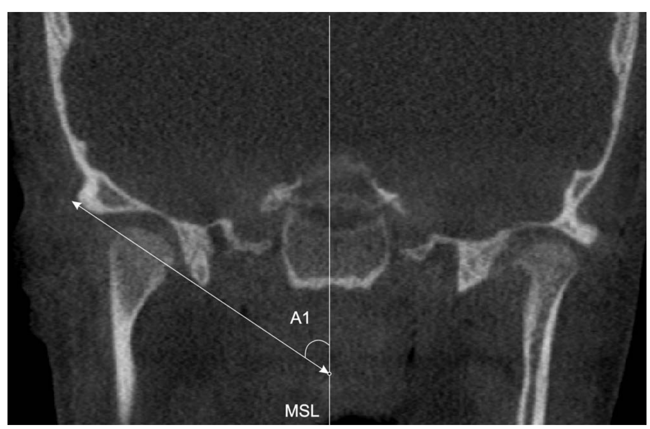

Figure 3. Glenoid fossa angulation relative to the mid-sagittal line. The tangent lines to the medial and lateral walls of the glenoid fossa form the angle of the glenoid fossa (A1) relative to the mid-sagittal line (MSL).

Table 1. Gender Comparison of the Temporomandibular Joint Position of Class II Subdivision Patients[a]

	Right Side					Left Side				
	Male		Female			Male		Female		
Measurement	Mean	SD	Mean	SD	*P* Value	Mean	SD	Mean	SD	*P* Value
P1-SP	53.3	5.2	50.2	3.2	.035*	53.7	5.2	50.9	3.6	.006*
P2-SP	69.3	5.4	65	8.1	.046*	70.5	5.3	66.9	3.4	.002*
C-SP	61.2	5.1	58.4	3.5	.032*	62.6	5.2	59.8	3.8	.036*
C-P1	8.3	1.3	8.2	1.2	.673	8.1	1.4	8.1	1.4	.960
C-P2	7.9	1.1	8.3	1.2	.319	7.9	1	7.4	1.4	.170
C-MSL	48.5	2.6	45.9	3.1	.006*	48.4	3.3	46.3	1.9	.017*
A1	19.5	4.2	19.3	4.1	.851	20	3.7	19	2.9	.365

[a] SD indicates standard deviation.
asterisks indicates statistical difference between groups

after a 2-week interval. Interexaminer agreement was confirmed with the remeasurement of 20 individuals. Descriptive statistics, including means, standard deviations, and medians, were calculated for all variables. The chi-square test was used to assess gender differences in both groups. For quantitative analysis, assumptions of normality and homoscedasticity were confirmed using the Kolmogorov–Smirnov and Levene statistical tests, respectively.

Paired *t*-tests were used to compare Class I and Class II sides of C2SD and the right and left sides of C2 patients, whereas an independent *t*-test was used to compare the position of the glenoid fossae between groups (C2SD and C2). Analysis was performed using the Statistical Package for the Social Sciences version 16.0 (SPSS Inc, Chicago, Ill), for which the level of significance was set at 5%.

RESULTS

High agreement (intraclass correlation coefficient $\geq$ 0.8) was found for all measures. The distribution of males and females in the sample was similar in all groups ($P = .822$, chi-square). An overall greater absolute distance between the glenoid fossae and the anterior cranial base or sella turcica was found in the males, although the condyles were centrally positioned in the glenoid fossae in both genders.

In both the C2SD (Table 1) and C2 groups (Table 2), statistically significant gender differences were found regarding the distance from the glenoid fossae to the anterior cranial base as well as from the condyles to the anterior cranial base. Glenoid fossae in the males were more distally and laterally positioned relative to the fiduciary anterior cranial base reference because the cranial base dimensions were greater in the males than in the females. However, condyles were symmetrically positioned within the right and left glenoid fossae in both the males and females (Tables 1 and 2).

Symmetry in the position of the glenoid fossae was found in patients with Class II malocclusion, but not in those with Class II subdivision malocclusion, both relative to the FMN and to the sella turcica. Those with Class II malocclusion showed a symmetric spatial positioning of the right and left sides and the glenoid fossae and mandibular condyles. No statistically significant difference ($P > .05$) was found between the right and left sides of patients in the C2 group (Table 3). However, patients in the C2SD group (Figure 4 and Table 4) exhibited glenoid fossae on the Class II side that were more distally and laterally positioned than those on the Class I side (*P* value ranging from .003 to .046), suggesting an asymmetric condyle–fossa–cranial base relationship. No positional differences of the Class I side in patients in the C2SD group

Table 2. Gender Comparison of the Temporomandibular Joint Position of Class II Patients[a]

	Right Side					Left Side				
	Male		Female			Male		Female		
Measurement	Mean	SD	Mean	SD	*P* Value	Mean	SD	Mean	SD	*P* Value
P1-SP	51	4.8	47.3	4.1	.014*	51.9	5.1	47.6	4.8	.010*
P2-SP	65.9	5.6	61.9	4.7	.016*	67.2	5.4	62.9	5.2	.015*
C-SP	58.9	5.3	54.3	4.2	.006*	59.9	4.9	54.3	5.9	.002*
C-P1	7.9	1.1	7.3	1.3	.093	7.6	1.1	7	1.1	.086
C-P2	7.9	1.3	7.3	1.6	.217	7.7	1.5	7.2	1.3	.289
C-MSL	49.1	2.4	47.1	3.9	.031*	48.3	2.5	46.8	2.1	.047*
A1	17.7	3.8	16.9	3.9	.491	18.9	3.1	17.7	4.3	.347

[a] SD indicates standard deviation.
asterisks indicates statistical difference between groups

Table 3. Comparison of the Right and Left Sides of the Temporomandibular Joint Position of Class II Patients, According to Gender[a]

	Male					Female				
	Right		Left			Right		Left		
Measurement	Mean	SD	Mean	SD	*P* Value	Mean	SD	Mean	SD	*P* Value
P1-SP	51	4.8	51.9	5.1	.413	47.3	4.1	47.6	4.8	.761
P2-SP	65.9	5.6	67.2	5.4	.287	61.9	4.7	62.9	5.2	.363
C-SP	58.9	5.3	59.9	4.9	.377	54.3	4.2	54.3	5.9	.999
C-P1	7.9	1.1	7.6	1.1	.220	7.3	1.3	7	1.1	.262
C-P2	7.9	1.3	7.7	1.5	.520	7.3	1.6	7.2	1.3	.756
C-MSL	49.1	2.4	48.3	2.5	.200	47.1	3.9	46.8	2.1	.665
A1	17.7	3.8	18.9	3.1	.121	16.9	3.9	17.7	4.3	.380

[a] SD indicates standard deviation.
asterisks indicates statistical difference between groups

or on either side in patients in the C2 group were found (Table 5). Nevertheless, the glenoid fossae were significantly more distally positioned (*P* value ranging from .005 to .024) on the Class II side of patients in the C2SD group relative to FMN (Table 6) when compared with both sides of patients in the C2 group. Relative to sella turcica, however, there were no statistically significant differences (*P* value ranging from .115 to .488 among all 3D components), despite the 0.8-mm more forward positioned glenoid fossa of the Class II side of C2SD patients in comparison with C2 individuals (Table 7).

DISCUSSION

Because the position of the mandible relative to the face is highly dependent on the position of glenoid fossae relative to the cranial base, investigations into the topic are necessary to understand the complex components of Class II subdivision skeletal patterns. Studies of mandibular morphology that do not consider the relationships among the condyle, fossa, and cranium cannot explain the complex relationship that culminates in dentofacial asymmetry.

Figure 4. Axial view of the cone beam computed tomography from a Class II subdivision patient showing the asymmetric position of the glenoid fossae relative to the anterior cranial fossa and the symmetric position of the condyles within the glenoid fossae.

Although pioneering 2D studies found that the primary etiological factor of Class II subdivision malocclusion was dental asymmetry without skeletal abnormalities,[4,5,13,16,17] recent 3D investigations have concluded that asymmetric mandibular length and glenoid fossae positioning relative to the cranial base might also contribute to unbalanced Class II malocclusion.[9,10,11] The current study corroborated the recent findings of Li et al.,[11] who reported right- and left-side differences in spatial positioning of glenoid fossae of patients with Class II subdivision malocclusion. Although they assessed the position of glenoid fossae in Class II subdivision in comparison with Class I patients, the present study is the first to have compared Class II subdivision with skeletal Class II patients.

The primary etiology of occlusal asymmetries is complex, and the literature offers no consensus about their exact cause.[10–12] Such uncertainty is of concern to clinicians because there is difficulty in diagnosing and treating patients with Class II subdivision malocclusion,

Table 4. Temporomandibular Joint Position of Class II Subdivision Male and Female Patients Comparing the Class I Side and Class II Side

	Class II Side		Class I Side			*P*
Measurement	Mean	SD	Mean	SD	Difference	Value
Male						
P1-SP	54.3	5.5	51.3	3.4	3.0	*.013**
P2-SP	69.7	5.8	66.1	5.4	3.6	*.003**
C-SP	61.7	5.5	60.1	3.8	1.6	*.046**
C-P1	8.4	1.0	7.6	1.4	0.5	.284
C-P2	7.6	1.0	8.4	1.5	0.8	.601
C-MSL	49.2	2.2	47.8	2.7	2.5	*.026**
Female						
P1-SP	49.9	3.7	47.4	2.4	2.5	*.024**
P2-SP	66.7	4.2	63.7	3.2	3.0	*.007**
C-SP	59.4	1.9	58	2	1.4	*.026**
C-P1	8.3	1	8.1	1.2	0.2	.581
C-P2	8.6	1.2	8.1	1.3	0.5	.402
C-MSL	45.8	3.1	45.9	3.7	−0.1	.756

[a] SD indicates standard deviation.
asterisks indicates statistical difference between groups

Table 5. Comparison Between Class II Group and Class I Side of Class II Subdivision Group[a]

	C2		Class I Side of C2SB			
Measurement	Mean	SD	Mean	SD	Difference	*P* Value
P1-SP	49.6	4.8	51.8	3.4	2.2	0.144
P2-SP	64.3	5.6	66.2	10	1.9	0.392
C-SP	57	5.3	60	3.3	2.9	0.078
C-P1	7.5	1.2	7.9	1.1	0.4	0.379
C-P2	7.6	1.4	8.2	1.3	0.6	0.215
C-MSL	48.1	3.1	46.7	3.3	1.4	0.187
A1	17.4	3.8	19.8	2.5	2.8	0.059

[a] C2 indicates Class II group; C2SB, Class II subdivision group; SD, standard deviation.
asterisks indicates statistical difference between groups

Table 6. Comparison Between Class II Group and Class II Side of Class II Subdivision Group[a]

	Angle Class II, C2		Class II Side, C2SB			
Measurement	Mean	SD	Mean	SD	Difference	*P* Value
P1-SP	49.6	4.8	52.7	5.3	3.1	.023*
P2-SP	64.3	5.6	68.6	5.4	4.3	.005*
C-SP	57.1	5.3	60.4	5.4	3.2	.024*
C-P1	7.5	1.2	8.4	1.3	0.86	.014*
C-P2	7.6	1.4	8	1.2	0.4	.348
C-MSL	48.1	3.1	48	3.1	0.1	.916
A1	17.4	3.8	19.9	4.2	2.5	.021*

[a] C2 indicates Class II group; C2SB, Class II subdivision group; SD, standard deviation.
asterisks indicates statistical difference between groups

particularly regarding the possibility of transforming the Class II side into a Class I relationship. If the concept of an asymmetric morphogenetic pattern offers a fatalistic explanation of the difficulty of performing treatments for a Class II subdivision,[3,9] then the fact that the origin of the problem in patients with an asymmetric occlusal relationship is the uneven sagittal positions of the glenoid fossae offers orthodontists mostly dentoalveolar therapeutic alternatives as compensation. The literature on the treatment of Class II subdivision malocclusion using dentofacial orthopedics is scarce. Bock et al.[18] presented the only functional appliance study on the treatment of asymmetric Class II patients and found, by means of study models, that asymmetric Herbst treatment demonstrated success that was similar to symmetric Class II Herbst treatment with respect to the occlusal correction. Aras and Pasaoglu[19] reported that patients with Class II subdivision malocclusion treated with a Forsus fatigue resistant device were corrected mainly by dentoalveolar changes, without significant skeletal modifications. In that light, the current findings point out a significant cranial base skeletal contribution to the development of Class II subdivision that, although consistent with other reports,[11,20] is beyond the therapeutic range of correction for orthodontists.

The present results also show that the Class II side in patients, especially males with Class II subdivision, is more laterally positioned relative to the MSL. It can therefore be inferred that Class II subdivision is associated with an axial rotation of the mandibular fossae, with a center of rotation on the Class I side and distalization of the fossa on the Class II side.

However, the current findings do not fully agree with those of other 2D studies.[4,5,13] Such differences might be a result of the limitations of 2D.[7,8,12] The difficulty of visualizing the TMJ in 2D exams derives from its complex anatomy and the overlap of adjacent structures. This may have contributed to differences between the current and previously reported results.[2,9,17] In contrast, CBCT images do not present such biases and allow the quantitative and qualitative assessment of bone in actual dimensions.[9,20,21] As such, 3D imaging has opened a new horizon in scientific fields, and new evidence to confirm previous reports or at least show that different ways of thinking are needed. The first case-control investigation that used CBCT technology to assess the etiology of Class II subdivision malocclusion showed different results from what 2D studies had previously provided,[9] and it concluded that the cause of Class II subdivision malocclusion was chiefly a result of a shorter mandible on the Class II side. However, in that study, a comprehensive analysis of the glenoid fossae and condylar positioning relative to a stable cranial base structure was not performed.

The previous literature lacks gender comparisons of the positioning of the glenoid fossae in patients with Class II subdivision malocclusion. In the present study, associated with greater dimensions of the cranial base, males presented with glenoid fossae in a more posterior position relative to the anterior cranial base and more laterally positioned relative to the midsagittal line. No association between gender and the degree of asymmetry of the position of the glenoid fossae was found. Condylar positioning within the glenoid fossa was similar, independent of the Class II group or gender, in accordance with previous studies performed with panoramic radiographs[13] and CBCT.[22,23]

The skeletal positional asymmetry of the mandibular fossae and mandibular condyles in Class II subdivision malocclusion is a relatively new concern in orthodontics, and controversies persist. Additional 3D studies, including comprehensive assessments of all dentoskeletal components, are therefore necessary. This study concluded that, in patients with Class II subdivision malocclusion, it is likely that the right- and left-side mandibular fossae are asymmetrically positioned and the condyles symmetrically positioned within the glenoid fossae. Moreover, male patients

Table 7. Comparison Between the Three-Dimensional Position and the X, Y and Z Distances of the Glenoid Fossae Relative to Sella Turcica of Class II Subdivision Patients (Both the Class II Side and the Class I Side), and the Mean Value of Both Sides of Class II Patients[a]

Comparisons	Coordinates[b]	Groups	Mean	SD	Mean Difference	95% CI	*P* Value
Class II side (CII S) vs Class I side (CI S) of C2SD patients	X	CII S	46.7	2.1	1.1	0.8 to 1.5	.000*
		CI S	45.6	2.3			
	Y	CII S	18.2	2.3	0.7	0.7 to 1.9	.022*
		CI S	17.5	2.5			
	Z	CII S	14.3	2.6	0.2	−0.6 to 1.1	.523
		CI S	14.0	3.4			
	3D	CII S	52.3	2.2	1.3	1.1 to 1.4	.000*
		CI S	50.9	2.2			
Class II sides of C2 patients (C2) vs Class II side of C2SD patients (CII S)	X	C2	46.3	2.1	−0.4	−1.4 to 0.5	.350
		CII S	46.7	2.1			
	Y	C2	17.4	2.2	−0.8	−1.8 to 0.2	.115
		CII S	18.2	2.3			
	Z	C2	14.7	2.9	0.4	−1.6 to 0.8	.488
		CII S	14.3	2.6			
	3D	C2	51.7	2.4	−0.5	−1.6 to 0.4	.283
		CII S	52.2	2.2			
Class II side of C2 patients (C2) vs Class I side of C2SD patients (CI S)	X	C2	46.3	2.1	0.7	−0.2 to 1.7	.143
		CI S	45.6	2.3			
	Y	C2	17.5	2.2	0.0	−0.9 to 1.1	.865
		CI S	17.5	2.5			
	Z	C2	14.7	2.9	0.7	−0.7 to 2.1	.316
		CI S	14.0	3.4			
	3D	C2	51.6	2.4	0.7	−0.2 to 1.7	.152
		CI S	50.9	2.2			

[a] Italic font indicates an association with statistically significant difference. CII S indicates Class II side of subdivision patients; CI S, Class I side of subdivision patients; C2, both sides of Class II patients; SD, standard deviation; CI, confidence interval.

[b] X and Y were measured in the axial view, and Z was measured in the coronal view. 3D means the Euclidean distance between the glenoid fossae and sella turcica. X, mesial–lateral; Y, anterior–posterior; Z, superior–inferior projections.

displayed greater distances between the glenoid fossae and anatomic references in the anterior cranial base despite there being no differences in condylar position within the glenoid fossae.

CONCLUSIONS

The null hypotheses were rejected.

- Asymmetric positioning of the glenoid fossae was found in Class II subdivision patients, whereas symmetry was found in patients with Class II malocclusion. In the former group, the Class II side was more posteriorly and laterally positioned than the Class I side.
- Mandibular condyles were centrally positioned within the glenoid fossae in patients with Class II malocclusion or Class II subdivision malocclusion, without any differences by gender.
- Male patients showed more posteriorly and laterally positioned glenoid fossae than did the female patients.

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