Tomographic assessment of temporomandibular joints in patients with malocclusion

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The predisposing position for malrelationship of the mandibular condyle and temporal fossa with respect to temporomandibular joint problems was first stated in 1918 by Pringle.[1] The recent literature[2-6] is replete with notations regarding proper condyle-fossa relationships. Some investigators[5,7-11] have alluded to the fact that condylar position is related to internal derangements of the TM joint, and the literature[2-4,11] suggests concurrence of the opinion that the most health-conducive condyle-fossa relationship is where the condyle is centered anteroposteriorly in the fossa. Several investigators[12-14] have stated that the mandible is locked posteriorly in cases of Class II, Division 2 malocclusion with deepbite. Others[5,15,16] have commented on the detrimental effects of premolar extractions because of the resulting reduction in overjet and an assumption that the mandible is held in a posterior relationship.

Ricketts[17,18] compared the joints of individuals who had normal occlusion with those of patients who had Class II or Class III malocclusion and found major variations in the joints of the Class II subjects. Thompson,[4] and Farrar and McCarty[5] stated that condylar retroposition occurs in patients with excessive overbite of the incisors. However, Pullinger et al.[19] found no association between condylar position and overbite, overjet, or slides in the centric. They reported than nonconcentric condylar positioning was a feature of Class II malocclusion and that the condyles

Abstract

There is a paucity of information on the morphological assessment of the temporomandibular joint in relation to varying skeletal and dental relationships. The purpose of this study was to evaluate the morphologic relationship of the condyle and fossa in patients with different malocclusions and skeletal relationships. Pretreatment records of 232 orthodontic patients, 95 males and 137 females, of Caucasian descent and ranging in age from 9 years 4 months to 42 years 6 months, were examined. Records included dental casts, lateral cephalometric radiographs, hand-wrist radiographs, and corrected tomograms of right and left TM joints. Nonconcentricity and mild asymmetry of the condyle-fossa relationship were commonly observed. The left condyle was found to be more anteriorly positioned than the right, with the mean percentage of joint space being 6.93% on the left side and -1.24% on the right. Skeletal and dental Class III patients demonstrated significantly more anteriorly positioned condyles ($P<0.05$). There were no significant differences in condylar position between Class I and Class II groups based on ANB or Angle's classification. Further, no significant difference in condylar position was observed between groups based on overbite or crossbite.

Key Words

Corrected tomograms • Malocclusion • Condylar position

Submitted: September 1994 **Revised and accepted:** January 1995 Angle Orthod 1996;66(1):27-36.

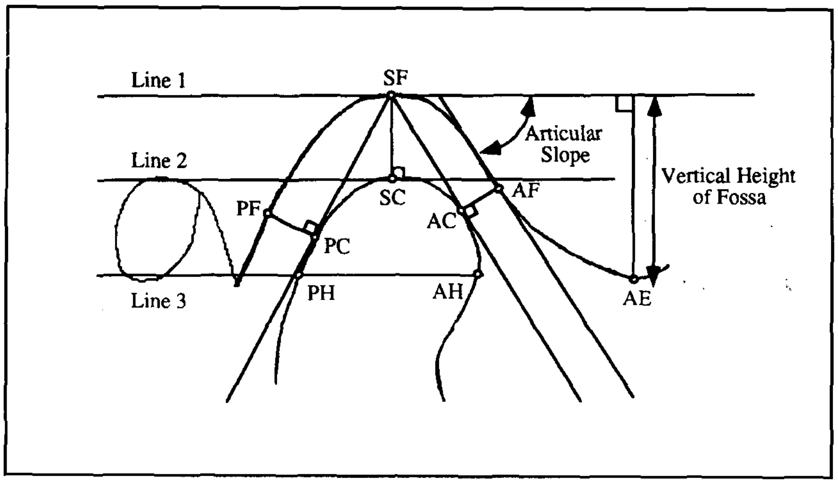

Figure 1
Construction of landmarks used in the analysis of tomographs with AC-AF as anterior joint space, PC-PF as posterior joint space, SC-SF as superior joint space, and AH-PH as the A-P thickness of the condylar head.

were placed more anteriorly in patients with Class II, Division 1 malocclusion than in those with Class I. Occlusal factors such as crossbite and malposed or lost posterior teeth have also been implicated as causes of internal derangement of the TM joint.[4,20-22]

There is a paucity of information on the varying skeletal and dental relationships in relation to the position of mandibular condyles in the glenoid fossa. The shape and size of the condyles and their relationship to the glenoid fossae have consistently been considered factors in TM joint disorders. This study will evaluate the morphological relationship of the condyle and fossa prior to orthodontic therapy in patients with different malocclusions and skeletal relationships.

Materials and methods

Pretreatment records of 232 orthodontic patients, 95 males and 137 females, of Caucasian descent and ranging in age from 9 years 4 months to 42 years 6 months, were examined. The records analyzed included dental casts, lateral cephalometric radiographs, hand-wrist radiographs, and corrected tomograms of right and left TM joints. Clinical records were also available in reference to mandibular movements and the presence of joint sounds and/or tenderness.

Dental casts were used to determine characteristics of the malocclusion as follows:

Angle classification: The sample was divided into five groups based on Angle's classification of malocclusion: Class I, n=73; end-to-end, n=39; Class II, Division 1, n=72; Class II, Division 2, n=24; and Class III, n=18. Six of the 232 individuals in the sample could not be classified due to missing permanent first molars.

Overbite: Vertical overlap of the maxillary and mandibular permanent incisors was measured. The sample was divided into four groups: openbite, <0% overlap, n=10; normal, 0% to 50% overlap, n=91; deepbite, 50% to 75% overlap, n=80; and very deepbite, >75% overlap, n=51.

Overjet: The linear distance in millimeters from the facial surface of the mandibular permanent incisors to the incisal edge of the most protrusive maxillary permanent central incisor was used to gauge overjet. The sample was divided into four groups: insufficient, <1 mm overjet, n=16; normal, 1 to 3 mm overjet, n=104; increased, 3 to 6 mm, n=71; and excessive, >6 mm overjet, n=41.

Crossbite: Anterior and posterior crossbites were identified and the direction and amount of any related functional shifts of the mandible were noted.

Lateral cephalometric radiographs were used to determine the angles ANB and Frankfort-to-mandibular-plane (FMA). Based on angle ANB, the sample was divided into three groups: prognathic, ANB ≤0°, n=22; orthognathic, ANB 0° to +5°, n=137; and retrognathic, ANB >+5°, n=73. The sample was also divided into three groups based on FMA: low, FMA <20°, n=56; average, FMA 20° to 29°, n=137; and high, FMA>29°, n=39.

Clinical evaluation of joint function was recorded using information obtained from the initial clinical examination. Mean maximum opening for the sample was 46 mm ± 5 mm, and the range was 32 mm to 64 mm. Thirteen patients had maximum openings of less than 40 mm and three patients had maximum openings greater than 60 mm. The mean right lateral excursion for the entire sample was 9.8 mm ± 2.1 mm, and the range was 4 mm to 17 mm. Fourteen patients had right lateral excursions of less than 7 mm and four patients had right lateral excursions greater than 14 mm. The mean left lateral excursion was 10.0 mm ± 2.0 mm, and the range was 5 mm to 16 mm. Eleven patients had left lateral excursions of less than 7 mm and three had left lateral excursions greater than 14 mm. Slides in centric ranged from 0 mm to 4.0 mm. Slides were absent in 164 of 232 patients, 45 had slides of 1.0 mm or less, and 23 had slides greater than 1.0 mm. Presence or absence of joint tenderness was determined from reports in the health history questionnaires and by preauricular palpation during function. Only one patient reported joint tenderness without palpation. The sample was largely asymptomatic, with no tenderness in 219 right and 224 left joints. Presence of joint sounds (click and/or crepitation) was determined for each joint. Joint sounds were absent in 212 right and 211 left joints, from a total sample of 232.

There were 13 right and 10 left joints with single clicks, and five right and nine left joints with reciprocal clicks. Crepitation was noted unilaterally in two patients and bilaterally in one.

Corrected tomograms were made in centric occlusion using the Tomax machine (Incubation Industries, Ivyland, Penn), a computer-automated pluridirectional x-ray tomograph, after obtaining the condylar angulation and the depth of cut measurements using a submentovertex projection. The tomographic section through the center of the medial and lateral poles of the condylar head was studied.

The landmarks used for analysis are illustrated in Figure 1 and were constructed in the following manner: Line 1 was drawn tangent to the most superior point of the glenoid fossa (SF) and parallel to the superior border of the radiographic film. Line 2 was drawn parallel to line 1 to locate the superior aspect of the condyle (SC). Lines were then drawn from SF point tangent to the anterior and posterior aspects of the condylar head at the anterior condyle point (AC) and posterior condyle point (PC), respectively. Perpendiculars to these tangents from AC and PC points intersected the glenoid fossa at points anterior fossa (AF) and posterior fossa (PF), respectively. A line was then drawn through AF point tangent and best fit to the anterior slope of the glenoid fossa and called articular slope (AS). Line 3 was drawn parallel to line 2 through the most convex point on the anterior aspect of the condylar head. The intersections of line 3 with anterior and posterior aspects of the condyle were referred to as anterior head of the condyle (AH) and posterior head of condyle (PH), respectively. The most inferior aspect of the crest of the articular eminence was located at point AE. The landmarks were digitized using Dentofacial Planner software (Dentofacial Software Inc, Toronto, Canada) and linear and angular measurements were made.

Measurements from the corrected tomograms were:

1. Anterior joint space as the distance between AC and AF;
2. Posterior joint space as the distance between PC and PF;
3. Superior joint space as the distance between SC and SF;
4. A-P thickness of condylar head as the distance between AH and PH;
5. Vertical height of articular fossa as the measurement of a perpendicular line extending from AE to line 1;
6. Angle of the articular slope as the angular measurements of the articular surface along the inner aspect of the anterior portion of the fossa;
7. Ratio of posterior to anterior joint space (P/A) as posterior joint space measurement divided by anterior joint space measurement, whereby a perfectly centered condyle would be expressed as 1.00; and
8. Percentage of posterior to anterior joint space, expressed as:

$$\frac{\text{posterior joint space - anterior joint space}}{\text{posterior joint space + anterior joint space}} \times 100\%$$

This formula represents condylar position as percent displacement from absolute concentricity, whereby a perfectly centered condyle would be expressed as 0%. A positive value would indicate an anterior condylar positioning and a negative value would indicate posterior condylar positioning.

Statistical evaluation of the data collected was performed using SAS software (SAS Institute Inc, Cary, NC). The general linear model procedure was performed to determine significant differences within groups for age, gender, and skeletal and dental variables and their combinations. Post-hoc Student-Neuman-Keuls tests were performed to determine significant differences between groups. The left and right joints were evaluated independently and compared with one another.

Results

There were no differences in any of the measurements between the group of patients that exhibited symptoms of either joint tenderness or sounds (n=40) and the asymptomatic group (n=192). Hence, all patients were grouped together for evaluation. Table 1 shows that males had significantly larger measurements only in the superior joint space for both right and left joints. The right posterior joint space, A-P thickness of the condylar head, vertical height of the articular fossa, and the left angle of the articular slope were also significant at $P<0.05$. When examined on the basis of age, no significant differences between children and adolescents were revealed. The adult sample showed significantly smaller right and left posterior joint spaces and condyles that were positioned relatively posteriorly.

Left and right joint measurements

The mean left anterior joint space for the entire sample was smaller than that of the right, 2.51 mm versus 2.69 mm, $P<0.01$; posterior joint space was larger on the left than on the right, 2.89 mm versus 2.63 mm, $P<0.001$. Thus, the left condyle was more anteriorly positioned than the right,

Table 1
Left and right joint spaces for males and females

Measurements			N	Mean	S.D.	Min	Max
Anterior joint space (mm)							
	Left	Male	95	2.54	1.03	1.10	9.20
		Female	137	2.48	0.86	0.80	5.70
	Right	Male	95	2.67	0.84	0.80	4.90
		Female	135	2.69	1.04	1.10	7.10
Posterior joint space (mm)							
	Left	Male	95	3.04	0.96	0.80	6.00
		Female	137	2.78	0.96	1.30	6.20
	Right	Male	95	2.82*	0.91	1.10	6.00
		Female	135	2.50*	1.10	0.90	9.50
Superior joint space (mm)							
	Left	Male	95	3.67*	0.92	1.40	5.70
		Female	137	3.28*	1.02	1.50	7.10
	Right	Male	95	3.40*	0.88	1.60	6.60
		Female	135	3.11*	0.94	1.30	5.60
A-P thickness condylar head (mm)							
	Left	Male	95	8.92	1.57	5.00	16.20
		Female	137	8.57	1.30	5.70	12.40
	Right	Male	95	9.03*	1.17	6.50	12.40
		Female	135	8.55*	1.44	4.80	13.40
Vertical height articular fossa (mm)							
	Left	Male	95	8.56	1.85	2.70	13.70
		Female	137	8.22	1.73	4.10	13.20
	Right	Male	95	8.74*	1.84	4.80	13.60
		Female	135	8.18*	1.64	3.60	13.40
Angle of the articular slope							
	Left	Male	95	59.89*	12.49	21.90	96.00
		Female	137	56.71*	10.73	24.20	82.00
	Right	Male	95	56.39	10.29	29.10	81.20
		Female	135	54.20	10.93	28.40	88.40
Ratio of P to A joint space (P/A)							
	Left	Male	95	1.34	0.60	0.27	2.80
		Female	137	1.28	0.71	0.37	4.72
	Right	Male	95	1.18	0.59	0.24	3.26
		Female	135	1.07	0.68	0.21	6.24
Percentage of joint space (P-A/P+A)x100							
	Left	Male	95	8.91	22.76	-57.50	47.30
		Female	137	5.55	23.27	-46.30	65.10
	Right	Male	95	2.50	22.81	-61.30	53.10
		Female	135	-3.87	25.26	-65.50	72.40

A = anterior joint space; P = posterior joint space;
* indicates significant difference between sexes at P<0.05

with the percentage of joint space being 6.93% on the left and -1.24% on the right. The left side also had a larger mean superior joint space, 3.44 mm versus 3.23 mm, P<0.001, and a larger angle of articular slope, 58.01° versus 55.10°, P<0.001.

Analysis by malocclusion type

Table 2 shows the ratio of posterior to anterior joint space and the percentage of joint space. These figures indicate that the condyles of Class III individuals were positioned significantly more anteriorly than those of all other classes at P<0.05. The joint space measurments indicate that for the left joint, Class III individuals differed significantly only from those with Class II, Division 2, whereas in the right joint, Class III individuals differed from those with Class II, Division 1.

Overbite

Left and right mean angles of the articular slope were significantly smaller for the open bite

Table 2
Two measurements revealed significant differences for left and right joint spaces by Angle's classification. Student-Newman-Keuls (SNK) groupings were made independently for left and right joints. Means with same SNK group letter are not significantly different.

Measurements Angle's Class	N	Left Joint Mean	 SNK	 SD	Right Joint Mean	 SNK	 SD
Ratio of P to A joint space (P/A)							
Class I	73	1.25	B	0.53	1.07	B	0.47
End-to-end	39	1.41	B	0.69	1.18	B	0.58
Class II, Div 1	72	1.26	B	0.60	1.01	B	0.59
Class II, Div 2	24	1.15	B	0.67	1.09	B	0.59
Class III	18	1.77*	A	1.09	1.59*	A	1.32
Percentage of joint space (P-A/P+A) x 100							
Class I	73	6.62	A B	20.85	-0.87	A B	20.01
End-to-end	39	10.83	A B	23.63	1.05	A B	28.13
Class II, Div 1	72	6.33	A B	21.33	-6.27*	B	25.39
Class II, Div 2	24	-1.18*	B	27.73	-2.30	A B	25.43
Class III	18	19.22	A	25.47	12.29*	A	25.24

Table 3
Three measurements revealed significant differences for left and right joint spaces by overjet. Student-Newman-Keuls (SNK) groupings were made independently for left and right joints. Means with same SNK group letter are not significantly different.

Measurements Overjet	N	Left Joint Mean	 SNK	 SD	Right Joint Mean	 SNK	 SD
Posterior joint space (mm)							
Insufficient (< 1mm)	16	3.48*	A	1.38	3.52*	A	1.89
Normal (1 - 3 mm)	104	2.76	B	0.88	2.53	B	0.83
Increased (3 - 6 mm)	71	3.02	B	1.04	2.68	B	0.99
Excessive (>6 mm)	41	2.75	B	0.76	2.45	B	0.99
Vertical height articular fossa (mm)							
Insufficient (< 1mm)	16	7.13*	B	1.52	6.82*	B	1.66
Normal (1 - 3 mm)	104	8.24	A	1.77	8.35	A	1.71
Increased (3 - 6 mm)	71	8.80	A	1.80	8.86	A	1.63
Excessive (>6 mm)	41	8.37	A	1.65	8.40	A	1.73
Ratio of P to A joint space (P/A)							
Insufficient (< 1mm)	16	1.72*	A	0.93	1.66*	A	1.31
Normal (1 - 3 mm)	104	1.27	B	0.66	1.07	B	0.54
Increased (3 - 6 mm)	71	1.27	B	0.63	1.10	B	0.56
Excessive (>6 mm)	41	1.28	B	0.57	1.04	B	0.58

group, at P<0.05. The left joint mean was 50.06° for the openbite group versus 57.79° for the normal, 58.98° for the deepbite, and 58.44° for the very deepbite group. The right joint mean for the openbite group was 49.07°, versus 54.62° for the normal, 55.00° for the deep bite, and 57.29° for the very deep bite. There were no significant differences in condylar position between the four groups of the sample based on overbite.

Overjet

Compared with the other three groups, the insufficient overjet group had significantly larger mean left and right posterior joint spaces and ratios of posterior to anterior joint spaces (P<0.05), and significantly smaller left and right mean vertical heights of the articular fossa. See Table 3.

Table 4
Measurements of concentricity for left and right joint spaces by angle ANB. Student-Newman-Keuls (SNK) groupings were made independently for left and right joints. Means with same SNK group letter are not significantly different.

Measurements Angle ANB	N	Left Joint Mean	SNK	SD	Right Joint Mean	SNK	SD
Ratio of P to A joint space (P/A)							
0 to +5	137	1.26	B	0.57	1.05	B	0.52
> +5	73	1.27	B	0.65	1.14	B	0.60
< 0	22	1.65*	A	1.07	1.48*	A	1.23
Percentage of joint space (P-A/P+A) x 100							
0 to +5	137	6.28	A	22.16	-3.35	A	23.65
> +5	73	5.88	A	22.84	-0.01	A	24.56
< 0	22	14.43	A	28.64	8.19	A	27.54

Table 5
Two measurements revealed significant differences for left and right joint spaces by angle FMA. Student-Newman-Keuls (SNK) groupings were made independently for left and right joints. Means with same SNK group letter are not significantly different.

Measurements FMA angle Class	N	Left Joint Mean	SNK	SD	Right Joint Mean	SNK	SD
Vertical height articular fossa (mm)							
Low	56	8.92	B	1.55	8.75	A	1.43
Average	137	8.36	B	1.79	8.46	A	1.86
High	39	7.54*	A	1.79	7.77*	B	1.60
Angle or articular slope							
Low	56	60.59	B	10.79	57.54	A	10.11
Average	137	58.47	B	11.13	55.64	A	10.55
High	39	52.68*	A	12.70	49.79**	B	10.52

Crossbite

There were no significant differences in condylar position between individuals with or without crossbites. The only difference was the A-P thickness of the condylar head, which was significantly larger in the noncrossbite group than in any of the crossbite groups ($P<0.05$). Both the left and right mean A-P thicknesses of the condylar heads for the noncrossbite group were 8.96 mm. The means for the condylar head thicknesses for the crossbite group were 8.35 mm for the left and 8.43 mm for the right; means for the anterior crossbite groups were 8.20 mm for the left and 8.33 mm for the right; means for the posterior crossbite group were 8.38 mm for the left and 8.48 mm for the right.

Analysis by skeletal type

Angle ANB

Table 4 shows the left and right joint measures of concentricity for the sample divided by three groups of angle ANB. Condyles of patients in the prognathic group were positioned significantly more anteriorly than condyles in orthognathic and retrognathic patients at $P<0.05$, using the ratio of joint space measurments. No significant differences were noted in any of the joint measurements between orthognathic and retrognathic groups.

Angle FMA

Table 5 shows that patients with large Frankfort-to-mandibular plane angles (FMA) exhibited a significantly smaller vertical height of the articular fossa and angle of the articular slope than patients with low and average FMA measurments ($P<0.05$). There were no significant differences in condylar position between the three groups divided by angle FMA.

Discussion

There were large variations in the spatial relationships within the TM joints in these pretreatment orthodontic patients. None of the patients had two perfectly centered condyles. However, if a range of -12% to +12% of posterior-to-anterior joint space is used to describe concentricity, as in a previous report,[23-27] then 39% (90) of the patients in the study had either the right or left condyle centered in the fossa and 17% (40 patients) had both condyles centered. Asymmetry of the TM joint was also a finding, confirming previous[23,24,28] reports. However, the anteroposterior thickness of the condylar head was not found to be significantly different between the right and left sides. Therefore, either asymmetry of joint space ratio or percentage measurements may be attributed to differences in dimensions of the fossa or spatial differences in condylar position. The left condyle was found to be more anteriorly positioned than the right, as seen in earlier reports.[23,26] This asymmetry may be related to normally occurring cranial base asymmetries[23,29] and side preferences during mastication.[28]

Although there was a trend for larger joint space values in males, the differences were statistically significant only for the superior joint space. Males also had larger values for thickness of the condylar head and the height of the fossa, with a steeper articular slope. The condyles in males were more anteriorly positioned than in females by 3.4% on the left side and 6.4% on the right. These differences were not statistically significant. Pullinger et al.[23] reported larger differences, 9.2% on the left and 11.4% on the right, and related the greater prevalence of mandibular dysfunction in females[30,31] to their posteriorly positioned condyles. He later stated that this could preexist or predispose females to anterior disc displacement.[19] Condylar position has been related to age in previous reports[8,32] with a greater likelihood of abnormal positions and function in adults. However, a posterior condylar position in adults, as seen in this study, has not been reported in the past and could have an important influence on disc position. Other investigators have related posterior condylar position with an anterior displacement of the articular disc.[9,10] Thus, condylar position could explain the increased incidence of TM dysfunction in adults. However, there were only 17 individuals in the study over 18, so it would be important to verify these results with a larger sample.

There were no significant differences in condylar position between patients with Angle Class I, end-to-end, Class II, Division 1, or Class II, Division 2 malocclusions. A forward posture of the mandible in Class II, Division 1 patients, as previously described,[18] was not found in this study. Class II, Division 2 malocclusion has also been implicated as a factor in TM joint dysfunction.[12,13] The results of this study support Gianelly et al.,[33] who found the condylar position in Class II deepbite patients to be essentially centered; these researchers did not support the theory that the mandible is entrapped posteriorly in Class II, Division 2 malocclusions, and that treatment of the overbite would allow the mandible to shift forward. In the present study, no significant differences in joint measurements were found between patients with orthognathic and those with retrognathic patterns.

Patients with Class III dental malocclusion demonstrated significantly more anterior condylar position than did any other malocclusion group. This finding differs from previous reports,[18,27] which found no differences in condylar position between any of the groups divided by Angle classification. Ricketts,[18] however, did find a shallower articular fossa and flatter articular eminence in Class III patients, a trend also seen in the present study.

There was a similarity in condylar positions when patients were grouped by dental Class III malocclusions (n=18) and prognathic jaw discrepancies (n=22). These patients demonstrated anteriorly positioned condyles with a trend for smaller anterior joint spaces and larger posterior and superior joint spaces.

Vertical jaw discrepancies, reflected in the FMA measurements, did not show differences in condylar position. However, patients with high FMA measurements had shallower glenoid fossae and flatter articular slopes. This has not been reported in the past, and its implications are not clearly understood. It may be related to the shallower anterior guidance during protrusive function typically associated with openbites and vertically growing patients.[6] On the other hand, a steep articular slope may increase the likelihood of disc derangement disorders by causing a greater rotational movement of the disc on the condyle.[6]

Pullinger et al.[32] alerted clinicians to watch carefully for signs of TM dysfunction in patients with excessive overjet. In this study, however, patients with normal to large overjet measurements had essentially no differences in their TM joints. Patients with insufficient overjet (<1 mm) demonstrated an anteriorly positioned condyle, larger posterior joint space, and smaller vertical height of the articular fossa. However, these conditions could be due to several factors, including anterior crossbites or Class III dental malrelationships, which would fall into the category of insufficient overjet.

It has been stated that patients with an anterior openbite are at greater risk for TM joint dysfunction.[32] No relationship was noted between condylar position and the degree of overbite in this study. The only difference was that patients with anterior openbite had a significantly smaller vertical height of the articular fossa. These results for the openbite group were similar to the those obtained for the high FMA group, which would be consistent with a hyperdivergent facial pattern. There were six patients who had both a high mandibular plane angle as well as an anterior openbite. There was only a trend for smaller height of the fossa and angle of articular slope in this group of patients. A larger sample would be necessary to further substantiate these findings.

Some investigators[14,18,22,34] have stated that patients with deep overbites could produce posterior displacement of the mandible during closure that could lead to anterior disc dislocation. The results of the present study did not support this hypothesis and did confirm data from previous investigations.[19,27,33]

The occurrence of a crossbite did not seem to affect the position of the condyle or the dimensions of the fossa. The anteroposterior thickness of the condylar head was the only joint measurement that showed a significant difference, with the crossbite group exhibiting significantly smaller thicknesses. There was also no difference in condylar position between patients with and without anterior crossbites. The four patients who had anterior crossbite along with anterior slide from initial contact to centric occlusion were also no different in condylar positions when compared with the 52 patients who had an anterior crossbite but no slide in centric.

Patients with posterior crossbites did not show an increased degree of asymmetry in condylar positions when compared with the noncrossbite group, contrary to a previous study.[35] Of the 57 patients with posterior crossbites, three had an associated mandibular shift to the right and two had a shift to the left from initial contact to centric occlusion. Condylar asymmetry was affected by slide direction. In the patients with posterior crossbites and slides to the right, the left condyle was anterior to the right by a difference of 44%, while in patients with posterior crossbites and slides to the left, the left condyle was posterior to the right by a difference of 7% This indicates that patients whose tomographs reveal greater than normal asymmetric condylar positioning should be carefully examined for mandibular deviations during closing.

Acknowledgments

We would like to thank the Foundation for Orthodontic Research for their financial contribution to this project.

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