Original Article

Cephalometric Evaluation of Nongrowing Females with Skeletal and Dental Class II, division 1 Malocclusion

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Abstract: Studies evaluating maxillary and mandibular skeletal and dental positions and the vertical components of Class II patients have reported conflicting results. In addition, no common results have been found regarding cranial base configurations. However, few studies have evaluated nongrowing subjects. The aim of this study was to establish whether patients with skeletal and dental Class II division 1 malocclusion have specific craniofacial features. For this, 40 nongrowing females were evaluated cephalometrically. Wide variations were observed for almost all measurements of Class II division 1 patients. However, a posteriorly positioned and rotated mandible, protrusive mandibular incisors, and an increased cranial base angle were all mean characteristics of Class II division 1 patients. (*Angle Orthod* 2005;75:656–660.)

Key Words: Cephalometric evaluation; Class II division 1 malocclusion; Nongrowing females

INTRODUCTION

Class II malocclusion is a frequently seen disharmony that has been studied in many different populations.[1–6] Because excessive overjet is easily recognized, Class II division 1 malocclusion is of a great concern for both patients and their parents.

A review of the literature shows that Class II malocclusion has been evaluated in all three dimensions of space. In general, these studies have compared the craniofacial morphology of patients with Class II malocclusions with Class I control subjects.

Studies evaluating maxillary and mandibular skeletal and dental positions and vertical components of Class II patients have reported conflicting results from both cross-sectional and longitudinal studies. No common results have been found regarding cranial base configurations.

Most of the studies selected Class II patients on a dental basis, but patients with a dental Class II malocclusion may have a Class I or a Class II skeletal pattern. Few studies evaluated patients with both skeletal and dental Class II malocclusion.[7–9] In addition, some of the studies included both Class II division 1 and division 2 cases.[10–13] This may affect the results of these studies because these two malocclusions may have rather different craniofacial characteristics.

Dibbets[14] stated that the differences in mandibular size between Angle classes emerge later during development, and therefore, these differences are more likely to be found in adult samples. In a longitudinal study, Kerr and Hirst[15] found that the craniofacial characteristics of subjects with normal and postnormal occlusions became more defined with advancing age. However, most of these studies evaluated growing subjects at various ages.

Because subjects at the same chronological age may have different skeletal maturation levels, evaluation of nongrowing subjects may be of value in determining specific characteristics of a given malocclusion. Most of the studies have included both sexes despite the fact that males and females may exhibit differentiation in craniofacial dimensions. In a longitudinal study of normal subjects, Sinclair and Little[16] reported a considerable degree of sexual dimorphism with males showing larger dimensions in all parameters, more postpubertal growth, and greater late skeletal and dental changes.

To our knowledge, only one study[17] has evaluated craniofacial morphology of nongrowing females with Class II division 1 malocclusions. Fushima et al[17] evaluated adult females with Class II division 1 malocclusion without clarifying whether these subjects had skeletal or dental Class II division 1 malocclusion. Gilmore[18] evaluated adult males and females with dental

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Class II division 1 malocclusions, but they only studied mandibular morphology. Ellis et al[19] evaluated adults that included both sexes, but they compared open bite and non–open bite Class II division 1 malocclusion groups.

The purposes of this study were (1) to determine whether nongrowing females with both skeletal and dental Class II division 1 malocclusion have specific craniofacial features, (2) to clarify whether these craniofacial features were correlated with the severity of the Class II malocclusion, and (3) to explore whether these subjects have specific cranial base configurations.

MATERIALS AND METHODS

After a careful selection from the files of the Departments of Orthodontics, Suleyman Demirel University and Ankara University, 40 women having a skeletal and dental Class II division 1 malocclusion (mean age 17.86 $\pm$ 2.70 years) were evaluated and compared with 20 women having skeletal Class I pattern and ideal occlusion (mean age 21.08 $\pm$ 2.15 years).

Selection criteria for the Class II division 1 sample were:

- ANB angle $>4°$;
- Overjet >4 mm;
- Convex facial profile;
- No missing teeth (except wisdom teeth);
- Bilateral Class II molar relationship in centric occlusion;
- No previous orthodontic treatment.

Selection criteria for the Class I sample were:

- ANB angle $\leq 4°$;
- Overjet ≤ 4 mm;
- Class I soft tissue profile;
- No missing teeth (except wisdom teeth);
- Well-aligned maxillary and mandibular arches with less than two mm crowding or spacing;
- Bilateral Class I molar relationship in centric occlusion;
- No previous orthodontic treatment.

Cephalometric landmarks were marked and digitized by one author to avoid interobserver variability. Angular and linear variables were established and measured by Vistadent™ AT Software (GAC Int. Inc. Bohemia, NY). All the measurements of 20 patients were taken again two weeks later to determine the measurement error. The reliability coefficient was 0.932 or above for all of the measurements.

Descriptive statistics were calculated for all measurements. Statistical comparison of the two groups was performed with Mann–Whitney *U*-test. Pearson correlations were examined for interrelationships between ANB angle and other cephalometric measurements. All the statistical analyses were performed by using SPSS v11.0 (SPSS Inc., Chicago, Ill).

RESULTS

Table 1 shows descriptive statistics and comparisons of cephalometric measurements between the groups. There was no difference in the mean position of the maxilla (SNA) between the two groups, and the Class II appeared to be the result of a more recessive (SNB) and shorter mandible (Cd-Gn). (These results were also supported by maxillary and mandibular skeletal measurements that were not Sella-Nasion based).

This was accompanied by an increased mandibular plane angle (Go-GN/SN) but no increase in anterior facial height. The increased mandibular plane angle appeared to be the result of a reduced ramus height with a reduced posterior facial height in the Class II division 1 group.

In the Class II division 1 patients, the maxillary incisors were normally positioned (upper incisor-NA) whereas the mandibular incisors were more protrusive (lower incisor-NB). Nevertheless, the overjet was significantly greater in the Class II division 1 group.

The cranial base angle was significantly greater in Class II division 1 patients. Also, the anterior and posterior cranial lengths were significantly shorter in the Class II group.

Correlations between ANB angle and other cephalometric measurements (Table 2) supported our findings concerning the differences found in craniofacial measurements between Class I and Class II division 1 samples.

DISCUSSION

Class II malocclusion has been evaluated in numerous studies.[7–13,17–38] These studies have reported conflicting results about the features of Class II malocclusions both in the anteroposterior and vertical dimensions.

Class II malocclusions may result from numerous combinations of skeletal and dental components.[10,21,23,29,39] This was also true for our sample because wide variations were observed for almost all measurements of the Class II division 1 patients (Table 1). Fushima et al[17] reported a retruded and smaller mandible in adult females with Class II division 1 malocclusion. In another study of adult patients, Gilmore[18] reported that the mandible was shorter in dental Class II division 1 patients with a greater critical ratio in females.

Because our results are consistent with previous studies on adults, we suggest that the majority of

TABLE 1. Descriptive Statistics and Mann-Whitney *U*-test Comparison of the Measurements

	Class I				Class II				
	Mean	SD	Min	Max	Mean	SD	Min	Max	P[a]
SNA (°)	80.98	3.58	73.70	87.80	80.43	3.24	73.40	87.00	NS
SNB (°)	78.76	3.91	70.30	85.40	73.84	3.51	65.90	80.90	***
ANB (°)	2.22	1.25	0.00	3.90	6.57	1.72	4.10	10.40	***
Wits	−1.32	2.20	−6.00	2.60	5.85	3.57	−4.00	13.50	***
Effective maxillary length (mm)	91.88	4.13	82.10	99.20	88.48	4.48	79.80	96.80	**
Effective mandibular length (mm)	121.06	5.97	110.80	135.10	113.25	4.74	99.20	121.70	***
Maxillary skeletal (mm)	−0.15	2.99	−5.40	5.30	0.86	3.42	−3.90	12.30	NS
Mandibular skeletal (mm)	−2.84	5.93	−15.60	8.00	−10.59	8.13	−31.90	13.20	***
Go-Gn/SN (°)	30.00	5.87	14.90	40.60	38.07	7.49	23.40	60.60	***
Mandibular plane/Frankfort horizontal (°)	21.46	4.98	9.00	30.00	28.30	7.44	10.90	51.30	***
Y axis (°)	60.24	4.20	54.10	74.70	63.31	4.16	55.20	77.40	**
Anterior face height (mm)	123.42	6.63	112.20	137.50	123.55	7.43	109.40	144.30	NS
Posterior face height (mm)	81.48	4.86	71.90	90.60	75.72	4.21	67.00	87.60	***
Face height ratio	0.66	0.05	0.59	0.79	0.62	0.05	0.53	0.73	**
Ramus height (mm)	48.39	4.55	40.80	61.10	44.89	4.30	37.40	54.10	**
Lower anterior facial height	69.31	6.07	57.40	79.20	71.78	6.72	60.60	87.90	NS
Overbite	3.05	1.50	0.00	5.00	3.33	2.63	−3.00	8.00	NS
Upper incisor-NA (mm)	5.08	1.74	1.50	7.40	5.59	2.71	−0.20	11.60	NS
Upper incisor/NA (°)	24.02	5.96	11.70	32.80	25.33	7.26	13.10	46.50	NS
Lower incisor-NB (mm)	5.20	1.74	1.80	7.80	7.00	2.65	1.70	12.10	*
Lower incisor/NB (°)	26.97	5.08	17.20	36.40	28.44	5.85	13.60	40.80	NS
Overjet	3.00	0.73	2.00	4.00	7.95	2.75	4.10	16.00	***
Interincisal angle	126.80	8.00	111.80	142.30	119.67	8.05	100.90	136.50	**
Maxillary dental (mm)	5.11	1.40	2.10	7.40	5.91	2.40	1.20	10.80	NS
Mandibular dental (mm)	3.00	1.57	0.70	5.70	2.18	2.87	−4.50	8.70	NS
Cranial base angle (°)	128.90	5.10	119.00	143.00	132.35	4.93	124.00	148.00	*
Anterior cranial length (mm)	72.08	2.53	66.30	76.10	69.32	3.45	62.70	78.00	**
Posterior cranial length (mm)	36.88	2.63	31.50	42.50	33.92	2.83	28.60	40.20	**

[a] NS indicates nonsignificant; * $P < .05$, ** $P < .01$, *** $P < .001$.

Class II division 1 patients have a normally positioned maxilla but a smaller and more retruded mandible when compared with Class I patients. Conflicting results of studies regarding anteroposterior positions of maxilla and mandible in growing Class II patients may be attributed to the individual differences in skeletal growth rates of these patients.

Our results also indicated that Class II division 1 patients show an increased mandibular plane angle but no increase in anterior facial height. The increased mandibular plane angle appeared to be the result of a reduced ramus height. In accordance with our results, Fushima et al[17] also reported backward rotation of the mandible in Class II division 1 patients. Björk and Skieller[40] reported that the intensity of the condylar growth was strongly correlated with the rotation of the mandible. Sinclair and Little[16] reported that the degree of vertical mandibular growth was closely correlated with the total amount of condylar growth.

Discrepancy in the posterior face height especially in ramus height may indicate decreased condylar growth in Class II division 1 patients. Because histological and implant studies[41–43] have demonstrated that growth in mandibular length occurs primarily at the condyle, the decreased mandibular length found in Class II division 1 patients also supports our findings.

Certainly, treatment regimens for Class II division 1 patients must be designed individually. However, the resultant growth of Class II division 1 patients suggests that the use of functional appliances that stimulate mandibular growth might be considered for the majority of growing Class II division 1 patients. When stimulating mandibular growth in Class II patients, the probability of decreased posterior face height and posterior rotation also must be kept in mind. McNamara[10] evaluated growing patients with Class II malocclusions and suggested that approaches altering the amount and direction of mandibular growth were more appropriate in many cases.

Our results indicate that the inclination and position of maxillary incisors were similar in Class II division 1 patients and Class I subjects, whereas the mandibular incisors were more protrusive in Class II division 1 subjects. Protrusion of mandibular incisors in Class II division 1 cases may be explained by dentoalveolar compensation that was defined as a system that attempts to maintain normal interarch relationships under varying jaw relationships.[44] It is logical to suggest

TABLE 2. Pearson Correlation Coefficients of the Measurements

	ANB
SNA (°)	−0.034
SNB (°)	−0.633**
Wits	0.751**
Effective maxillary length (mm)	−0.279*
Effective mandibular length (mm)	−0.581**
Maxillary skeletal (mm)	0.224
Mandibular skeletal (mm)	−0.602**
Go-Gn/SN (°)	0.632**
Mandibular plane/Frankfort horizontal (°)	0.594**
Y axis (°)	0.492**
Anterior face height (mm)	0.197
Posterior face height (mm)	−0.517**
Face height ratio	−0.546**
Ramus height (mm)	−0.413**
Lower anterior facial height	0.401**
Overbite	0.035
Upper incisor-NA (mm)	−0.152
Upper incisor/NA (°)	−0.185
Lower incisor-NB (mm)	0.583**
Lower incisor/NB (°)	0.387**
Overjet	0.644**
Interincisal angle	−0.406**
Maxillary dental (mm)	−0.049
Mandibular dental (mm)	0.025
Cranial base angle (°)	0.283*
Anterior cranial length (mm)	−0.357**
Posterior cranial length (mm)	−0.391**

* $P < .05$, ** $P < .01$.

that this mechanism might be more significant with increasing age. This may explain the contradiction regarding incisor positions of our results with other studies who evaluated subjects at earlier ages.[10,27,35,36]

Hopkin et al[45] stated that cranial base configuration was an etiological factor in determining anteroposterior malrelationships of the jaws. However, a review of the literature indicated no common results concerning cranial base configurations of Class II patients. Dhopatkar et al[46] has suggested that cranial base morphology was more important in the establishment of malocclusion when there was a significant skeletal discrepancy. This is also acceptable for our study because our Class II patients have significantly greater overjets and ANB angles than Class I subjects.

Another reason for this controversy may be the continuing growth of the sphenooccipital synchondrosis. Because growth of the sphenooccipital synchondrosis influences the height and depth of the upper face and spatial position of the upper teeth, its continuing growth translates the anterior cranial base and its attached upper face upward and forward.[47] It was reported that sphenooccipital synchondrosis is active through puberty and completes its growth at the end of pubertal cycle. However, this might vary according to general maturation and sex with earlier closure in females.[48] Evaluation of our nongrowing female sample indicated that cranial base angle was significantly greater in Class II division 1 patients. It has been reported that a larger cranial base angle in Class II patients might explain the distal positioning of the mandible.[49]

In light of our findings, it is reasonable to suggest that not only an increased cranial base angle but also posterior rotation and decreased length of the mandible may contribute to the posterior position of the mandible in Class II division 1 patients.

Undoubtedly, it would be more useful to evaluate untreated patients having Class II division 1 malocclusion longitudinally from childhood to adulthood. Because, for ethical reasons it would be impossible to do this, further studies evaluating nongrowing patients, especially by sex, will be helpful.

CONCLUSIONS

Wide variations were observed for almost all measurements of Class II division 1 patients, but on average, the maxilla of Class II division 1 patients was normally positioned. However, their mandibles were smaller in size, posteriorly positioned, and rotated open when compared with Class I subjects.

The inclination and position of the maxillary incisors were similar in Class II division 1 patients and Class I subjects, whereas the mandibular incisors were more protrusive in Class II division 1 patients.

The cranial base angle was significantly larger in Class II division 1 patients. Also, the anterior and posterior cranial lengths were significantly shorter in the Class II group.

Craniofacial features of Class II division 1 patients were correlated with the severity of Class II malocclusion as indicated by ANB.

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