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Craniofacial Morphology of Japanese Girls with Class II Division 1 Malocclusion

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Abstract

***Objective**: To identify the craniofacial features of Japanese girls with Class II division 1 malocclusions.*

***Method**: One hundred and ninety lateral cephalometric radiographs were analysed, and the subjects whose age ranged from 7 years 6 months to 15 years 10 months were divided into three groups by their dentition: middle mixed dentition, late mixed dentition, and early permanent dentition. The mean values of 5 linear and 16 angular cephalometric parameters were compared with established Japanese Class I control values.*

***Results**: Japanese girls with Class II division 1 malocclusion had a significantly small S-N-B angle ($p < 0{\cdot}001$), short mandibular ramus ($p < 0{\cdot}05$–$0{\cdot}001$), and a large mandibular plane angle ($p < 0{\cdot}05$–$0{\cdot}001$).*

***Conclusion**: Japanese girls with Class II division 1 malocclusion had a high-angle facial pattern associated with the short mandibular ramus.*

Index words: Angle Class II Malocclusion, Computer-aided Cephalogram, Japanese Adolescents, Skeletal Class II.

Introduction

Analysis of craniofacial structures using lateral cephalometric radiographs has been used for the prediction of growth, as well as diagnosis and treatment planning in orthodontics for many years. A Class II skeletal pattern with maxillary protrusion and mandibular retrusion, positionally and morphologically, is a frequent dentofacial abnormality in American and European whites (Haynes, 1970; Proffit *et al*., 1998), Chinese (Lew *et al*., 1993), and Japanese (Susami *et al*., 1971; Kitai *et al*., 1990). Many studies have attempted to clarify the morphological features of skeletal Class II malocclusion, and most investigators have reported the presence of a retrognathic mandible, proclined upper incisors, and neutral positioned lower incisors in Caucasian (Drelich, 1948; Renfroe, 1948; Henry, 1957; Harris *et al*., 1972; Hitchcock, 1973; McNamara, 1981), Chinese (Lau and Hagg, 1999), and Japanese Class II patients (Miura *et al*., 1958; Kuwahara, 1968; Iwasawa *et al*., 1969, 1980). However, investigations of the antero-posterior position of the maxilla and the size of the mandible in Class II subjects have not reported consistent results. Furthermore, the skeletal Class II pattern arises from not only horizontal, but also vertical discrepancies (Adams and Kerr, 1981), aided by the morphology of the cranial base (Bacon *et al*., 1992). The influence of these morphological features has not been fully evaluated for a Japanese population. As a result, the purpose of the present study was to further define the morphology of Japanese skeletal Class II malocclusion and compare these features to those of normal Japanese Class I data.

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Material and Methods

One-hundred-and-ninety lateral cephalometric radiographs of Japanese girls with Class II division 1 malocclusion and who had no history of any orthodontic treatment were examined. All patients had an A–N–B angle > 5 degrees, an Angle's Class II molar relationship, and an increased overjet. The control data represented the cephalometric standard values of Class I Japanese children published by the Japanese Society of Paediatric Dentistry in 1995 (JSPD). The Class II sample were divided into three groups based on dental age:

1. Middle mixed dentition, in which the upper and lower central and lateral incisors had erupted fully, but the deciduous canines and molars were still present.
2. Late mixed dentition, in which the permanent canines and premolars were erupting.
3. Early permanent dentition, in which all deciduous teeth had been shed and the second molars were at least partially erupted.

The mean age of each group is shown in Table 1.

Cephalometric Analysis

All lateral cephalometric radiographs of the Class II sample were taken using the same cephalostat system, and both the

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test and control data had the same image magnification (10·0 per cent enlargement). The lateral cephalometric radiograph of each subject was traced by the same investigator. The selected landmarks were digitized and converted to an *x–y* co-ordinate system (WinCeph, Rise Corporation, Sendai, Japan; Figure 1). In this study, points Po and Or were not used since poor reproducibility has been reported previously (Cooke and Wei, 1991). From these, five linear and 16 angular measurements were compared with those of the Class I standards.

Error of the Method

Fifty radiographs were re-traced and re-digitized a few weeks later to examine the error of the method. The coefficient of reliability was calculated for each measurement as follows: coefficient of reliability $= 1 - S_e^2/S_t^2$, where S_e^2 is the variance due to random error, and S_t^2 is the total variance of the measurements (Houston, 1983). The results are presented in Table 2.

Statistical Analysis

Standard descriptive statistics, means and standard deviations, of age and cephalometric parameters were calculated for each group. The chi-square test was applied to all cephalometric parameters to test for normal distribution. Equality of variance was tested between each of the groups and differences between groups identified using the unpaired Student's and Welch's *t*-test.

TABLE 1 *Distribution of Class II division 1 and Class I Japanese females*

Present study						Japanese Society of Pediatric Dentistry (1995)					
Class II division 1 Japanese females						Class I Japanese females					
Group 1 (n = 76)		Group 2 (n = 55)		Group 3 (n = 59)		Group I (n = 24)		Group 2 (n = 29)		Group 3 (n = 36)	
7 y 6 m–11 y 0 m		9 y 1 m–13 y 6 m		10 y 9 m–15 y 10 m		7 y 7 m–11 y 7 m		8 y 0 m–12 y 1 m		10 y 10 m–16 y 10 m	
Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
8 y 6 m	9·9	10 y 11 m	9·3	13 y 0 m	18·9	9 y 1 m	11·0	10 y 8 m	10·8	13 y 2 m	15·7

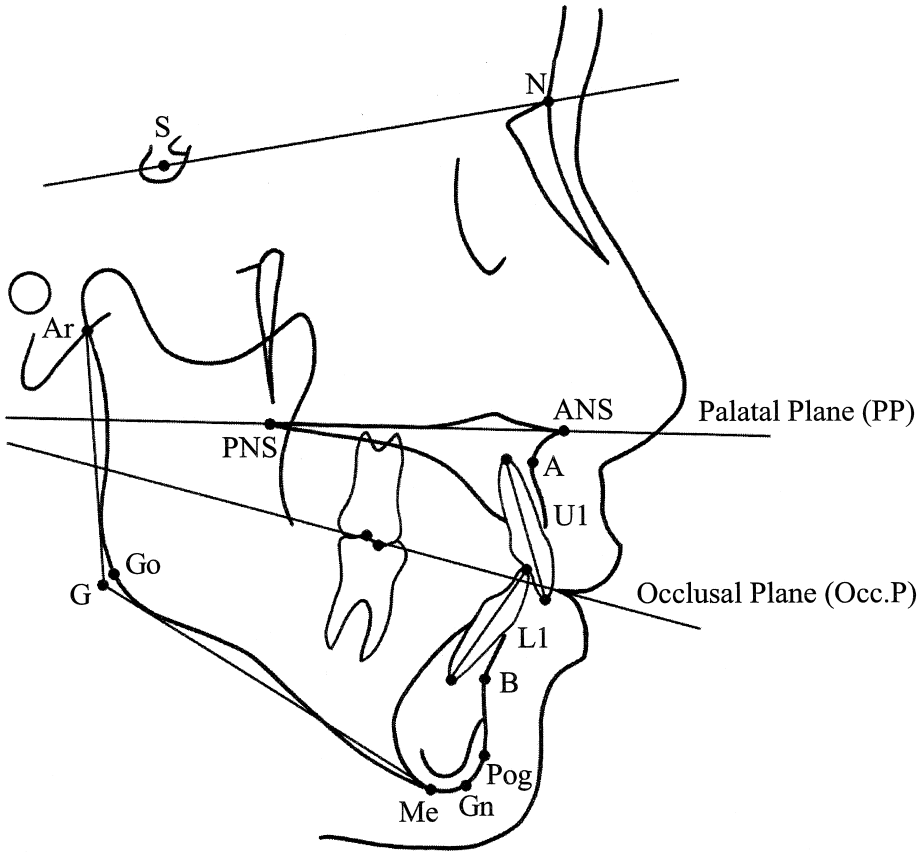

FIG. 1 Cephalometric landmarks recorded in this study.

TABLE 2 *Comparison of mean values between Class II division 1 and Class I Japanese females*

			Present study						JSPD (1995)					
			Class II division 1						Class I					
			Group 1 (n = 76)		Group 2 (n = 55)		Group 3 (n = 59)		Group 1 (n = 24)		Group 2 (n = 29)		Group 3 (n = 36)	
		Coefficient of reliability	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Cranial base relationships														
	S–N	0·957	65·3	2·7	66·9	2·6	67·8***	2·3	65·8	2·7	67·8	3·1	69·6***	2·6
	S–Ar	0·974	32·7	2·7	34·7	2·8	35·9	2·8	—	—	—	—	—	—
	N–S–Ar	0.978	127.3	4.4	127.2	4.4	127.2	4.7	—	—	—	—	—	—
Maxillary skeletal relationships														
Antero-posterior	Ar–A	0.991	82.2	3.3	85.0	3.9	86.8	4.0	—	—	—	—	—	—
	S–N–A	0.942	81.5	3.2	81.8**	2.9	82.0**	3.3	80.2	3.2	79.7**	3.0	80.1**	2.5
Vertical	N–ANS	0.950	50.5	3.0	53.2	2.9	55.9	3.0	—	—	—	—	—	— —
	PP/S–N	0.903	9.3	3.0	8.8	2.9	9.9	3.0	9.1	2.7	9.6	2.7	10.1	3.1
Mandibular skeletal relationships														
Antero-posterior	S–N–B	0.953	74.2**	2.9	75.5	3.0	75.7**	3.3	76.3**	2.9	76.3	3.1	77.6**	2.2
	S–N–Pog	0.965	73.6**	2.9	74.9	3.0	74.9***	3.3	75.4**	2.7	75.6	2.8	77.4***	2.7
Vertical	N–Me	0.990	112.1	4.4	118.5	5.9	123.7	6.9	113.1	5.0	116.8	4.6	122.8	6.2
	S–Me	0.995	108.2**	4.1	115.5	5.2	120.3*	6.3	111.0**	5.2	115.4	4.4	123.2*	5.6
	S–N/Ar–G	0.922	93.1	4.6	93.9	4.9	94.4	5.7	94.1	3.8	93.5	3.9	92.7	4.4
	S–N/G–Me	0.986	39.9	4.8	39.6*	5.2	40.4***	6.3	37.8	4.5	36.9*	4.7	36.1***	4.6
	S–Ar–Go	0.957	143.5	5.3	144.2	5.5	144.7	6.1	—	—	—	—	—	—
	Y–Axis	0.962	73.5*	2.8	73.5*	3.3	74.3***	3.6	72.1*	2.5	71.9*	2.7	71.1***	2.7
	N–Ar/S–Gn	0.980	90.5**	2.7	90.9**	3.2	92.0***	3.7	88.7**	3.5	88.6**	2.9	88.0***	2.2
	N–Pog/G–Me	0.987	66.5	3.5	65.5*	3.8	64.7*	5.2	66.8	4.1	67.5*	4.6	66.6*	3.7
Mandible	Ar–G	0.979	39.2***	2.7	41.7*	4.0	43.9***	4.3	42.0***	2.9	43.9*	3.6	47.0***	3.3
	Go–Pog	0.978	68.1	3.9	72.3	4.2	74.2	4.1	—	—	—	—	—	—
	Go–Me	0.969	62.1	3.9	66.6	4.1	68.4***	3.8	63.9	4.2	67.0	2.6	72.4***	4.4
	Ar–Pog	0.996	95.0	3.6	100.6	4.6	104.3	5.4	—	—	—	—	—	—
	Ar–G–Me	0.983	126.8**	6.4	125.7	5.9	126.0	7.9	123.7**	6.6	123.4	5.4	123.4	5.9
Intermaxilliary relationships														
Antero-posterior	A–N–B	0.924	7.3***	1.4	6.3***	1.0	6.3***	1.2	3.8***	1.5	3.3***	1.3	2.6***	1.7
	A–B/N–Pog	0.881	9.7***	2.0	8.4***	1.7	8.4***	1.8	5.2***	2.3	5.0***	2.9	4.1***	2.6
Vertical	ANS–Me	0.989	64.9	3.7	68.2	4.7	70.9	5.6	—	—	—	—	—	—
	PP/G–Me	0.989	30.5	5.1	30.8	5.3	30.3	5.9	—	—	—	—	—	—
Dentoalveolar relationships														
	U1/S–N	0.982	104.7	6.3	106.8	6.3	108.2	6.3	104.9	5.0	105.5	7.0	106.0	4.7
	L1/G–Me	0.972	97.8	5.2	97.8	5.4	99.3*	7.5	97.6	6.2	99.1	5.1	96.4*	5.1
	U1/L1	0.990	117.6	8.1	115.8	7.5	112.1***	9.1	119.7	6.9	118.5	9.9	121.5***	6.9
	Occ.P/S–N	0.847	22.4	3.4	20.5	3.9	20.3	3.9	22.8	2.9	21.3	3.1	19.8	3.3

The symbols mean the significant level: *$P < 0{\cdot}05$; **$P < 0{\cdot}01$; ***$P < 0{\cdot}001$.

Results

The coefficient of reliability for almost all cephalometric parameters satisfied the level of confidence (>0·90). However, two results, A–B/N–Pog angle and Occ.P/S–N angle, had a low coefficient of reliability (<0·90); these should be viewed with caution (Houston, 1983).

Comparison between the cephalometric measurements of the Class II division 1 Japanese girls and Class I controls are shown in Table 2.

The results may be summarized as follows:

Cranial Base Relationships

Although the mean anterior cranial base length (S–N) tended to be shorter in subjects with Class II division 1 malocclusions, this was significantly different only at the early permanent dentition stage.

Maxillary Skeletal Relationship

The anteroposterior position of the maxilla evaluated by the S–N–A angle showed a significantly more protrusive maxilla in Class II division 1 female subjects compared with the control. According to the angle between the palatal and S–N plane, the maxilla was positioned approximately at the same vertical position in both the test and control groups.

Mandibular Skeletal Relationship

The anteroposterior position of the mandible was evaluated by the S–N–B and S–N–Pog angles. The mandible in the Class II division 1 group indicated a significant retrusive position. The vertical position of the mandible was evaluated by two linear parameters (N–Me, S–Me) and five angles (S–N/Ar–G, S–N/G–Me, *y*-axis, N–Ar/S–G, and N–Pog/G–Me). The anterior facial height (N–Me) showed no significant difference in the test and control groups, but S–Me in Class II division 1 group indicated a significant excessive vertical development. It was evident that the following angular measurements showed a significantly excessive vertical development in the Class II sample: S–N/G–Me angle, *y*-axis, N–Ar/S–Gn angle, and N–Pog/G–Me angle. In contrast, the test and control subjects had a similar S–N/Ar–G angle. The mean length of the mandibular ramus (Ar–G) was significantly shorter in the Class II division 1 sample, but the mandibular body length (Go–Me) was not significantly different from the control, except for Group 3. Subjects with Class II malocclusion also had a similar gonial angle (Ar–G–Me angle), except for Group 1.

Intermaxillary Relationship

The anteroposterior relationship between the maxilla and mandible was evaluated by the A–N–B angle and the A–B/N–Pog angle. All were significantly larger in the Class II subjects compared with the controls.

Dentoalveolar Relationship

These were similar in the Class II division 1 and Class I groups except at the early permanent dentition, where the lower incisors were more proclined. Otherwise, the inclination of both upper and lower incisors, and the occlusal plane inclination were similar in both groups.

Discussion

Our study revealed that Class II Division 1 subjects had on average an anteriorly positioned maxilla when compared to JSPD normal controls. When we considered the mandible our results showed a significant retrognathia in the Class II sample according to the S–N–B angle and a shorter mandibular ramus. This agrees with Menezes (1974), who noted that all mandibular dimensions, overall mandibular length, mandibular body length, and vertical ramus were significantly shorter in Class II division 1 subjects. Other investigators have also reported the presence of a short mandibular body length (Nelson and Higley, 1948; Craig, 1951; Henry, 1957). However, in these Caucasian studies, there was no significant difference in the mandibular ramus length between Class II and I. These data indicated that the short mandibular ramus is one of the distinctive features of Japanese female subjects with Class II division 1 malocclusion, and the short posterior facial height (Ar–G) in the present study is the cause of the dolichofacial pattern. Furthermore, the retrusive mandible may be explained by the short mandibular ramus, slightly short mandibular body, and the obtuse gonial angle associated with backward rotation of the mandible.

Conclusions

The characteristic features of Japanese Class II division 1 malocclusion are as follows:

1. Slightly obtuse cranial base angle.
2. Relatively anterior positioned maxilla.
3. Significantly short mandibular ramus.
4. Retrognathic mandible.
5. Slightly obtuse gonial angle.
6. High-angle facial pattern
7. Relatively short posterior facial height associated with a short mandibular ramus.

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References

Adams, C. P. and Kerr, W. J. (1981)
Overbite and face height in 44 male subjects with class I, class II/1 and class II/2 occlusion,
European Journal of Orthodontics, **3,** 125–129.

Bacon, W., Eiller, V., Hildwein, M. and Dubois, G. (1992)
The cranial base in subjects with dental and skeletal Class II,
European Journal of Orthodontics, **14,** 224–228.

Cooke, M. S. and Wei, S. H. (1991)
Cephalometric errors: a comparison between repeat measurements and retaken radiographs,
Australian Dental Journal, **36,** 38–43.

Craig, C. E. (1951)
The skeletal patterns characteristic of Class I and Class II, division 1 malocclusions, in norma lateralis,
Angle Orthodontist, **21,** 44–56.

Drelich, R. C. (1948)
A cephalometric study of untreated Class II, division 1 malocclusion,
Angle Orthodontist, **18,** 70–75.

Harris, J. E., Kowalski, C. J. and Walker, G. F. (1972)
Discrimination between normal and class II individuals using Steiner's analysis,
Angle Orthodontist, **42,** 212–220.

Haynes, S. (1970)
The prevalence of malocclusion in English children aged 11–12 years,
Transactions of the European Orthodontic Society, 89–98.

Henry, R. G. (1957)
A Classification of Class II, division 1 malocclusion,
Angle Orthodontist, **27,** 83–92.

Hitchcock, H. P. (1973)
A cephalometric description of Class II, division 1 malocclusion,
American Journal of Orthodontics, **63,** 414–423.

Houston, W. J. (1983)
The analysis of errors in orthodontic measurements,
American Journal of Orthodontics, **83,** 382–390.

Iwasawa, T., Nakakuki, M. and Matsumoto, Y. (1969)
A study on lateral head plates of normal occlusion and malocclusions,
Journal of Japanese Orthodontic Society, **28,** 105–112.

Iwasawa, T., Okada, T., Ichikawa, M., Kubota, M. and Iwasaki, T. (1980)
Morphological studies on the bimaxillary protrusion patients. Part 2. On Angle Class II malocclusion,
Journal of Japanese Orthodontic Society, **39,** 167–175.

Japanese Society of Pediatric Dentistry (1995)
A study on the cephalometric standards of Japanese children,
Japanese Journal of Pediatric Dentistry, **33,** 659–696.

Kitai, N., Takada, K., Yasuda, Y., Adachi, S., Hirase, E., Kitaguchi, T. and Sakuda, M. (1990)
Prevalence of malocclusions and demand for orthodontic treatment among students at a women's high school,
Journal of the Osaka University Dental School, **35,** 321–327.

Kuwahara, Y. (1968)
A study on dento-facial morphology in maxillary protrusion,
Journal of the Stomatological Society, **35,** 637–656.

Lau, J. W. and Hagg, U. (1999)
Cephalometric morphology of Chinese with Class II division 1 malocclusion,
British Dental Journal, **186,** 188–190.

Lew, K. K., Foong, W. C. and Loh, E. (1993)
Malocclusion prevalence in an ethnic Chinese population,
Australian Dental Journal, **38,** 442–449.

McNamara, J. A. (1981)
Components of class II malocclusion in children 8–10 years of age,
Angle Orthodontist, **51,** 177–202.

Menezes, D. M. (1974)
Comparisons of craniofacial features of English children with Angle Class II division l and Angle Class I occlusions,
Journal of Dentistry, **2,** 250–254.

Miura, F., Sakamto, T., Irie, M. and Yano, Y. (1958)
Analysis of Class II, division 1 malocclusion in Japanese by Henry's method,
Journal of Japanese Orthodontic Society, **17,** 201–209.

Nelson, W. E. and Higley, L. B. (1948)
Length of mandibular basal bone in normal occlusion and Class I malocclusion compared to Class II, division 1 malocclusion,
American Journal of Orthodontics, **34,** 610–617.

Proffit, W. R., Fields, H. W. and Moray, L. J. (1998)
Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES III survey,
International Journal of Adult Orthodontics and Orthognathic Surgery, **13,** 97–106.

Renfroe, E. W. (1948)
A study of the facial patterns associated with Class I, Class II, division 1 and Class II, division 2 malocclusion,
Angle Orthodontist, **18,** 12–15.

Susami, R., Asai, Y., Hirose, K., Hosoi, T. and Hayashi, I. (1971)
The prevalence of malocclusion in Japanese school children. 1. Total frequency,
Journal of Japanese Orthodontic Society, **30,** 221–229.