European Journal of Orthodontics 24 (2002) 61–67

Morphological differences in the craniofacial structure between Japanese and Caucasian girls with Class II division 1 malocclusions

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SUMMARY The craniofacial features of 49 Japanese and 75 British Caucasian girls with Class II division 1 malocclusions were evaluated from lateral cephalometric radiographs, and the morphological differences between both races were examined. The subjects' ages ranged from 11 years 1 month to 12 years 11 months. The mean values of 13 linear and 13 angular cephalometric parameters were compared.

The Japanese Class II division 1 sample had a significantly shorter anterior cranial base length (S–N; $P < 0.001$) and a more obtuse articular angle (S–Ar–Go; $P < 0.001$). Analysis of the dentoalveolar components in Japanese subjects showed more proclined lower incisors (L1/Go–Me; $P < 0.05$) and a steeper occlusal plane (Occ.P/S–N; $P < 0.01$) relative to those of Caucasians. The short anterior cranial base length and excessive vertical development in the Japanese population might be common racial morphological features, but the main reason for the Class II division 1 skeletal disharmony in both races was different; it was caused by the anteriorly positioned maxilla in Caucasians and the backward rotated mandible in the Japanese.

Introduction

Although many investigators have attempted to clarify the morphological features of Japanese and Caucasian Class II division 1 patients (Table 1), there are few previous studies that have examined the morphological differences in the craniofacial structure between Japanese and Caucasian patients with Class II division 1 malocclusions (Ono *et al*., 1986; Yamaki, 1987; Ishizuka *et al*., 1989). Ono *et al*. (1986) reported that both the maxilla and mandible of Japanese were located more posteriorly than those of Americans, with the Japanese exhibiting greater vertical development. Yamaki (1987) noted that Japanese Class II division 1 patients had a relatively shorter and more posterior positioned maxilla, and greater backward rotation of the mandible compared with Caucasian Class II division 1 patients, and stated that the differences in the maxillary region between Japanese and Caucasians with Class II division 1 malocclusions were common racial differences, and not specific to Class II division 1 malocclusions. Ishizuka *et al*. (1989) reported that Japanese Class II division 1 patients had a significantly shorter anterior cranial base and maxilla, and evidently more backward rotation of the mandible compared with Caucasians. Despite these investigations, there is still a lack of information regarding the morphological differences between Japanese and Caucasians with Class II division 1 malocclusions.

The purpose of this study was to further define the morphology of Japanese Class II division 1 malocclusion, to compare in features with those

Table 1 Previous morphological studies of Class II malocclusions.

Japanese		Caucasians	
		Drelich	1948
		Nelson and Higley	1948
		Renfroe	1948
		Gilmore	1950
		Craig	1951
		Riedel	1952
		Altemus	1955
		Henry	1957
		Blair	1954
Miura *et al.*	1958		
Kuwahara	1968		
Iwasawa *et al.*	1969		
		Rothstein	1971
		Harris *et al.*	1972
		Hitchcock	1973
		Konfino	1973
		Menezes	1974
Iwasawa *et al.*	1980	Moyers *et al.*	1980
		Adams and Kerr	1981
		McNamara	1981
		Anderson and Popovich	1983
		Järvinen	1984
		Siriwat and Jarabak	1985
Tokuda	1987	Carter	1987
		Bacon *et al.*	1992
		Karlsen	1994
Kasai *et al.*	1995	Rosenblum	1995
		Dibbets	1996
		Baccetti *et al.*	1997
		Pancherz *et al.*	1997

of a Caucasian Class II division 1 sample and to elucidate the differences in craniofacial morphology between both races.

Material and methods

The Japanese and Caucasian cephalometric radiographs were selected at random from a private orthodontic practice in Himeji, Japan, and the Eastman Dental Hospital, London, UK, respectively. As a consequence, the lateral cephalometric radiographs of 49 Japanese and 75 Caucasian girls with Class II division 1 malocclusions with no history of orthodontic treatment were examined. All Japanese and Caucasian subjects had an ANB angle >5 degrees on an Angle Class II molar relationship and increased overjet. The mean age of each group is shown in Table 2.

Table 2 Age distribution of the Japanese and Caucasian female sample in this study.

Japanese Class II division 1		Caucasian Class II division 1	
$n = 49$		$n = 75$	
Mean	SD	Mean	SD
11 years 8 months	6.9	11 years 11 months	6.2

Cephalometric analysis

For each group, all lateral cephalometric radiographs were taken using the same cephalostats. The Japanese and Caucasian radiographs had an image magnification of 10 and 7 per cent, respectively. All linear measurements reported in this study were adjusted accordingly. The lateral cephalometric radiographs of each subject were 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 previously reported (Cooke and Wei, 1991). The 13 linear and 13 angular measurements mostly derived from the

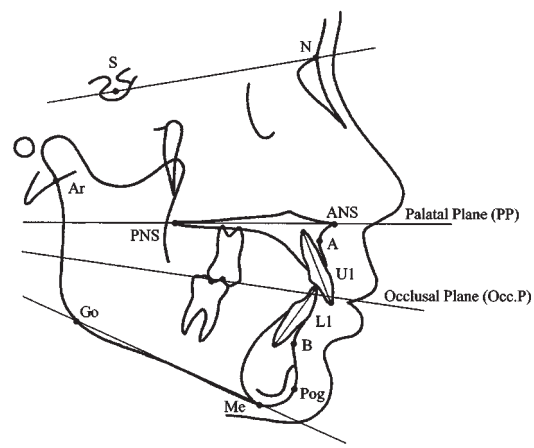

Figure 1 Cephalometric landmarks used in this study.

analyses of Steiner (1953, 1959, 1960) and Jarabak (Jarabak and Fizzell, 1972) were used in this study.

Error of the method

All 124 lateral head films were traced twice. The second tracing was carried out a few weeks later. The error of the method was determined using the coefficient of reliability, which 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).

Statistical analysis

Means and standard deviations of all parameters were calculated. The D'Agostino–Pearson test was used to test for normality of distribution in the cephalometric variables prior to using parametric tests. Equality of variance was tested between each of the groups. The unpaired Student's and Welch's *t*-test were applied to each parameter to identify the differences between groups; the former was applied for the parameters that had equal variances and the later was applied for those that had unequal variances at the *F*-test.

Results

The coefficient of reliability for all cephalometric parameters indicated values within a range between 0.912 and 0.996, and satisfied the level of confidence (>0.90; Houston, 1983). Comparison between the cephalometric measurements of Japanese and Caucasian girls with Class II division 1 malocclusions is shown in Table 3 and Figure 2.

Cranial base relationships

The mean anterior (S–N) and total cranial base length (N–Ar) were significantly shorter in Japanese subjects compared with Caucasians ($P < 0.001$). However, the posterior cranial base length (S–Ar) and the saddle angle (N–S–Ar) did not show significant differences between the groups.

Maxillary skeletal relationships

The anteroposterior position of the maxilla was evaluated using S–A, Ar–A, and the S–N–A angle. The linear parameters, S–A and Ar–A, showed a significantly more protrusive maxilla in the Caucasian sample compared with the Japanese ($P < 0.001$), but the S–N–A angle did not indicate a significant difference between groups. According to the N–ANS distance, the Japanese had a significantly larger anterior upper facial height ($P < 0.05$). The PP/S–N angle was slightly larger in Japanese subjects, although the difference was not significant.

Mandibular skeletal relationships

The anteroposterior position of the mandible was evaluated by the S–B and S–N–B angle. According to these parameters, there was no significant difference in the anteroposterior position of mandible between Japanese and Caucasian. The anteroposterior position of the chin (S–Pog and the S–N–Pog angle) also showed no significant difference between the Japanese and the Caucasian sample. The vertical position of the mandible was evaluated using N–Me, and angles S–N/Go–Me and S–Ar–Go. All these parameters in the Japanese group indicated significantly more vertical development compared with Caucasians ($P < 0.01$, $P < 0.001$, and $P < 0.001$, respectively). The mean length of the mandibular ramus (Ar–Go) showed no significant difference between the groups, but the mandibular body (Go–Pog) and the total mandibular length (Ar–Pog) in the Caucasian sample were significantly longer compared with the Japanese sample ($P < 0.05$). Both groups had a similar gonial angle (Ar–Go–Me).

Inter-maxillary relationships

There was no significant difference between the groups in the anteroposterior relationship between the maxilla and mandible (ANB angle). The vertical height was evaluated by the ANS–Me distance and the PP/Go–Me angle. According to these measurements, the Japanese subjects had a significantly larger anterior lower facial height ($P < 0.05$, $P < 0.001$, respectively).

Table 3 Comparison of mean values between Japanese and Caucasian females with Class II division 1 malocclusions.

		Japanese Class II division 1		Caucasian Class II division 1		Significance
		Mean	SD	Mean	SD	
Cranial base relationships	S–N	61.4	2.4	65.4	2.7	***
	S–Ar	32.1	2.4	31.6	2.8	NS
	N–Ar	84.6	3.8	88.3	3.8	***
	N–S–Ar	126.8	4.4	127.6	5.3	NS
Maxillary skeletal relationships						
Anteroposterior	S–A	75.9	3.1	78.3	3.5	***
	Ar–A	78.2	3.5	81.9	4.5	***
	S–N–A	82.0	3.2	81.7	3.3	NS
Vertical	N–ANS	49.6	2.6	48.5	2.8	*
	PP/S–N	9.1	2.9	8.2	3.5	NS
Mandibular skeletal relationships						
Anteroposterior	S–B	95.6	4.4	94.9	4.8	NS
	S–N–B	75.9	3.1	75.4	3.1	NS
	S–Pog	107.1	5.0	106.7	5.6	NS
	S–N–Pog	75.2	3.0	76.0	3.4	NS
Vertical	N–Me	109.4	5.6	106.4	5.7	**
	S–N/Go–Me	41.1	5.2	37.0	5.6	***
	S–Ar–Go	143.5	5.1	139.2	7.4	***
Mandible	Ar–Go	38.1	3.7	39.2	3.9	NS
	Go–Pog	66.0	3.5	67.6	4.5	*
	Ar–Pog	93.0	4.6	95.1	5.5	*
	Ar–Go–Me	130.8	5.7	130.2	6.4	NS
Inter-maxillary relationships						
Anteroposterior	A–N–B	6.1	1.0	6.3	1.4	NS
Vertical	ANS–Me	62.6	4.6	60.9	4.5	*
	PP/Go–Me	32.0	5.1	28.9	4.7	***
Dentoalveolar relationships	U1/S–N	107.3	6.6	105.0	7.9	NS
	L1/Go–Me	96.6	4.8	94.3	6.6	*
	Occ.P/S–N	20.0	3.4	17.5	4.5	**

NS, no significant differences; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

Dentoalveolar relationships

The inclination of the upper incisors was similar in both groups, but the lower incisors in the Japanese subjects were significantly more proclined compared with the Caucasian group. The occlusal plane inclination in the Japanese was significantly steeper compared with the Caucasians ($P < 0.01$).

Discussion

The short anterior cranial base length in the Japanese Class II division 1 sample does not represent a specific morphological feature of a Class II division 1 malocclusion, but rather a feature of the Japanese population in general. Masaki (1980) reported that Japanese Class I patients had a significantly shorter anterior cranial base length when compared with Caucasians. Cooke and Wei (1989) also found that southern Chinese boys had significantly shorter anterior cranial base length compared with Caucasian boys. Thus, a short anterior cranial base could be a racial feature of an Asian population who have a brachycephalic skeletal pattern. All previous studies have reported that Japanese patients have more excessive vertical skeletal development compared with Caucasians in both Class I

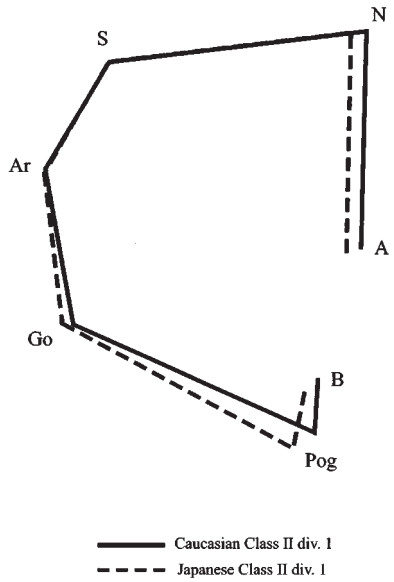

Figure 2 Comparison between Class II division 1 Japanese and Caucasian females.

(Masaki, 1980; Nezu *et al*., 1982; Deguchi *et al*., 1993; Miyajima *et al*., 1996) and Class II division 1 malocclusions (Ono *et al*., 1986; Yamaki, 1987; Ishizuka *et al*., 1989). Although a steeper mandibular plane has been reported in Japanese Class II studies (Miura *et al*., 1958; Kuwahara, 1968; Iwasawa *et al*., 1969, 1980; Ishii *et al*., 2001), previous racial comparisons have concluded that there is no significant difference in the form and size of the mandible between Japanese and Caucasians for both Class I (Masaki, 1980; Miyajima *et al*., 1996) and Class II division 1 malocclusions (Ishizuka *et al*., 1989). Although a shorter mandibular body length and total mandibular length were shown in Japanese subjects in this study, these findings could not be the conclusive differences since low significance ($P < 0.05$) was calculated. The high-angle facial pattern of Japanese Class II division 1 subjects could be related to the more obtuse articular angle, leading to a greater backward rotation of the mandible, rather than an effect of the mandibular form. Therefore, the inter-maxillary disharmony seen in Japanese Class II division 1 subjects may be a feature of the vertical problem associated with a backward rotation of the mandible, whereas in Caucasians this disharmony may reflect a horizontal problem associated with an anterior positioned maxilla.

In the light of these findings, orthodontic treatment mechanics for Class II division 1 malocclusions should be considered depending on race. Nezu *et al*. (1982) stated that control of the chin, and vertical control of bite opening during orthodontic treatment was more important for Japanese patients, since that population had a tendency for facial axis opening; anteroposterior force may be more appropriate for Class II Caucasian malocclusions.

Conclusions

The morphological differences between Japanese and Caucasians with Class II division 1 malocclusions are as follows:

1. Caucasians had a significantly longer anterior cranial base length and a slightly longer mandibular body length.
2. Japanese had a significantly more obtuse articular angle, significantly steeper mandibular and occlusal plane angles, high-angle facial pattern, and significantly more proclined lower incisors.

Class II division 1 maxillary protrusion in Japanese girls may represent a vertical problem, whereas in Caucasians this may indicate a horizontal problem. The backward rotation of the mandible associated with Japanese and the anterior positioned maxilla in Caucasians could be the main reasons for the inter-maxillary disharmony.

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Acknowledgement

The authors wish to thank Dr Ryuzo Kanomi for generously providing the Japanese cephalometric radiographs used in this study.

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