The Online
ANGLE ORTHODONTIST
An International Journal of Orthodontics and Dentofacial Orthopedics
78th Anniversary 1930-2008

[Print Version]
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doi: 10.2319/0003-3219(2007)077[0397:LIRICI]2.0.CO;2
The Angle Orthodontist: **Vol. 77, No. 3, pp. 397–403.**

Longitudinal Intermaxillary Relationships in Class III Malocclusions with Low and High Mandibular Plane Angles

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ABSTRACT

Objective: To analyze the sagittal, vertical, and transverse relationships of the maxilla and mandible in Japanese girls with Class III malocclusions with different inclination of mandibular plane.

Materials and Methods: This longitudinal study utilized serial posteroanterior and lateral cephalograms of 56 untreated subjects from the age of 8 years until the age of 14 years (low mandibular plane angle group: n = 20; average mandibular plane angle group: n = 15; high mandibular plane angle group: n = 21). Sagittal and vertical growth was analyzed on the basis of lateral cephalograms, and transverse growth was analyzed on the basis of posteroanterior cephalograms.

Results: There was no significant difference in intermaxillary sagittal relationships among the three groups from age 8 until 14. On the other hand, there were significant changes in the vertical and transverse intermaxillary relationships during this period. When comparing the three groups at the same age, there were significant differences in vertical and transverse intermaxillary relationships in some ages, whereas no significant difference was found in sagittal relationships in any ages.

Conclusions: The inclination of mandibular plane might play a role in anticipating changes in vertical and transverse intermaxillary relationships from 8 until 14 years of age.

KEY WORDS: Class III malocclusion, Growth, Intermaxlliary relationship.

Accepted: June 2006. Submitted: April 2006

INTRODUCTION Return to TOC

Class III malocclusions are common clinical problems among Asian people. Yang[1] discovered that 40%–50% of orthodontic patients in Korea sought treatment for Class III malocclusions. Kitai et al[2] reported that 5%–20% of the Japanese population have the characteristics of a Class III malocclusion. Similarly, Johnson et al[3] discovered that 23% of Chinese children had Class III malocclusions.

The dentofacial disharmony associated with Class III malocclusions is challenging in both the diagnostic and the treatment areas. Treatment decisions and their successes or failures rely heavily on the growth potential in the Class III individual.[4,5] An understanding of the craniofacial growth behavior, especially the relative intermaxillary relationship (RIR), in Class III patients will help in determining the treatment timing and mechanics.

Longitudinal data are of great value to orthodontists who are interested in the detailed study of facial growth. The use of normative cephalometric standards obtained for subjects at one age in the diagnosis of individuals who might be of a completely different age group could adversely influence both the diagnosis and the treatment plan.[6]

A number of studies, predominantly based on Class I samples, have addressed the development of the intermaxillary relationships.[7–12] In contrast, few studies have focused on the RIR and growth in Class III malocclusions.

Sugawara and Mitani[13] have studied the sagittal RIR of Japanese boys from the age of 10 years until the age of 15 years and found the skeletal Class III malocclusions showed neither excessive mandibular growth nor deficient maxillary growth when compared with the Class I subjects. Their investigations have focused only on sagittal growth according to the lateral cephalograms. Evaluation of the sagittal, vertical, and transverse RIRs is needed for a comprehensive dentofacial analysis. Radiographic analysis of growth in all three dimensions has rarely been described in the same population with Class III malocclusions.

The inclination of the mandibular plane (MP-SN) is a major determinant of the vertical dimension of a face (long or short). A person with a larger MP-SN angle usually has a long face type, and a person with a smaller MP-SN angle usually has a short face type. Many reports have suggested a possible link between the developments of the maxillofacial complex and different face types.[14–18]

Hence, the aim of the present study was to analyze the RIR changes with growth in three dimensions (sagittal, vertical, and transverse) during an orthodontically relevant period of dentofacial development (ie, between 8 and 14 years of age) in Class III malocclusions with low, average, and high MP-SN angles.

MATERIALS AND METHODS Return to TOC

Longitudinal lateral and posteroanterior cephalograms of 56 Japanese girls were selected from the files of the Orthodontic Department at Niigata University Medical and Hospital, which were recorded during the years 1984 to 1999. Only Japanese girls were selected as the present subjects because of growth difference in gender and race. The Class III subjects exhibited bilateral Class III molar and canine relationships and skeletal Class III relationship.

All subjects in Class III malocclusions were selected from the files of patients waiting for surgical orthodontic treatment. Nine of these Class III malocclusion patients had no need for orthodontic treatment during this period. Others did not receive orthodontic treatment because of their own personal reasons, such as being unwilling to do treatment early. Exclusion criteria included systemic disease and marked mandibular asymmetry. Serial cephalometric films were exposed biennially at ages 8, 10, 12, and 14 years.

The sample was categorized into three groups according to the MP-SN angles at age 8 years: (1) low angle (<27°, n = 20), (2) average angle (27°–37°, n = 15), and (3) high angle (>37°, n = 21). The mean MP-SN angles at about age 8 years were 25.39° ± 2.12° for the low-angle group, 32.29° ± 2.46° for the average-angle group, and 39.12° ± 2.38° for the high-angle group.

Lateral and posteroanterior cephalograms were taken by a standardized technique with the jaws in centric occlusion. The distance from the anode to the midsagittal (or midtransverse) plane of the patient was 150 cm, whereas the distance from the midsagittal plane to the film was 15 cm.

All lateral and posteroanterior cephalometric radiographs were scanned (Epson 2200, Epson Inc, Tokyo, Japan) and imported to analysis software (Igensoft Company, Shanghai, China). The landmarks were digitized by the first author (F.C.), and then linear, angular items were measured by computer. The landmarks used in this study are shown in Figures 1 and 2.

The following angular and linear items (Figures 1 and 2) were measured:

a. ANB (°): the angle formed by the planes nasion-point A and nasion-point B

b. Wits appraisal (mm): the distance between the point AO (the perpendicular projection onto the occlusal plane from point A) and the point BO (the perpendicular projection onto the occlusal plane from point B)

c. PP-MP (°): the angle formed by the palatal plane (ANS-PNS) and mandibular plane (Go-Gn)

d. PFH/AFH: the ratios of posterior facial height (S-Go) to anterior facial height (N-Me)

e. J-J/Ag-Ag: the ratios of the maxillary width (J-J) to mandibular width (Ag-Ag)

f. Mx-Mx/Go-Go: the ratios of the maxillary width (Mx-Mx) to mandibular width (Go-Go)

The precision of the identification of landmarks was tested by double determination, separated by at least a 10-day interval, by the same examiner. The reproducibility of the measurements was determined by picking 20 cephalograms from each of four groups at random, redigitizing points, and computing the difference between all pairs. The mean difference was taken as a parameter for the reproducibility of the measurements. The size of the combined method error (ME) was calculated by ME = $(\Sigma d^2/2n)^{1/2}$, in which d was the difference between two registrations of a pair and n was the number of samples. No significant differences were found between the measurements at different occasions ($P > .05$). The standard deviations ranged from 0.20 mm to 0.32 mm for the distances and from 0.15° to 0.25° for the angles.

Statistical Analysis

Data were analyzed by using a statistical package program SPSS Version 10.0 (SPSS Inc, Chicago, Ill). Descriptive statistics, including the means and standard deviations, were calculated for each subject. Student's *t*-test with a group design was used to compare the difference among the three groups. Bonferroni multiple comparison tests were used to assess the effects of age on the longitudinal growth changes in the measurements used in this study. $P < .05$ was considered to be statistically significant.

RESULTS Return to TOC

Descriptive statistics, including means and standard deviations, for each age group from 8 years to 14 years and the *P*-values of the group comparison are shown in Table 1. Table 2 shows the *P*-values of the age comparisons for each age group from 8 years to 14 years. Figure 3 shows the RIR change in three group with ages.

Sagittal Intermaxillary Relationship (ANB and Wits Appraisal)

With respect to the group comparison, no significant differences were found at any age among the three groups (Table 1). Concerning the age comparison, there were no significant changes in ANB and Wits appraisal in each group from 8 years to 14 years (Table 2; Figure 3).

Vertical Relationship (PP-MP and PFH/AFH)

Group differences among the three groups were statistically significant from ages 8 years and 14 years (Table 1). Concerning age comparison, significant changes in both PP-MP and PFH/AFH were found in each group during the same age period (Table 2; Figure 3).

Transverse Relationship (J-J/Ag-Ag and Mx-Mx/Go-Go)

With respect to the group comparisons, the significant differences were found at age 14 between the low-angle group and the average-angle or high-angle group (Table 1). Concerning the age comparison, significant differences were found between any age periods in the low-angle group, whereas there was a significant difference in the average-angle and high-angle group in the same age period (Table 2; Figure 3).

DISCUSSION Return to TOC

The period between 8 and 14 years of age is a stage at which corrective orthodontic treatment is most frequently applied. Therefore, an evaluation of the growth changes normally occurring during this period could provide valuable information for treatment planning.[19]

The angle ANB is commonly used to describe skeletal discrepancies between the maxilla and the mandible. However, its reliability as a true indicator of the sagittal RIR has been questioned, and many investigators have used alternative angular and linear measurements such as the Wits appraisal. To overcome the limitations ascribed to the use of ANB in the cephalometric evaluation of facial form and its change with growth,[20] both ANB and the Wits appraisal were used to evaluate sagittal jaw relationship in this study. Similar to previous studies,[8,13,21] PP-MP and PFH/AFH were selected to evaluate vertical RIR. From an analysis of the literature,[22,23] it was ascertained that J-J and Mx-Mx were best discriminators of the subjects with maxillary width, and Ag-Ag and Go-Go were best discriminators of the subjects with mandibular width. In the present study, therefore, both J-J/Ag-Ag and Mx-Mx/Go-

Go were selected to evaluate transverse RIR.

Sagittal Intermaxillary Relationship

Sugawara and Mitani[13] studied the craniofacial growth of untreated skeletal Class III malocclusion in Japanese boys from the age of 10 years until the age of 15 years and found no significant changes in ANB angle and Wits appraisal during this period. Our results support their conclusion that the sagittal RIR has been established before the pubertal growth and remains through puberty.

Vertical Intermaxillary Relationship

In the present study, PP-MP decreased and PFH/ AFH increased with ages in the low-angle group and PP-MP increased and PFH/AFH decreased with ages in the high-angle group. This might be because the mandibular plane was rotated counterclockwise in the low-angle group, whereas it was rotated clockwise in the high-angle group. From the functional anatomy point of view, the skeletal mandibular growth direction is influenced by masticatory function, and jaw-closing muscle activity is said to be greatest in subjects with lower MP-SN angles.[18] The difference of jaw-closing muscle activity leads to the different rotation of the mandible. These findings fail to support the observation by Nanda,[8] who stated that the pattern of vertical facial development was established at an early age and was maintained during the progression of growth.

Transverse Intermaxillary Relationship

Huertas and Ghafari[23] found that the increase in mandibular width (Ag-Ag) was twice as much as that in maxillary width (J-J). Cortella et al[22] investigated a sample of 36 subjects (18 girls and 18 boys, Class I) from the Bolton-Brush growth center and reported greater growth observed in the mandibular width relative to the maxillary width in a normal group, and as a consequence the ratio of J-J to Ag-Ag decreased from the age of 8 years until the age of 14 years. In the present study, we also found J-J/Ag-Ag in the two Class III groups. The change of the J-J/Ag-Ag during this period is larger in the low-angle group than in the high-angle group. This is expected because the Ag and Go point is closer to the ramus and the area of attachment of the masticatory muscles. Jaw-closing muscle activity is said to be greatest in individuals with lower MP-SN angles.[18]

An important objective of orthodontic and orthopedic treatment during adolescence is to take advantage of growth in patients with skeletal discrepancies. Superior results can be achieved through effective management of the growing craniofacial complex. According to the present results, as Class III subjects in the mixed dentition present with a deficiency in maxillary arch width, correction of the intermaxillary arch width coordination should be considered during early treatment. Rapid maxillary expansion involving protraction of the maxilla with a facemask therefore might be one of the best orthopedic treatment protocols. Overcorrection should be considered especially for the low-angle group. Furthermore, the direction of protraction force should be carefully monitored because of different rotations during this growth period.[24]

In some patients with mild to moderate Class III problems, the improvement of transverse discrepancy between the maxilla and the mandible might lead to a spontaneous correction of the Class III occlusal relationship. The amount of possible posttreatment relapse in the transverse dimension suggests an overcorrection of the maxillary transverse deficiency as part of the treatment strategy in Class III subjects who are growing.[20,25]

Finally, the limitations of this study must be acknowledged because of the large individual variation encountered, and all findings present tendencies rather than general growth laws. Nevertheless, the clinician should be aware of the change in intermaxillary relationship with age and, as a consequence, pay attention to interarch discrepancies in the diagnostic process of different malocclusions. In addition, the morphological characteristics depicted in the various types of malocclusions may serve as additional determinants when choosing suitable treatment strategies in borderline cases between extraction and nonextraction treatment.

CONCLUSIONS Return to TOC

a. In the sagittal relationship, there is no significant difference among the three groups at the same age points, and there are no significant changes from age 8 years until age 14 years.

b. In the vertical relationship, there is a significant difference among the three groups at the same age points, and there are significant changes from age 8 years until age 14 years.

c. In the transverse relationship, there are significant differences among the three groups only at age 14 years, and there are significant changes in each group from age 8 years until age 14 years.

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TABLES Return to TOC

Table 1. The measurements of this study and the result of group comparison (data presented as mean ± standard deviation)[a]

	Group					
Measurement	Low angle (L)	Average angle (A)	High angle (H)	L vs A	L vs H	A vs H
ANB, °						
8 y	−1.56 ± 1.28	−1.46 ± 1.12	−1.32 ± 1.34	NS	NS	NS
10 y	−1.67 ± 1.29	−1.53 ± 1.27	−1.45 ± 1.82	NS	NS	NS
12 y	−1.79 ± 1.45	−1.73 ± 1.45	−1.68 ± 1.23	NS	NS	NS
14 y	−1.92 ± 1.72	−1.89 ± 1.29	−1.87 ± 1.34	NS	NS	NS
Wits appraisal, mm						
8 y	−7.17 ± 1.37	−6.72 ± 2.44	−6.31 ± 2.22	NS	NS	NS
10 y	−7.34 ± 2.23	−6.98 ± 2.27	−6.37 ± 2.78	NS	NS	NS
12 y	−7.43 ± 2.78	−7.12 ± 2.29	−6.65 ± 2.89	NS	NS	NS
14 y	−7.78 ± 2.19	−7.56 ± 2.57	−6.99 ± 2.67	NS	NS	NS
PP-MP, °						
8 y	21.25 ± 3.45	25.32 ± 3.23	32.42 ± 3.38	*	*	*
10 y	20.66 ± 3.74	25.66 ± 3.76	33.32 ± 3.56	*	*	*
12 y	19.38 ± 4.97	26.12 ± 3.38	34.12 ± 3.72	*	*	*
14 y	18.11 ± 4.61	26.22 ± 3.18	35.44 ± 3.58	*	*	*
PFH/AFH, mm						
8 y	60.23 ± 3.21	58.61 ± 4.16	56.56 ± 4.23	*	*	*
10 y	60.91 ± 2.19	58.32 ± 2.13	55.32 ± 2.45	*	*	*
12 y	61.72 ± 3.23	58.19 ± 2.47	54.95 ± 2.87	*	*	*
14 y	62.61 ± 2.61	58.05 ± 3.29	54.14 ± 3.21	*	*	*
J-J/Ag-Ag, mm						
8 y	73.64 ± 2.89	73.83 ± 3.71	74.03 ± 3.38	NS	NS	NS
10 y	71.57 ± 3.54	72.08 ± 3.22	72.68 ± 3.92	NS	NS	NS
12 y	69.42 ± 3.13	70.62 ± 3.15	71.25 ± 3.89	NS	NS	NS
14 y	66.12 ± 2.98	68.28 ± 4.23	69.29 ± 4.43	*	*	NS
Mx-Mx/Go-Go, mm						
8 y	64.63 ± 3.12	65.13 ± 4.27	65.41 ± 4.87	NS	NS	NS
10 y	62.52 ± 4.13	63.92 ± 3.17	64.22 ± 3.17	NS	NS	NS
12 y	60.46 ± 3.23	61.21 ± 2.56	62.12 ± 2.67	NS	NS	NS
14 y	56.12 ± 3.45	58.56 ± 4.12	59.14 ± 4.34	*	*	NS

[a] NS indicates not significant; * $P < .05$.

Table 2. *P*-value results of age comparison in two groups

Measurement	Age, y					
	8 vs 10	8 vs 12	8 vs 14	10 vs 12	10 vs 14	12 vs 14
ANB						
Low	.623	.321	.461	.397	.564	.632
Average	.678	.332	.107	.367	.267	.452
High	.544	.254	.092	.334	.153	.344
Wits appraisal						
Low	.711	.677	.446	.855	.474	.483
Average	.623	.615	.416	.895	.485	.497
High	.711	.646	.652	.618	.614	.539
PP-MP						
Low	.341	.012*	.013*	.362	.023*	.270
Average	.341	.332	.212	.362	.243	.270
High	.432	.023*	.010*	.211	.012*	.190
PFH/AFH						
Low	.312	.011*	.029*	.231	.032*	.068
Average	.312	.241	.219	.231	.262	.216
High	.342	.023*	.013*	.322	.019*	.061
J-J/Ag-Ag						
Low	.032*	.006*	.001*	.031*	.006*	.033*
Average	.053	.005*	.001*	.054	.008*	.033*
High	.058	.042*	.002*	.067	.013*	.034*
Mx-Mx/Go-Go						
Low	.031*	.012*	.001*	.034*	.002*	.001*
Average	.063	.015*	.001*	.034*	.002*	.019*
High	.074	.019*	.001*	.028*	.003*	.013*

* $P < .05$.

FIGURES Return to TOC

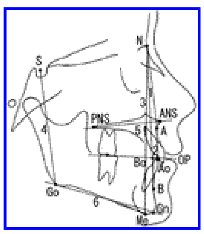

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Figure 1. Lateral cephalometric landmarks and measurements used in the present study. S indicates sella; N, nasion; Go, gonion; PNS, posterior nasal spine; ANS, anterior nasal spine; A, point A; B, point B; Me, menton; Gn, gnathion; Ao, the perpendicular projection onto the occlusal plane from point A; Bo, the perpendicular projection onto the occlusal plane from point B; OP, functional occlusal plane (a plane drawn through the points of occlusal contact between the first permanent molars and the first premolars [or deciduous molars]); 1, ANB angle; 2, Wits appraisal (Ao-Bo); 3, anterior facial height (AFH, N-Me); 4, posterior facial height (PFH, S-Go); 5, palatal plane (PNS-ANS); and 6, mandibular plane (Go-Gn)

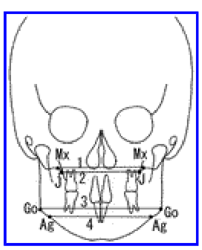

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Figure 2. Posteroanterior cephalometric landmarks used in the present study. J indicates jugale, the intersection of the outline of the tuberosity of the maxilla and the zygomatic buttress; Ag, antigonion, the lateral inferior margin of the antigonial protuberances; Mx, maxillare, the intersection of the lateral contour of the maxillary alveolar process and the lower contour of the maxillozygomatic process of the maxilla (left and right); Go, gonion, the point located at the gonial angle of the mandible; 1, Mx-Mx; 2, J-J; 3, Go-Go; and 4, Ag-Ag

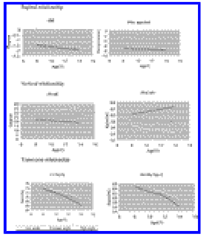

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Figure 3. The sagittal, vertical and transverse intermaxillary relationship from age 8 years until age 14 years in this study

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