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Longitudinal Evaluation of the Intermaxillary Relationship in Class III Malocclusions

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ABSTRACT

Objective: To analyze the sagittal, vertical, and transverse relationship of the maxilla and mandible in Japanese girls with Class III malocclusions.

Materials and Methods: This longitudinal study utilized biannual posteroanterior and lateral cephalograms of 44 untreated subjects from age 8 to 14 years (Class I, 23 girls; Class III, 21 girls). Sagittal and vertical growths were 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 sagittal intermaxillary relationships in Class III malocclusion from age 8 to 14 years, whereas significant difference in vertical and transverse intermaxillary relationships appeared with ages during this period. When comparing Class III to Class I malocclusions at the same age point, there were significant differences in sagittal and transverse intermaxillary relationships, whereas significant difference in vertical intermaxillary relationship appeared after 12 years of age.

Conclusion: The results suggest that the sagittal intermaxillary relationships in Class III malocclusions were established before 8 years of age and remained through puberty and that the vertical and transverse intermaxillary relationships in Class III malocclusions changed with ages from 8 to 14 years.

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

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INTRODUCTION Return to TOC

Class III malocclusions are common clinical problems among Asian patients. 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 have Class III malocclusions.

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

Longitudinal data is of great value to orthodontists who are interested in the detailed study of facial growth. The use of normative cephalometric standards obtained for subjects of one age group when making a 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 IR and growth in Class III malocclusions.

Sugawara et al[13] studied the sagittal IR of Japanese male adolescents from 10 to 15 years of age and found the skeletal Class III malocclusions had neither excessive mandibular growth nor deficient maxillary growth when compared with Class I occlusions. However, their investigations have only focused on sagittal growth determined by lateral cephalograms. Evaluation of the sagittal, vertical, and transverse IR 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.

Hence, the aim of the present study was to analyze the IR 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).

MATERIALS AND METHODS Return to TOC

Longitudinal lateral and posteroanterior cephalograms of 44 Japanese girls, recorded during the years 1985 to 1998, were selected from the files of the Orthodontic Department at Niigata University Medical and Dental Hospital. The 44 subjects comprised 21 Class I and 23 Class III occlusions. For each subject, occlusions were classified from the radiographs and study models taken at age 14 years.

The Class I subjects exhibited bilateral Class I molar and canine relationships and ANB angles of 0° to 4°. The Class III subjects exhibited bilateral Class III molar and canine relationships, overbites between −2 and 4 mm, and ANB angles less than −2°. Serial cephalometric films were taken biannually at 8, 10, 12, and 14 years of age. The mean age of the sample was 8.42 years (SD 0.36 year) at the beginning and 14.38 years (SD 0.56 year) at the end.

Each subject in the Class I group showed a clinically acceptable occlusion. All subjects with Class III malocclusions were selected from the files of patients waiting for surgical orthodontic treatment. Some of these patients had no need for orthodontic treatment during this period, while others did not receive orthodontic treatment because of their own reasons, such as unwillingness to undertake early treatment. Exclusion criteria included systemic disease and marked mandibular asymmetry.

Cephalometric Analysis

Lateral and posteroanterior cephalograms were taken by a standardized technique with the patients' jaws in centric occlusion. The distance from the anode to the midsagittal (or midtransverse) plane of the patient was 150 cm, while 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) and imported to analysis software (Orthod-expert, Igensoft Company, Shanghai, China). The landmarks were digitized by the first author, and then linear and angular items were measured with the computer. The landmarks used in this study are shown in Figures 1 and 2.

Lateral cephalometric landmarks and measurements used in this study were as follows: S, sella; N, nasion; Go, gonion; PNS, posterior nasal spine; ANS, anterior nasal spine; Me, menton; and Gn, gnathion.

Posteroanterior cephalometric landmarks used in this study were as follows: J, 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); and Go, gonion, the point located at the gonial angle of the mandible.

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

- ANB (°): the angle formed by the planes nasion point A and nasion point B;
- Wits appraisal (mm): the distance between point Ao (the perpendicular projection onto the occlusal plane from point A) and Bo (the perpendicular projection onto the occlusal plane from point B);
- PP–MP (°): the angle formed by the palatal plane (ANS–PNS) and mandibular plane (Go–Gn);
- PFH/AFH: the ratio of posterior face height (S–Go) to anterior face height (N–Me);
- J–J/Ag–Ag: the ratio of the maxillary width (J–J) to mandibular width Ag–Ag (Ag, antigonion); and
- Mx–Mx/Go–Go: the ratio of the maxillary width (Mx– Mx) to mandibular width (Go–Go).

The precision of the identification of landmarks was tested by double determination by the same examiner, separated by at least a 10-day interval. The reproducibility of the measurements was determined by choosing 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 $ME = \Sigma d^2/2n$, 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 to 0.32 mm for the distances and 0.15° to 0.25° for the angles.

Statistical Analysis

Data were analyzed with 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 between the two groups.

Bonferroni multiple comparison tests were used to assess the effects of age on the longitudinal growth changes in the measurements in this study. $P < .05$ were considered to be statistically significant.

RESULTS Return to TOC

Descriptive statistics, including means and standard deviations, were determined for ages from 8 to 14 years; the *P* values of the class group comparisons are shown in Table 1. Table 2 shows the *P* values of the age comparisons for ages from 8 to 14 years. Figure 3 shows the IR change in three dimensions with age.

Sagittal Intermaxillary Relationship (ANB and Wits appraisal)

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

Vertical Relationship (PP–MP angle and PFH/AFH)

Group differences between Class III and Class I malocclusions were statistically significant at age 12 years and 14 years (Table 1). With respect to the age comparison, significant changes in both the PP–MP angle and PFH/AFH were found in the Class III and Class I groups for ages from 12 to 14 years. (Table 2; Figure 3)

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

With respect to the group comparisons, significant differences were found between the values in both groups at any age point (Table 1). With respect to the age comparison, significant differences were found between the values at any age in the Class III group, whereas there was a significant difference in the Class I group between the values at age 8 years and those at age 14 years (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.[14]

The ANB angle is commonly used to describe skeletal discrepancies between the maxilla and the mandible. However, its reliability as a true indicator of the sagittal IR has been questioned, and many investigators have employed 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, both the ANB angle and the Wits appraisal were used to evaluate sagittal jaw relationships in this study. Similar to the results of previous studies,[8,13,15] the PP–MP angle and PFH/AFH were selected to evaluate the vertical IR. From an analysis of the literature,[16,17] it was ascertained that J–J and Mx– Mx were the best discriminators of the maxillary width and that Ag–Ag and Go–Go were the best discriminators of the mandibular width. In the present study, therefore, both J–J/Ag–Ag and Mx–Mx/Go–Go were selected to evaluate transverse IR.

Sagittal Intermaxillary Relationship

Jamison et al[10] concluded that the IR in Class I subjects changed significantly from 8 to 17 years of age. On the other hand, Bishara et al [18] reported that the ANB angle changed significantly, while the Wits appraisal showed little change between the age 5 years and adulthood. Williams et al[19] reported similar findings between 11 and 19 years of age. However, Sherman et al[20] found that the Wits appraisal showed a statistically significant increase between the ages of 4 and 24 years. Aydemir et al[21] investigated untreated Class I subjects and found that the ANB angle and Wits appraisal did not change significantly between the ages of 10 and 14 years. In the present study, the ANB angle and Wits appraisal did not change significantly from age 8 to 14 years in both groups. The different results between the previous studies and the present study might be because of sample differences, such as sex, malocclusions, age, and race.

Sugawara et al[13] compared the craniofacial growth of untreated skeletal Class III and Class I occlusions in Japanese male subjects from 10 to 15 years of age. They found a significant difference in the ANB angle and Wits appraisal at each age between the two groups. No significant differences in the total changes in the ANB angle and Wits appraisal were observed between the two groups. Our results support their conclusion that the sagittal IR has been established before the pubertal growth spurt and remains through puberty.

Vertical Intermaxillary Relationship

The PP-MP angle in the Class III group increased with age (Figure 3). This might be due to the clockwise rotation of the mandibular plane in the Class III group during this growth period, so that the PFH/AFH angle in the Class III group decreased significantly during this period. This finding fails 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.

As for the Class I group, the mandibular plane rotated counterclockwise during this growth period. The PP-MP angle decreased with age, whereas the PFH/ AFH angle increased with age. Our results are in agreement with the finding of Ngan et al,[15] who revealed that the PFH/AFH ratio increased in the Class I sample during pubertal growth period.

Transverse Intermaxillary Relationship

Huertas and Ghafari[17] found that the increase in mandibular width (Ag–Ag) was twice the increase in maxillary width (J–J). Cortella et al[16] investigated a sample of 36 subjects (18 girls and 18 boys, Class I) from the Bolton-Brush growth center and reported greater growth in the mandibular width relative to the maxilla in a normal group and, as a consequence, the ratio of J–J to Ag–Ag decreased from age 8 to 14 years. In the present study, we also found that J–J/ Ag–Ag in the Class I groups decreased from age 8 to 14 years. Furthermore, J–J/Ag–Ag in the Class III groups decreased faster than that in Class I group from age 8 to 14 years. Mx–Mx/Go–Go showed the same changes as J–J/Ag–Ag in the two groups from age 8 to 14 years.

An important objective of orthodontic treatment during adolescence is to take advantage of the growth in patients with skeletal discrepancies. According to the present results, because Class III subjects in the mixed dentition present with a deficiency in maxillary arch width, early treatment and correction of the intermaxillary arch width coordination should be considered. Rapid maxillary expansion involving protraction of the maxilla with a facemask, therefore, might be one of the best orthopedic treatment protocols. However, the direction of the protraction force should be carefully monitored because of the clockwise rotation during this growth period.[22]

In some patients with mild to moderate Class III problems, the improvement of a 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 overcorrection of the maxillary transverse deficiency as part of the treatment strategy in growing Class III subjects.

Finally, the limitations of this study must be acknowledged. Sample size restrictions also prevented further subgroup analysis (eg, open bite or deep bite subgroups). It should also be emphasized that, because of the large individual variation encountered, 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

- In the sagittal relationship, the ANB angle and Wits appraisal in Class III malocclusion did not change significantly from age 8 to 14 years. There was the significant difference between Class I and III groups at the same age points.
- In the vertical relationship, the PP–MP angle and PFH/AFH in Class III malocclusion changed significantly from age 12 to 14 years. The significant difference between two groups in the PP–MP angle and PFH/AFH appeared after 12 years of age.
- In the transverse relationship, the Class III malocclusion significantly changed from age 8 to 14 years. There was a significant difference between the two groups at each same age point. The Class III group significantly changed from age 8 to 14 years, whereas there was significant difference in Class I group only when comparing the values at 8 and 14 years of age.

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TABLES Return to TOC

Table 1. Study Measurements and Class Group Comparison Results by Age[a,b]

Measurements	Age, y	Class I Mean (SD)	Class III Mean (SD)	Comparison P
ANB angle, deg	8	2.24 (1.49)	−1.15 (1.14)	.037*
	10	2.18 (1.56)	−1.32 (1.03)	.023*
	12	1.79 (1.88)	−1.98 (1.03)	.014*
	14	1.92 (1.72)	−2.68 (1.19)	.012*
Wits appraisal, mm	8	−0.17 (1.99)	−7.31 (2.02)	.009*
	10	−0.34 (2.46)	−7.37 (2.34)	.010*
	12	−0.43 (2.54)	−7.65 (2.68)	.005*
	14	−0.78 (2.89)	−7.99 (2.72)	.006*
PP–MP angle, deg	8	35.13 (3.22)	35.12 (4.98)	.695
	10	34.66 (4.23)	35.32 (3.87)	.563
	12	34.38 (4.97)	36.12 (3.12)	.042*
	14	32.11 (4.61)	37.94 (5.78)	.011*
PFH/AFH	8	60.23 (3.21)	59.56 (4.23)	.571
	10	60.91 (2.19)	59.12 (2.45)	.052
	12	61.72 (3.23)	59.02 (2.87)	.041*
	14	63.61 (2.61)	57.14 (3.21)	.005*
J–J/Ag–Ag	8	76.53 (2.89)	74.01 (4.34)	.033*
	10	75.70 (3.23)	71.68 (3.23)	.016*
	12	75.11 (3.51)	69.52 (2.34)	.004*
	14	74.22 (2.58)	67.32 (3.21)	.001*
Mx–Mx/Go–Go	8	67.63 (3.12)	65.11 (4.23)	.041*
	10	66.80 (4.13)	62.92 (3.56)	.022*
	12	65.76 (3.92)	60.20 (2.71)	.008*
	14	65.12 (3.85)	58.14 (4.21)	.002*

[a] ANB, the angle formed by the planes nasion point A and nasion point B; Wits appraisal, the distance between point Ao (the perpendicular projection onto the occlusal plane from point A) and Bo (the perpendicular projection onto the occlusal plane from point B); PP–MP, the angle formed by the palatal plane (ANS–PNS [ANS, anterior nasal spine; PNS, posterior nasal spine]) and mandibular plane (Go–Gn [Go, gonion; Gn, gnathion]); PFH/AFH, the ratio of posterior face height (S–Go [S, sella]) to anterior face height (N–Me [N, nasion; Me, mention]); J–J/Ag–Ag, the ratio of the maxillary width (J–J [J, jugale]) to mandibular width (Ag–Ag [Ag, antigonion]); and Mx–Mx/Go–Go, the ratio of the maxillary width (Mx–Mx [Mx, maxillare]) to mandibular width (Go–Go).

* $P < .05$.