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Dentoalveolar Compensation in Negative Overjet Cases

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ABSTRACT

The purpose of this study was to investigate dentoalveolar compensation in negative overjet cases. Eighty-eight adult females with either skeletal Class I or skeletal Class III jaw relationships were examined. Of the total, 44 cases showed anterior crossbite and the remaining 44 cases had normal incisor relationships. Four cephalometric parameters were measured: the sagittal jaw relationship, maxillary and mandibular incisor inclination, and the occlusal plane angulation. In the negative overjet cases, correlation analysis was performed between the skeletal and dental measurements. Stepwise discriminate analysis was carried out to separate the negative and normal overjet cases. Compensatory changes for sagittal jaw discrepancies in the negative overjet cases were statistically confirmed for both incisor inclination and occlusal plane angulation. However, the compensatory effects were weaker than in the normal overjet cases. The discriminate analysis successfully separated the normal and negative overjet cases, suggesting that negative overjet results from insufficient dentoalveolar compensation for variations in the sagittal jaw relationships.

KEY WORDS: Dentoalveolar compensation, Negative overjet, Incisor inclination, Occlusal plane, Skeletal Class III.

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INTRODUCTION Return to TOC

The role of dentoalveolar compensation in the development of normal occlusion has been reported by a number of studies.[1–16] The compensatory inclination of the maxillary and mandibular incisors results in normal incisor relationships despite some variations in sagittal jaw relationships.[1–6,9–15] The cant of the occlusal plane adjusts sagittal relationships between the maxillary and mandibular dental arches.[7,8,13,16] Some authors have suggested that malocclusion results from insufficient dentoalveolar compensation for variations in facial patterns.[4,9,15]

Skeletal Class III malocclusion generally shows negative overjet in incisor relationships, despite the compensatory inclination of the incisors.[17–20] Therefore, a better understanding of the differences in the effects of dentoalveolar compensation in normal and negative overjet cases is necessary to establish an additional basis for planning the treatment of skeletal Class III cases.

A previous cephalometric study investigated dentoalveolar compensation in 44 adult females with normal incisor relationships and either skeletal Class I or skeletal Class III jaw relationships, and determined 4 cephalometric parameters that quantitatively describe dental compensation: the SN-AB angle as a jaw relationship parameter, and 3 dental parameters: the maxillary and mandibular incisor inclination and the occlusal plane angulation relative to the S-N plane.[21]

This study further examined 44 adult females with anterior crossbite. The purpose was threefold: (1) to evaluate dentoalveolar compensation in the negative overjet cases; (2) to compare the compensatory effects with those in the normal overjet cases; and (3) to attempt to separate the negative and normal overjet cases by discriminate analysis, using the 4 cephalometric dental compensation parameters.

MATERIALS AND METHODS Return to TOC

Pretreatment lateral cephalograms of 88 untreated Japanese females were analyzed. The cephalograms were obtained from orthodontic records at the Hokkaido University Dental Hospital. The age of the subjects was more than 16 years, and the ANB angle was less than 3.39°, the mean of Japanese adult females as reported by Izuka and Ishikawa.[22] Of all the cases, 44 showed normal overbite, overjet ranging from 1 to 5 mm, and mild anterior crowding (normal overjet group). These subjects were the same used in the previous study.[21] The other 44 cases had anterior crossbite with an overbite ranging from 1 to 5 mm and an overjet ranging from −8 to −1 mm (negative overjet group). The ANB angle ranged from −5.29° to 3.34° with a mean of 1.02° ± 2.08° in the normal overjet group, and from −8.96° to 3.17° with a mean of −1.98° ± 2.86° in the negative overjet group. With the normal range of Japanese adult females, 3.39° ± 1.77°,[22] variations in the sagittal jaw relationships in each group extended from skeletal Class I to skeletal Class III categories. Facial asymmetry, posterior crossbite, open bite, and excessive overbite cases were excluded from the study because transverse or vertical abnormalities may affect the sagittal jaw relationship assessment.

Figure 1 shows the cephalometric measurements in the study. The 4 parameters used to describe dentoalveolar compensation in the previous study were measured.[21] The occlusal plane was located as the bisected occlusal plane.

To evaluate dental compensation in the negative overjet group, correlation coefficients, coefficients of determination, and regression equations between the SN-AB angle[1] and the 3 dental measurements were calculated. The regression lines were compared with those in the normal overjet group obtained by the previous study.[21] Further, stepwise linear discriminate analysis was performed in an attempt to separate the negative and normal overjet groups by using the 4 cephalometric parameters.

RESULTS Return to TOC

Table 1 shows the means, standard deviations, and ranges of the cephalometric measurements of the 4 parameters in each group. The skewness and kurtosis statistics indicated normal distributions for the variables in both groups.

Table 2 shows the correlation coefficients and coefficients of determination between SN-AB and the 3 dental measurements in the negative overjet group. All of the dental measurements showed statistically significant correlation to SN-AB. The highest correlation coefficient, 0.82 ($P < .001$), was with SN-L1, while the lowest, 0.51 ($P < .001$) was with SN-U1.

Figure 2 shows scatter diagrams and regression lines of SN-AB versus SN-U1, SN-L1, and SN-OP for the negative overjet group. The regression lines for the normal overjet group obtained from the previous study are also included.[21] For the negative overjet group, the regression lines show that as SN-AB increases by 1.0° the maxillary incisor inclines labially by 0.47°, the mandibular incisor inclines lingually by 1.01°, and the occlusal plane flattens by 0.3° with reference to the S-N plane. In all scattergrams, the regression lines for the negative and normal overjet groups did not intersect within the range of the minimum to maximum values of SN-AB in the negative overjet group (71.5° to 102.5°). For SN-L1 and SN-OP, the regression lines in the 2 groups ran almost parallel. The regression line of SN-L1 in the negative overjet group was 3.2° to 4.9° below that in the normal overjet group, whereas the regression line of SN-OP in the negative overjet group ran 3.3° to 4.5° above that of the normal overjet group. The regression line of SN-U1 in the negative overjet group was below that of the normal overjet group with the more flattened slope. At the maximum SN-AB in the negative overjet group, the SN-U1 difference was 11.9°.

Based on the 4 cephalometric parameters, a stepwise discriminate analysis was performed to separate the negative and normal overjet groups. All 4 variables remained after the variable selection procedure. Table 3 shows discriminate function coefficients. Of the 44 negative overjet cases, 38 (86.4%) were correctly classified as negative, whereas 6 (13.6%) were incorrectly classified. Of the 44 normal overjet cases, 41 (93.2%) were correctly classified as normal, whereas 3 (6.8%) were incorrectly classified.

DISCUSSION Return to TOC

Many studies have reported that mandibular prognathism or skeletal Class III malocclusion is characterized by compensatory inclination of the maxillary and mandibular incisors for skeletal imbalances between the jaws.[17–20] However, these findings were drawn from comparisons of facial patterns of skeletal Class III malocclusion and normal occlusion, and within skeletal Class III malocclusions a quantitative association between the skeletal imbalances and the incisal changes has not been confirmed. A previous study[21] reported compensatory changes in the incisor inclination and the occlusal plane angulation for sagittal jaw discrepancies in subjects with normal incisor relationships, and determined 1 skeletal and 3 dental cephalometric parameters for describing dental compensation quantitatively. This study examined negative overjet cases with either skeletal Class I or skeletal Class III jaw relationships, and evaluated their dental compensation in relation to sagittal jaw relationships by using the 4 cephalometric parameters.

Correlation analysis showed statistically significant relationships between SN-AB and all 3 dental measurements. These correlations confirmed dentoalveolar compensatory changes in the negative overjet cases: as the sagittal jaw relationship worsens, the maxillary incisors incline more labially, the mandibular incisors more lingually, and the occlusal plane continues to flatten. However, the correlation coefficients varied considerably among the 3 dental parameters. The SN-L1 value showed the strongest correlation to SN-AB with a correlation coefficient of 0.82 and a coefficient of determination of 0.67, indicating that 67% of the total variation in SN-L1 is determined by SN-AB. This parameter also showed the largest change for each degree of change in SN-AB. Therefore, the mandibular incisor inclination in negative overjet cases is considered to be strongly regulated by the sagittal jaw relationship, which is coincident with findings from normal overjet cases obtained from the previous study.[21] The SN-U1 and SN-OP showed statistically significant but lower correlation coefficients. The coefficients of determination were 0.26 (SN-U1) and 0.28 (SN-OP), suggesting that less than 30% of the total variation in the 2 parameters is determined by SN-AB. The maxillary incisor inclination and the occlusal plane angulation seemed to show a greater degree of variation, though these were somewhat influenced by the sagittal jaw relationship.

To evaluate differences in dentoalveolar compensations between the normal and negative overjet groups, regression equations for both groups were compared. For SN-L1 and SN-OP, the regression lines in the 2 groups were nearly parallel, suggesting that, at a sagittal jaw discrepancy, the lingual inclination of the mandibular incisors and flattening of the occlusal plane were 3° to 5° smaller in the negative overjet group than in the normal overjet group. The differences in inclination of the mandibular incisors between the 2 groups may be due to differences in direction and magnitude of the occlusal force exerted on the mandibular incisors in the normal and abnormal incisor relationships. Comparison of the regression lines of SN-U1 in the 2 groups showed that maxillary incisors inclined more labially in the normal overjet group, especially for larger skeletal discrepancies. The maxillary incisors with the normal incisor relationships appear to be forced labially by a growing and protrusive mandible. Therefore, compensatory effects of both incisor inclination and occlusal plane angulation in the negative overjet cases are considered to be weaker than in cases with normal incisor relationships.

The discriminate function for the separation between the negative and normal overjet groups was calculated with stepwise linear discriminate analysis. All 4 parameters associated with the incisor inclination and the occlusal plane angulation, as well as the sagittal jaw relationship were significant in the discrimination. The discriminate function correctly classified the majority of cases into the 2 groups with minimal misclassification. The results appear to confirm the suggestion by several authors[4,9,15] that malocclusion results from insufficient dentoalveolar compensation for variations in the sagittal jaw relationships, though there must be limits in sagittal jaw relationships where normal incisor relationships are obtained. At the same time, the results seem to indicate that for sagittal jaw discrepancies, normal incisor relationships can be attained by a combination of compensatory effects of the incisor inclination and occlusal plane angulation. This suggests the clinical importance of changing the occlusal plane angulation and the incisor inclination in nonsurgical treatment of skeletal Class III malocclusions. According to a geometric study by Braun and Legan,[16] flattening the occlusal plane by 1.0° results in approximately 0.5 mm backward displacement of the mandibular dental arch relative to the maxillary dental arch. However, limits in sagittal jaw relationships where normal incisor relationships are obtained in the natural growth process are still unknown. Further investigation with a larger group of cases should be conducted.

CONCLUSION Return to TOC

Dentoalveolar compensation in negative overjet cases with either skeletal Class I or skeletal Class III jaw relationships was investigated. Compensatory changes for sagittal jaw discrepancies were statistically confirmed for both incisor inclination and occlusal plane angulation. However, the compensatory effects were weaker than with normal overjet cases. Discriminate analysis to separate normal and negative overjet cases confirmed that negative overjet results from insufficient dentoalveolar compensation, though there must be limits in sagittal jaw relationships where normal incisor relationships are obtained.

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TABLES Return to TOC

Table 1. Means, Standard Deviations, and Ranges of the Cephalometric Measurements in the Normal and Negative Overjet Groups

Table 2. Correlation Coefficients and Coefficients of Determination Between SN-AB and Three Dental Measurements in the Negative Overjet Group

Table 3. Discriminate Function Coefficients

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FIGURE 1. Cephalometric measurements. (1) SN-AB[1]; (2) SN-U1; (3) SN-L1; (4) SN-OP

Click on thumbnail for full-sized image.

FIGURE 2. Scatter diagrams and regression lines of SN-AB versus SN-U1, SN-L1, and SN-OP for the negative overjet group. Regression lines for the normal overjet group are also included.[21]

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