Original Article

Preliminary Investigation of Nonsurgical Treatment of Severe Skeletal Class III Malocclusion in the Permanent Dentition

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Abstract: The purpose of the study was to analyze the effects of nonsurgical treatment on subjects with a severe skeletal Class III deformity and to directly evaluate dental and facial profile changes. Eighteen patients with severe skeletal Class III malocclusions (5 males, 13 females), diagnosed as indication for orthognathic surgery, were included in the study. The average age was 13.7 ± 2.5 years. All the cases were treated with Tip-Edge straight-wire technique or Begg light wire technique. Lateral cephalometric films taken at the beginning and at the end of treatment were analyzed with the Pancherz analysis and traditional cephalometric analysis. The arithmetic mean and standard deviation were calculated for each variable and paired *t*-test was performed. A mean reduction of 6.5 mm in the overjet was noted ($P < .001$), with skeletal changes and dental changes contributing 20% and 80% to the overjet correction, respectively. The inclination of the upper incisors to the SN plane was increased 5.9° ($P < .01$). The inclination of the lower incisors to the mandibular plane was decreased 6.6° ($P < .001$). The difference between the distance of the upper lip and lower lip to Sn-Pg′ at the beginning of treatment changed from a negative value to a positive value with a significant difference ($P < .001$). Successful treatment effects can be obtained with nonsurgical therapy in severe skeletal Class III malocclusions in the permanent dentition. A remarkable soft tissue change was noted after the treatment, and the concave facial profile changed to a straight profile (see two case reports). (*Angle Orthod* 2003;73:401–410.)

Key Words: Nonsurgical treatment; Facial profile; Soft tissue change

INTRODUCTION

Skeletal Class III malocclusion is a common kind of malocclusion in orthodontic clinics in China. Studies have reported that skeletal Class III discrepancy worsens with age.[1–2] Hence, the difficulty in successfully treating a developing Class III malocclusion increases with time. Early intervention of skeletal Class III deformities in the mixed dentition or even in the deciduous dentition has received increasing attention in the orthodontic field. The alternative approaches include the use of reverse headgears, chin cups, functional appliances and simple fixed appliance with heavy interarch elastic.[3–5] However, some patients, either with deformities that were apparently corrected during childhood recurred during the adolescent growth spurt or never had the chance to obtain early intervention, ask for comprehensive orthodontic treatment in the late permanent dentition. This brings extreme difficulties for successful and confident treatment. Meanwhile, the majority of the patients who present with a severe skeletal Class III deformity are candidates for orthognathic surgery as the only choice toward normal occlusion and an esthetic profile. However, the dilemma we have to confront is that, in China the majority of these patients reject or are not willing to accept surgical therapy and persist in their pursuit of orthodontic treatment. Furthermore, the facial profile of skeletal Class III deformities is always the main concern of these patients to seek treatment. This is indeed a harsh challenge to the orthodontists and it is essential when developing a treatment plan to estimate facial changes along with occlusal improvements.[6,7]

Because of the relationship between age and growth and development, early intervention methods cannot be applied in the treatment of skeletal deformities in the permanent dentition or in the adult. The only alternative for a nonsur-

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gical approach to management of skeletal deformities in the permanent dentition or in the adult is comprehensive treatment with fixed appliances.

The purpose of this study is to (1) analyze the treatment effects of nonsurgical treatment on severe skeletal Class III malocclusion and (2) directly evaluate dental and soft tissue changes with two case reports.

MATERIALS AND METHODS

Subjects

Eighteen consecutive patients with severe skeletal Class III malocclusion (5 males, 13 females) were included in the study. The average age was 13.7 $\pm$ 2.5 years. The selection criteria included (1) anterior crossbite, (2) mesial or superior mesial Class III molar relationship, (3) no mandibular shift, (4) ANB $<-1.5°$, (5) concave facial profile, and (6) diagnosed as indication for orthognathic surgery and impossible for nonsurgical orthodontic treatment even by experienced orthodontists. All patients and their parents intensely rejected orthognathic surgery.

Treatment approach

All the cases were treated by Dr Jiuxiang Lin. Tip-Edge straight-wire technique was used in 11 cases and the Begg light wire technique in 7 cases. Twelve patients were treated with extractions. The remaining six patients accepted nonextraction orthodontic treatment. The mean treatment duration was 2.5 $\pm$ 0.8 years.

Cephalometric analysis

Pretreatment and posttreatment cephalograms were taken with the same cephalostat and traced on acetate paper. The reference points were marked with a sharp pencil by one observer under optimal conditions. The midpoint between the right and left traced images was used for bilateral landmarks. Traditional cephalometric analysis and the Pancherz analysis with occlusal plane (OL) and occlusal plane perpendiculars (OLp) as reference grids were performed.[8] The measurements included (Figure 1) (1) U1-SN; (2) L1-MP; (3) U1-L1; (4) SNA; (5) SNB; (6) ANB; (7) Overjet (is/OLp-ii/OLp); (8) A-OLp: maxillary base; (9) Pg-OLp: mandibular base; (10) is-OLp: maxillary incisor; (11) ii-OLp: mandibular incisor; (12) is/OLp-A/OLp: maxillary incisor (dental); (13) ii/OLp-Pg/OLp: mandibular incisor (dental); (14) NSL-ML (°); (15) OL-ML (°); (16) UL-SnPg′: the distance of the most convex point of upper lip to SnPg′ line (the line connected subnose and soft tissue Pg); (17) LL-SnPg′: the distance of the most convex point of lower lip to SnPg′ line; (18) UL-SnPg′-LL-SnPg′: distance difference of the most convex points of upper and lower lips to Sn Pg′ line.

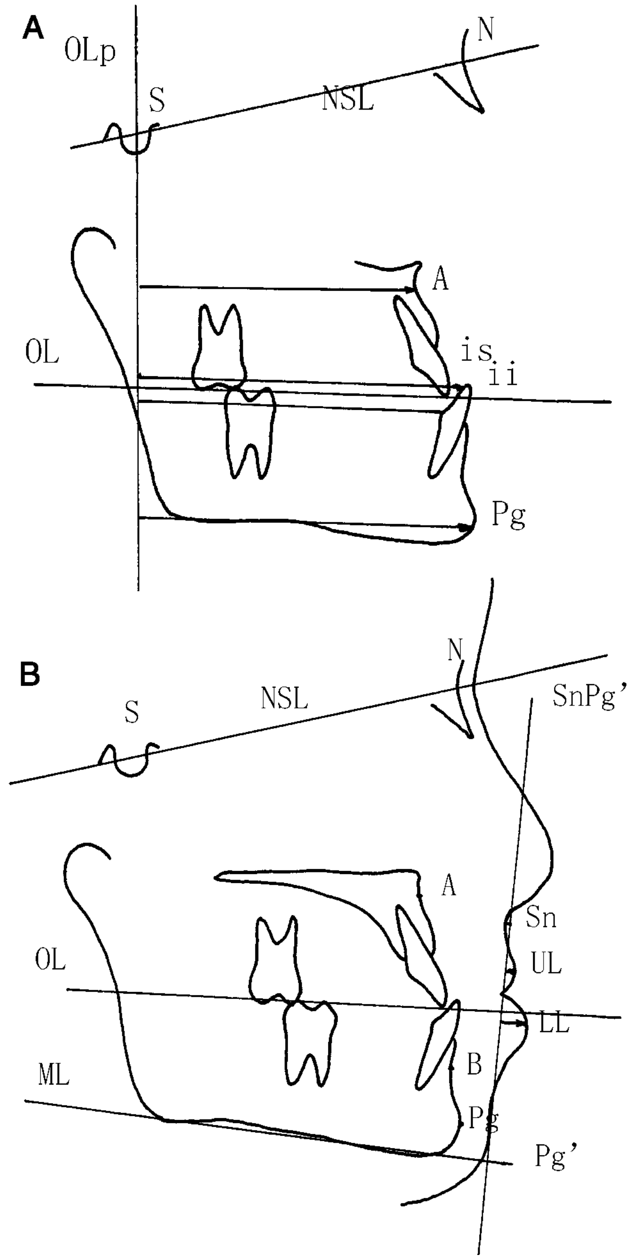

FIGURE 1. (A) Measurements in Pancherz analysis. (B) Reference lines and landmarks used in traditional cephalometric analysis.

Statistical analysis

The statistical analysis was performed with SPSS 10.0 for Windows. The arithmetic mean and standard deviation were calculated for each variable. Paired *t*-test was performed to evaluate the treatment effects. The level of significance was: $P > .05$ (NS), * $P < .05$; ** $P < .01$; *** $P < .001$.

Method error in locating, superimposing, and measuring the changes of different landmarks was calculated by the formula[9]

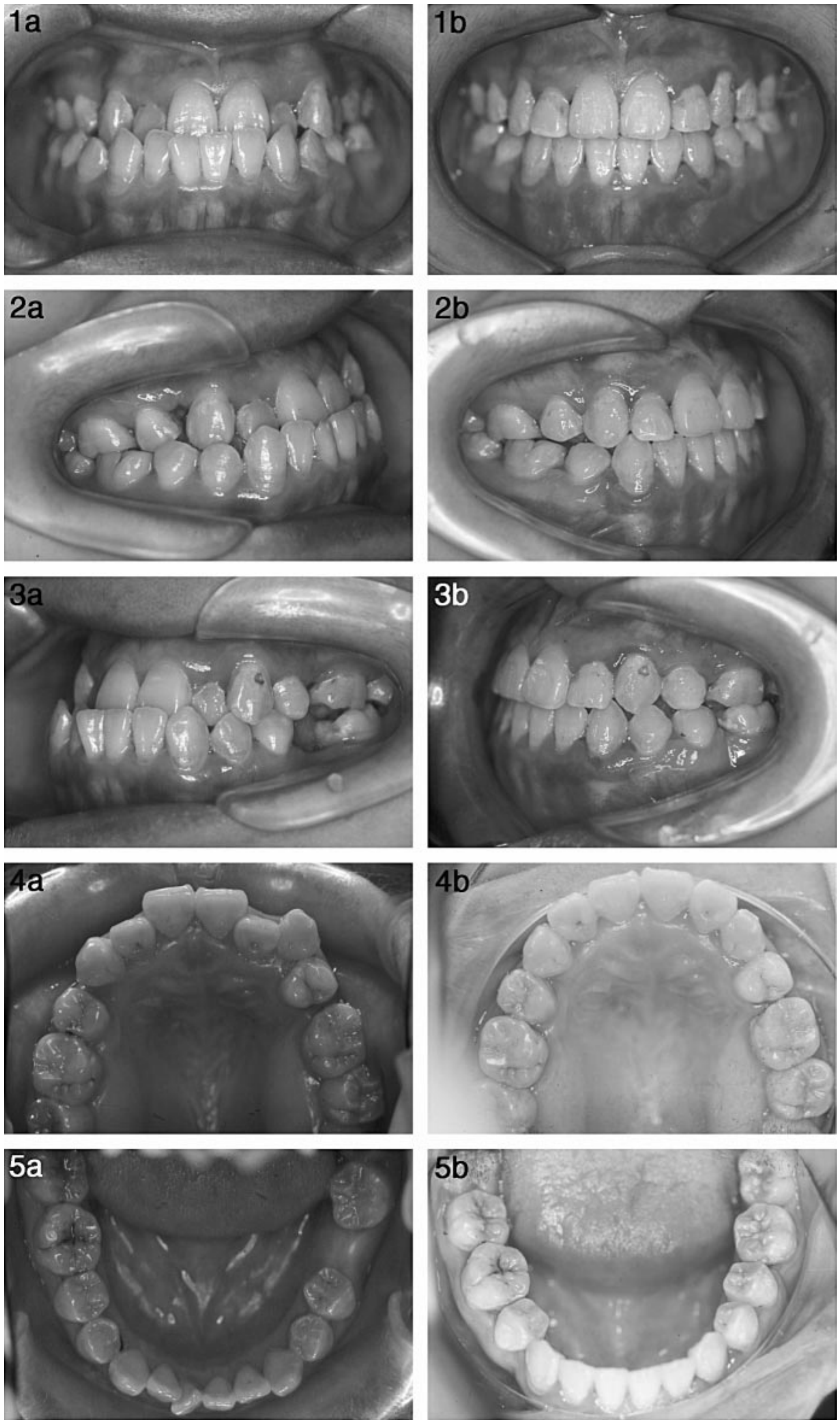

FIGURE 2. (A) (Case 1) Pretreatment and posttreatment intraoral photographs. a, indicates pretreatment; b, posttreatment.

$$ME = \sqrt{\sum d^2/2n}$$

Where d is the difference between two registrations of a pair and n is the number of double registrations. All variables were traced and superimposed with measurements recorded on two different occasions. The combined method error did not exceed 0.4 mm for the linear variables and 0.5° for the angular variables investigated.

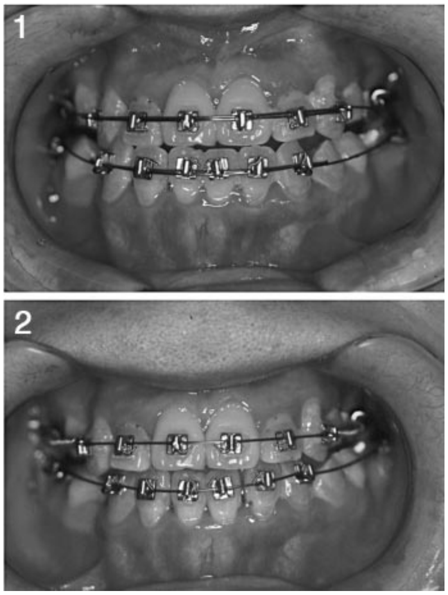

FIGURE 2. (B) (Case 1) During the treatment.

FIGURE 2. (C) (Case 1) Pretreatment and posttreatment facial photographs. a, indicates pretreatment; b, posttreatment.

RESULTS

At the end of the treatment, the anterior crossbites were corrected and Class I molar relationships and canine relationships were achieved in all subjects. The facial profile was improved dramatically from a concave to a straight profile.

Dental changes

The upper incisors to the SN plane were proclined a mean of 5.9° ($P < .001$; Table 1). The lower incisors to the mandibular plane were retroclined a mean of 6.6° ($P < .001$; Table 1). The tip of the lower incisors to the occlusal plane perpendicular was retracted a mean of 2.2 mm ($P < .001$; Table 1). The tip of the upper incisor to the occlusal plane perpendicular tipped facially a mean of 3 mm ($P < .001$; Table 1).

Skeletal change

A statistically significant increase of 1.9° was found in the ANB angle after treatment ($P < .001$; Table 1). ''A'' point was forward at the end of the treatment with a mean increase of 1.1 mm ($P > .05$; Table 1).

Vertical change

The mandibular plane remained unchanged during the treatment, and the angle between the occlusal plane and mandibular plane was significantly increased a mean of 3.3° after treatment ($P < .001$; Table 1). This suggested a counterclockwise rotation of the occlusal plane.

Soft tissue changes

A mean increase of 1.6 mm in the distance of the most convex point of upper lip to the SnPg′ line and mean decrease of 1.4 mm in the distance of the most convex point of lower lip to SnPg′ line were noted after treatment resulting in a statistically significant difference ($P < .001$; Table 1). Furthermore, the negative value of the distance difference of the most convex points of the upper lip and the lower lip to Sn-Pg′ at the beginning of treatment changed to a statistically significant positive value ($P < .001$; Table 1), which indicated a dramatic improvement of the concave profile.

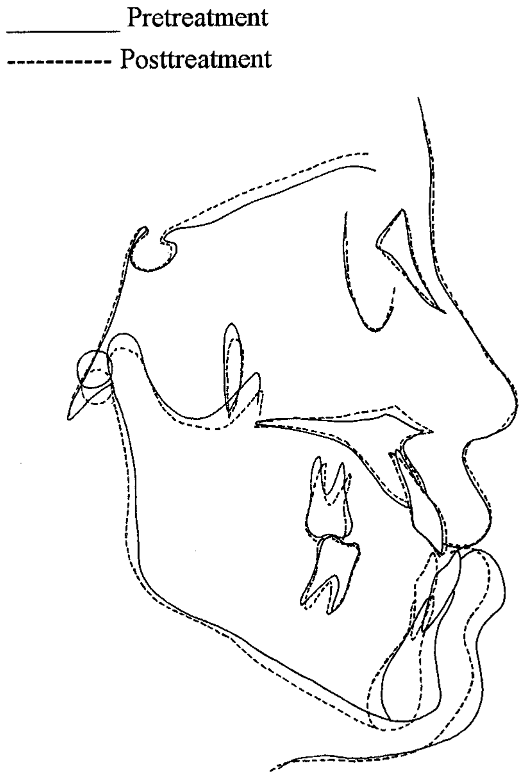

FIGURE 2. (D) (Case 1) Superimposition of pretreatment and post-treatment cephalometric tracings.

DISCUSSION

The mechanics of a nonsurgical treatment for the correction of a skeletal Class III deformity using a Tip-Edge straight-wire technique or Begg light wire technique was applied in this study. The characteristic of this technique is the tipping movement of teeth with a light and continuous force. The initial force of the Class III elastics is light, about 50–60 g. Intraoral anchorage is adequate, and there is no need to use extraoral forces to increase the anchorage. A tipping movement of teeth is much easier than a bodily movement and, therefore, the range of movement is larger.[10–12] After tipping the teeth to the desired position, they can be made upright or rotated to suitable positions allowing indirect bodily tooth movement. In this study, with extraction of lower teeth or with enough space in the lower arch, there was much backward movement of the lower teeth. Combined with the forward movement of the upper teeth, this contributed to correction of the anterior crossbites and achieving a Class I molar relationship.[13–17] With light and continuous forces, the vertical component of the Class III traction on the upper molar is minor, and this might be the reason for an almost unchanged mandibular plane angle at the end of the treatment. Furthermore, much lingual movement and relative extrusion of the mandibular incisors in relation to the maxillary molars during Class III traction seemed to contribute to the counterclockwise ro-

TABLE 1. Results of Cephalometric Analysis

	Pretreatment		Posttreatment		PostTx-PreTx		
	Mean	SD	Mean	SD	Mean	SD	*P* Value[a]
Overjet (is/OLp-ii/Olp)	−3.0	1.2	3.5	1.5	6.5	1.8	.000***
Skeletal measurements							
SNA	80.8	3.7	82.1	3.6	1.3	2.1	.016*
SNB	84.8	3.3	84.3	2.9	−0.5	1.7	.261
ANB	−4.1	2.2	−2.2	2.1	1.9	1.2	.000***
Maxillary base (A/Olp)	73.5	4.7	74.6	5.7	1.1	2.9	.12
Mandibular base (Pg/Olp)	89.7	4.6	89.5	8.2	−0.2	6.3	.883
Skeletal + dental measurements							
Maxillary incisor (is/Olp)	85.4	4.9	89.6	6.8	4.1	4.3	.001***
Mandibular incisor (ii/Olp)	88.5	4.3	86.1	7.0	−2.4	4.9	.05*
Dental measurements							
Maxillary incisor (is/Olp-A/Olp)	11.9	3.4	14.9	3.3	3.0	2.1	.000***
Mandibular incisor (ii/Olp-Pg/Olp)	−1.2	2.3	−3.4	3.2	−2.2	2.6	.002**
U1-SN	110.9	4.1	116.8	8.0	5.9	6.1	.001***
L1-MP	85.4	5.2	78.8	5.8	−6.6	4.5	.000***
U1/L1	128.9	6.5	129.3	8.9	0.4	7.2	.825
Vertical measurements							
NSL-ML(°)	34.9	5.9	35.5	5.2	0.6	2.2	.237
OL-ML(°)	17.7	2.7	21.0	4.1	3.3	2.4	.000***
Soft tissue measurements							
UL-SnPg	4.7	1.9	6.3	1.9	1.6	1.8	.001***
LL-SnPg	7.1	1.9	5.7	2.0	−1.4	1.5	.001***
UL-SnPg-LL-SnPg	−2.4	1.2	0.7	0.7	3.1	1.2	.000***

[a] * $P < .05$; ** $P < .01$; *** $P < .001$.

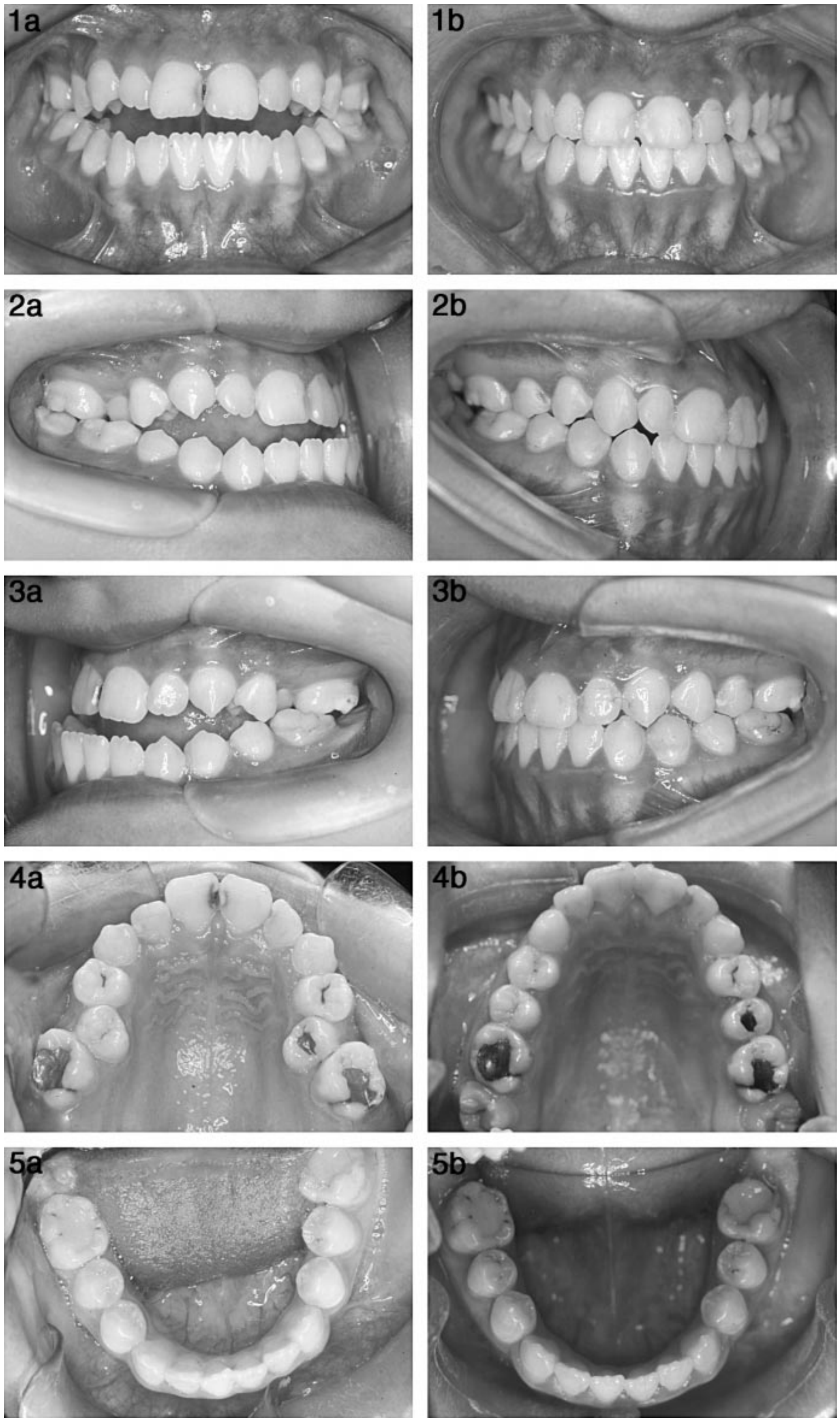

FIGURE 3. (A) (Case 2) Pretreatment and posttreatment intraoral photographs. a, indicates pretreatment; b, posttreatment.

tation of the occlusal plane. All these are beneficial in the correction of skeletal Class III malocclusion with a high mandibular plane angle.

Even though a significant change in the ANB angle was illustrated with a mean increase of 1.9° ($P < .001$; Table 1), the negative value of the ANB angle persisted over the course of this study after the treatment. Therefore, the influence of nonsurgical orthodontic treatment on skeletal pattern is limited.

In this study, a dramatic overjet change occurred with a

FIGURE 3. (B) (Case 2) During the treatment, lower second molars were extracted.

mean decrease of 6.5 mm ($P < .001$; Table 1). Skeletal changes contributed 20% to the overjet correction. The mean 5.9°, proclination of the upper incisors and a mean 6.6°, retroclination of the lower incisors contributed 80% to overjet correction.

Influence of a non-surgical treatment on the facial profile of skeletal Class III malocclusion

With the goals of orthodontic treatment as harmonious facial esthetics and a functional occlusion, the soft tissue changes play an important role in evaluating treatment effects. Because of the easy identification of a concave profile, patients may have been suffering from the potential psychosocial problems from childhood. The improvement of facial esthetics, therefore, is one of the major reasons for seeking treatment.[7] Soft tissue changes following orthodontic treatment are usually regarded as secondary to underlying hard tissues alterations.[7] Different opinions exist as to whether there is a definite correlation between incisor change and soft tissue change.[18–25] However, no matter which cephalometric analysis is applied, the balance and harmony of the facial profile should receive much attention.[26–28]

Soft tissue overlying the hard tissue displayed statistically significant changes in this study (Table 1). The forward movement of the upper lip and the backward movement of the lower lip were closely related to the facial movement of the upper incisors and lingual movement of the lower incisors. A positive value of the difference between the distance of the upper and lower lips to Sn-Pg′ was noted at the end of the treatment as compared to a negative one at the beginning of the treatment ($P < .001$; Table 1). From the extraoral examination, a concave facial profile changed to straight profile even though no distinct relationship was verified among the skeletal, dental, and soft tissue changes.[26,29,30] It could be confirmed that the soft tissue changes, as a result of the proper use of light and continuous force in this study, significantly compensated for the limited skeletal change. The imbalance of soft tissue change and skeletal change after orthodontic treatment is valuable to a nonsurgical treatment of severe skeletal Class III malocclusion.

In two cases with extraction of lower second molars, the third molars erupted during the treatment with minor adjustments. In two other cases with exaction of lower second molars, the third molars erupted after two years in a correct position. Furthermore, two adult cases and one case followed for four years until the patients was 19 years old were included in the study. Stable treatment effects with healthy periodontal tissues were followed until the end of growth and development in the above seven cases. The remaining eleven cases are still being followed till the end of growth and development. In addition, the lower third molars were extracted after the treatment in two nonextraction cases. Even though the skeletal change was limited, the results of this study demonstrated that nonsurgical treatment of skeletal Class III malocclusions can lead to dramatic dental changes and satisfactory facial profile changes. Continuous light forces combined with extractions permit mild to moderate mandibular prognathism to be camouflaged by tipping tooth movements. As a result, the treatment effect in severe skeletal Class III malocclusion is acceptable. This is the potential of nonsurgical therapy of a skeletal deformity, which enlarges the range of orthodontic treatment options.

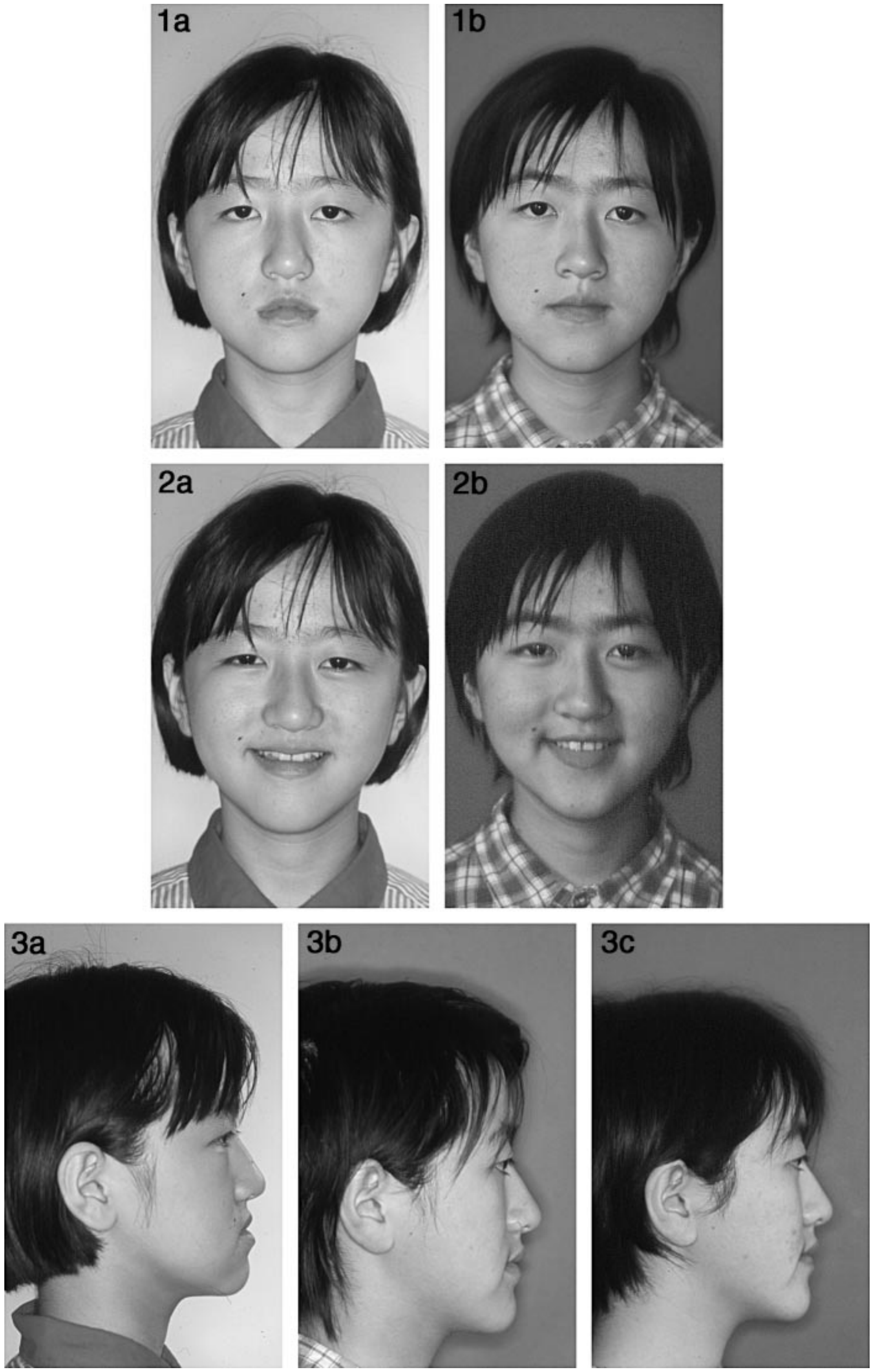

FIGURE 3. (C) (Case 2) Pretreatment, posttreatment, and follow-up facial photographs. a indicates pretreatment; b, posttreatment; c, follow-up.

CASE REPORT 1 (FIGURE 2)

A 20-year-old female presented with anterior crossbites and crowding in the upper and lower arches. The patient was transferred from another doctor after extraction of 14, 25, and 36, and failure of the previous treatment. Surgical correction of the anterior crossbite was recommended, but the patient refused. The intraoral examination showed obvious crowding in the upper arch and slight crowding in the lower arch with remaining extraction space at 36. The overjet was −2 mm. The mandibular dental midline was three mm to the right of the facial midline. The patient presented with a concave profile and prognathic mandible with no functional shift. Treatment started with extraction

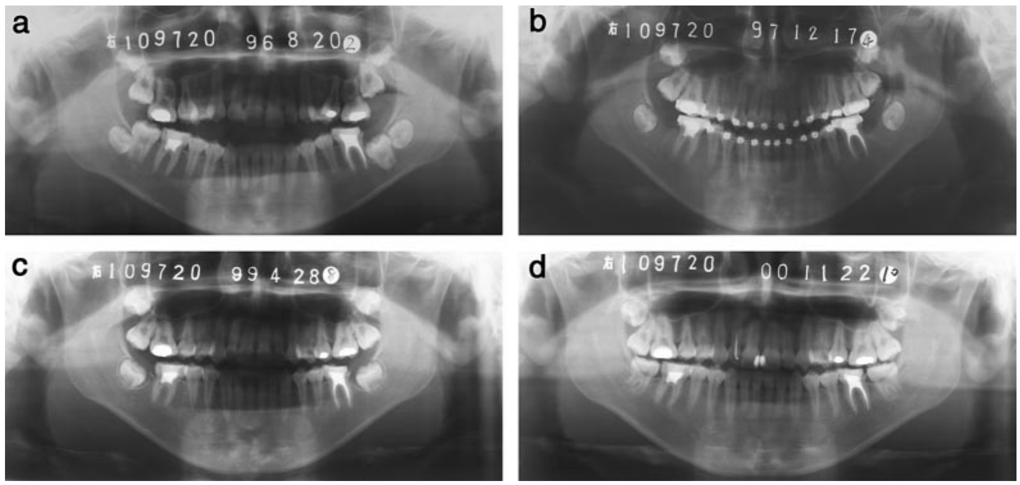

FIGURE 3. (D) (Case 2) Panelipses of pretreatment, after extraction of lower second molars, and posttreatment. a, indicates pretreatment; b, after extraction of lower second molars; c, posttreatment; d, follow-up after eruption of third molars.

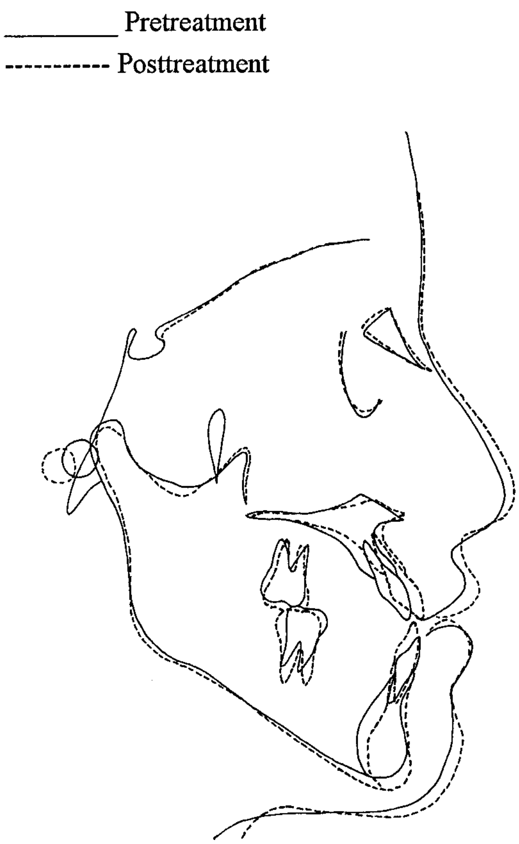

FIGURE 3. (E) (Case 2) Superimposition of pretreatment and posttreatment cephalometric tracings.

of 44 and a Begg light wire technique was applied. After seven months of Class III traction, the anterior crossbite was corrected. After 1.5 years of treatment, a Class I canine relationship was established with a corrected midline. Final records showed a straight facial profile. Superimposition of pretreatment and posttreatment cephalometric tracings revealed that there was a remarkable retroclination of the lower anterior teeth of −12.5°. During the follow-up period, stable treatment effects with healthy periodontal tissues were noted.

CASE REPORT 2 (FIGURE 3)

A 12-year-old girl presented with anterior crossbites, open bite, and a concave profile. Intraoral examination showed a complete Class III molar relationship on the right side and 1/2 cusp Class III molar relationship on the left side. An anterior crossbite from 15 to 24 and an open bite of 4 mm were noted. The lower second premolars were erupted lingually without enough space, and severe crowding was present in the upper arch. The facial profile was concave, and the mandible appeared prognathic with no mandibular shift. Surgical correction of the skeletal deformity and facial profile was recommended but the patient refused and insisted on an orthodontic correction. A Tip-Edge straight-wire appliance was initiated after extraction of the lower second molars. With 7 months of Class III elastic, the anterior crossbite was corrected, but the open bite persisted. Seventeen months later, the open bite was eliminated, the overbite was normalized and a Class I molar relationship was established. At the end of treatment, the patient was noted with a straight profile, normal overbite, and overjet. The superimposition of pretreatment and posttreatment cephalograms tracings revealed the retroclination of the lower anterior teeth a mean of 11.5°. A skeletal Class III tendency remained after the treatment with an ANB–4.0°, but facial profile showed significant improvement. A follow-up panelipse showed complete eruption of the lower third molars.

CONCLUSIONS

This study showed the treatment mechanism of nonsurgical treatments of 18 subjects with severe skeletal Class III malocclusion in the permanent dentition.

Successful treatment effects can be obtained with nonsurgical treatment in severe skeletal Class III malocclusion in the permanent dentition.

Tip-Edge and Begg techniques allowed a larger range of tipping movement of teeth and significant but limited skeletal change.

A remarkable soft tissue change was noted after the treatment, the concave facial profile changed to a straight profile. The compensatory mechanism is worthy of further study.

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