CDABO CASE REPORT

Nonsurgical correction of a Class II malocclusion with a vertical growth tendency

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Malocclusion, with a superimposed vertical growth tendency, is often difficult to treat without a combined surgical orthodontic approach. Certain situations, however, may preclude surgery as a treatment option. The following case report demonstrates the use of orthodontic mechanotherapy alone in successfully treating a patient that exhibited a Class II Division I malocclusion with a high mandibular plane angle and vertical growth tendency. (Am J Orthod Dentofacial Orthop 1999;116:66-74)

In the literature, 2 distinct types, or extremes, of facial form have been characterized: the skeletal deep-bite and the skeletal open bite.[1] Schudy[2] used the terms hypodivergent and hyperdivergent, respectively, to describe these facial patterns, the latter of which has also been referred to as long face syndrome.[3] The cause of these skeletal discrepancies is usually related to positional and/or size variations of the maxilla, the mandible, and/or the cranial base.[4] These facial extremes commonly manifest clinically as disproportionalities between certain face dimensions, particularly the upper and lower face heights.[5] Longitudinal studies by Nanda[6] indicate that the fundamental difference between open bite and deep bite faces is found in the anterior segments of the face rather than in variations of posterior facial dimensions. For example, subjects with a deep bite generally have an increased upper, relative to lower, face height. In contrast, subjects with an open bite have an increased lower relative to upper face height.

These differences in facial form lend themselves to different treatment modalities. Because patients with a deep bite usually have decreased lower face height dimensions, orthodontic extrusion of mandibular teeth is commonly used to open the bite, increase the lower anterior face height, and achieve a functional occlusion. The traditional patient with an anterior open bite, however, is not as easily treated by orthodontic means alone. In these situations, the maxilla is often vertically overdeveloped, resulting in an increased lower anterior face height with an anterior open bite. In adolescent individuals with vertical growth tendencies, it is also difficult to predictably control the growth of the maxillomandibular complex and close the bite to achieve a functional occlusion with proper coupling of the anterior teeth. Consequently, surgical repositioning of the maxilla and possibly the mandible is often the most realistic treatment option that allows the orthodontist to achieve the goal of a reasonably esthetic and functionally stable occlusion.

In certain situations, however, orthognathic surgery may not be a viable treatment option. This may be due to patient apprehension toward surgical intervention, increased surgical costs, or other reasons. Regardless, these patients may still benefit from orthodontic treatment. Hence, the following case report demonstrates the use of orthodontic mechanotherapy alone in successfully treating a patient who exhibited a Class II Division 1 malocclusion with a high mandibular plane angle and a vertical growth tendency.

HISTORY AND CAUSE

Patient JC had a chief complaint of "my front teeth stick out." His chronologic age was 13 years 5 months; his skeletal maturation was established as 13 years 3 months, based on cross-referencing with Todd's *Atlas of Skeletal Maturation*.[7] He was self-motivated with regard to orthodontic treatment; therefore, cooperation was predicted to be above average. His medical history was noncontributory. Facially, the patient had a tendency toward a dolicocephalic craniofacial form with a tapering ovoid or a longilinear shape (Fig 1). This appeared to be due in part to a long lower facial third. Facial structures were fairly symmetrical, how-

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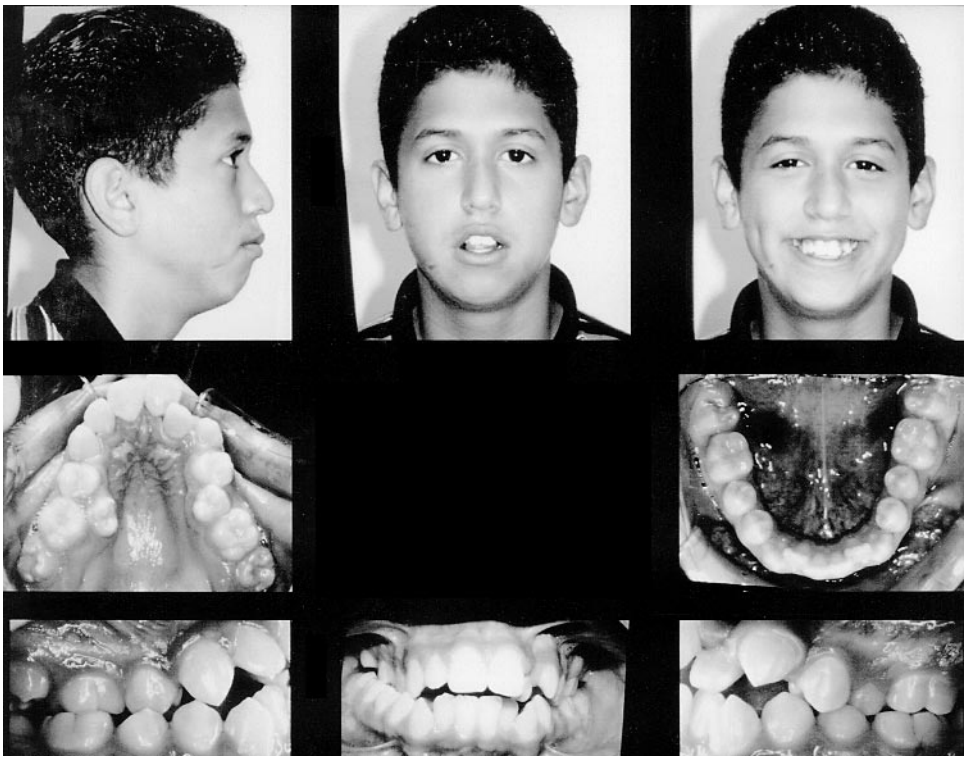

Fig 1. Pretreatment photographs.

ever. The chin deviated slightly to the right of the glabella-subnasale midline, and the left gonial angle appeared lower than the right. The glabella-subnasale midline was coincident with Cupid's bow. The maxillary dental midline was 1.5 mm to the right of the glabella-subnasale midline. The mandibular dental midline was 2 mm to the right of the maxillary dental midline, and 2 mm of gingiva superior to the maxillary central incisors were visible at full smile.

Intraoral examination revealed a normal color and texture of the hard and soft palates, cheeks, and tongue. Oral hygiene was excellent, and periodontal health was good. The color and shape of the teeth were within normal limits; however, the maxillary lateral incisors were narrow mesiodistally at the incisal edge. No history of abnormal habits existed. At the time treatment was initiated, all permanent teeth except the third molars were present clinically. Both his mother and older brother had undergone nonsurgical orthodontic treatment for almost identical malocclusions, suggesting that heredity may have had an etiologic role in the patient's malocclusion.

DIAGNOSIS

Facial Soft Tissue

The patient's lips were both full and procumbent. The lips were also incompetent with a 9 mm interlabial gap and an incision-stomion distance of 6 mm. The soft tissue profile was convex, and the nasolabial angle was acute. Lack of good chin projection (contour deficient chin) and a poor chin-throat angle contributed to an increased facial convexity.

Skeletal

All anteroposterior skeletal measurements indicated a Class I skeletal relationship (Table I). However, an FMA of 40º, an increased Y-axis (67 º), and a lower anterior facial height 10 mm greater than normal suggested a vertical growth pattern (Fig 2).

Dental

The patient presented in the permanent dentition with a Class II right, Subdivision left molar relationship, which was presumably due to mesial drift of the maxillary right first molar. Both right and left canines were in a Class I relationship. The maxillary arch was V-shaped and constricted, with 10 mm of crowding, based on occlusogram analysis (Fig 3). Both the maxillary right and left second premolars were blocked to the lingual. The mandibular arch was U-shaped with 6 mm of crowding. There was a 1 mm anterior openbite measured at the level of the occlusal plane. The mandibular dental midline was 2 mm to the right of

Table I. Cephalometric summary

Cephalometric area of study	*Cephalometric measurements*	*Pretreatment (norm)*	*Progress (norm)*	*Posttreatment (norm)*	*One-yr posttreatment (norm)*
Cranial base	S-N	75.0 mm (71.2)	75.5 mm (72.1)	76.5 mm (72.8)	74.9 mm (74.6)
	N-S-Ar	122.1º (125.9)	121.8º (126.0)	120.5º (126.0)	121.4º (125.5)
Maxilla to cranial base	S-N-A	74.5º (81.2)	75.4º (80.7)	77.5º (80.9)	78.6º (81.4)
	N-A/FH	84.8º (90.0)	84.5º (90.0)	87.0º (90.0)	85.6º (90.0)
Mandible to cranial base	S-N-B	71.3º (77.5)	71.6º (77.3)	73.2º (77.6)	75.2º (78.2)
	N-Pg/FH	82.2º (82.3)	81.6º (83.3)	83.5º (82.9)	82.0º (82.5)
Maxillomandibular relations	A-N-B	3.2º (3.7)	3.8º (3.4)	4.3º (3.3)	3.4º (3.2)
	A-B/OP	6.4 mm (-0.7)	7.1 mm (-0.9)	5.6 mm (-1.2)	3.2 mm (-1.2)
Vertical relations	N-ANS	63.4 mm (50.8)	63.0 mm (52.1)	63.2 mm (52.8)	63.6 mm (53.4)
	ANS-Me	74.8 mm (64.5)	79.6 mm (66.5)	81.8 mm (68.7)	82.6 mm (71.2)
	Go-Me/FH	39.8º (21.3)	42.0º (21.3)	40.5º (21.3)	42.7º (21.3)
	N-S/Go-Gn	48.1º (33.5)	48.5º (33.5)	45.3º (33.5)	43.2º (33.5)
	S-Gn/FH	66.9º (62.6)	68.7º (61.8)	67.5º (63.1)	69.7º (63.5)
Maxillary and mandibular incisor position	U1/S-N	112.0º (127.6)	94.3º (102.6)	100.0º (103.0)	100.0º (103.0)
	U1/N-A	37.6º (22.1)	19.0º (21.9)	20.3º (22.1)	20.3º (22.1)
	U1/A-Pg	13.8 mm (3.5)	8.2 mm (3.5)	8.1 mm (3.5)	8.1 mm (3.5)
	L1/Go-Me	85.1º (95.9)	82.0º (95.9)	83.6º (95.9)	83.6º (95.9)
	L1/N-B	27.2º (26.6)	23.4º (25.1)	24.7º (25.3)	24.7º (25.3)
	L1/A-Pg	6.3 mm (2.1)	5.2 mm (1.7)	4.9 mm (1.8)	4.9 mm (1.8)
	U1/L1	112.1º (103.3)	133.8º (129.6)	130.7º (129.2)	130.7º (129.2)
Soft tissue	Gl'-Sn-Pg'	11.9º (6.7)	15.4º (6.7)	14.0º (6.7)	11.4º (6.7)
	Nasolabial	71.7º (110.8)	75.9º (116.7)	74.2º (110.8)	78.1º (110.8)
	Ls (pSn-Pg')	10.0 mm (3.4)	9.6 mm (3.0)	10.1 mm (2.6)	8.5 mm (2.3)
	Li (pSn-Pg')	8.3 mm (2.5)	8.3 mm (2.0)	8.6 mm (2.1)	8.2 mm (2.3)
	Inc-Stm	5.5 mm (2.0)	5.3 mm (2.0)	5.5 mm (2.0)	5.3 mm (2.0)
Other	N-A-Pg	5.6º (3.9)	5.9º (3.9)	7.1º (3.9)	5.9º (3.9)
	N-S/OP	16.0º (15.6)	15.8º (15.4)	15.6º (14.3)	16.8º (12.9)

Note: Norms are based on Michigan Growth Study[12] (age and sex matched).

the maxillary dental midline, probably as a result of a right functional shift, which also contributed to a relative lingual crossbite in the maxillary right buccal segment. The roots of the upper anteriors and the lower canines appeared blunted on the panoramic radiograph (Fig 4). The patient and his parents were informed of the potential for root resorption as a result of treatment.[8,9]

TREATMENT OPTIONS AND SPECIFIC OBJECTIVES OF TREATMENT

Various surgical and orthodontic-only treatment options were offered as potential solutions to the skeletal, dental, and soft tissue problems presented by the patient. Based on the goals of the patient and his parents, an orthodontic-only treatment option (including rapid palatal expansion) was selected to achieve the following treatment objectives. (Note: The decision to use rapid palatal expansion was influenced by the transverse relapse seen in the older brother, who had been previously treated without palatal expansion.)

Facial Esthetics

- Accept normal growth changes in the facial profile.
- Decrease upper and lower lip protrusion and lip incompetence.
- Minimize any increase in facial heights or interlabial gap.
- Accept the retrusive chin point.

Maxilla

- Minimize any extrusive force on the maxilla.
- Widen the maxilla in the transverse dimension to correct thefunctional shift and crossbite.

Mandible

- Prevent open rotation of the mandible by minimizing maxillary and mandibular molar eruption; possibly encouraging upward and forward (closed) rotation of the mandible into the intermaxillary growth space.

Maxillary dentition

- Treat to the maxillary posterior occlusal plane (level and cant) and maintain the incision-stomion relationship.
- Treat to the maxillary geometric midline since it was

coincident with the glabella-subnasale midline, cupid's bow (philtrum midline), and the maxillary apical base midline.
- Hold the anteroposterior position of the maxillary molars (maximum anchorage).
- Alleviate crowding, widen the intermolar width, and treat to a normal archform.
- Retract the incisors to obtain a normal overjet and overbite (as defined by prevailing vertical skeletal relationships).
- Esthetically restore the maxillary laterals after treatment.

Mandibular dentition

- Treat to the maxillary posterior occlusal plane and the maxillary geometric midline.
- Retract the lower incisors 2 mm and allow the molars to slip (protract) forward into a Class I molar relationship.

Occlusion

- Treat to a Class I dental relationship with normal overjet and overbite.
- Obtain a bilateral, mutually protected occlusion.
- Treat centric occlusion and centric relation to coincidence.

Treatment plan and mechanics

- Extract maxillary and mandibular second premolars to eliminate crowding and obtain space for necessary tooth movement.
- Widen the maxilla with rapid palatal expansion and use vertical-pull chin cup therapy[10] (if necessary) to maintain the vertical dimension.
- Band first molars and bond maxillary premolars and mandibular canines and premolars with 0.022-inch edgewise (Burstone) appliance.
- Place 0.036-inch lingual arch to consolidate the mandibular reactive elements.
- Perform sectional retraction of the maxillary left premolar with a moment to force ratio of α = 7:1, β = 10:1, and 150 g of force[11] for maximum anchorage. (See Smith and Burstone[11] for review.)
- Use sectional attraction mechanics between mandibular molars and canine/premolar segments to close the extraction space with a spring generating a moment to force ratio of α = 10:1, β = 10:1, and 200 g of force (reciprocal space closure).
- Stabilize maxillary halves, once expansion is achieved, with an 0.036-inch stainless steel (SS) transpalatal arch followed by en masse retraction of the central and lateral incisors to close any residual space.

Finish and detail occlusion

- Remove appliances and place maxillary Hawley retainer and mandibular-bonded canine-to-canine retainer.
- Restore maxillary lateral incisors after active treatment.

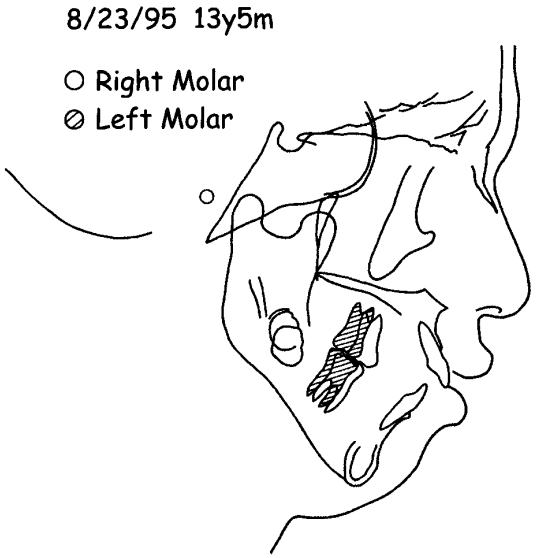

Fig 2. Pretreatment cephalometric tracing.

TREATMENT PROGRESS

The maxillary second premolars were extracted before expander placement due to their lingual position. The mandibular second premolars were extracted at the same time. Within 5 weeks, the maxilla was widened with a 6 mm rapid palatal expander, which was replaced with a 9 mm expander to fully correct the crossbite. High-pull chincup therapy was not necessary, because the vertical dimension remained stable based on clinical and cephalometric reevaluation. Sectional retraction with 0.017 × 0.025-inch TMA "T" springs was almost completed in 8 weeks, and the remaining anterior teeth were bonded. Preliminary bracket alignment was achieved with 0.019 × 0.025-inch wires (CuNiTi) in 8 weeks. The expander was removed, and the maxillary second molars were bonded.

In 8 weeks, the maxillary and mandibular anterior space was consolidated on 0.016 × 0.022-inch and 0.019 × 0.025-inch CuNiTi wires, respectively, with powerchain from lateral to lateral incisors. Then, a 0.017 × 0.025-inch TMA rectangular loop (1st order, V-geometry between the premolar and molar) was used to correct the maxillary right first molar rotation. Once the molar rotation was corrected, a 0.036-inch passive transpalatal arch was placed for the remainder of treatment. Cantilever mechanics were used to protract the mandibular left first molar. The assembly included a guidewire (0.020-inch SS), a power arm (0.017 × 0.025-inch SS) on the left canine, and a tip back spring (0.017 × 0.025-inch TMA) from the left molar to canine (Fig 5). The arch was consolidated as a single unit by ligating each

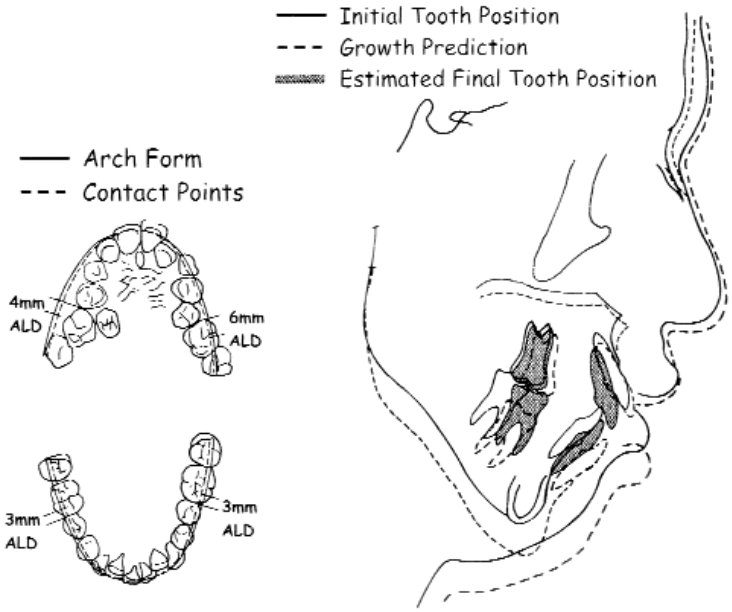

Fig 3. Twenty-four month growth prediction with visual treatment objective. *ALD*, Arch length discrepancy.

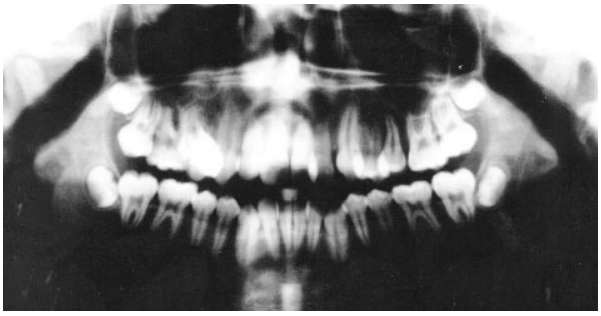

Fig 4. Pretreatment panoramic radiograph.

tooth together from the left canine to the right second molar; the retraction force was provided by a power-chain. At the same time, an asymmetric space distal to the maxillary left lateral was closed sectionally, by "hinge-motion" with a TMA "T" spring (0.017 × 0.025) from the first molar to the lateral incisor (Fig 5). Activation of the "T" spring swung the maxillary anterior segment to the left.

Space closure was complete in 8 weeks, and progress records were taken at that time. Four weeks later, a slight anterior open bite had developed, probably as a result of the high β moment in the "T" spring. Upper and lower 0.019 × 0.025-inch SS arch wires with appropriate second order bends were placed, and bilateral triangular elastics (3/16 inch, 6 oz) were worn from the upper canines to the lower laterals and first premolars. An anterior box elastic (¼ inch, 6 oz) was worn from the upper to the lower laterals. The open bite settled in 4 weeks. Then, Class II elastics (¼ inch, 6 oz) were worn from the lower second molars to the upper canines and back to the lower first premolars, concurrently with an anterior box (¼ inch, 6 oz) elastic, which was worn only at night for 12 weeks.

Artistic finishing procedures and final detailing of the occlusion was accomplished in 0.018-inch round SS arch wires in conjunction with posterior vertical elastics (¾ inch, 2 oz) and an anterior box elastic (¼ inch, 3.5 oz). The elastics were worn 24 hours each day for 3 weeks, followed by appliance removal and retainer placement.

RESULTS ACHIEVED

Maxilla

Growth of the maxilla continued in a normal downward and forward pattern (Fig 6). The maxillary transverse dimension was increased via palatal expansion to correct the constricted maxillary arch, the functional shift, and the crossbite (Fig 7).

Mandible

No significant growth modification was observed. Growth occurred as might be expected in a patient with vertical tendencies, more downward than forward movement (Fig 8).

Maxillary Dentition

The maxillary posterior occlusal plane and the incision-stomion relationship were maintained. The upper incisors underwent controlled tipping/retraction

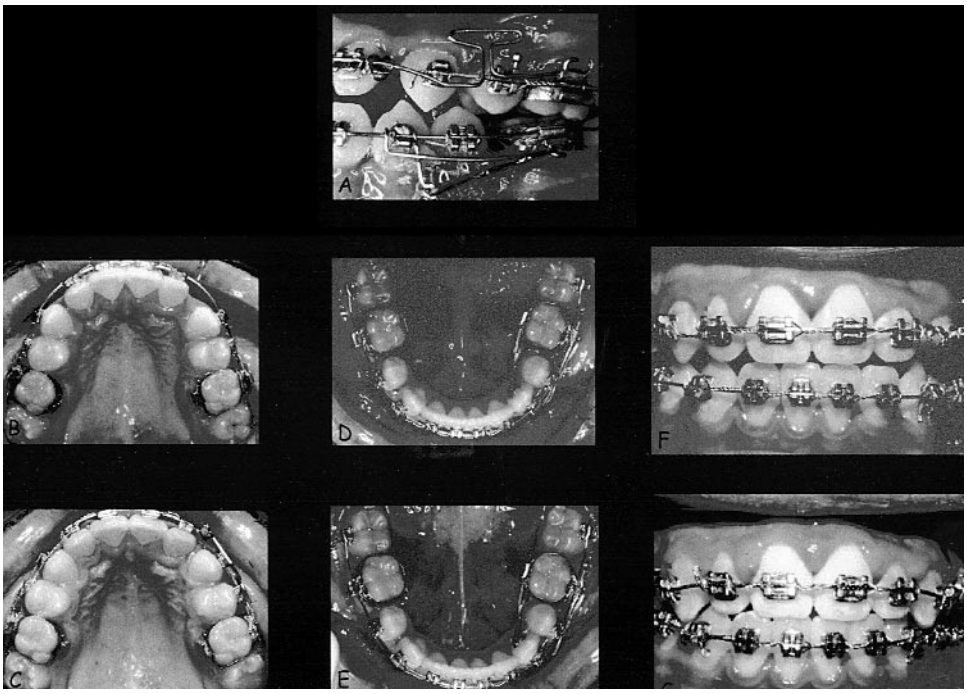

Fig 5. Maxillary and mandibular sectional mechanics. **A**, Left buccal view of mechanics; **B** and **C**, maxillary arch before and after (note: Upper right canine and lateral are only connected by ligature to allow rotation by swinging anterior segment to left and distally); **D** and **E**, mandibular arch before and after (note: Power chain was added on lingual to prevent molar rotation); **F** and **G**, midline before and after.

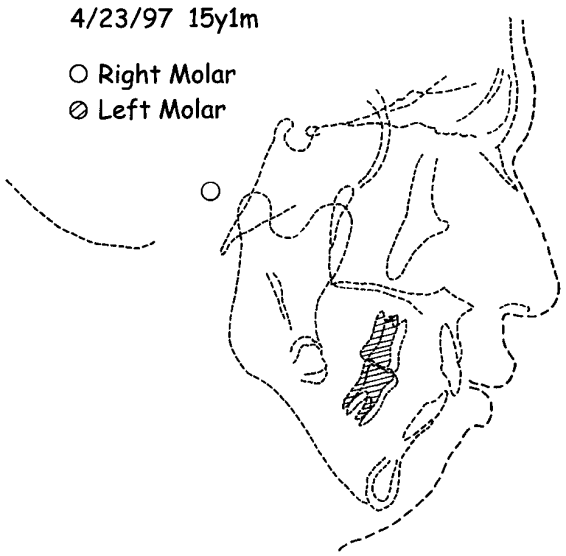

Fig 6. Posttreatment cephalometric tracing.

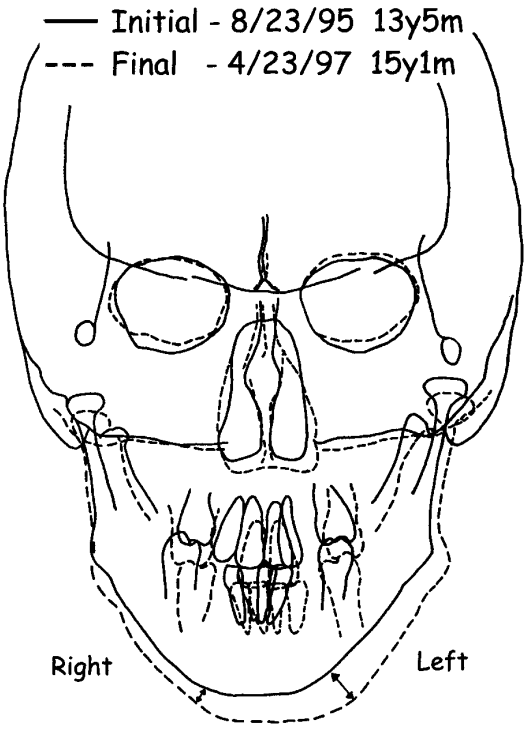

Fig 7. Posteroanterior superimposition. (Note change in mandibular position.)

of 8 mm and relative extrusion of 7 mm (Fig 8). The maxillary dental midline was treated to the maxillary geometric midline. The molars were relatively intruded, only erupting 1.5 mm. The right and left molars [apparently] slipped forward 2 mm and 1 mm,

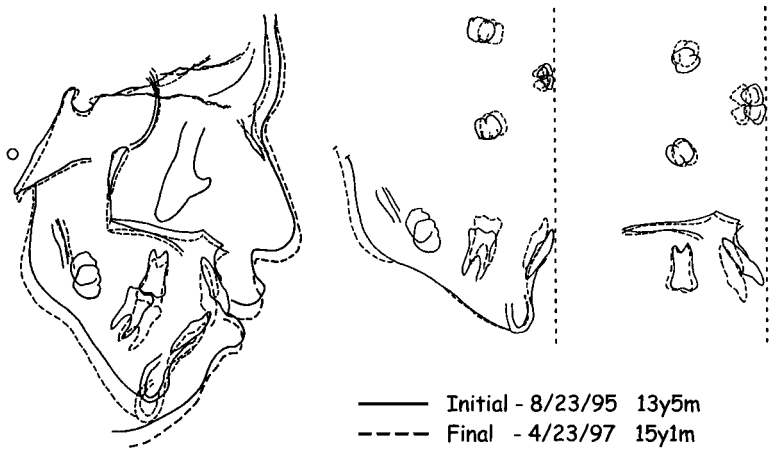

Fig 8. Superimpositions. Cranial base (**left**), mandibular (**center**), and maxillary (**right**).

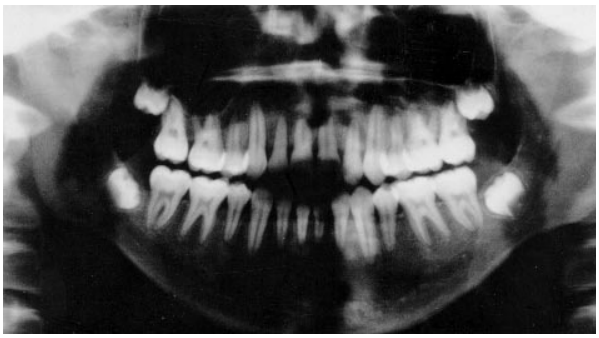

Fig 9. Posttreatment panoramic radiograph.

respectively. The intermolar width was expanded to normal dimensions. Good root parallelism was achieved, and crowding was alleviated. Slight root resorption was noted in the anterior region (Fig 9). The mesioincisal line angles of the upper lateral incisors were restored for esthetics.

Mandibular Dentition

The mandibular posterior occlusal plane was treated to the maxillary posterior occlusal plane. The lower incisors were bodily retracted 3 mm and erupted/extruded 3 mm (Fig 8). The molars were allowed to differentially erupt into the intermaxillary growth space and slip forward 2.5 mm each. The lower dental midline was treated to the maxillary geometric midline. Good root parallelism was achieved, except for the lower right first premolar. Slight root resorption was noted in the anterior region. Crowding was alleviated.

Occlusion

A Class I buccal segment and canine relationship were obtained (Fig 10). The final overjet and overbite were 2 mm and 1 mm, respectively. A normal interincisal angle was achieved. A bilateral, canine-protected occlusion was obtained, and centric (habitual) occlusion was coincident with centric relation, as determined by mandibular manipulatin.

Facial Esthetics

The angle of facial convexity increased with growth. Lip protrusion did not decrease, but lip incompetence improved. The lower anterior facial height increased (a consequence of normal growth). The nasolabial angle was not significantly changed.

RETENTION

A maxillary Hawley retainer was placed and will be worn 24 hours per day for 3 months. At that time, retainer wear will taper to nighttime only, indefinitely. A fixed mandibular canine-to-canine retainer was bonded and will remain in place until the third molars have been resolved. Based on axial inclination and space requirements, it appears that the third molars will have to be removed. The patient will be continually monitored over the next 3 to 4 years for possible relapse, specifically in the areas of open bite and maxillary constriction. If relapse does occur, it will be managed appropriately, either with chincup therapy or the incorporation of a posterior bite block into the Hawley retainer.

FINAL EVALUATION

The limited treatment objectives (ie, orthodontic-only) were accomplished. Although a surgical treatment option was presented at the consultation appointment, the patient and parents preferred a nonsurgical approach, probably due in part to the apparent success of previous

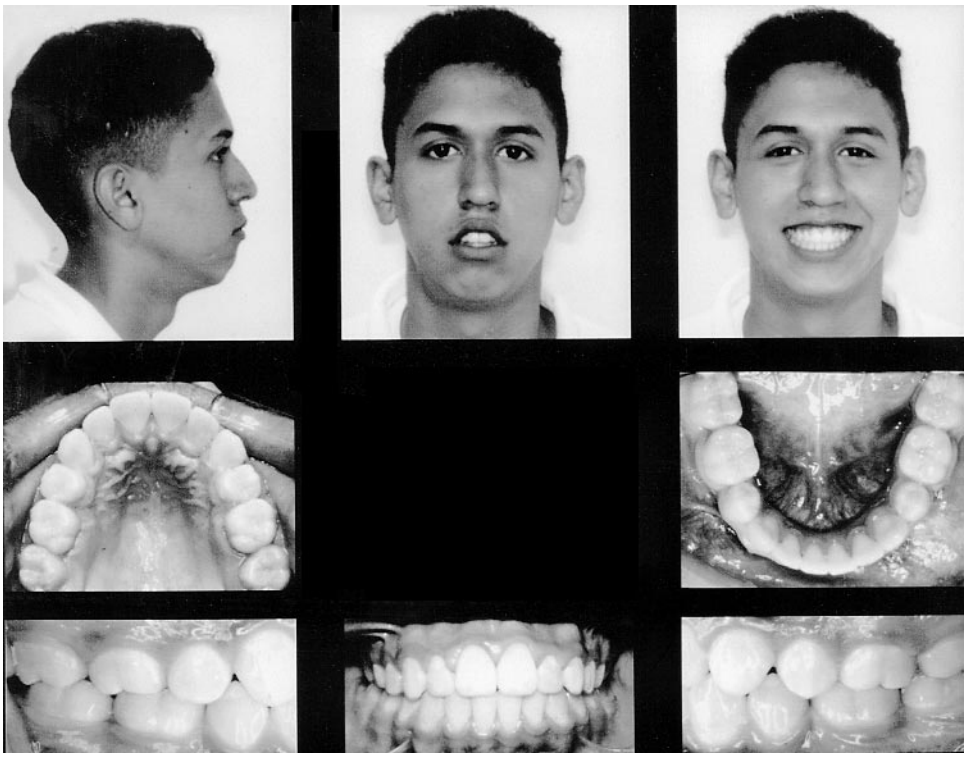

Fig 10. Posttreatment photographs.

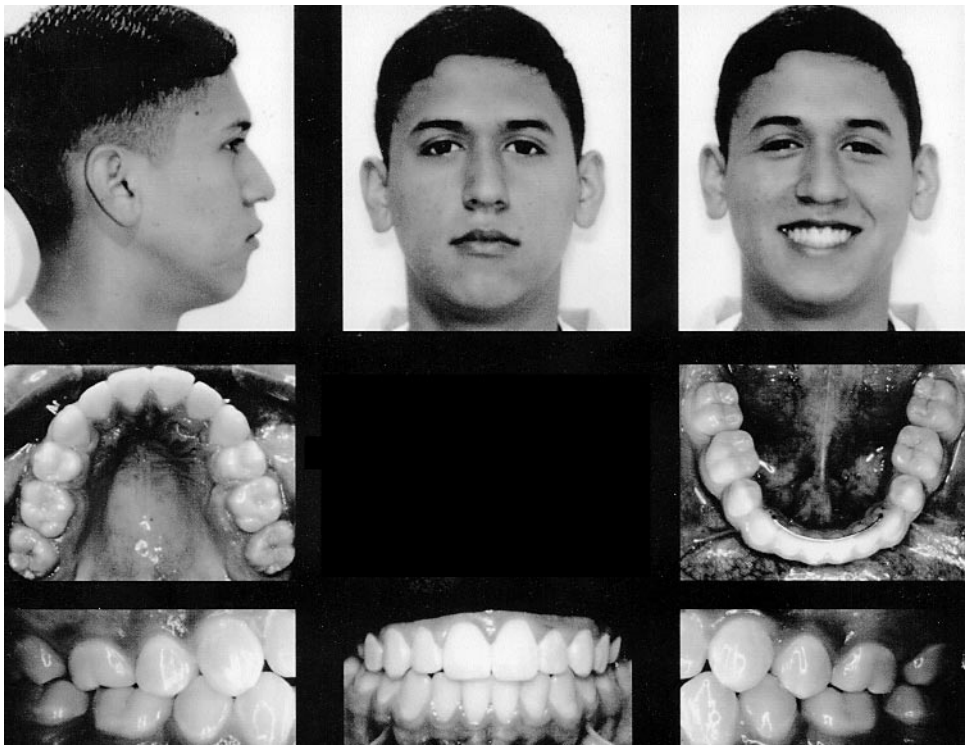

Fig 11. One-year posttreatment photographs.

nonsurgical treatment of the mother and brother. Based on root morphology, the patient was at risk for root resorption of the upper and lower anterior teeth during treatment [8]; therefore, the forces applied to the anterior teeth were of limited duration (minimized by delaying continuous arch mechanics). Although the course of treatment was estimated at 24 months, treatment was completed in 18 months. Therefore, it should be noted that the patient's growth on the visual treatment objective was overestimated.

Sectional retraction in the upper arch was initiated during maxillary expansion in an effort to use the rigid expansion device as anchorage to maximally retract the canines without slipping the molars forward. It appears, however, that the molars did [possibly] slip forward between 1 to 2 mm, at some stage during treatment. There are 2 plausible explanations for this occurrence: (1) this may have occurred during the 2 months that it took to correct the upper right molar rotation, between the removal of the expander and the placement of the transpalatal arch; or (2) this could be an artifact as a result of radiographic projection error (ie, the mesial surface of the maxillary right first molar, upon correction of the mesiolingual rotation during the interim between pretreatment and posttreatment cephalograms, was artifactually projected farther forward as the result of x-ray beam divergence).

It appears that the mandible may have rotated slightly upward and forward. The FMA increased slightly (<1°) and N-S/Go-Gn actually decreased (3°). Although, these measurements may not be definitive markers with which to evaluate mandibular rotation, other measurements also support this notion. The sum total of maxillary vertical growth (2 mm), upper molar eruption (1.5 mm), and lower molar eruption (5 mm) with mesial movement (2.5 mm) did not exceed vertical condylar growth (7 mm) measured with respect to the occlusal plane, suggesting that the intermaxillary growth space was not violated.

Controlled tipping/retraction of the upper incisors was accompanied by 7 mm of relative extrusion. Vertical growth of the lips maintained a favorable incision-stomion relationship. Although cephalometric reevaluation does not indicate that lip protrusion improved, these measurements may be flawed if nose growth, which does influence relative lip procumbence, is not taken into account. Clinically, the patient has a pleasing lip drape, and it appears that both lip protrusion and lip incompetence have improved. Although the final overbite is not ideal, it does fall within the range of normality. In addition, a bilateral mutually protected occlusion (canine rise in lateral excursion, incisal guidance in protrusion) was established; therefore it is believed that the final occlusion will remain stable.

Furthermore, stability should be enhanced because the intermaxillary growth space was not violated and because intermolar and intercanine widths were not indiscriminately widened. The patient is expected to exhibit continued growth, and it is believed that compensating eruption of the dentition will occur and maintain a stable occlusal scheme. Risk factors such as tongue thrust, aberrant tongue posture and function, occlusal prematurities, and CR-CO discrepancies are not present, enhancing the potential for a stable result over time. (Note: In the year after active appliance removal, the patient has grown over 3 inches in height, and the occlusion remains stable with minimal evidence of bite opening (Fig 11). This observation suggests that the occlusal scheme will probably remain stable. If the bite does tend to open, a high-pull orthopedic appliance, exerting an intrusive force on the maxillary posterior segments, can be worn for active retention.)

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