Case Report

A Nonsurgical Approach to Treatment of High-Angle Class II Malocclusion

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ABSTRACT

Malocclusions with a hyperdivergent vertical facial pattern are often difficult to treat without a combined surgical/orthodontic approach. The aim of this article is to describe a nonsurgical approach to the treatment of a high-angle Class II malocclusion in a growing patient. Some fundamental aspects, such as correct diagnosis, treatment timing, favorable mandibular growth pattern, and patient compliance, proved to be critical to correct the severe dentoskeletal disharmony.

KEY WORDS: Class II malocclusion; Vertical growth pattern; Nonsurgical approach

INTRODUCTION

Malocclusions with a hyperdivergent vertical facial pattern are often difficult to treat without a combined surgical/orthodontic approach.[1,2] In growing persons with skeletal open bite it is difficult to attain a predictable control of the growth of the maxillo-mandibular complex. Surgical repositioning of the maxilla, and possibly of the mandible, at the end of active growth is often the most realistic treatment option that allows the orthodontist to achieve the goal of a reasonably esthetic and functionally stable occlusion.[3]

Successful orthopedic/orthodontic treatment of a high-angle Class II division 1 malocclusion requires attentive evaluation of the components that contribute to the vertical skeletal disharmony.[1,2] The use of specific appliances for treating the individual patient with increased vertical relationships evolves from specific diagnostic interpretation. For example, the clinician should consider that the bite opening effects associated with the use of various orthodontic appliances could result in a downward and backward mandibular rotation that exacerbates the malocclusion.[1,2]

High-pull headgear has been proposed for treating patients with high-angle Class II division 1 malocclusion.[4–10] Forces produced by the high-pull headgear include both a distal component and an intrusive component that redirect the growth of the maxilla inferiorly. Furthermore, with the high-pull headgear, it is possible to change the direction of force in relation to the center of resistance of the dental units to achieve better control of the tooth movement. A force of 500 g is considered sufficient to induce maxillary orthopedic changes characterized by relative restriction of horizontal and vertical maxillary growth and distal movement of the maxillary anterior border.[7,10]

A patient's growth potential is an important factor in successful orthopedic/orthodontic treatment of a skeletal Class II malocclusion. In particular, a favorable amount and direction of facial skeletal growth can greatly facilitate the correction during therapy.

CASE REPORT

A 12-year, 6-month-old white boy was referred for orthodontic consultation (Figure 1A through G). A review of his medical history showed nothing remarkable. The patient's face was symmetric, and he had a severe gummy smile, short upper lip, increased lower facial height, and convex profile. The clinical examination showed a complete permanent dentition.

Occlusal analysis revealed a Class II division 1 malocclusion with full Class II molar and canine relationships, increased overjet (13 mm), and normal overbite (2.5 mm). Maxillary and mandibular midlines were coincident with the facial midline.

The patient had a panoramic radiograph taken about 4 months before our consultation that showed

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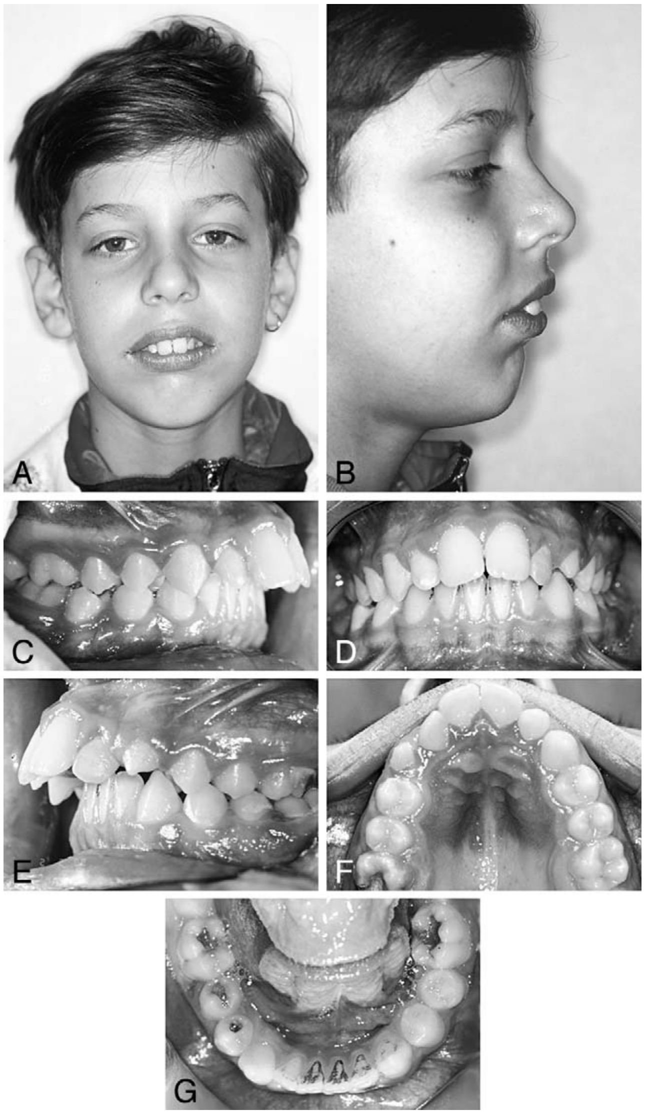

Figure 1A–G. Pretreatment facial and intraoral photographs.

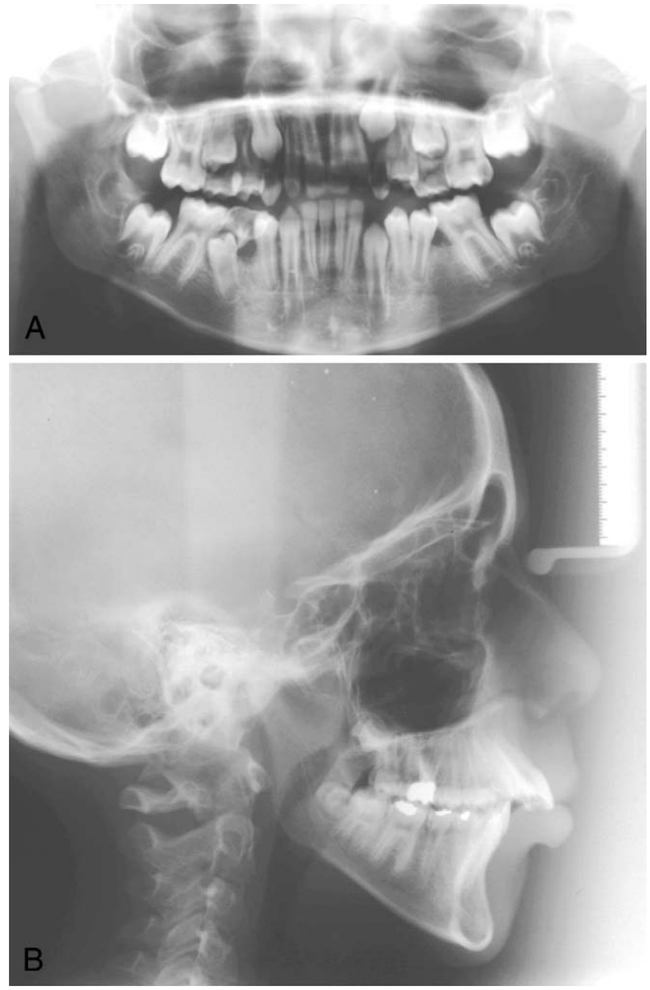

Figure 2A–B. Pretreatment panoramic and cephalometric radiographs.

that the alveolar bone and root formation were within normal limits (Figure 2A). Pretreatment cephalometric evaluation revealed a skeletal Class II relationship (ANB = 6°) associated with mandibular retrusion (SNB = 70°) (Figure 2B; Table 1). Analysis of vertical skeletal relationships showed an increased mandibular plane angle (FMA = 35°; S-N $\wedge$ Go-Gn = 44°), an upward inclination of the palatal plane (S-N $\wedge$ Palat Pl. = −2°) associated with a clockwise rotation growth pattern (Σ = 404°; Y axis = 62°). To carefully assess the skeletal factors associated with the development of vertical facial disproportions, the proportional ratio between mandibular ramus height (Ar-Go) and the height of the posterior portion of the maxillary complex (S-PNS′; point PNS′, projection of point PNS to a vertical line drawn from point Sella to point pterygomaxillare) was measured.[11] Ideal values are 0.99 ± 0.014 for subjects with normal vertical skeletal relationships, 1.07 ± 0.057 for subjects with hypodivergent facial pattern, and 0.87 ± 0.078 for subjects with hyperdivergent facial pattern. The ratio of our patient was 0.74, thus indicating a relative deficiency of mandibular ramus height.

The maxillary incisors were proclined (Upper Inc. $\wedge$ FH = 122°), and the mandibular incisors were retroclined (IMPA = 84°). The soft tissue profile was convex (Upper Lip-ELine = 4 mm, Lower Lip-ELine = 6 mm).

TREATMENT OBJECTIVES

- To restrain forward growth of the maxilla and to induce a downward rotation of the anterior portion of the palatal plane;
- To prevent downward and backward mandibular rotation;
- To encourage full potential of mandibular growth;
- To achieve a stable, functional occlusion by estab-

Table 1. Cephalometric Values Before Treatment (T0), After Treatment (T1), 29 Months from the End of Treatment (T2), and 41 Months From the End of Treatment (T3)

Variables	T0	T1	T2	T3
SNA (°)	76	72	73	73
SNB (°)	70	70	72	72
ANB (°)	6°	2°	1°	1°
A to N perp. (mm)	−4	−7	−7	−7
Pg to N perp. (mm)	−12	−14	−12	−12
Go-Gn (mm)	67	81	81	82
S-N (mm)	73	79	80	81
FMA (°)	35	34	33	33
SN^GoGn (°)	44	41	40	40
SN^Palatal Pl. (°)	−2	3	3	3
Palatal Pl.^GoGn (°)	46	38	37	37
S-N^Occl.Pl. (°)	25	18	16	15
Palatal Pl.^Occl.Pl. (°)	27	16	13	12
Go-Gn^Occl.Pl. (°)	19	23	24	23
FH^Occl.Pl. (°)	7	7	4	3
S-Go/N-Me %	56	57	57	58
Ar-Go/ANS-Me %	50	54	58	59
Ar-Go/Se-PNS'	0.74	0.80	0.88	0.89
Overjet (mm)	13	2	3	3
Overbite (mm)	2	3	2	2
IMPA (°)	84	92	90	89
FMIA (°)	61	54	57	56
Upper Inc.^FH (°)	122	114	117	118
Interincisal angle (°)	120	115	110	111
ANL (°)	107	111	112	112
Z angle (°)	58	65	63	64
Upper Lip-ELine (mm)	4	−4	−6	−6
Lower Lip-ELine (mm)	6	1	1	0
S-N^S-Ar (°)	120	119	117	117
S-Ar^Ar-Go (°)	150	153	157	156
Ar-Go^Go-Me (°)	134	133	128	128
Σ (°)	404	405	402	401
Ar-Go^Go-N (°)	52	50	48	48
N-Go^Go-Me (°)	82	83	80	80
Y Axis (°)	62	63	63	63

Figure 3A–C. Progress intraoral photographs: completion of molar distalization.

Figure 4A–C. Progress intraoral photographs: retraction of upper incisors.

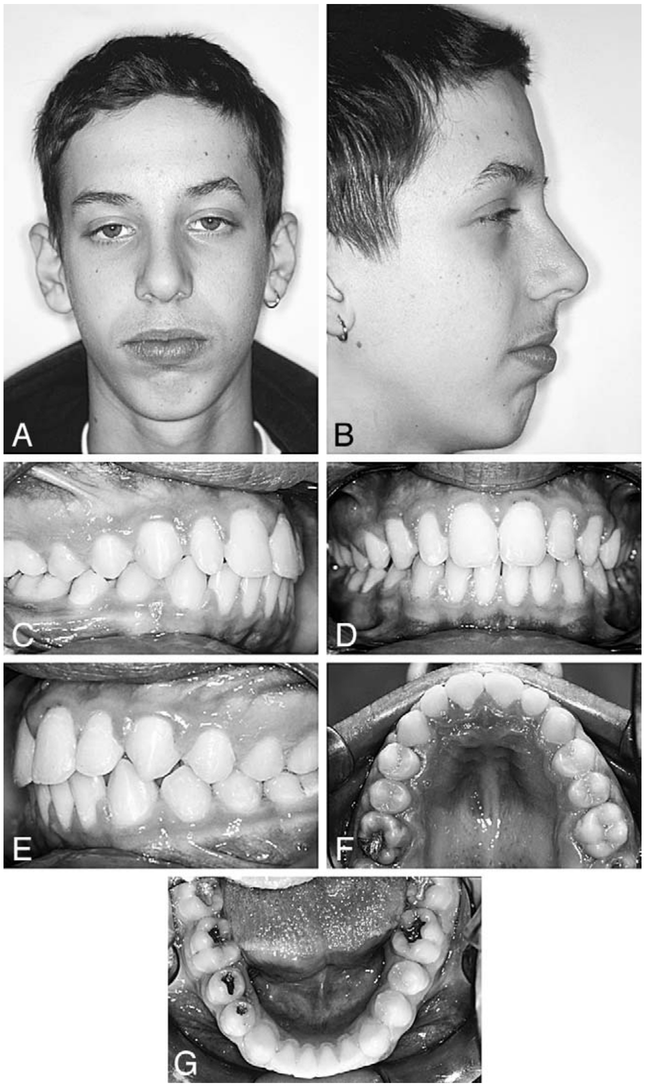

Figure 5A–G. Posttreatment facial and intraoral photographs.

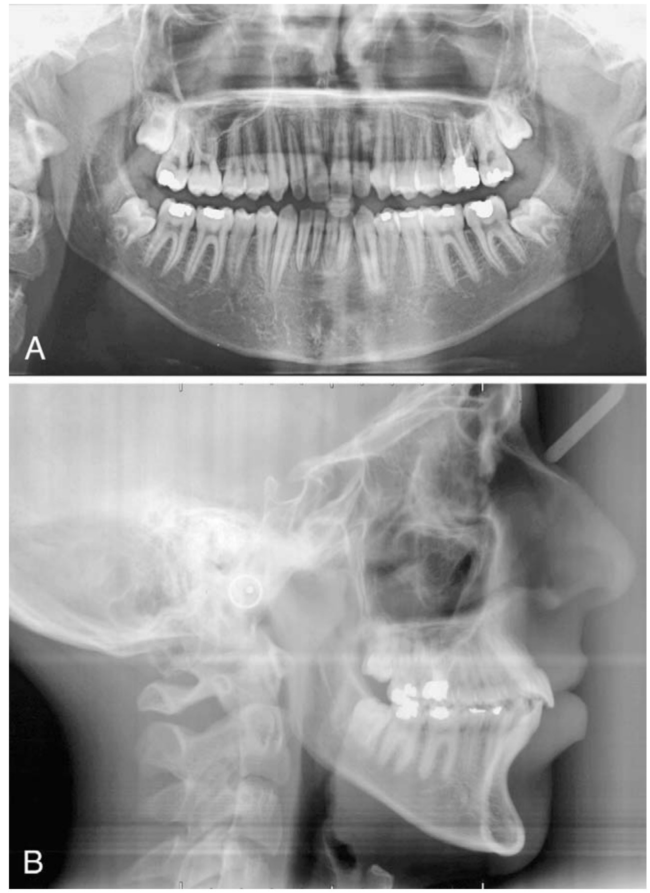

Figure 6A–B. Posttreatment panoramic and cephalometric radiographs.

lishing Class I molar and canine relationships as well as a pleasing smile and lip competence.

TREATMENT ALTERNATIVES

In a growing person several nonsurgical options are available for treating a high-angle Class II malocclusion, that is, functional appliances, selective removal of permanent teeth, and molar-distalizing appliances. The dentoskeletal effects induced by functional appliances with posterior bite blocks or by high-pull headgear to functional appliances are still controversial.[12] Extraction of maxillary first premolars alone or in combination with mandibular second premolars would create mainly a camouflage of the dentoskeletal disharmony. Intraoral distalization appliances have the advantage of reduced patient compliance. Side effects on the other maxillary teeth (premolar mesialization and incisor proclination) or mandibular teeth, breakage, the need for frequent reactivation, and the lack of favorable skeletal effects are all possible disadvantages of these appliances.[13] Use of a high-pull headgear followed by fixed-appliance therapy produces favorable dentoskeletal changes in growing subjects with high-angle Class II malocclusion, although it is indicated in patients with high degree of cooperation.[4–8]

Another option is orthognathic surgery, which would be performed at the end of growth. This option provides the best results especially in terms of facial esthetics. In the case report presented here, however, the surgical approach to treatment was not desired by the patient or the family.

TREATMENT PLAN

A comprehensive diagnosis, treatment objectives, and treatment alternatives were presented to the patient and the parents. With the parents' consent, the following treatment plan was chosen:

— Placement of bands on the maxillary molars and delivery of a high-pull headgear to achieve Class I molar relationships;

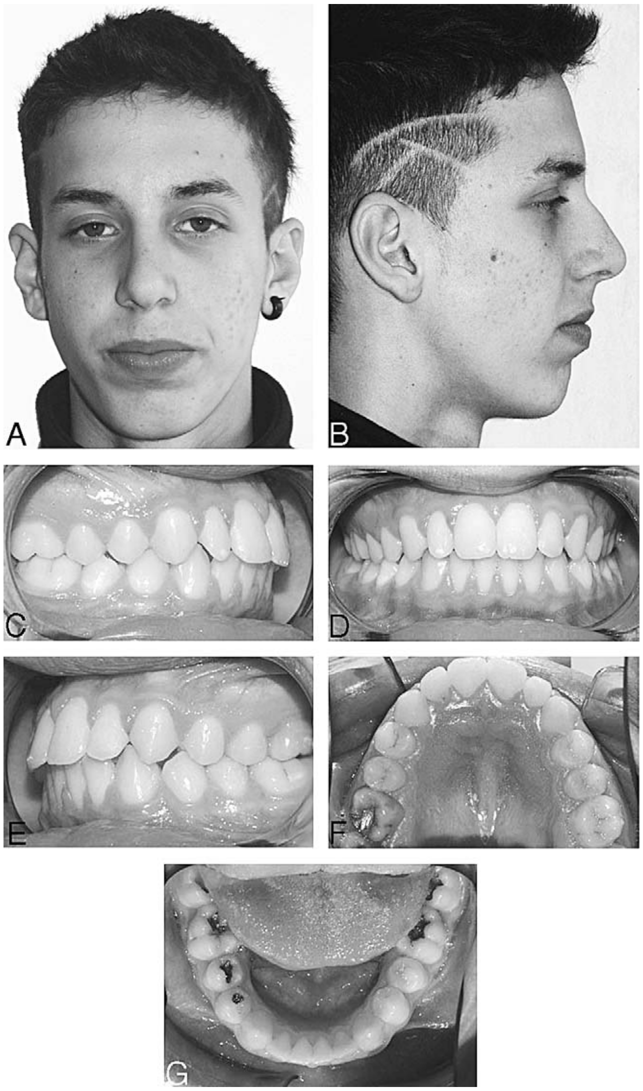

Figure 7A–G. Long-term (29 months posttreatment) facial and intraoral photographs.

- Stabilization of molar position with the headgear worn at night only and spontaneous distal drifting of the maxillary premolars into Class I relationships;
- Placement of preadjusted edgewise appliances (bidimensional technique) to level and align the dental arches and to retract the anterior teeth;
- Myofunctional therapy with muscle exercises to improve the hypertonicity of the mentalis muscle.

TREATMENT PROGRESS

Molar bands were placed on the maxillary molars and a high-pull headgear was delivered to the patient who was instructed to wear the appliance 14 to 16 hours/day with monthly adjustments. A Class I molar relationship was achieved after 11 months (Figure 3A through C). To maintain the Class I molar relationship, the high-pull headgear was worn at night only. During

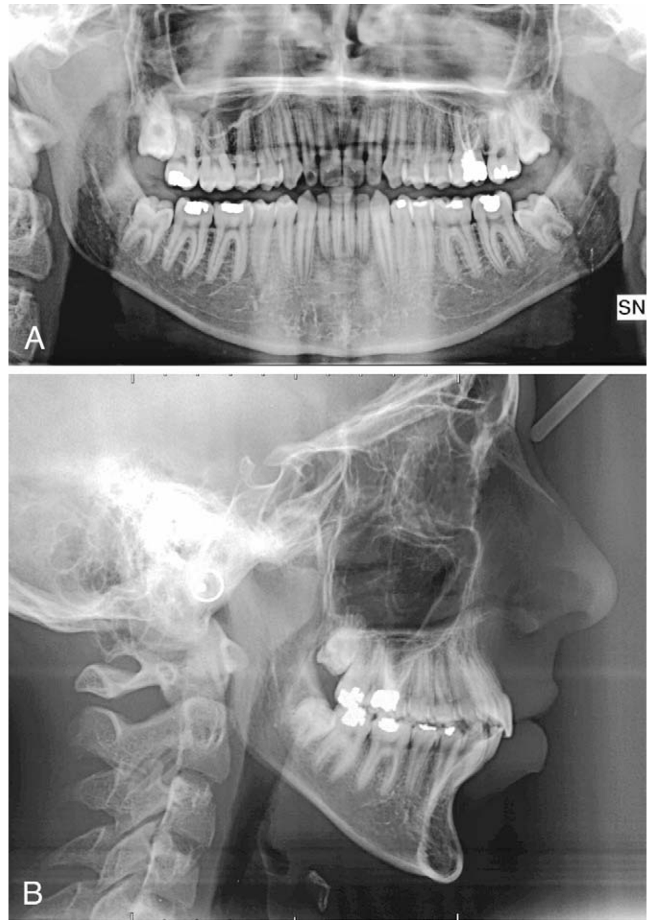

Figure 8A,B. Long-term (29 months posttreatment) panoramic and cephalometric radiographs.

stabilization of the molar position, the premolars drifted distally into a Class I occlusion after 6 months.

After the molar and premolar relationships were corrected on both sides, the patient was fully bonded with a preadjusted edgewise appliance (bidimensional technique). After bracket alignment, which took about 3 months, a 0.016-in × 0.022-in stainless steel wire was used to develop arch form and to retract the maxillary canines into a Class I relationships using Class I elastics from the first molar tubes to the canine brackets. Upper incisor retraction was carried out with a 0.018-in × 0.022-in stainless steel wire using Class I elastics from the first molars to hooks crimped between lateral incisors and canines (Figure 4A through 4C). Hypertonicity of the mentalis muscle was controlled by instructing the patient to perform muscle exercises.

The collaboration of the patient was good and fixed appliances were removed after 26 months. Retention was accomplished with removable acrylic retainers. The patient was instructed to wear the retainers at night only. The patient was reevaluated at 2 long-term

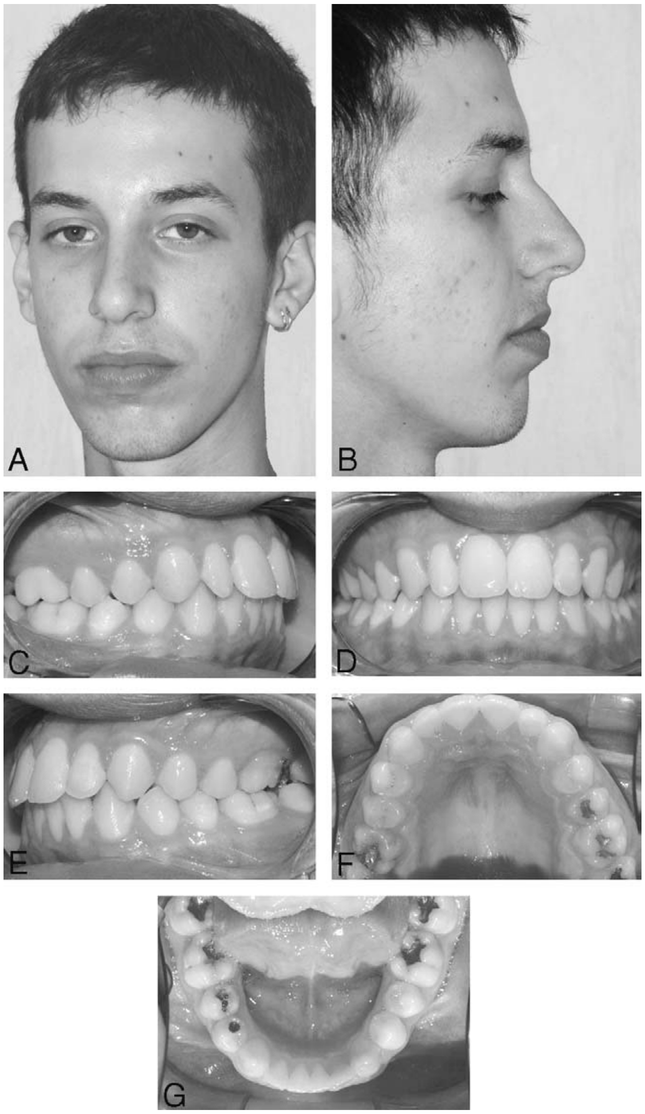

Figure 9A–G. Long-term (41 months posttreatment) facial and intraoral photographs.

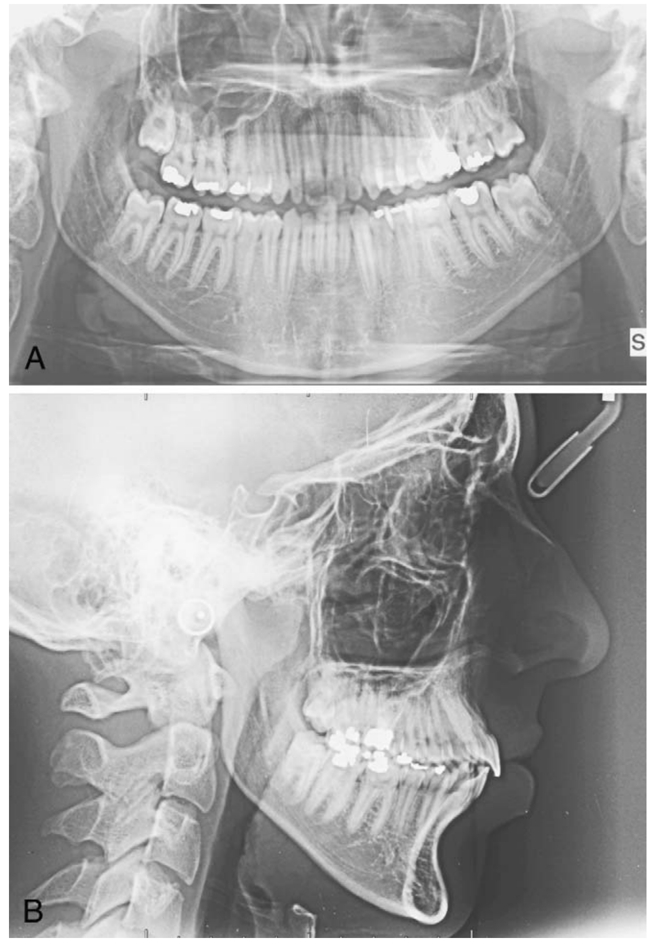

Figure 10A,B. Long-term (41 months posttreatment) panoramic and cephalometric radiographs.

observations, 29 months and 41 months from the end of therapy. Complete records were taken at the 4 observation periods: start of treatment (T0), end of active treatment (T1), 29 months from the end of therapy (T2), and 41 months from the end of therapy (T3).

RESULTS

Treatment produced an improvement of facial esthetics and a notable change in lip posture and balance (Figure 5A,B). The arches were well aligned (Figure 5C through G and 6A). Normal overbite (T1 = 3 mm) and overjet (T1 = 2 mm) were established, and Class I molar and canine relationships were achieved. The gummy smile decreased and less gingival was exposed.

A skeletal Class I relationship (ANB° T1 = 2°) was achieved, mainly by a decrease in the SNA angle (SNA° T0 = 76°, T1 = 72°) (Table 1; Figure 6B). Anterior rotation of the mandibular plane was observed (FMA T0 = 35°, T1 = 34°; S-N ∧ Go-Gn T0 = 44°, T1 = 41°). The increase in the proportional ratios Ar-Go/Se-PNS′ and Ar-Go/ANS-Me reflected the increased amount of vertical growth of the mandibular ramus (Ar-Go/Se-PNS′ T0 = 0.74, T1 = 0.80; Ar-Go/ANS-Me% T0 = 50 T1 = 54). Downward rotation of the palatal plane (S-N ∧ Palatal Pl. T0 = −2°, T1 = 3°), associated with a decrease in the intermaxillary divergence (Palatal Pl. ∧ GoGn T0 = 46, T1 = 38), was observed. The maxillary incisors were retroclined relative to the Frankfort plane (Upper Inc. ∧ FH T0 = 122°, T1 = 114°) while the mandibular incisors were proclined (IMPA T0 = 84°, T1 = 92°). In addition, the soft-tissue profile improved (Upper Lip-ELine T0 = 4 mm, T1 = −4 mm, Lower Lip-ELine T0 = 6 mm, T1 = 1 mm).

The long-term observation 29 months from the end of therapy (T2) showed a very good maintenance of the treatment results (Figure 7A through G and Figure

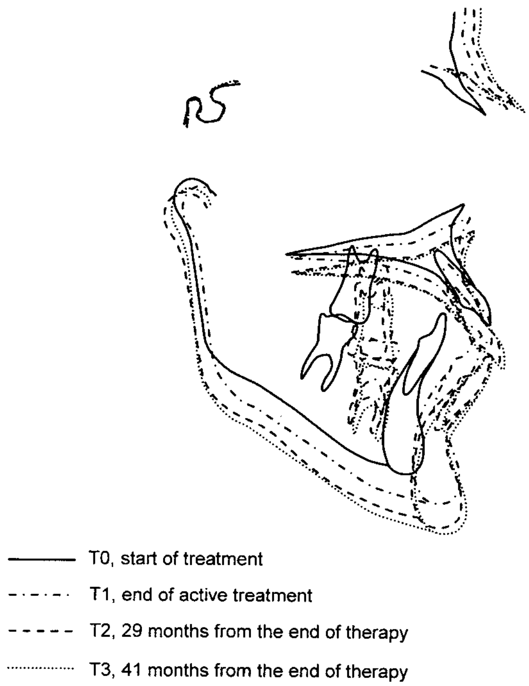

Figure 11. Superimposition of cephalometric tracings on the anterior cranial base (along S-N plane with Sella as registration point).

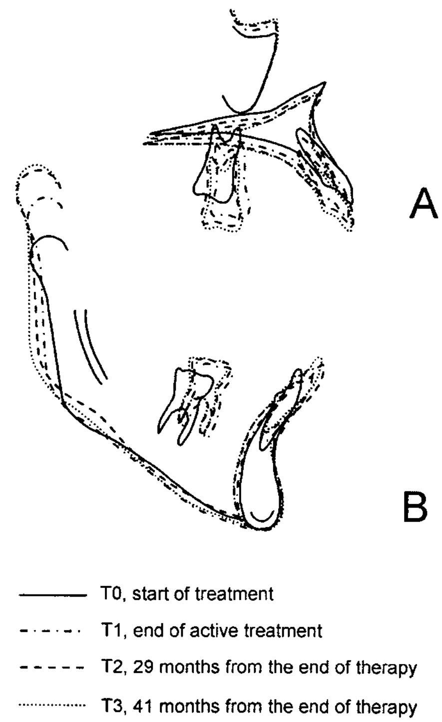

Figure 12. Superimpositions on regional stable structures. (A) Maxilla; (B) Mandible.

8A,B). A good skeletal Class I relationship was maintained (ANB° T2 = 1°) (Table 1), the vertical skeletal discrepancy improved (FMA T1 = 34°, T2 = 33°; S-N $\wedge$ Go-Gn T1 = 41, T2 = 40°), and the mandibular ramus height increased (Ar-Go/Se-PNS′ T1 = 0.80, T2 = 0.88; Ar-Go/ANS-Me% T1 = 54 T1 = 58). Good maintenance of the inclinations of the upper and lower incisors was also evident. A notable change in mentalis muscle posture and balance could also be observed. Myofunctional therapy improved muscle function and the habitual position of soft tissue (Figure 7B), a factor that probably helped in the stability of the skeletal and dental correction of the malocclusion.

The long-term observation performed 41 months from the end of therapy (T3) showed very good stability of both occlusal and dentoskeletal features with respect to T2 (Table 1; Figure 9A through G and Figure 10A,B).

Superimpositions on the anterior cranial base (along S-N plane with Sella as registration point (Figure 11) revealed restriction of the forward growth of the maxilla associated with a downward rotation of the anterior portion of the palatal plane. The mandible exhibited a favorable amount of growth both in the vertical (mandibular ramus) and sagittal directions. The maxillary and mandibular regional superimpositions on the stable structures[14,15] show the dentoalveolar changes in the molar and incisor areas together with the growth and remodeling events that occurred in the bony bases (Figure 12). The vertical dentoalveolar changes did not have a major impact on vertical skeletal relationships as they were compensated by the vertical growth of the mandibular ramus. Another interesting aspect is that the sagittal position of the maxillary molar at T4 was even more mesial than at T1. However, as observed by Melsen,[16] this did not lead to a relapse of the Class I molar relationship obtained during treatment. During the posttreatment period, the sagittal molar relationship was maintained through forward growth of the facial skeleton. This growth was more pronounced in the mandible than in the maxilla, thus accounting for the intramaxillary movement of the maxillary first molars.

DISCUSSION

Treatment options for correcting Class II malocclusions usually include orthognathic surgery or selective removal of permanent teeth, with subsequent dental compensation to mask the skeletal discrepancy.[2,8] In the case report presented here, extractions or a surgical approach to treatment were not desired by the patient or the family.

Very good patient compliance and a favorable mandibular growth pattern were key elements for the successful treatment of this severe high-angle Class II malocclusion. In this patient, timing for the start of treatment was also a determinant factor. Treatment was started during the early phase of the permanent dentition when the patient was still showing a prepubertal stage of skeletal maturity (Cervical Stage, CS 1, Figure 2B) as assessed by means of the cervical vertebral maturation method.[17] At posttreatment observation (T1) the patient exhibited a postpubertal stage of skeletal maturity (CS 5, Figure 6B), thus indicating that the pubertal growth spurt had occurred during treatment.

The headgear effect on the maxilla restricted forward growth associated with a downward rotation of the anterior portion of the palatal plane that contributed to the decrease in intermaxillary divergence. The success achieved in treating this severe malocclusion could be attributed, at least in part, to the favorable mandibular growth pattern in the vertical and sagittal directions. In particular, mandibular ramus height showed favorable growth increments when evaluated with respect to the lower anterior facial height (Ar-Go/ANS-Me %) and to the height of the posterior portion of the maxillary complex (Ar-Go/Se-PNS′). The increase in mandibular ramus height can explain why the mandible did not show a counterclockwise rotation, but rather maintained a stable value of the facial axis. The reduction of the SN-GoGn angle can be attributed mainly to a greater increase of the height of the mandibular ramus rather than to the increase of the anterior facial height. These observations suggest that one of the key factors for successful treatment of this type of malocclusion was a favorable mandibular growth pattern in the vertical and sagittal directions.

CONCLUSIONS

- An accurate cephalometric analysis allowed identification of the components of the skeletal deformity and, consequently, successful correction of the malocclusion.
- A satisfactory correction of the high-angle Class II malocclusion was obtained by restricting forward growth of the maxilla and by a favorable amount of growth in mandibular ramus height.
- Treatment timing, favorable mandibular growth pattern, and patient compliance proved to be essential in correcting the severe dentoskeletal disharmony.
- Correction of malocclusion was achieved with a notable improvement in patient esthetics and self-esteem.

REFERENCES

1. Collins MK. A nonsurgical approach to treatment of high angle class II, division 1 malocclusion in a nongrowing patient. *Am J Orthod Dentofacial Orthop.* 1996;110:678–861.
2. Cope JB, Sachdeva RCL. Nonsurgical correction of a class II malocclusion with a vertical growth tendency. *Am J Orthod Dentofacial Orthop.* 1999;116:66–74.
3. Maggioncalda EA. Treatment of a class II, division 1 vertical growth pattern severe anterior crowding. *Am J Orthod Dentofacial Orthop.* 1997;112:300–308.
4. Brown P. A cephalometric evaluation of high-pull molar headgear and face-bow neck strap therapy. *Am J Orthod Dentofacial Orthop.* 1978;74:621–632.
5. Burke M, Jacobson A. Vertical changes in high angle class II, division 1 patients treated with cervical or occipital pull headgear. *Am J Orthod Dentofacial Orthop.* 1992;102:501–508.
6. Cangialosi TJ, Meistrell ME, Leung MA, Ko JY. A cephalometric appraisal of edgewise class II nonextraction treatment with extraoral force. *Am J Orthod Dentofacial Orthop.* 1988;93:315–324.
7. Firouz M, Zernik J, Nanda R. Dental and orthopedic effects of high-pull headgear in treatment of class II, division 1 malocclusion. *Am J Orthod Dentofacial Orthop.* 1992;102:197–205.
8. Giancotti A. Nonextraction treatment of a high angle class II malocclusion: a case report. *Am J Orthod Dentofacial Orthop.* 2000;117:721–727.
9. Lima Filho RM, Lima AL, de Oliveira Ruellas AC. Longitudinal study of anteroposterior and vertical maxillary changes in skeletal class II patients treated with Kloehn cervical headgear. *Angle Orthod.* 2003;73:187–193.
10. O'Reilly MT, Nanda SK, Close J. Cervical and oblique headgear: a comparison of treatment effects. *Am J Orthod Dentofacial Orthop.* 1993;103:504–509.
11. Franchi L, Baccetti T, Defraia E, Geri C. Significato del complesso cefalometrico del ''pilastro postero superiore'' del complesso facciale nello studio dell'equilibrio verticale. Nota II. Indagine clinico-statistica su una casistica ortodontica. Paper presented at: Atti del XII Congresso Nazionale SIDO; 1993; Cernobbio, Italy.
12. Cozza P, Mucedero M, Baccetti T, Franchi L. Early orthodontic treatment of skeletal open-bite malocclusion: a systematic review. *Angle Orthod.* 2005;75:707–713.
13. Sfondrini MF, Cacciafesta V, Sfondrini G. Upper molar distalization: a critical analysis. *Orthod Craniofacial Res.* 2002;5:114–126.
14. Björk A, Skieller V. Roentgencephalometric growth analysis of the maxilla. *Trans Eur Orthod Soc.* 1977;53:51–55.
15. Björk A, Skieller V. Normal and abnormal growth of the mandible. A synthesis of longitudinal cephalometric implant studies over a period of 25 years. *Eur J Orthod.* 1983;5:1–46.
16. Melsen B. Effects of cervical anchorage during and after treatment: an implant study. *Am J Orthod.* 1978;73:526–540.
17. Baccetti T, Franchi L, McNamara JA, Jr. The Cervical Vertebral Maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. *Semin Orthod.* 2005;11:119–129.