AJO-DO

Correction of severe bimaxillary protrusion with first premolar extractions and total arch distalization with palatal anchorage plates

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Correction of a severe protrusive soft tissue profile without orthognathic surgery can be challenging. This case report describes the treatment of a young woman with a severe bimaxillary protrusion. Orthodontic treatment included extraction of her 4 first premolars and total arch distalization of both arches using a palatal plate appliance. The total treatment time was 24 months. Her occlusion and facial appearance were significantly improved. (Am J Orthod Dentofacial Orthop 2015;148:310-20)

Bimaxillary dentoalveolar protrusion is a common dentofacial deformity that results in functional and esthetic problems that traditionally were treated with premolar extractions.[1] Patients with severe bimaxillary dentoalveolar protrusion are often treated with a combination of orthodontics and orthognathic surgery to improve the facial profile.

In severe cases of protrusion, the typical orthodontic therapy that includes extraction of the 4 first premolars and retraction of anterior teeth may not be sufficient to improve the facial profile. Schacter and Schacter[2] reported that extracting both premolars in the same quadrant can generate enough space to alleviate severe crowding and allow incisor retraction to treat the bimaxillary protrusion and create contact between the canine and the first molar. However, this approach might lead to loss of the premolars' function and cause periodontal problems and disturbances in the occlusion. Therefore, total arch distalization might be required to supplement the extraction treatment if patients decline surgical options to improve their profiles.

Currently, it is being suggested that temporary skeletal anchorage devices can be used to support molar distalization devices.[3-6] However, placing temporary skeletal anchorage devices in the buccal plate of bone poses a higher risk of contacting the roots of adjacent teeth and a limited range of action because of the interradicular space.[7] Therefore, a modified palatal anchorage plate (MPAP) may overcome this drawback and effectively distalize the whole dental arch.[8-10]

This case report presents a young woman with a severe bimaxillary protrusion treated with 4 first premolar extractions and total arch distalization with a palatal anchorage plate.

DIAGNOSIS

A young woman, aged 20 years 4 months, came to the orthodontic department of Seoul St. Mary's Hospital, Catholic University of Korea, in Seoul with the chief complaint of lip protrusion. Her lips were incompetent because of the severe proclination of her maxillary incisors at rest. When smiling, the left side of her upper lip lifted more than the right. No significant skeletal asymmetry or temporomandibular joint disease was found. She was healthy, with no specific medical problems.

She had an overjet of 6.5 mm, a 10% overbite, and mild crowding in both arches. She had Class I molar relationships and dental caries on her mandibular

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Fig 1. Pretreatment facial and intraoral photographs.

second molars (Figs 1 and 2). The panoramic radiograph showed a missing mandibular left third molar, and her other third molars were in the developmental stage (Fig 3, *A*).

The lateral cephalometric analysis indicated a skeletal Class I pattern (ANB, 3.5°; Wits appraisal, −1.0 mm) with a hyperdivergent growth pattern (FMA, 33.0°). The maxillary and mandibular incisors were proclined (U1-FH, 135.0°; IMPA, 94.5°; U1/L1, 97.5°). The upper and lower lips were protrusive (upper lip to E-line, 2.5 mm; lower lip to E-line, 5.0 mm) with an acute nasolabial angle (79.0°). She had a short upper lip (subnasale-stomion, 17.0 mm) with an increased ratio of lower lip and chin to upper lip (stomion-soft tissue menton/subnasale-stomion, 3.0) (Figs 3, *B*, and 4; Table).

TREATMENT OBJECTIVES

The treatment objectives were to improve the patient's facial profile, obtain optimal inclination of her anterior teeth, obtain normal overjet and overbite, maintain a Class I molar and canine relationship, and resolve the crowding in both arches.

TREATMENT ALTERNATIVES

The first treatment option was to perform an anterior segmental osteotomy combined with first premolar extractions because of her thin anterior alveolus. The second treatment option was to fully retract her anterior teeth after extraction of her first premolars. However, if the improvement in her profile was not satisfactory after closure of the extraction space, a further treatment option was to distalize the entire maxillary dentition using a palatal plate appliance. The mandibular dentition would be distalized along with the maxillary dentition using Class III elastics.

The patient refused the surgical treatment option. Therefore, the second and the additional treatment options were used to improve her profile.

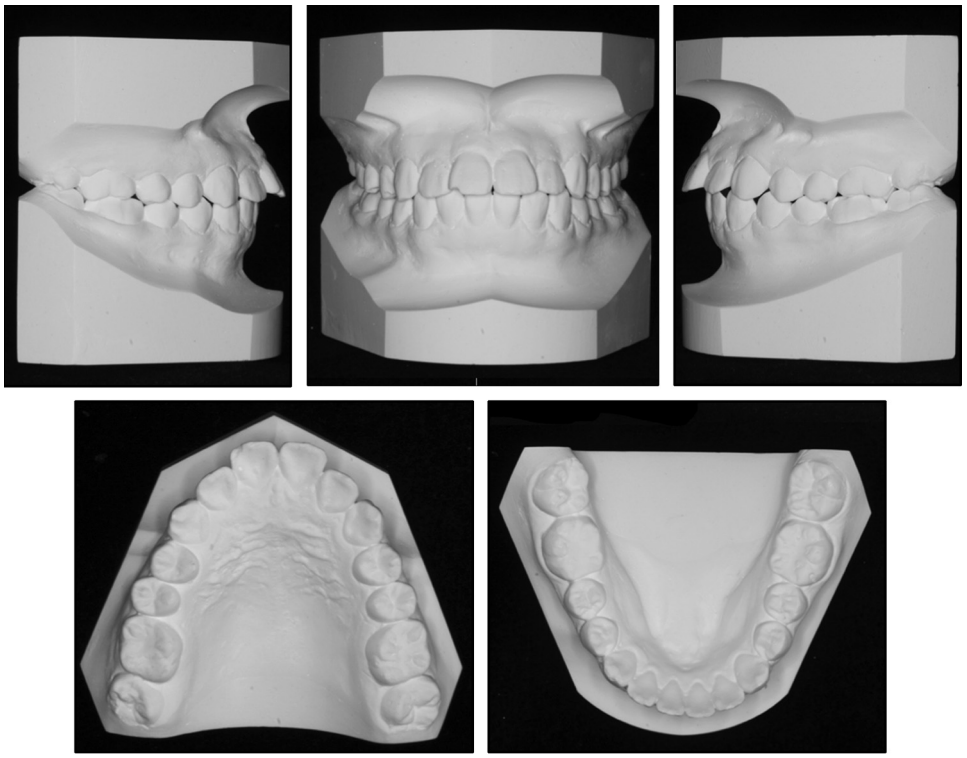

Fig 2. Pretreatment dental casts.

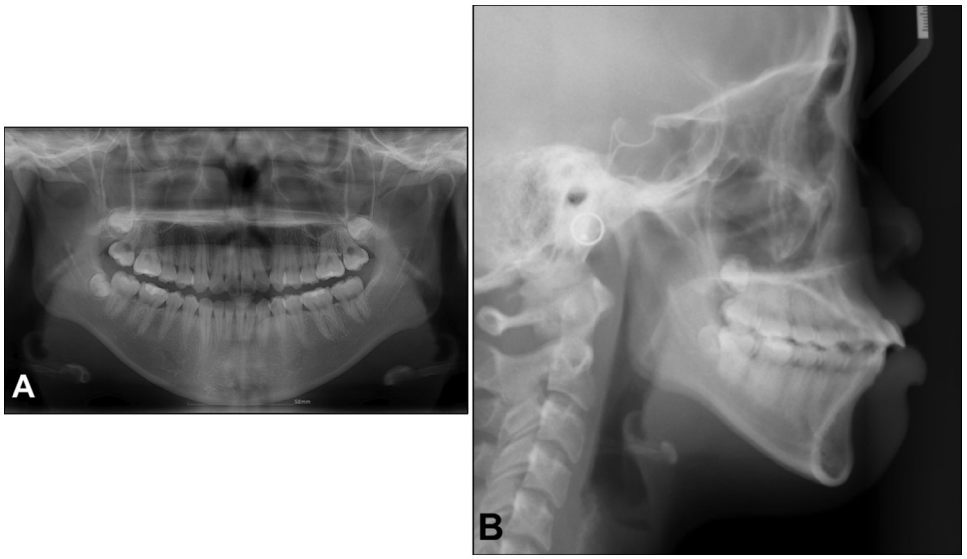

Fig 3. Pretreatment radiographs: **A,** panoramic radiograph; **B,** lateral cephalogram.

TREATMENT PROGRESS

Before orthodontic treatment, the patient was referred to a general dentist for treatment of the dental caries and extraction of all first premolars. She was also sent to an oral surgeon to evaluate the extraction of her third molars, but she declined the extractions. Preadjusted appliances with 0.022-in slots were bonded on both arches for leveling and

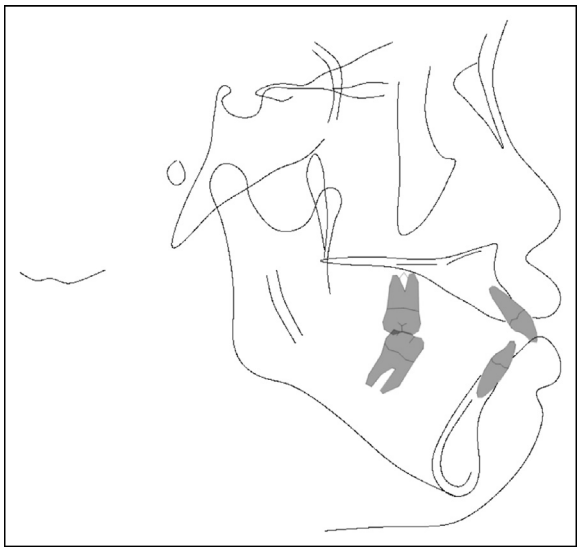

Fig 4. Pretreatment cephalometric tracing.

alignment. Her maxillary arch was leveled with archwires, starting with 0.016-in nickel-titanium and working up to 0.019 × 0.025-in stainless steel wires. Two miniscrews were placed between the maxillary first and second molars for maximum anchorage. The maxillary and mandibular anterior teeth were retracted en masse using 0.019 × 0.025-in stainless steel wires with hooks between the lateral incisors and the canines for 7 months. Unfortunately, even after retraction of the maxillary anterior segment with maximum anchorage, the patient still had protrusive lips (Fig 5).

Therefore, to improve her profile, an MPAP was used to distalize the whole dentition of both arches. The MPAP was stabilized in the palate with 3 miniscrews (8 mm length, 2.0 mm diameter; Jeil Medical, Seoul, Korea) (Fig 6). A palatal arch running along the gingival margin was soldered to the banded maxillary first molars. Elastomeric chains exerting 250 g of force per side were engaged between the hooks of the palatal arch and the notches in the MPAP for 7 months for maxillary total arch distalization. Along with maxillary distalization, Class III elastics were used for retraction of the mandibular dentition for 5 months. During treatment, by selecting the appropriate notches on the MPAP arm, the vertical dimension was adjusted to improve the patient's facial profile.[11]

In addition, the mandibular incisors were carefully observed during retraction because of the thin lingual cortical plate of bone at the symphyseal area that was noted in her initial lateral cephalogram, to prevent fenestration and severe gingival recession.

Table. Cephalometric measurements

Measurement	*Norm ± SD*	*Pre-treatment*	*Progress (after maximum retraction)*	*Post-treatment*
SNA (°)	82.0 ± 2.0	83.5	83.5	83.5
SNB (°)	80.0 ± 2.0	80.0	79.5	78.0
ANB (°)	3.5 ± 1.9	3.5	4.0	5.5
Wits (mm)	−2.5 ± 1.8	−1.0	−0.8	−0.5
Harvold (mm)	26 ± 4.0	34.0	33.9	33.3
FMA (°)	22 ± 3.0	33.0	34.5	36.0
U1-FH (°)	114 ± 6.5	135.0	110.0	100.0
U1-APog (mm)	7.8 ± 2.2	14.0	5.5	2.5
IMPA (°)	91.6 ± 2.0	94.5	81.0	75.0
L1-NB (mm)	3 ± 2.0	10.0	6.5	4.0
U1/L1 (°)	124 ± 8.3	97.5	130.0	148.0
E-line–upper lip (mm)	−1.2 ± 2.2	2.5	1.5	0.5
E-line–lower lip (mm)	0.14 ± 2.8	5.0	2.0	1.0
Nasolabial angle (°)	84.9 ± 5.0	79.0	89.0	92.0
TVL-UL (mm)	3.7 ± 1.2	9.5	6.7	6.5
TVL-LL (mm)	1.9 ± 1.4	10.0	4.5	2.5
TVL-Pog′ (mm)	−2.6 ± 1.9	2.5	0.0	−2.0
Sn-Stm (mm)	22.6 ± 2.1	17.0	17.0	20.0
Stm-Me (mm)	48.8 ± 3.3	43.5	43.5	43.0
Stm-Me/Sn-St (ratio)	2.0 ± 0.2	3.0	3.0	2.5
PTV-UL (mm)		68.0	65.0	63.5
PTV-LL (mm)		68.0	64.5	59.5
PTV-Pog′ (mm)		64.5	59.5	54.5

PTV, Pterygoid true vertical line.

At the finishing stage, final detailing of the occlusion was accomplished with 0.016 × 0.022-in stainless steel archwires in conjunction with posterior vertical and Class III elastics. Bonded lingual premolar to premolar retainers were placed on both the maxillary and mandibular dentitions, and additional Essix retainers were delivered. Total treatment time was 24 months.

TREATMENT RESULTS

The posttreatment records show an improved smile and better profile esthetics. Her overbite and overjet were also improved, and Class I canine and molar relationships were maintained with a canine-protected occlusion (Figs 7 and 8). The posttreatment panoramic radiograph showed proper space closure and acceptable root parallelism with no significant sign of bone or root resorption (Fig 9, *A*).

Overjet was decreased from 6.5 to 2.5 mm. The maxillary incisors were retracted by 11.5 mm. The mandibular incisors were uprighted (IMPA, 94.5° to 75.0°). The interincisal angle increased from 97.5°

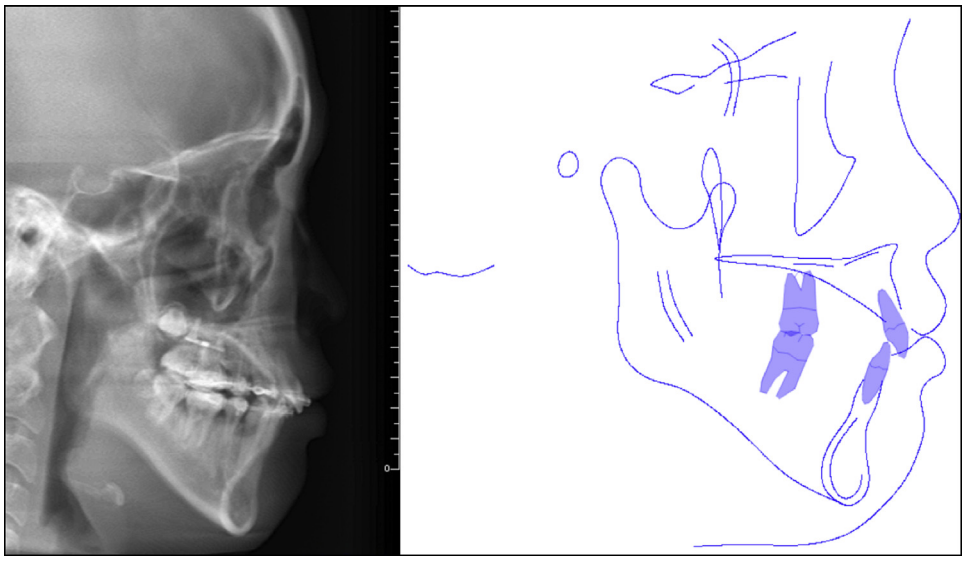

Fig 5. Progress lateral cephalogram and tracing after maximum retraction of the maxillary anterior teeth.

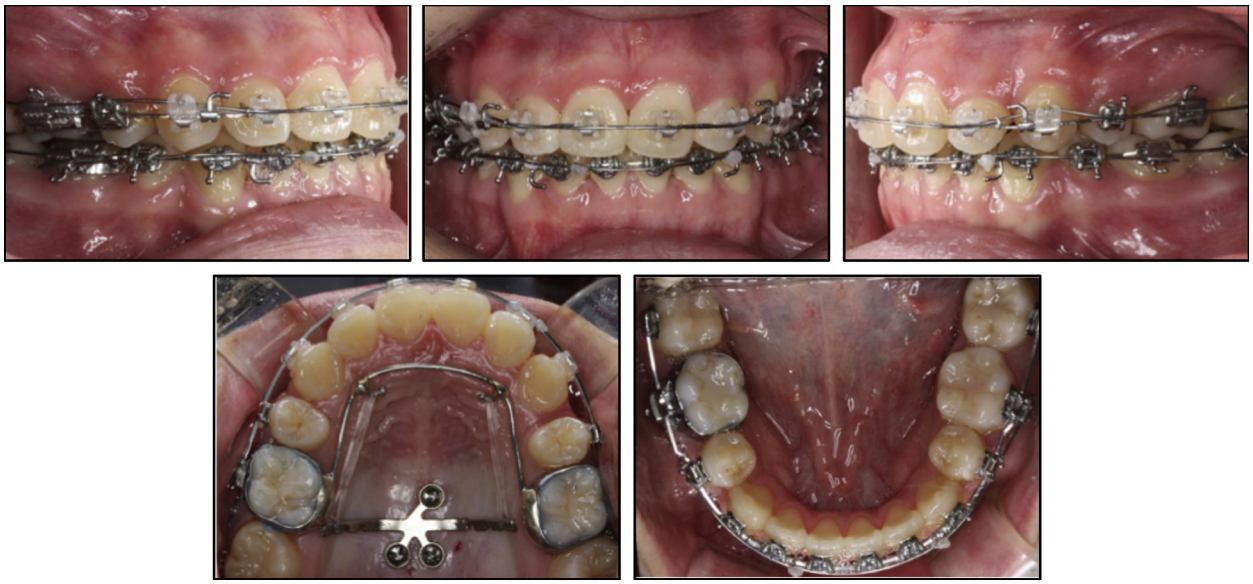

Fig 6. Progress intraoral photographs with the placement of the MPAP.

to 148.0°. Several changes were apparent in the soft tissues; from the true vertical line, upper lip projection improved from 9.5 to 6.5 mm, lower lip from 10.0 to 2.5 mm, and soft tissue pogonion from 2.5 to −2.0 mm. The mandibular plane angle increased from 33° to 36°, and the occlusal plane angle from 3° to 13° (Figs 9, *B*, 10, and 11; Table). The mandibular incisors were clinically evaluated, and no signs of mobility, loss of vitality, or periodontal complications were found. The patient maintained good occlusion, and there were no significant cephalometric changes in her profile 1 year after the end of treatment (Figs 12 and 13).

DISCUSSION

Headgear and intraoral noncompliance appliances have been used for maxillary molar distalization.

Fig 7. Posttreatment facial and intraoral photographs.

Recently, the combination of the 2 modalities has been reported.[12] Although this decreased the unfavorable effects of the intraoral appliances, it still depended on the patient's cooperation. Several authors have reported the application of temporary skeletal anchorage devices to distalize the maxillary posterior teeth. However, some of these appliances are bulky, whereas others contributed to distal crown tipping.[13-15] Meanwhile, the MPAP appliance has been reported to effectively distalize the posterior teeth in adults.[8]

Although the third molars seem to work as a fulcrum when posterior teeth are distalized, previous studies have shown controversial results.[8,16-18] For example, Gianelly et al[16] recommended that the maxillary third molars should be extracted before distalization of the posterior teeth. Even though the sample size was small, Kook et al[8] recently reported no significant difference in the amounts of distalization and tipping using MPAP between subjects with retained third molars and those who had them extracted. Our patient declined the extraction option; hence, the treatment plan was implemented without modification.

An anterior segmental osteotomy might be recommended as the treatment of choice in patients with bimaxillary dentoalveolar protrusion because it is simple and has minimal postoperative complications, a shorter treatment time, and a limited relapse rate.[19] Yet, if a patient is reluctant to have surgery, it is important to find alternative treatment options. For instance, extracting 2 premolars in the same quadrant can generate enough space for incisor retraction.[2] However, this may result in a disturbed occlusion and esthetic and periodontal problems. Park and Hwang[19] reported a retraction of 5.9 mm for the maxillary incisors and a 14.1° increase in the nasiolabial angle after anterior segmental osteotomy. The extraction of 2

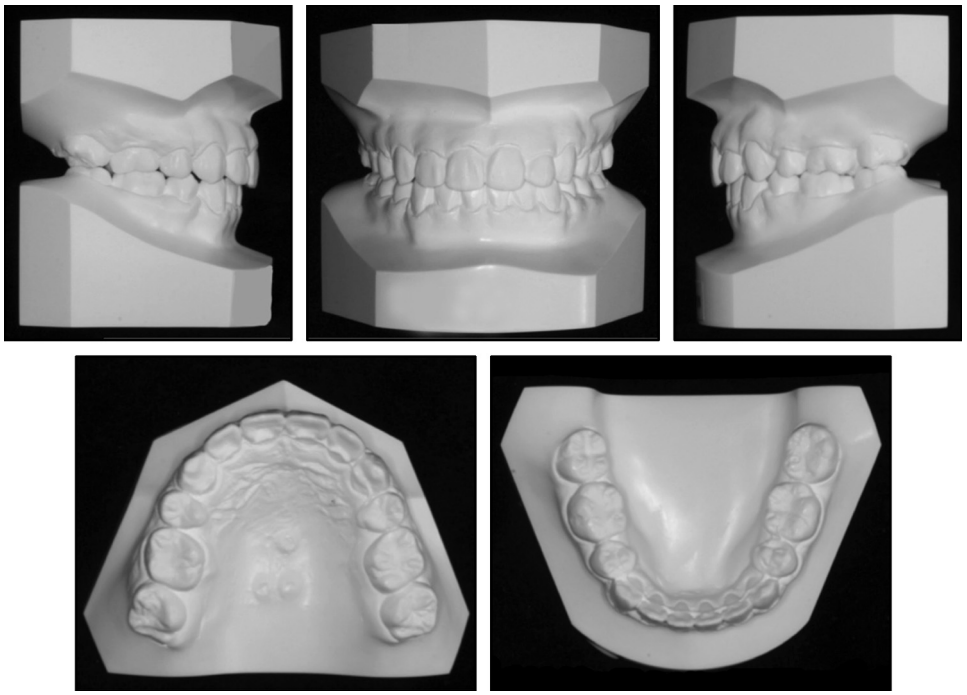

Fig 8. Posttreatment dental casts.

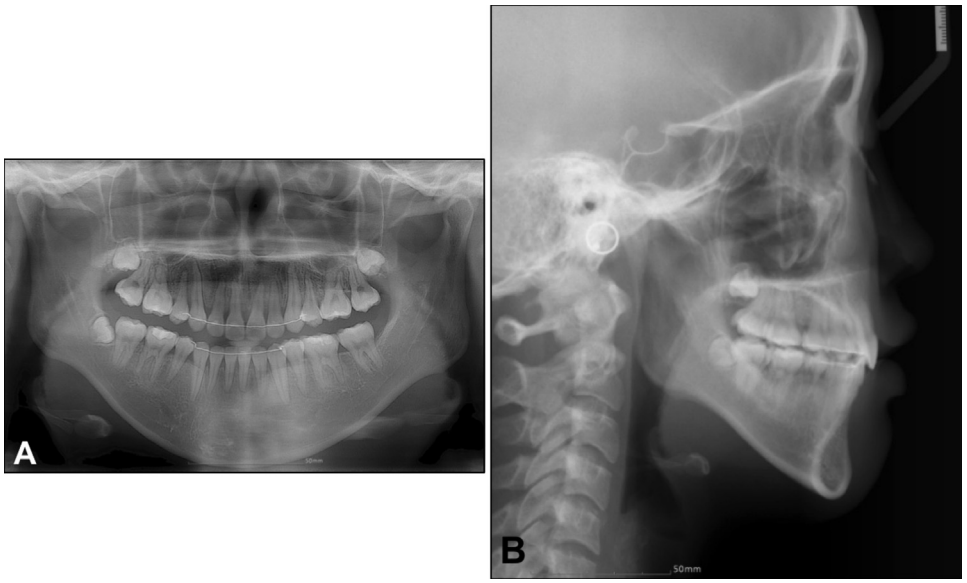

Fig 9. Posttreatment radiographs: **A,** panoramic radiograph; **B,** lateral cephalogram.

premolars in the same quadrant resulted in retraction of the maxillary incisors of 3.5 mm.[2]

In our patient, an MPAP was used to distalize the whole dentition and reduce the lip protrusion because she was not satisfied with her facial profile after the en-masse retraction of her anterior dentition. The total maxillary incisor retraction was 11.5 mm without surgery or the extraction of 2 premolars.

During the treatment, the patient had a rhinoplasty to improve her facial appearance, especially around her nasal bridge and nostrils. The surgical procedure resulted in a minor change in the position of subnasale

Fig 10. Posttreatment cephalometric tracing.

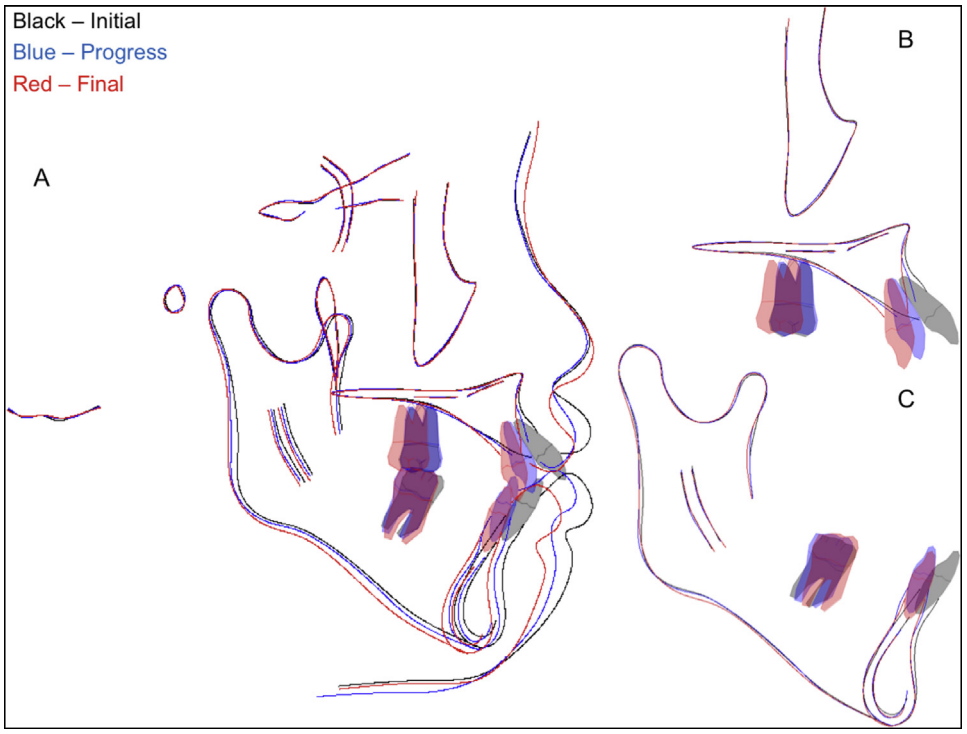

Fig 11. Cephalometric superimpositions: **A,** overall superimposition; **B,** maxillary superimposition; **C,** mandibular superimposition. *Black*, Pretreatment; *blue*, progress; *red*; posttreatment.

(<1 mm; evaluated through superimposition of the before and after rhinoplasty lateral cephalograms). Therefore, the true vertical line at pterygoid was added to our cephalometric analysis to accurately evaluate the amount of retraction of the upper and lower lips and chin (Table).

The chin is a dominant region of the lower face. Reduction of a protruded and long chin resulted in improving the quality of life by addressing psychological and esthetic concerns.[20] Rustemeyer and Lehmann[20] reported additional reductions of approximately 4 and 5 mm in the horizontal and vertical

Fig 12. One-year posttreatment facial and intraoral photographs.

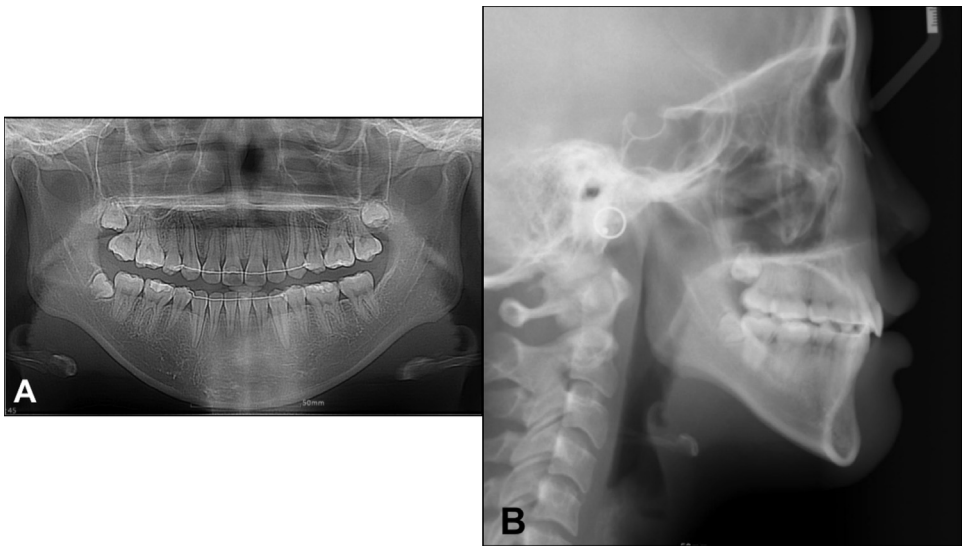

Fig 13. One-year posttreatment radiographs: **A,** panoramic radiograph; **B,** lateral cephalogram.

positions of the soft tissue pogonion by incorporating reduction genioplasty with 2-jaw surgery. To improve our patient's lower anterior facial height, reduction genioplasty was recommended, but she declined the surgical option.

Since her pretreatment Harvold measurement was 34.0 mm (normal average, 26.0 ± 4 mm), a counterclockwise rotation of her mandible would have resulted in protrusion of the chin and consequently worsened her profile. In addition, the pretreatment records showed a significantly increased ratio of lower lip to soft tissue menton to upper lip length (3.0), with a short upper lip length (17.0 mm).

Since treatment was somewhat compromised because the patient declined reduction genioplasty, we were able to improve either the horizontal or the vertical position of her pogonion orthodontically. During treatment, the maxillary molars were extruded with Class III elastics and using the first notch of the MPAP arms. This caused clockwise rotation of the mandible and improved the protrusiveness of soft tissue pogonion and consequently the patient's facial appearance by increasing the length of her upper lip (20.0 mm) and decreasing its ratio to the lower lip and chin (2.5). The soft tissue pogonion was retruded about 4.0 mm by clockwise rotation of the mandible at the expense of lower anterior facial height to improve the protrusiveness of the chin. Moreover, our results agreed with previous studies that reported increased lower anterior facial height and mandibular plane angle after treatment of patients with bimaxillary protrusion that might have been due to their tendency to have a vertical growth pattern.[21,22]

Recently, the treatment results of total arch distalization using miniscrews have not been significantly different from those achieved by second premolar extraction treatment in resolving crowding and retracting the anterior dentition.[23] Also, Choi et al[3] reported successful total arch distalization using skeletal anchorage in Class II malocclusion patients. They placed 5 miniscrews during the treatment procedures and achieved the results with a 2-step technique starting with the distalization of the second molars, followed by the rest of teeth. However, placing 4 miniscrews in the interradicular spaces mesial and distal to the second premolar may interfere with the distal movement of the dentition.

The application of an MPAP for total maxillary arch distalization resulted in more than 3 mm of distalization of the first molars with minimal distal tipping.[8-10] Palatal anchorage overcomes the limitation caused by interradicular spaces. Moreover, the palatal bone's thickness and density and the palatal soft tissues have been evaluated for the placement of miniscrews.[24-27]

In our case, it would have been possible to decrease treatment time by placing the MPAP at the time of the premolar extractions and using it as an anchorage for both en-masse retraction and molar distalization, although this might have required some modifications on the palatal arch during treatment. A future study is recommended to evaluate the treatment effect of this combination using finite element analysis.

CONCLUSIONS

A combination of extraction treatment and total arch distalization might be a feasible treatment option to avoid surgery in patients with moderate bimaxillary protrusion and achieve better facial esthetics. The application of the palatal anchorage plate shows the correction of a severely protrusive soft tissue profile without orthognathic surgery by 4 first premolar extractions along with total distalization.

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