Simultaneous Reduction in Vertical Dimension and Gummy Smile Using Miniscrew Anchorage

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Controlling the vertical dimension in adults with long-face syndrome has always been a clinical challenge.[1-8] Although a combination of orthodontics with orthognathic surgery may be the ideal approach,[2,9,10] the complications, risks, and costs of surgery have stimulated interest in alternative treatment methods. Miniscrews can now be used as effective anchors to reduce the vertical dimension orthodontically in adult patients, primarily by intruding the posterior teeth.[11-21]

Most case reports of this skeletal-anchorage technique have featured patients with anterior open bites; few have involved concurrent, skeletally based "gummy smiles".[22] As reported in two previous articles,[23,24] we have developed a combined approach that uses skeletal anchorage to simultaneously control the vertical dimension and resolve skeletal-origin gummy smiles in adult long-face patients. Eight basic and two advanced types of miniscrew mechanics can be used independently or in combination to simulate several orthognathic treatment effects (Fig. 1, Table 1):

- Retraction and intrusion of the upper anterior teeth to mimic a maxillary anterior subapical osteotomy.
- Intrusion of the entire upper dentition to mimic a Le Fort I impaction of the maxilla.
- Maintenance or even intrusion of the lower molars to maximize counterclockwise rotation of the mandible.
- Retraction and intrusion of the lower anterior teeth to optimize mandibular autorotation, thus enhancing chin prominence.

The following two cases demonstrate the use of these mechanics to treat different types of malocclusions.

Case 1

A 21-year-old woman presented with the chief complaints of protrusion and excessive gingival display in smiling (Fig. 2). Clinical examination showed a convex profile, an acute nasolabial angle, a retrusive chin, a short upper lip, and mentalis strain on lip closure. Intraoral evaluation revealed bilateral Class I canine and molar relationships; mild anterior crowding in both arches, with no periodontal concerns; and a 2mm overjet

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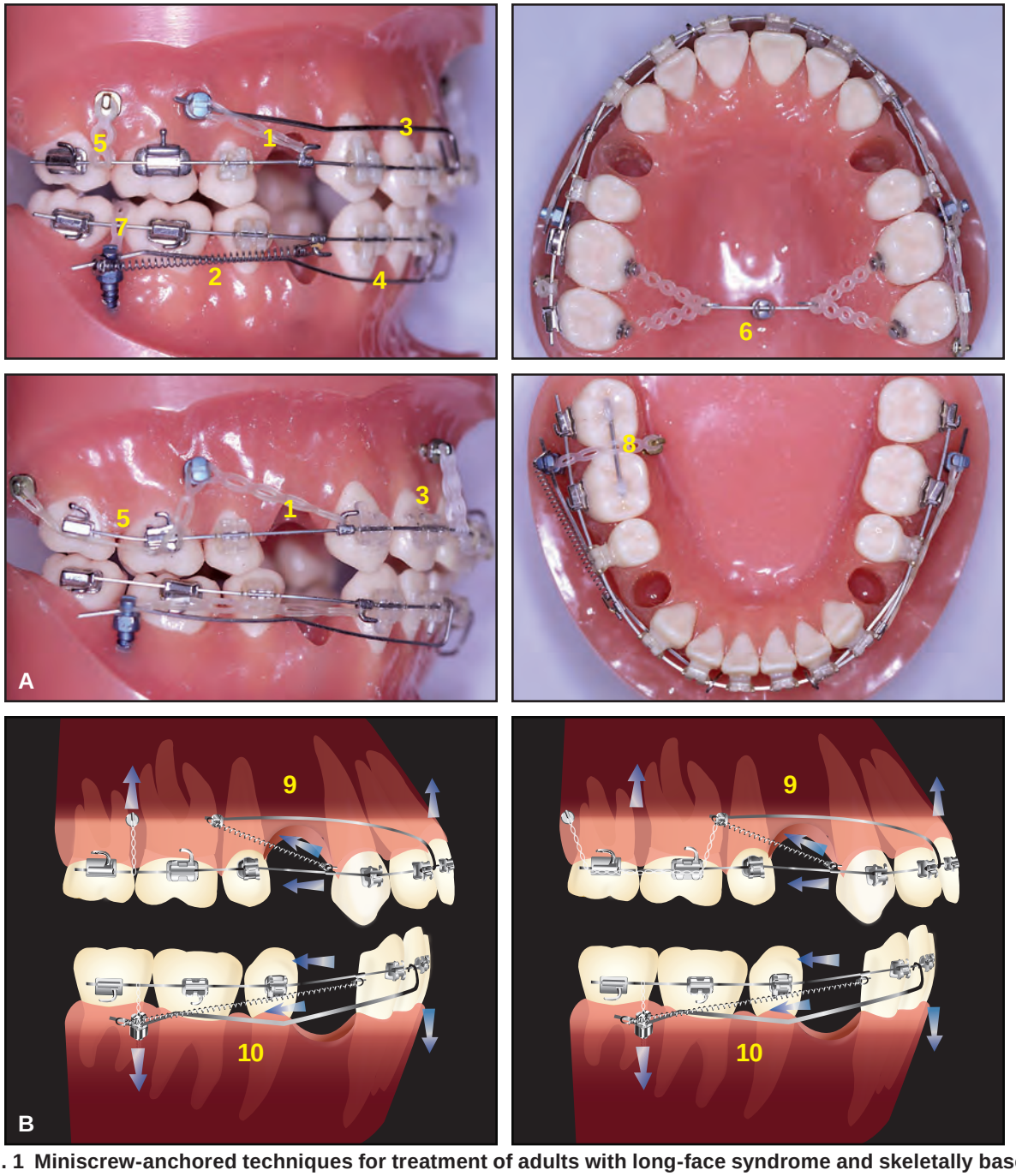

Fig. 1 Miniscrew-anchored techniques for treatment of adults with long-face syndrome and skeletally based "gummy smiles". A. Basic techniques: 1,2—En masse upper and lower anterior retraction; 3,4—En masse upper and lower anterior intrusion; 5,6—Maxillary posterior intrusion from buccal and palatal aspects; 7,8—Mandibular posterior intrusion from buccal and lingual aspects. B. Advanced techniques: 9—En masse upper anterior intrusion-retraction and posterior intrusion (showing two variations of miniscrew placement in molar region); 10—En masse lower anterior intrusion-retraction and posterior intrusion.

TABLE 1
MINISCREW MECHANICS FOR ACHIEVING ORTHOGNATHIC TREATMENT EFFECTS (FIG. 1)

Technique	Miniscrew	Insertion Site	Appliance
1. En masse anterior retraction (upper arch)	Hook* (1.5mm × 9mm)	Buccal interdental area between U5 & 6	Nickel titanium coil spring; power chain
	Quattro* (1.5mm × 9mm)	Buccal interdental area between U5 & 6	Nickel titanium coil spring; power chain
2. En masse anterior retraction (lower arch)	Quattro (2mm × 9mm)	Oblique ridge between L6 & 7	Nickel titanium coil spring; power chain
3. En masse anterior intrusion (upper arch)	Hook (1.5mm × 9mm)	Above the root apex between U1 & 2	Nickel titanium coil spring; power chain
	Quattro (2mm × 7mm)	Buccal interdental area between U5 & 6	.017" × .025" TMA** intrusive lever arm
4. En masse anterior intrusion (lower arch)	Quattro (2mm × 9mm)	Oblique ridge between L6 & 7	.017" × .025" TMA intrusive lever arm
5. Upper posterior intrusion (buccal side)	Hook (1.5mm × 9mm)	Buccal interdental area between U6 & 7	Nickel titanium coil spring; power chain
		Tuberosity	Nickel titanium coil spring; power chain
6. Upper posterior intrusion (palatal side)	Hook (2mm × 7mm)	Paramedian area between U6 & 7	Nickel titanium coil spring; power chain
	Quattro (2mm × 7mm)	Paramedian area between U6 & 7	Nickel titanium coil spring; power chain and .017" × .025" TMA wire with hooks
7. Lower posterior intrusion (buccal side)	Quattro (2mm × 9mm)	Oblique ridge between L6 & 7	Nickel titanium coil spring; power chain and sectional wire fixed over the occlusal surface of L6 & 7
8. Lower posterior intrusion (lingual side)	Hook (1.5mm × 9mm)	Lingual alveolus between L6 & 7	Nickel titanium coil spring; power chain
9. En masse anterior intrusion-retraction and posterior intrusion (upper arch)			Combine techniques 1, 3, 5, and 6
10. En masse anterior intrusion-retraction and posterior intrusion (lower arch)			Combine techniques 2, 4, 7, and 8

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Fig. 2 Case 1. A. 21-year-old female patient with skeletal Class II relationship, hyperdivergent long-face pattern, retrognathic chin, and skeletal gummy smile. B. Nonsurgical treatment approach using miniscrew anchorage to simulate orthognathic treatment effect.

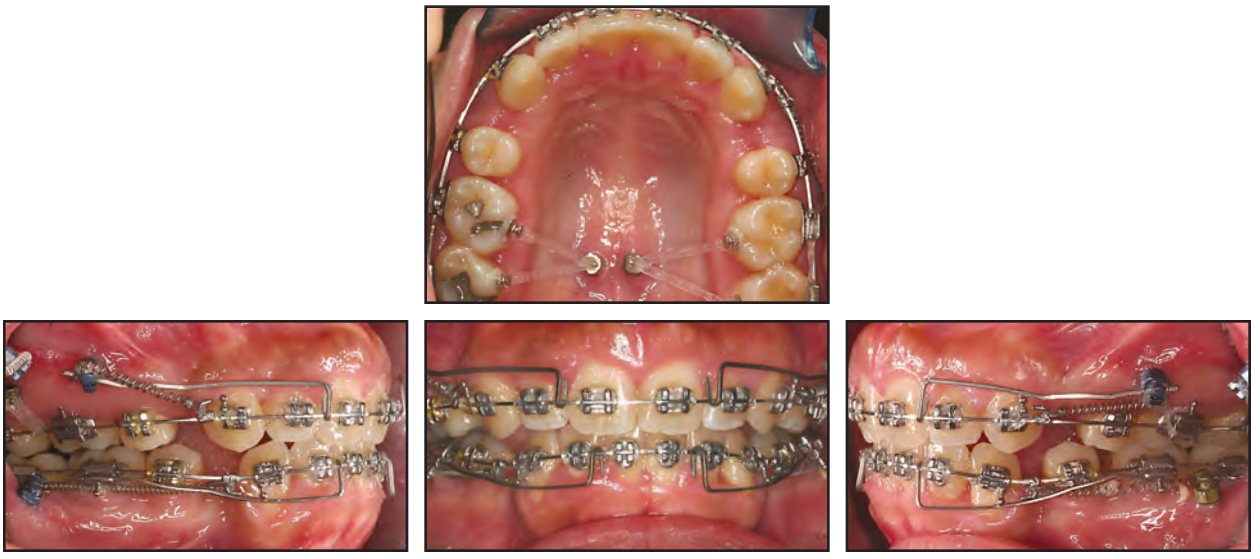

Fig. 3 Case 1. Simultaneous en masse upper and lower anterior intrusion-retraction and upper posterior intrusion using miniscrew anchorage.

and overbite. Cephalometric analysis showed a skeletal Class II relationship, a significantly obtuse mandibular plane angle, a retrognathic chin, and flared lower incisors (Table 2). The upper and lower incisors and molars were overerupted.

The diagnosis was a Class I malocclusion with a Class II skeletal relationship, a hyperdivergent long-face pattern, a retrognathic chin, and a gummy smile due to vertical maxillary excess. Treatment objectives were to normalize the gingival display, improve the facial appearance through maximum retraction of the anterior teeth, reduce the lower anterior facial height, and autorotate the mandible to strengthen the chin projection. After considering the advantages and disadvantages of a surgical-orthodontic approach, the patient chose a nonsurgical alternative using miniscrew anchorage to simulate orthognathic effects[25] (Fig. 2B).

After extraction of all four first premolars to provide space for correction of the bimaxillary protrusion, preadjusted fixed appliances were bonded for initial leveling and alignment in both arches. All third molars were also extracted.

Advanced miniscrew techniques (Fig. 1B, Table 1) were used in both arches, allowing the gummy smile, vertical dimension, and mandibular autorotation to be addressed simultaneously. Four months after initial bonding, LOMAS Quattro* miniscrews[26-28] (2mm × 7mm) were placed between the roots of the maxillary second premolars and first molars on both sides, LOMAS Hook* screws (1.5mm × 9mm) were inserted into the buccal alveolus between the maxillary first and second molars on both sides, and two LOMAS Hook screws (2mm × 7mm) were placed in the paramedian palatal area, 2mm from the midpalatal suture, near the imaginary midline between the first and second molars. In the mandibular arch, LOMAS Quattro screws (2mm × 9mm) were inserted into the buccal oblique ridges between the first and second molars on both sides.

TABLE 2
CASE 1 CEPHALOMETRIC DATA

	Pretreatment	Post-Treatment
SNA	80.0°	79.5°
SNB	72.5°	73.0°
ANB	7.5°	65.0°
MPA	49.0°	46.0°
U1-SN	101.0°	104.0°
IMPA	101.0°	94.0°
U6-PP	27.5mm	25.0mm
U1-PP	36.5mm	32.5mm
L6-MP	39.0mm	39.0mm
L1-MP	52.0mm	50.0mm

All miniscrews were loaded two weeks after placement. Intrusive .017" × .025" TMA** lever arms were inserted into the rectangular tubes of the maxillary buccal LOMAS Quattro miniscrews, and nickel titanium closed-coil springs were attached between the heads of these screws and anterior hooks on the main archwire (Fig. 3). The combination of forces from these miniscrews was designed to provide en masse upper anterior retrac-

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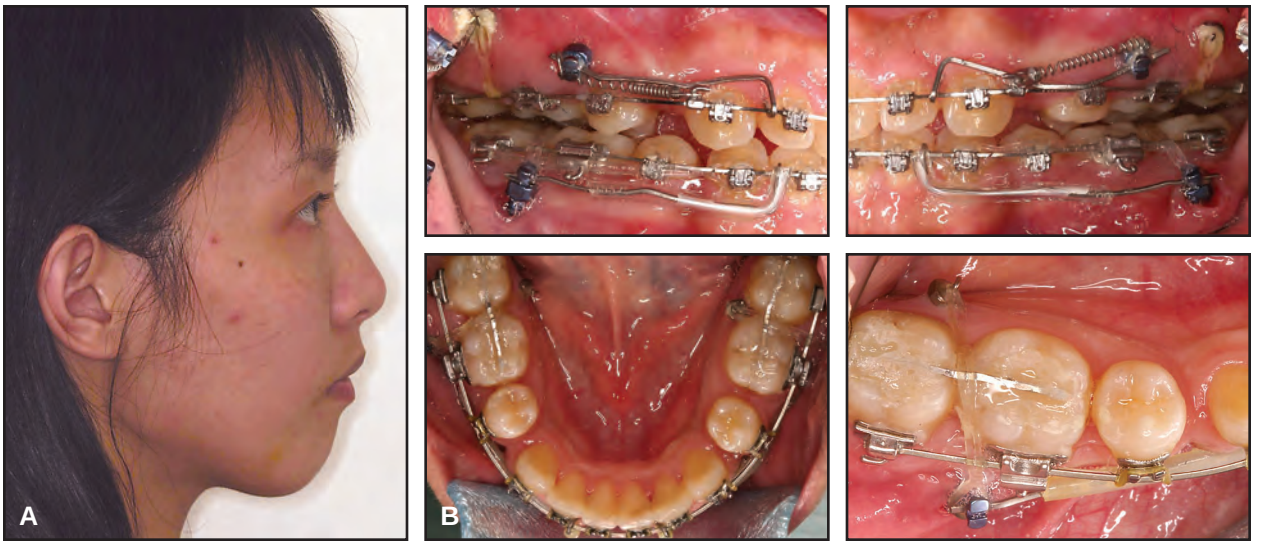

Fig. 4 Case 1. A. Insufficient chin projection after 15 months of treatment. B. Further lower posterior intrusion using anchorage from additional lingual miniscrews. Sectional wires bonded across occlusal surfaces of lower first and second molars, and power chain attached between each buccal and lingual miniscrew to initiate intrusion.

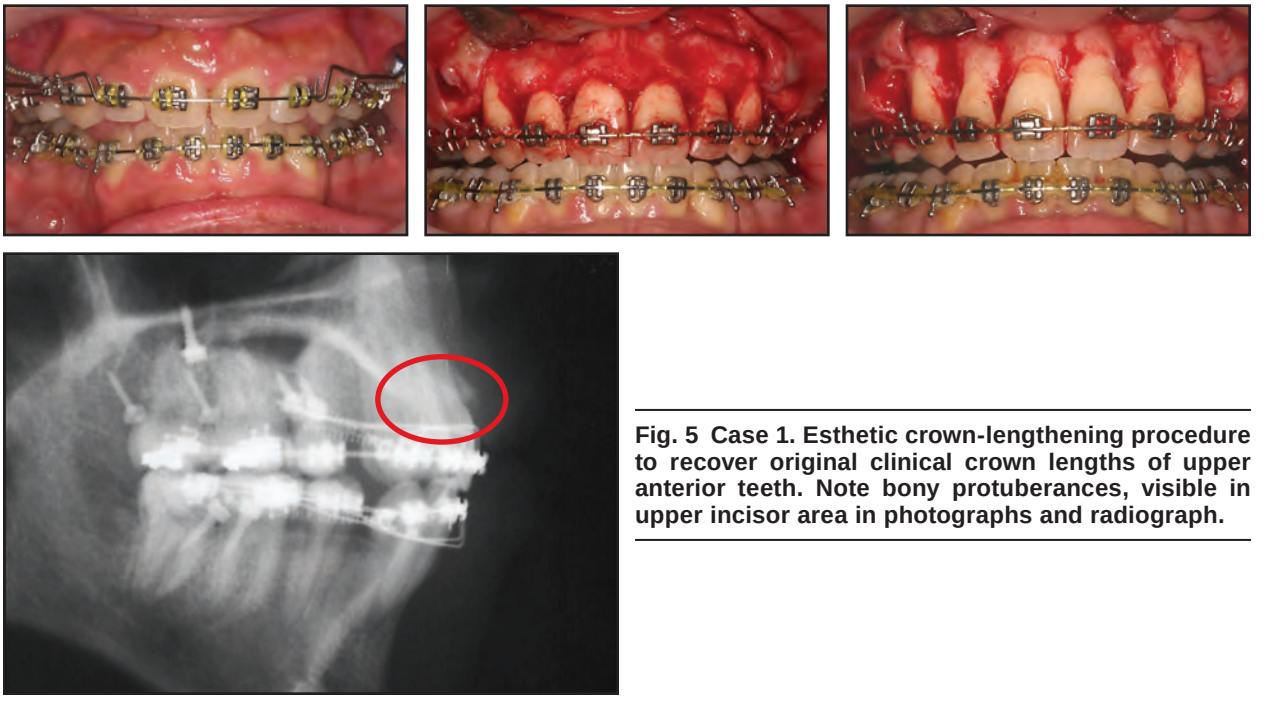

Fig. 5 Case 1. Esthetic crown-lengthening procedure to recover original clinical crown lengths of upper anterior teeth. Note bony protuberances, visible in upper incisor area in photographs and radiograph.

tion and intrusion. Upper posterior intrusion was achieved by attaching elastic power chain from the alveolar Hook screws to the main archwire and from the palatal Hook screws to lingual buttons on the upper molars. Simultaneously, intrusive lever arms were inserted into the mandibular Quattro miniscrews, and nickel titanium closed-coil springs were extended to hooks on the lower archwire for en masse lower anterior intrusion and retraction.

Significant posterior intrusion was noted at 15 months (Fig. 4). Because more chin projection was needed, however, additional LOMAS Hook screws (1.5mm × 9mm) were inserted obliquely into the lingual alveolus between the lower first and second molars on both sides. Immediately after screw placement, lower posterior intrusion was initiated by attaching power chains from the

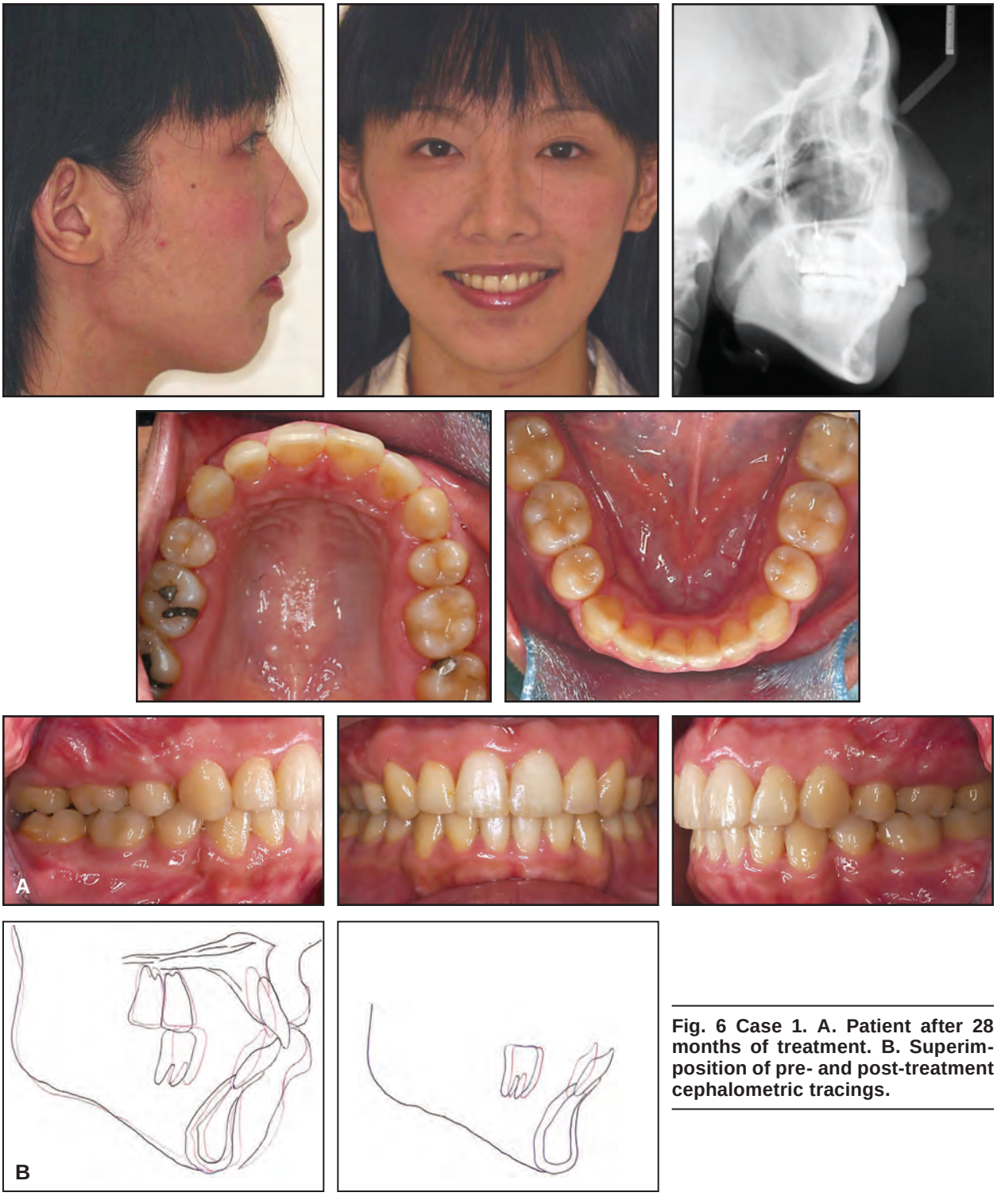

Fig. 6 Case 1. A. Patient after 28 months of treatment. B. Superimposition of pre- and post-treatment cephalometric tracings.

Fig. 7 Case 1. Follow-up records after 33 months of retention.

buccal Quattro screws to the lingual Hook screws, crossing .017" × .025" TMA sectional wires that had been bonded across the occlusal surfaces of the lower first and second molars (Fig. 4B).

After 24 months of treatment, the gummy smile had been substantially improved by the simultaneous intrusion and retraction of the upper anterior teeth. Unfortunately, the clinical crown lengths of the upper anterior teeth were reduced, and some resulting irregular bony protuberances were noted both intraorally and in the cephalometric radiograph. Therefore, crown-lengthening procedures were performed to recover the original clinical crown lengths (Fig. 5).

After 28 months of orthodontic treatment, the patient showed a Class I occlusion with normal overbite and overjet and an improved profile and smile (Fig. 6). Superimpositions demonstrated retraction and intrusion of the upper and lower anterior teeth and significant intrusion of the upper posterior teeth. The entire upper dentition appeared to have been retracted and intruded, as would have occurred with orthognathic surgery. The chin projection was improved due to the counterclockwise rotation of the mandible resulting from posterior intrusion. Figure 7 shows the patient 33 months after debonding.

Case 2

A 29-year-old woman presented with the chief complaints of dental protrusion, an unesthetic smile, and a carious lesion of the lower left second molar (Fig. 8). Clinical examination revealed a convex profile, an acute nasolabial angle, a slightly retrusive chin, lip incompetence, and a reverse smile arc. The patient had bilateral Class II canine and molar relationships, moderate anterior crowding in both arches, incisal edge abrasion, bony exostosis and irregular gingival margins in the upper anterior region, and fractures of the upper central and left lateral incisors. The panoramic x-ray showed favorable periodontal health, a missing lower left third molar, and an endodontically treated lower left second molar. Cephalometric analysis indicated a Class II skeletal relationship, an obtuse mandibular plane angle, and an overdeveloped maxillary alveolus

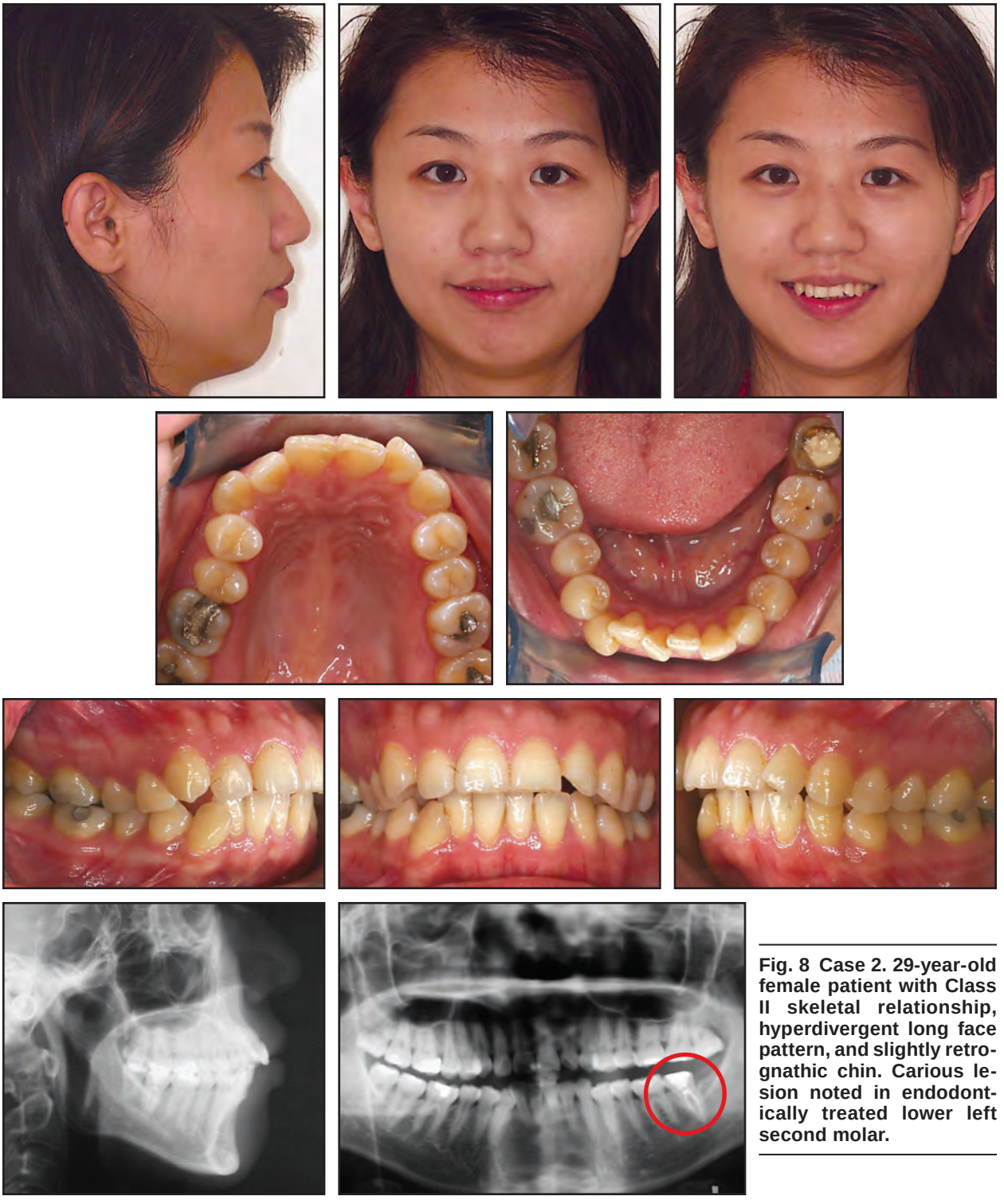

Fig. 8 Case 2. 29-year-old female patient with Class II skeletal relationship, hyperdivergent long face pattern, and slightly retrognathic chin. Carious lesion noted in endodontically treated lower left second molar.

TABLE 3
CASE 2 CEPHALOMETRIC DATA

	Pretreatment	Post-Treatment
SNA	80.0°	78.0°
SNB	74.0°	73.0°
ANB	6.0°	5.0°
MPA	42.0°	39.0°
U1-SN	108.0°	104.5°
MPA	42.0°	39.0°
U1-SN	108.0°	104.5°
IMPA	100.0°	87.0°
U6-PP	30.0mm	26.0mm
U1-PP	34.5mm	34.0mm
L6-MP	33.0mm	35.0mm
L1-MP	46.0mm	42.5mm

(Table 3).

A primary clinical concern was that the patient's facial appearance might become more hyperdivergent if posterior vertical control could not be maintained. Therefore, treatment objectives included improving the facial profile through maximum retraction of the anterior teeth and reduction of the vertical dimension, using bilateral upper molar intrusion; enhancing the smile esthetics by recovering the optimal crown shape and ratio of the upper anterior teeth and eliminating the excess bony exostosis; and restoring the lower left second molar. After both surgical and non-surgical treatment options were discussed, the patient elected miniscrew anchorage to manage the posterior vertical dimension and assist in retraction of the maxillary anterior teeth.

The upper first and lower second premolars were extracted to provide space for correction of the bimaxillary protrusion. All remaining third molars were also extracted.

Because the patient's chin position was favorable (compare to Case 1), advanced miniscrew techniques were needed only in the upper arch (Fig. 1B). After nine months of leveling and alignment, LOMAS Hook miniscrews (1.5mm × 9mm) were placed buccally between the roots of the maxillary second premolars and first molars on both sides, LOMAS Hook screws (2mm × 11mm) were inserted into the right and left buccal tuberosities, and one LOMAS Quattro screw (2mm × 7mm, .018" × .025" slot size*) was placed in the midpalatal area between the maxillary first and second molars.

Two weeks after miniscrew placement, en masse anterior retraction and intrusion were initiated by attaching elastic power chain from the two buccal Hook screws to anterior archwire hooks (Fig. 9). Upper posterior intrusion was begun with power chain from the same Hook screws to the main archwire, and additional chain was extended from lingual buttons on the palatal of the upper molars to an .017" × .025" TMA sectional wire inserted into the head of the midpalatal Quattro screw.

The lower left second molar crown was lengthened, and the crown height was restored with a temporary resin placed three weeks after surgery. Thirteen months into treatment, temporary crowns were fabricated for the two upper central incisors to simulate the ideal crown shape and ratio (Fig. 10). At that time, the bony exostosis and irregular gingival margins of the upper anterior teeth were improved by esthetic crown lengthening. One month after this surgery, temporary crowns were fabricated for the upper lateral incisors.

After 20 months of treatment, the patient's profile and smile showed a dramatic improvement (Fig. 11). Her original reverse smile arc was corrected, and a Class I occlusion with normal overbite and overjet had been achieved. Superimpositions revealed significant retraction and intrusion of the upper and lower anterior teeth, along with substantial upper posterior intrusion. The chin projection became more prominent due to the counterclockwise rotation of the mandible. At the conclusion of orthodontic treatment, ceramic crowns for the upper incisors and a porcelain crown for the lower left second molar were delivered. Figure 12 shows the patient 18 months after debonding.

Discussion

Previous techniques used to correct skeletal Class II malocclusion in adults with long-face

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Fig. 9 Case 2. En masse upper anterior intrusion-retraction and posterior intrusion using miniscrew anchorage.

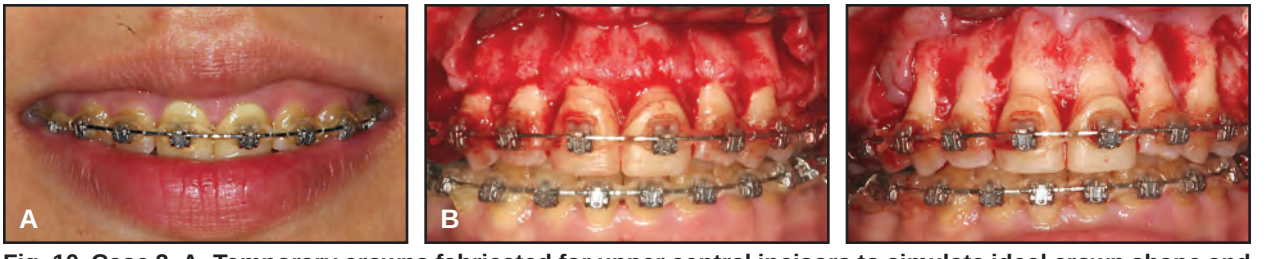

Fig. 10 Case 2. A. Temporary crowns fabricated for upper central incisors to simulate ideal crown shape and ratio. B. Esthetic crown lengthening of upper anterior teeth.

syndrome and retrognathic chins have relied on the intrusion of molars in only one arch to achieve upward and forward mandibular rotation. This approach may be inadequate in some patients, considering that the mandible might rotate clockwise or posteriorly due to compensating molar eruption or incisor extrusion in the opposing arch from the use of intermaxillary elastics. To obtain adequate autorotation of the mandible and chin projection, the opposing arch must often be held in place or even intruded with skeletal anchorage.[28-30] Our method combines the intrusion of both upper and lower molars to simulate an orthognathic treatment effect. If further improvement in the patient's facial appearance is still desired, a rhinoplasty and/or genioplasty might be recommended.

As an alternative to the use of midpalatal or lingual mandibular miniscrews, transpalatal arches and mandibular lingual arches can help control adverse buccal tipping of the molars. In this technique, elastic forces are applied from miniscrews inserted in the buccal alveolus to buccal tubes on the first molars. The auxiliary transpalatal or lower lingual arch, along with a continuous rectangular archwire, provides support to prevent the molars

Fig. 11 Case 2. A. Patient after 20 months of treatment. B. Superimposition of pre- and post-treatment cephalometric tracings.

Fig. 12 Case 2. Follow-up records after 18 months of retention.

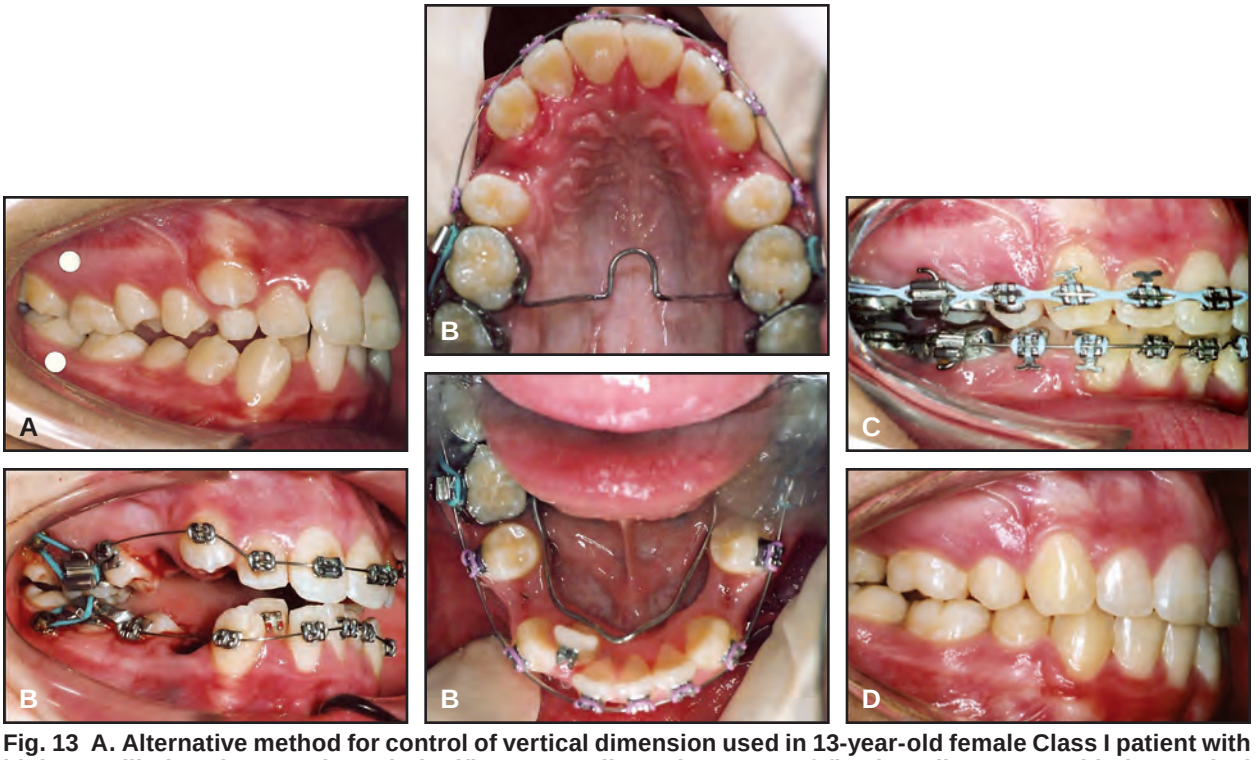

Fig. 13 A. Alternative method for control of vertical dimension used in 13-year-old female Class I patient with high mandibular plane angle and significant crowding. Placement of fixed appliances can hinder vertical control in high-angle patients. (White dots indicate intended miniscrew insertion sites.) B. Transpalatal and lingual arches were used to prevent adverse buccal tipping of posterior teeth. Instead of placing both buccal and lingual miniscrews, only buccal miniscrews were used to simultaneously intrude posterior teeth and indirectly support closure of extraction spaces in both arches. C,D. Forces from miniscrews were discontinued after 12 months, but screws were left in place for another nine months in case of need. Total treatment time was 29 months.

from "rolling out" to the buccal (Fig. 13). The added procedures and laboratory costs associated with these appliances must be weighed against those involved with palatal miniscrews when determining the treatment plan.

Relapse rates after upper molar intrusion reportedly range from 10% to nearly 30%.[31-33] Sugawara and colleagues observed an average 30% relapse of the lower posterior teeth after miniscrew-anchored posterior intrusion.[34] Strategies to

improve stability might include slow intrusive movement to allow for neuromuscular adaptation, overcorrection, longer retention periods, and active retention methods.

Some periodontal surgery may still be required after use of the techniques shown here. Compared with traditional orthognathic surgery, however, our approach has the advantages of reduced risk, greater cost-effectiveness, and more straightforward orthodontic biomechanics.

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