Nonsurgical correction using miniscrew-assisted vertical control of a severe high angle with mandibular retrusion and gummy smile in an adult

Xue-Dong Wang,[a] Jie-Ni Zhang,[a] Da-Wei Liu,[a] Fei-fei Lei,[b] Wei-tao Liu,[b] Yang Song,[a] and Yan-Heng Zhou[a]
Beijing, China

Orthodontic treatment in adult patients with a skeletal discrepancy can be challenging. In this case report, we achieved both sagittal and vertical control by combining the classic sliding mechanics straight-wire technique with miniscrew anchorage. We treated a 21-year-old Chinese woman with a severe high mandibular plane angle, a retrusive chin, and a gummy smile. Her diagnosis included a skeletal Class II skull base with a mild anterior open bite, a protrusive maxilla, and a backwardly rotated mandible. This case underscores the importance of anchorage control in both the sagittal and vertical directions. First, we used miniscrews in the maxillary and mandibular buccal segments to obtain rigid anchorage. Next, we achieved good anterior and posterior vertical control with miniscrews in the maxillary anterior labial and posterior buccolingual segments. Intrusion of the maxillary molars contributed to deepening of the anterior overbite and counterclockwise rotation of the mandibular plane, which, in turn, improved the facial profile. Intrusion of the maxillary incisors contributed to correction of the gummy smile. After 1 year of retention, the patient had a stable, well-aligned dentition with ideal intercuspation and an improved facial contour. Our results thus suggest that placement of miniscrews in the anterior and posterior regions of the maxilla is effective for camouflaging a high-angle skeletal Class II defect. This technique requires minimal patient compliance and is particularly useful for correction of a high angle in an adult with a gummy smile. (Am J Orthod Dentofacial Orthop 2017;151:978-88)

A skeletal Class II malocclusion with a high mandibular plane angle is a complicated and difficult malocclusion to treat using an orthodontic strategy alone. The condition is often caused by clockwise rotation of the mandible or excessive growth in the vertical dimensions of the buccal segments. In Chinese subjects, a skeletal Class II malocclusion in an adult is often accompanied by a retrusive mandible, micrognathism, and clockwise rotation of the mandible, forming a convex facial profile with excessive lower facial height. It is widely accepted that orthodontic treatment in adults is more difficult than in children.[1] Adult bone remodeling is slower, and simultaneous periodontal and temporomandibular joint treatments are problematic.

The fundamental and most effective treatment for a skeletal discrepancy, including a retrusive mandible, is surgical relocation of the jawbone.[2] However, many families find intrusive surgical methods difficult to accept, because of both the surgical risks and the high cost.

A severe gummy smile may not be successfully corrected using conventional orthodontic therapy. In such cases, a LeFort impaction may often create an attractive smile. However, if a patient with a severe gummy smile is unwilling to undergo orthognathic treatment, an alternative method should be considered to obtain intrusion of the maxillary incisors.

Recently, miniscrews have been used to achieve vertical control.[3] Intrusion of the molars enables counterclockwise rotation of the mandible, thereby correcting the anterior open bite and improving the facial profile.[4]

[a]Department of Orthodontics, Peking University School and Hospital of Stomatology, Beijing, China.
[b]Private practice, Beijing, China.
All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.
Supported by Beijing Municipal Science and Technology Commission (grant number Z171100001017128) and the National Natural Science Foundation of China (grant number 81671015, 81300850).
Address correspondence to: Yan-Heng Zhou, Department of Orthodontics, Peking University School and Hospital of Stomatology, 22# Zhongguancun South Avenue, Beijing, China 100081; e-mail, yanhengzhou@gmail.com.
Submitted, December 2015; revised and accepted, April 2016.
0889-5406/$36.00

http://dx.doi.org/10.1016/j.ajodo.2016.04.034

Fig 1. Pretreatment facial and intraoral photographs showed protruded mouth, retrognathic mandible, increased lower facial height, severe gummy smile, and incompetent lips.

Miniscrews are also frequently used to intrude the maxillary incisors, and it is possible to achieve true intrusion.[5] Intrusion of the maxillary anterior teeth also resolves a gummy smile.[6] However, rare cases require vertical control of both the posterior and anterior segments.

Here, we describe our treatment of an adult patient with a severe high mandibular plane angle, a retrusive mandible, and a gummy smile. The treatment featured both anterior and posterior vertical control, as well as sagittal control, to improve the overall appearance both frontally and laterally. Miniscrew-assisted nonsurgical correction was effective.

DIAGNOSIS AND ETIOLOGY

Our patient was a 21-year-old woman with the chief complaints of a protrusive mouth and a retrusive chin. She denied any negative oral habit. She suffered from a gummy smile and could not achieve lip closure at rest. Photographs taken before treatment showed that her facial structures were symmetrical (Fig 1). The facial profile was convex, attributable to a retrognathic mandible and a protrusive maxilla. The nasolabial angle was acute, the lips were incompetent, circumoral musculature strain was evident upon lip closure, and she had a gummy smile. The lower facial height was increased. Intraoral photographs and a dental cast showed that the patient had an Angle Class I molar relationship, with a mild anterior open bite and mild crowding of both the maxillary and mandibular dentitions (Fig 2).

Lateral cephalometry showed a skeletal Class II jaw with mandibular retrusion and a severe high mandibular plane angle (Fig 3). Both the maxillary and mandibular incisors were labially proclined. The panoramic radiograph showed no other abnormal sign. No symptom of a

Fig 2. Pretreatment dental casts displayed mild anterior open bite, protruded anterior teeth, and constricted dental arch.

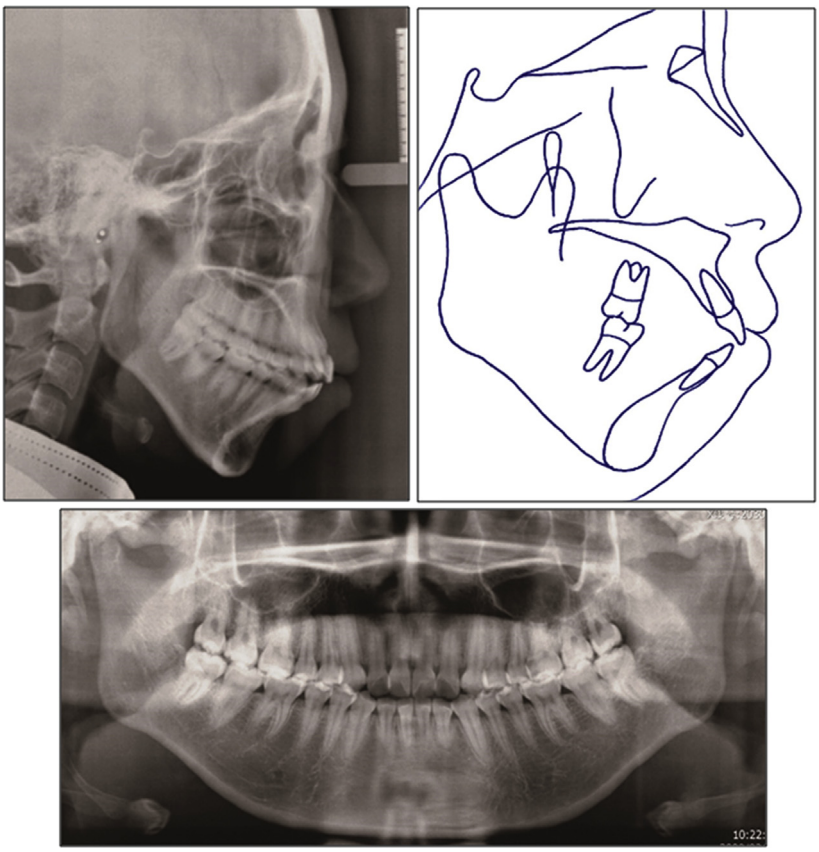

Fig 3. Pretreatment cephalograph, tracing, and panoramic radiograph.

Fig 4. Three months after bonding, fixed appliances were applied with 0.016 × 0.022-in nickel-titanium archwires.

temporomandibular disorder was evident. The patient was thus diagnosed with an Angle Class I malocclusion caused by a skeletal Class II condition, a high mandibular plane angle, and a mild anterior open bite.

TREATMENT OBJECTIVES

Our treatment objectives were to align and level the dental arch, to normalize the overjet and overbite relationships (thus correcting the anterior open bite), to intrude the maxillary posterior teeth combined with counterclockwise rotation of the mandible, to reduce the mandibular plane angle, to relieve the gummy smile by intruding the maxillary anterior teeth, and to improve the facial profile.

TREATMENT ALTERNATIVES

Four treatment options were considered. The first was orthodontics combined with orthognathic surgery: a LeFort I osteotomy to achieve maxillary impaction combined with a bilateral sagittal split ramus osteotomy to rotate the mandible. This strategy would fundamentally address the skeletal discrepancy. The second option was orthodontics combined with genioplasty to correct the retrusive chin. The third option was orthodontics alone (extraction of the 4 first premolars) to achieve a camouflaged outcome with no need for skeletal surgery. The fourth option was also orthodontics alone, with extraction of the 4 first premolars and the third molars but also miniscrew anchorage to retract both arches and impart both anterior and posterior vertical control to improve the facial convexity and the high angle profile. We discussed these 4 alternatives with our patient. She chose the fourth option and stated that she would cooperate completely with her orthodontic treatment, including miniscrew implantation. She refused both the first and second options because she was reluctant to submit to orthognathic surgery.

TREATMENT PROGRESS

The patient consented to her final treatment plan, and this was approved by the ethics committee of the Peking University School and the Hospital of Stomatology, Beijing, China. Her orthodontic treatment commenced on April 9, 2009. The 4 first premolars and the third molars were extracted before bonding. Next, esthetic preadjusted straight-wire appliances (TP Orthodontics, LaPorte, Ind) were bonded to both arches.

Archwires (0.014-in nickel-titanium, 0.016-in nickel-titanium, 0.016 × 0.022-in nickel-titanium, and 0.019 × 0.025-in nickel-titanium) were placed to allow initial alignment and leveling of both arches. When the 0.014-in nickel-titanium archwires were placed, miniscrews (diameter, 1.5 mm; length, 8 mm; Zhongbang Medical Treatment Appliance, Xi'an, China) were inserted under local anesthesia into the alveolar bones of the posterior segment on both sides of the mandible and the maxilla. To prevent proclination of the anterior teeth during alignment, the maxillary and mandibular canines were connected by elastic tiebacks from the miniscrews to the brackets; the connection force was approximately

Fig 5. Twelve months after bonding. Severe gummy smile was apparent. Classical sliding mechanics using 0.019 × 0.025-in stainless steel archwires was used to close the spaces of both arches with tiebacks to the miniscrews; miniscrews were used to intrude the maxillary molars and anterior teeth.

30 gN (Fig 4). The elastic tiebacks were removed soon after the alignment of the anterior teeth.

Classical sliding mechanics using 0.019 × 0.025-in stainless steel archwires was used to close the spaces of both arches. All tiebacks were placed on the miniscrews to prevent mesial molar movement (Figs 5 and 6). Miniscrews 9 mm in length were inserted into the maxillary palatal alveolar bone on both sides to intrude the maxillary molars; the intrusion force was approximately 50 gN (Fig 5, *C*). Miniscrews 7 mm in length were inserted into the anterior alveolar bones on both sides to intrude the maxillary incisors; the intrusion forces were approximately 50 gN (Fig 6). The intrusion of maxillary incisors and molars with light forces was accompanied by space closure. Interarch elastics were carefully placed to increase intercuspation and to coordinate the upper and lower midlines. The active treatment period was 35 months. At the end of this time, the miniscrews

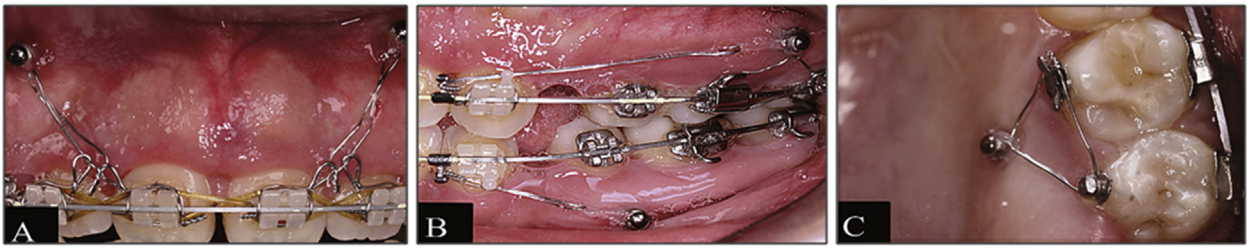

Fig 6. **A,** Intruding maxillary incisors by miniscrews with light force (about 50 gN); **B,** closing space with elastic tieback to the miniscrews in the both arches (about 180 gN); intruding maxillary molars by elastic tieback to the buccal miniscrews (about 50 gN); **C,** intruding maxillary molars by elastic tiebacks to the lingual miniscrew (about 50 gN).

Fig 7. Posttreatment facial and intraoral photographs showed improved facial profile, ideal intercuspation, and normalized overjet and overbite.

were removed and the brackets debonded. Treatment outcomes were then assessed (Fig 7). Full-time removable vacuum-formed retainers were suggested.

TREATMENT RESULTS

After treatment, the patient's facial balance was harmonious, her smile charming, and her dentition well aligned (Figs 7-10). Treatment outcomes included counterclockwise rotation of the mandible, intrusion of both the maxillary molars and incisors, reduction of the mandibular plane angle, and retraction of the maxillary and mandibular incisors. These changes were confirmed by cephalometry; the MP/SN angle had decreased by 2.2°; the SNB angle had increased by

Fig 8. Posttreatment dental casts displayed well-aligned dentitions, corrected anterior open bite, ideal intercuspation, and solid lingual occlusion.

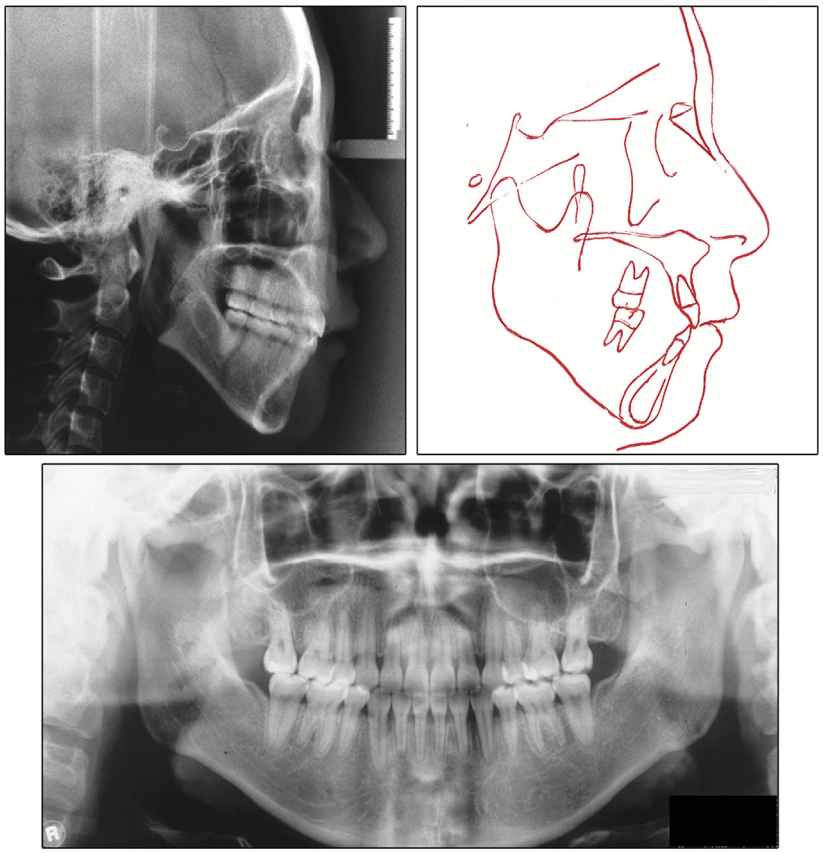

Fig 9. Posttreatment cephalograph, tracing, and panoramic radiograph.

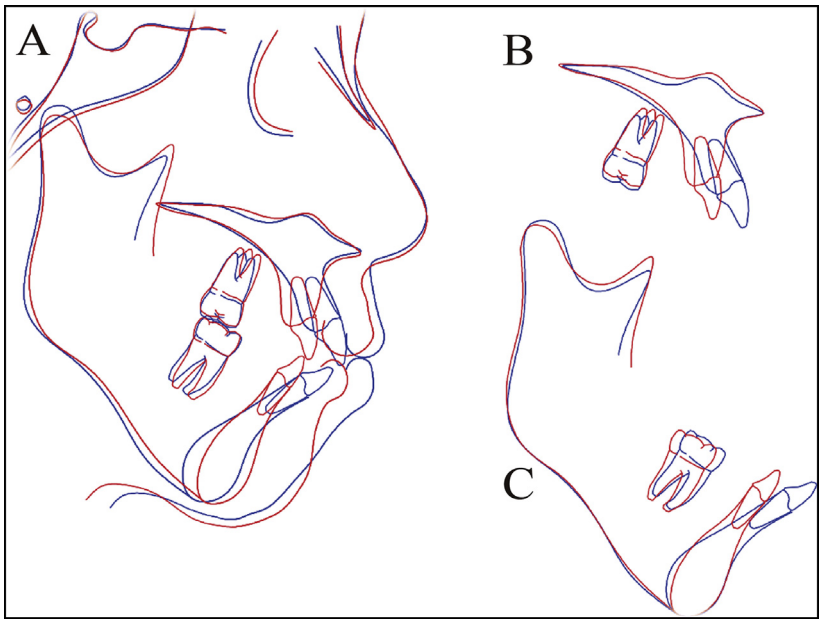

Fig 10. Cephalometric superimpositions showed marked differences between pretreatment (*blue*) and posttreatment (*red*): **A,** SN plane; **B,** maxillary plane; **C,** mandibular plane.

Table. Skeletal and dental changes indicated by the cephalometric measurements

	Norm				
Measurement	*Mean*	*SD*	*Pretreatment*	*Posttreatment*	*Difference*
Angular (°)					
SNA	82.8	4.0	83.5	82.7	−0.8
SNB	80.1	3.9	76.1	78.2	2.1
ANB	2.7	2.0	7.4	4.5	−2.9
U1/NA	22.8	5.7	23.1	16.8	−6.3
L1/NB	30.5	5.8	46.5	27.6	−18.9
U1/L1	124.2	8.2	102.9	132.2	29.2
U1/SN	105.7	6.3	108.0	100.2	−7.8
MP/SN	32.5	5.2	50.9	48.7	−2.2
MP/FH	31.1	5.6	47.2	45.6	−1.6
L1/MP	93.9	6.2	98.1	84.1	−14.0
Z angle	75.0	4.0	49.0	72.1	23.1
Linear (mm)					
U6-MxP	28.0	2.1	28.7	26.8	−1.9
L6-MnP	32.0	2.0	35.8	36.1	0.3

1.3°; the ANB angle had decreased by 2.9°; and the U1/L1 angle had decreased by 18.9° (Table; Fig 10).

Dramatic changes were evident in the facial profile and the occlusal relationship. The mandibular retrusion was greatly improved, and the lower facial height was reduced; the facial profile was nearly straight (Fig 7). Overjet and overbite of the anterior teeth were ideal, and the intercuspation from the buccal view was ideal (Fig 8). The gummy smile had dramatically improved. The Angle Class I molar relationship was maintained. Panoramic radiography showed no obvious apical root resorption. Root parallelism was acceptable (Fig 9). Two months after orthodontic treatment, a gingivectomy was performed by a periodontist (Fig 11). Our patient was satisfied with her treatment outcomes. At her 1-year follow-up, all outcomes were stable (Fig 12).

DISCUSSION

To achieve a satisfying treatment for an adult with a skeletal retrusive and clockwise rotated mandible, protrusive maxilla, and gummy smile, a combination of fixed orthodontic and orthognathic surgery is often implemented. In camouflage-only orthodontic treatment, anchorage control in both the sagittal and vertical directions is essential to improve treatment outcome. In this patient, we achieved excellent results by combining the classical sliding mechanics straight-wire technique with miniscrew-assisted vertical control when treating an adult with a high-angle, mandibular retrusion, and a gummy smile. We placed rigid miniscrew anchorages in the maxillary and mandibular buccal segments. We achieved anterior and posterior vertical control by placing more miniscrews in the maxillary anterior labial and posterior buccolingual segments. Intrusion of the maxillary molars deepened the anterior overbite and allowed counterclockwise rotation of the mandibular plane, improving the facial profile. Intrusion of the maxilalry incisors contributed to correction of the gummy

Fig 11. Two months after debonding, facial photographs after gingivoplasty showed further improved maxillary anterior gingival characteristics.

smile. Both the significantly improved facial profile and the well-aligned dentition with ideal intercuspation were stable.

Anchorage control during fixed orthodontic treatment critically influences both the treatment plan and the outcomes, especially in adults with a high angle. The principal complaint of our patient was a protrusive mouth. The pretreatment evaluation showed maxillary protrusion and mandibular retrusion. Clearly, maximum anteroposterior anchorage was required. Also, vertical control was crucial because the mandibular plane angle was 49°, and the lower facial height was increased.

Vertical control has always been a complicated issue in orthodontic treatment. Extraction using conventional mechanics does not always effectively exert vertical control, despite molar mesialization.[7-10] It remains unclear whether nonextraction or different extraction patterns might influence the occlusal wedge.[11,12] Some studies have reported that linear vertical dimensions increased in both extraction and nonextraction groups, but changes in these dimensions were greater in the extraction groups.[10] Molar extrusion increases the vertical dimensions and the extent of clockwise rotation of the mandible, which compromises the facial appearance and chin projection of high-angle patients. Therefore, control of the vertical dimension is crucial when these patients undergo orthodontic treatment, especially if they are adults lacking growth potential. One retrospective study compared the effect of extraction combined with high-pull headgear with that of nonextraction without vertical control for the treatment of high-angle cases that were similar in terms of their hyperdivergent skeletal patterns, malocclusion patterns, skeletal ages, and sex. They cited a study showing that

Fig 12. Follow-up at 1 year showed stable occlusion and facial profile.

conventional orthodontics had certain limitations when it was used to significantly alter the vertical skeletal dimensions.[13]

Miniscrew-assisted molar intrusion in high-angle patients delivers forces that effectively control the posterior dentoalveolar dimensions, affording significant improvements in both chin projection and overall facial profile. Compared with high-pull headgear, J-hooks, segmental archwires, and other methods of vertical control, miniscrews significantly simplify the entire system by which forces are applied and eliminate the need to bend wires and maintain appropriate labial inclinations of the maxillary molars. In both the anteroposterior and vertical directions, a modified transpalatal arch supported by midpalatal miniscrews afforded more stable anchorage than did high-pull headgear.[14] Additionally, the success of the miniscrew technique is much less dependent on patient compliance. When we compared data obtained before and after orthodontic treatment, it was evident that our patient's outcomes were satisfactory, approaching those obtainable by orthognathic surgery, although we used a purely orthodontic strategy.

A gummy smile is a multifactorial esthetic problem caused by overgrowth of the anterior vertical maxilla, an incompetent labial muscle, or other intraoral or extraoral problems. If a severe gummy smile is caused by an anterior vertical maxillary excess, orthognathic surgery is the best treatment choice. The etiology of the gummy smile must be analyzed before selecting a treatment option. The etiology of the gummy smile of our patient featured an anterior vertical maxillary excess, a sagittal maxillary protrusion, and labial muscle incompetence. Skeletal anchorage has been used to treat a gummy smile.[6] A midpalatal absolute anchorage system has been reported to treat a gummy smile by total maxillary intrusion. However, midpalatal anchorage is difficult to be combined with labial orthodontic appliance. Therefore, we chose to insert another 2 miniscrews in

the maxillary anterior segment to gently intrude the maxillary incisors and remodel the maxillary anterior vertical alveolar bone. We considered that both intrusion of the maxillary incisors and relaxation of the maxillary labial muscle after maxillary retraction would help correct the gummy smile.

Correction of the anterior open bite of our patient was not difficult. An anterior overbite may become deeper if sagittal retraction is in play after extraction of the 4 first premolars. However, clockwise rotation of the maxillary anterior segment does not aid in correction of a gummy smile. Intrusion of the maxillary incisors will help to correct a gummy smile but will worsen an open bite. Thus, posterior vertical control, achieved via molar intrusion, should be used to rotate the occlusal plane, allowing establishment of an appropriate anterior overbite.

Periodontal hyperplasia developing after debonding was noticeable in the maxillary anterior region (Fig 7); it was caused partly by poor oral hygiene and perhaps also by irritation of the gingiva by the intruding maxillary anterior teeth. Thus, good oral hygiene and regular scaling are important. After debonding, the hyperplastic gingiva was removed to create a clinically perfect crown display (Fig 11). This improved the smile quality. A risk associated with vertical control by miniscrews is root resorption after intrusion,[15] although it has been reported that the amount of root resorption was less in the implant group than in the J-hook headgear group.[16] Thus, the intrusion force should be strictly kept in the light range to minimize such resorption. The force we used to intrude the maxillary incisors was about 50 gN when we activated the ligature with elastic tiebacks to the miniscrews (Fig 6, *A*). The panoramic radiograph shows no obvious apical root resorption of the incisors before and after orthodontic treatment.

CONCLUSIONS

A severe high angle with mandibular retrusion and a gummy smile in an adult can be competently addressed through miniscrew-assisted vertical control, intrusion of both the anterior and posterior segments, and favorable counterclockwise rotation of the mandible. We used the most common sliding mechanics—straight-wire appliance and miniscrew anchorage—to greatly simplify the orthodontic procedure and improve the treatment effects. This camouflage technique requires minimal patient compliance and is particularly useful to treat high-angle skeletal patients who are reluctant to have surgery. All outcomes of our patient were stable after 1 year, although further follow-up is necessary to evaluate long-term stability.

REFERENCES

1. Tanne K, Yoshida S, Kawata T, Sasaki A, Knox J, Jones ML. An evaluation of the biomechanical response of the tooth and periodontium to orthodontic forces in adolescent and adult subjects. Br J Orthod 1998;25:109-15.
2. Fish LC, Wolford LM, Epker BN. Surgical-orthodontic correction of vertical maxillary excess. Am J Orthod 1978;73:241-57.
3. Feldmann I, Bondemark L. Orthodontic anchorage: a systematic review. Angle Orthod 2006;76:493-501.
4. Hart TR, Cousley RR, Fishman LS, Tallents RH. Dentoskeletal changes following mini-implant molar intrusion in anterior open bite patients. Angle Orthod 2015;85:941-8.
5. Polat-Ozsoy O, Arman-Ozcirpici A, Veziroglu F. Miniscrews for upper incisor intrusion. Eur J Orthod 2009;31:412-6.
6. Kaku M, Kojima S, Sumi H, Koseki H, Abedini S, Motokawa M, et al. Gummy smile and facial profile correction using miniscrew anchorage. Angle Orthod 2012;82:170-7.
7. Hans MG, Groisser G, Damon C, Amberman D, Nelson S, Palomo JM. Cephalometric changes in overbite and vertical facial height after removal of 4 first molars or first premolars. Am J Orthod Dentofacial Orthop 2006;130:183-8.
8. Wang Y, Yu H, Jiang C, Li J, An S, Chen Q, et al. Vertical changes in Class I malocclusion between 2 different extraction patterns. Saudi Med J 2013;34:302-6.
9. Aras A. Vertical changes following orthodontic extraction treatment in skeletal open bite subjects. Eur J Orthod 2002;24:407-16.
10. Sivakumar A, Valiathan A. Cephalometric assessment of dentofacial vertical changes in Class I subjects treated with and without extraction. Am J Orthod Dentofacial Orthop 2008;133:869-75.
11. Alkumru P, Erdem D, Altug-Atac AT. Evaluation of changes in the vertical facial dimension with different anchorage systems in extraction and non-extraction subjects treated by Begg fixed appliances: a retrospective study. Eur J Orthod 2007;29:508-16.
12. Kumari M, Fida M. Vertical facial and dental arch dimensional changes in extraction vs. non-extraction orthodontic treatment. J Coll Physicians Surg Pak 2010;20:17-21.
13. Gkantidis N, Halazonetis DJ, Alexandropoulos E, Haralabakis NB. Treatment strategies for patients with hyperdivergent Class II Division 1 malocclusion: is vertical dimension affected? Am J Orthod Dentofacial Orthop 2011;140:346-55.
14. Lee J, Miyazawa K, Tabuchi M, Kawaguchi M, Shibata M, Goto S. Midpalatal miniscrews and high-pull headgear for anteroposterior and vertical anchorage control: cephalometric comparisons of treatment changes. Am J Orthod Dentofacial Orthop 2013;144:238-50.
15. Liou EJ, Chang PM. Apical root resorption in orthodontic patients with en-masse maxillary anterior retraction and intrusion with miniscrews. Am J Orthod Dentofacial Orthop 2010;137:207-12.
16. Deguchi T, Murakami T, Kuroda S, Yabuuchi T, Kamioka H, Takano-Yamamoto T. Comparison of the intrusion effects on the maxillary incisors between implant anchorage and J-hook headgear. Am J Orthod Dentofacial Orthop 2008;133:654-60.