Distalization of the maxillary and mandibular dentitions with miniscrew anchorage in a patient with moderate Class I bimaxillary dentoalveolar protrusion

Gui Chen,[a] Fei Teng,[b] and Tian-Min Xu[c]
Beijing, China

This case report describes the treatment of a 25-year-old woman with a skeletal Class I pattern and moderate bimaxillary dentoalveolar protrusion. The orthodontic treatment included distal movement of her maxillary and mandibular dentitions using 1-stage miniscrews. The total active treatment time was about 12 months. Her tooth alignment and profile were significantly improved by the orthodontic treatment. The 2-year posttreatment records show a stable occlusion and satisfactory facial esthetics. (Am J Orthod Dentofacial Orthop 2016;149:401-10)

Bimaxillary protrusion is characterized by proclined anterior teeth, protrusive lips, and a convex lower facial profile. It can occur in almost every ethnic group, although it is more prevalent in African American and Asian populations.[1] Most patients with bimaxillary protrusion seek orthodontic or orthopedic treatment to decrease the protrusion and improve their facial profile and, consequently, facial esthetics.

The treatment of bimaxillary protrusion does not present many challenges, and the condition can be satisfactorily corrected by orthodontic or surgical treatment or a combination of both. Orthodontic treatment involves retraction of the anterior teeth with maximum anchorage, typically after extraction of the first premolars if required, thus correcting a dentoalveolar protrusion.[2-4] Surgical treatment, on the other hand, involves repositioning of segments of the jaws in conjunction with orthodontic treatment, thus correcting a skeletal protrusion.[5,6] Currently, anterior segmental osteotomy has become a popular procedure because it decreases the total treatment duration in adults who require orthodontic treatment.[7,8]

All above-mentioned methods for decreasing the proclination associated with bimaxillary protrusion require extraction of the maxillary or mandibular first premolars. Some patients do not want extraction of healthy teeth for various reasons; however, they are also concerned about proclined anterior teeth and protruding lips. Consequently, the improvement of facial esthetics in these patients becomes a challenge.

In 2013, Ishida et al[9] reported on a patient with an Angle Class II malocclusion corrected by asymmetric distalization of the maxillary molars using zygomatic arch anchorage, which, in fact, distalized the entire dentition. Furthermore, Tai et al[10] reported on a patient with a Class III malocclusion corrected by distalization of the mandibular dentition using temporary skeletal anchorage devices. Generally, bimaxillary protrusion is characterized by a Class I malocclusion with protrusion of both the maxillary and mandibular dentitions. However, it remains debatable whether distalization of both dentitions for the correction of bimaxillary protrusion is a feasible alternative to premolar extraction.

Here, we report on a 25-year-old woman with a Class I skeletal pattern and moderate bimaxillary protrusion that was successfully corrected by the distalization of both dentitions with 1-stage miniscrews for anchorage.

DIAGNOSIS AND ETIOLOGY

A 25-year-old woman with a convex lower facial profile came with a chief complaint of protruded maxillary

From the Department of Orthodontics, Peking University School and Hospital of Stomatology, Beijing, China.
[a]Resident.
[b]Postgraduate student.
[c]Professor.
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Address correspondence to: Tian-Min Xu, Department of Orthodontics, Peking University School and Hospital of Stomatology, 22 Zhongguancun South St, 100081 Beijing, China; e-mail, tmxuortho@163.com.
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front teeth. She required her treatment to be completed within a year because she was due to go abroad for further studies then. Furthermore, she was against extraction of any healthy teeth other than the third molars. Her medical and dental histories were unremarkable, with no previous maxillofacial or dental trauma or symptoms typically associated with the temporomandibular joint.

Her pretreatment facial photographs showed a near-normal nasolabial angle with a protruded lower lip. The chin was on the facial midline, and her face was generally symmetric. Intraorally, her molar and canine relationships were considered Class I, with a 5-mm overjet and a normal overbite. There was mild spacing in the maxillary anterior region and mild crowding in the mandibular anterior region, with a moderate curve of Spee on both sides. The dental midlines were aligned with the facial midline. All third molars were present, and the mandibular left third molar was horizontally impacted (Figs 1 and 2).

A lateral cephalogram and an orthopantomogram were obtained (Fig 3). Figure 3, *C*, shows the absence of caries, with pulp calcification in the maxillary left central incisor identified from the absence of a visible pulp canal. Her mandibular left third molar showed mesioangular impaction. The lateral cephalometric analysis (including a tracing) indicated a Class I skeletal pattern (ANB, 2.3°; Wits appraisal, 0.2 mm) with a steep mandibular plane angle (SN-MP, 43.5°). The maxillary and mandibular incisors were proclined (U1-PP, 119.4°; IMPA, 99.1°), and the interincisal angle (143.0°) was increased (Table I). A diagnosis of bimaxillary dentoalveolar protrusion was made.

TREATMENT OBJECTIVES

The treatment objectives for this patient were as follows: (1) distalization of the proclined maxillary anterior teeth, her chief complaint; (2) correction of the mandibular and maxillary anterior crowding and spacing, respectively; (3) creation of an ideal overbite and overjet; and (4) improvement of her facial profile and, consequently, esthetics.

TREATMENT ALTERNATIVES

To correct the moderate anterior proclination, extraction of the 4 second premolars would have been ideal for this patient. However, this course of treatment would require over 2 years; in addition, the patient had refused extraction of healthy teeth other than the third molars. Therefore, we decided to use miniscrew anchorage for distalization of the maxillary and mandibular dentitions to correct the dentoalveolar protrusion.

TREATMENT PROGRESS

The patient was referred to a periodontist to rule out periodontal problems and an oral and maxillofacial surgeon for the third molar extractions. Preadjusted appliances with 0.022 × 0.028-in slots were bonded to her teeth in both arches for leveling and alignment; 0.014-in and 0.016-in nickel-titanium archwires were used for leveling in the maxillary and mandibular arches, respectively.

Once leveling was complete, 4 miniscrews (Ci Bei, Zhejiang, China) were implanted between the second premolars and the first molars in both arches. The integrity of the interradicular bone in this region in all 4 quadrants was checked on an orthopantomogram before miniscrew implantation. All miniscrews were implanted close to the root of the first molar to provide enough space for distalization of the second premolar. Cone-beam computed tomography was performed to check the position of the miniscrews (Fig 4). The miniscrews were left unloaded for a week to allow soft tissue healing; then 0.019 × 0.025-in stainless steel archwires were used for distalization of both dentitions. Elastics were applied from the neck of the miniscrews to the crimpable hooks between the lateral incisors and the canines for distalization of the maxillary dentition (Fig 5). The initial force of the tie-backs was between 1.5 and 2.5 N, and the interval between visits was 4 weeks. The distalization process lasted for approximately 8 months.

After a year, removable clear vacuum-formed retainers, the patient's preference, were placed in both dentitions for maintenance.

TREATMENT RESULTS

The posttreatment records showed that the treatment objectives were achieved. The facial photographs showed significant improvements in her facial profile and esthetics. The anterior proclination had decreased (Fig 6), the crowding and spacing had been resolved, and ideal overbite and overjet were established. The Class I canine and molar relationships were maintained (Figs 6 and 7).

Compared with the first CBCT images obtained, those obtained 8 months after treatment showed significant retractions of both dentitions. The movements of the maxillary incisors and the second molars were measured on the basis of a 3-dimensional superimposition on the anterior surface of the zygomatic process, and that of the mandibular incisors and second molars was measured on the basis of a mandibular superimposition on the body of mandible (Fig 8). Because the patient was

Fig 1. Pretreatment facial and intraoral photographs.

Fig 2. Pretreatment dental casts.

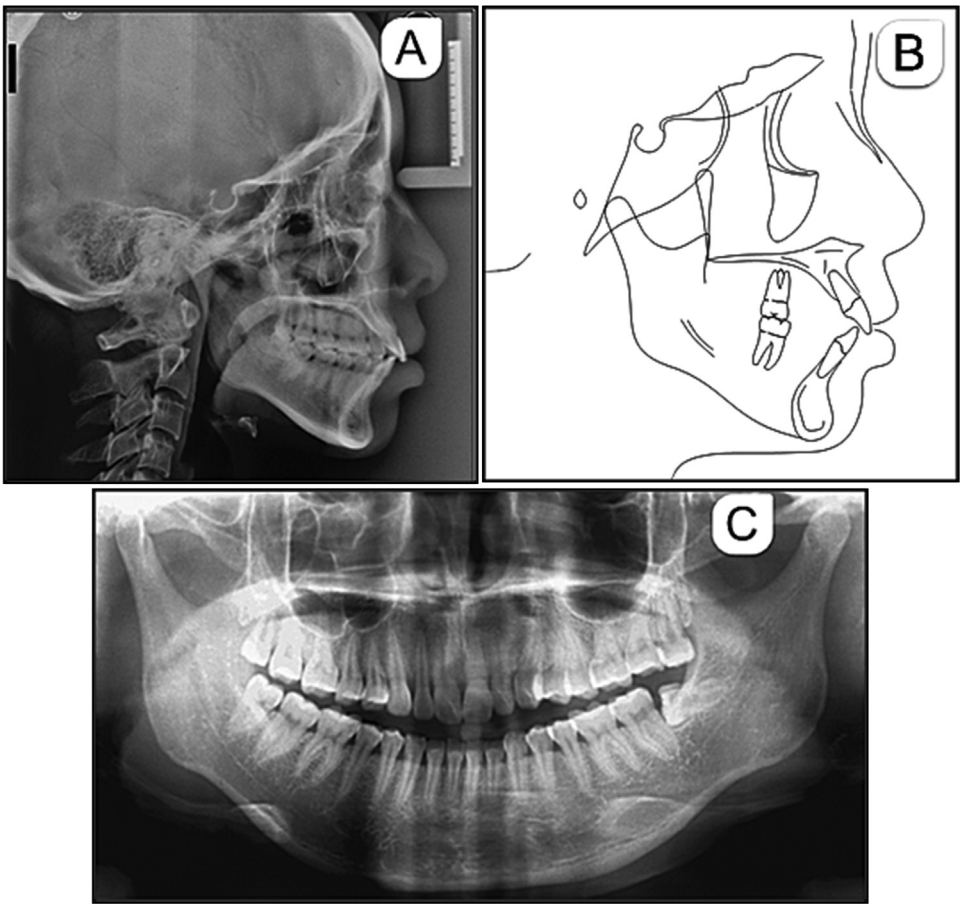

Fig 3. Pretreatment radiographs and tracing: **A,** lateral cephalogram; **B,** cephalometric tracing; **C,** panoramic radiograph.

Table I. Changes in cephalometric parameters after distalization of the maxillary and mandibular dentitions

Parameter	*Standard*	*Pretreatment*	*Posttreatment*
SNA (°)	82.8 ± 4.0	73.7	74.5
SNB (°)	80.1 ± 3.9	71.4	71.1
ANB (°)	2.7 ± 2.0	2.3	3.4
A-NFH (mm)	0.0 ± 3.7	−9.5	−5.4
Wits (mm)	−1.1 ± 2.9	0.2	0.6
MP2/SN (°)	32.5 ± 5.2	43.5	43.6
U1-AP (mm)	7.2 ± 2.2	10.2	3.5
L1-AP (mm)	4.9 ± 2.1	6.6	1.5
U1/PP (°)	115.8 ± 5.7	119.4	97.7
L1/MP (°)	93.9 ± 6.2	99.1	90.5
Interincisal angle (°)	130.0 ± 7.6	112.1	143.0

an adult with negligible craniofacial growth during the short treatment period, the 3-dimensional superimposition and CBCT measurements were considered reliable (Table II).

Two years after treatment, the occlusion was stable with satisfactory facial esthetics (Figs 9 and 10).

DISCUSSION

Patients with bimaxillary protrusion generally have Class I molar and canine relationships, which result in good oral function. Facial esthetics is a patient's primary reason for seeking treatment. Careful and complete skeletal, dental, and soft tissue evaluations are necessary before treatment planning. Treatment methods are selected according to the patient's chief complaint and the clinical diagnosis.

A severe skeletal bimaxillary protrusion is implied when a patient has severely protruded lips but upright maxillary and mandibular incisors. These patients require orthognathic surgery. An anterior subapical osteotomy can correct a sagittal excess in the jaw bones, whereas a segmental maxillary osteotomy corrects an exaggerated curve of Spee and vertical maxillary excess. Differential intrusion/impaction of the anterior and

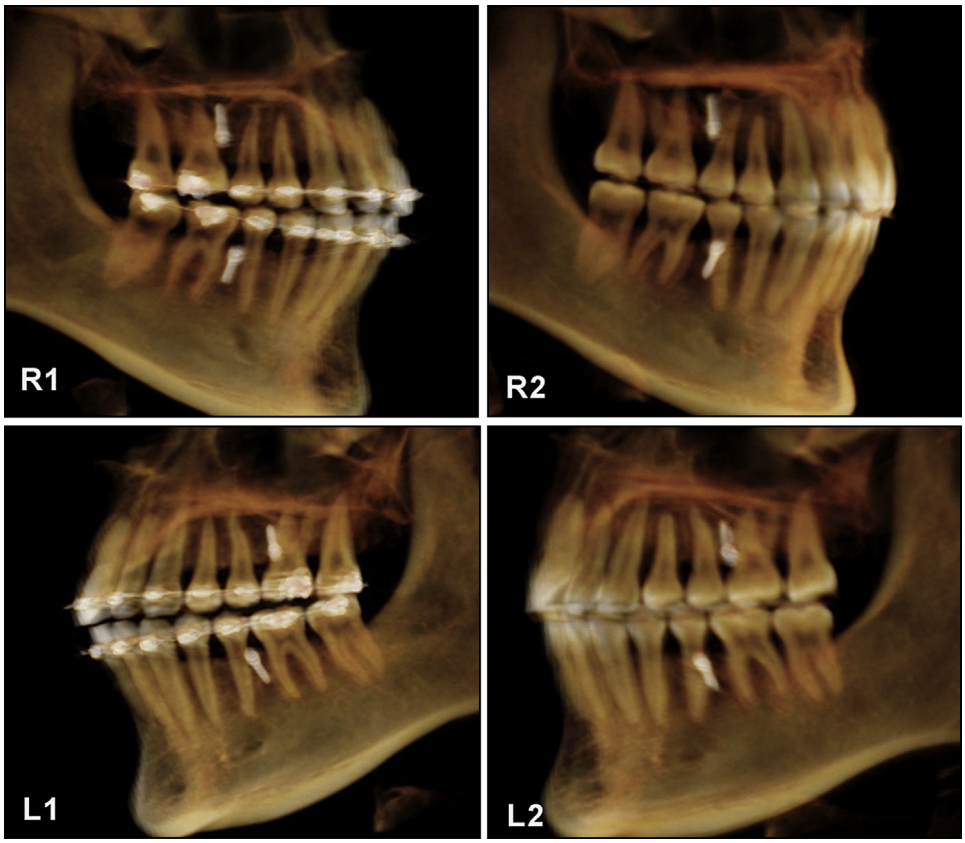

Fig 4. CBCT images show the positions of the miniscrews; *R1*, right side pretreatment; *R2*, right side posttreatment; *L1*, left side pretreatment; *L2*, left side posttreatment.

Fig 5. Progress intraoral photographs with miniscrews in each quarter.

posterior maxillary/mandibular segments with clockwise rotation of the occlusal plane is a useful technique for the treatment of an anterior open bite. A LeFort I osteotomy with setback sometimes provides an alternative to segmental maxillary osteotomy.[6]

Bimaxillary protrusion characterized by severely proclined maxillary and mandibular incisors can generally be corrected by orthodontic treatment alone. Orthodontic treatment often involves extraction of the maxillary or mandibular first premolars to provide the space for anterior tooth retraction. Meanwhile, maximum anchorage is believed to be the most critical part of the treatment plan. Studies have shown that extraction of the maxillary or mandibular first premolars can be extremely successful in decreasing dental and soft tissue protrusion in patients with bimaxillary protrusion,[1] although the molars cannot be kept stationary with conventional anchorage devices such as a headgear.[11-13] With the introduction of dental implants,[14] miniplates,[15,16] and miniscrews/implants[17] as anchorage devices, it has become possible to achieve absolute anchorage.[18] With the help of skeletal anchorage,

Fig 6. Posttreatment facial and intraoral photographs.

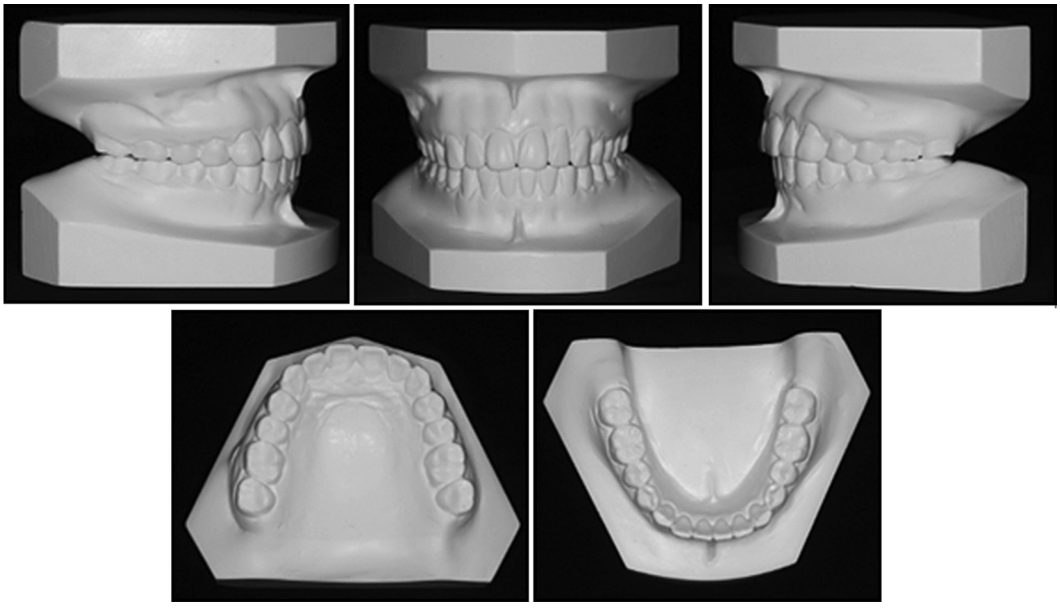

Fig 7. Posttreatment dental casts.

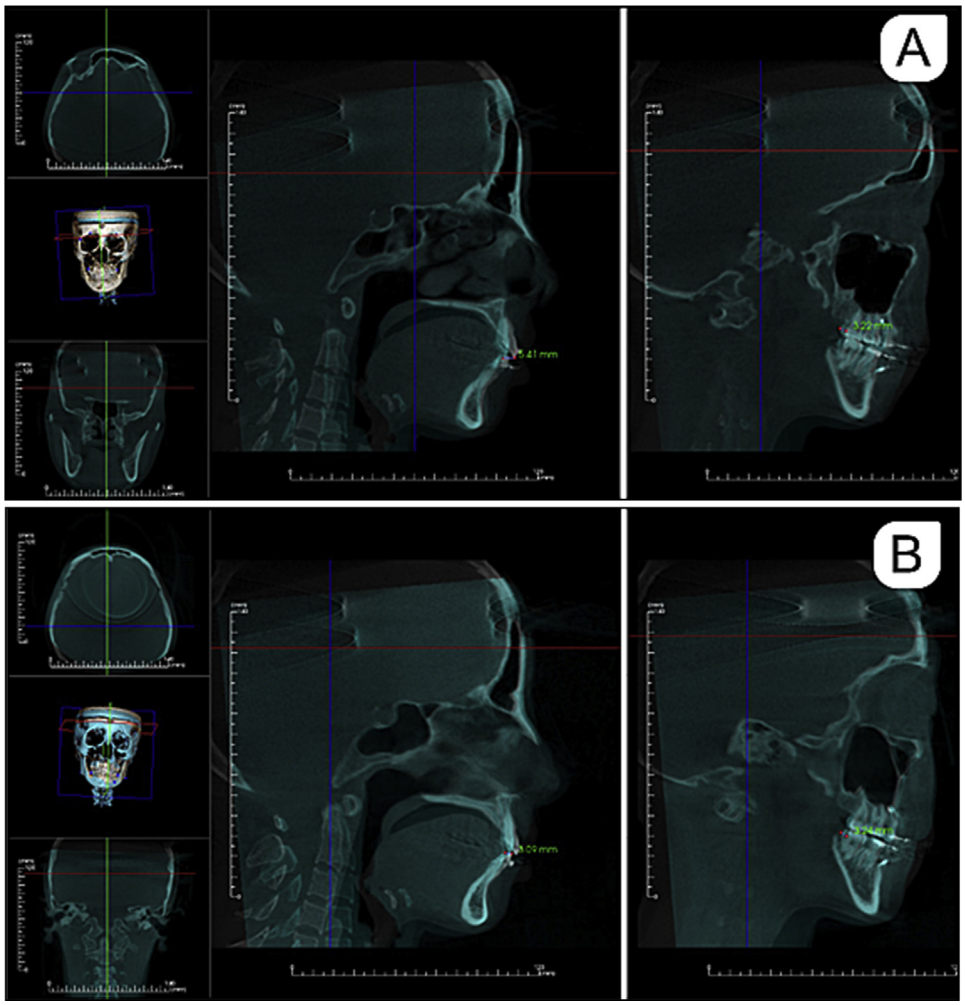

Fig 8. **A,** Sagittal movements of the maxillary incisors and second molars were measured based on cranial superimpositions; **B,** the mandibular incisors and second molars were measured based on mandibular superimpositions.

Table II. Distal movement of the central incisors and second molars assessed on CBCT images at the start and end of treatment

	*Tooth**							
	11	*17*	*21*	*27*	*31*	*37*	*41*	*47*
Displacement (mm)	5.41	3.34	5.40	3.22	3.67	3.09	3.49	3.24

*Fédération Dentaire Internationale tooth numbering system.

orthodontists can make maximum use of the extraction spaces and retract the anterior teeth as much as possible, increasing the chances of improved facial esthetics. Furthermore, the molars can be distalized to gain extra space to continue anterior tooth retraction when the extraction space is not large enough to resolve both anterior crowding and proclination. To the advantage of orthodontists, novel skeletal anchorage devices are continually introduced to correct various types of malocclusion.

With regard to mild or moderate bimaxillary protrusion, the space required to retract incisors is less than the size of a premolar, and this can result in inefficient use of the extraction space. Some patients refuse extraction of healthy teeth other than the third molars because their protrusion is not severe. In theory, we can use the

Fig 9. Two-year retention facial and intraoral photographs.

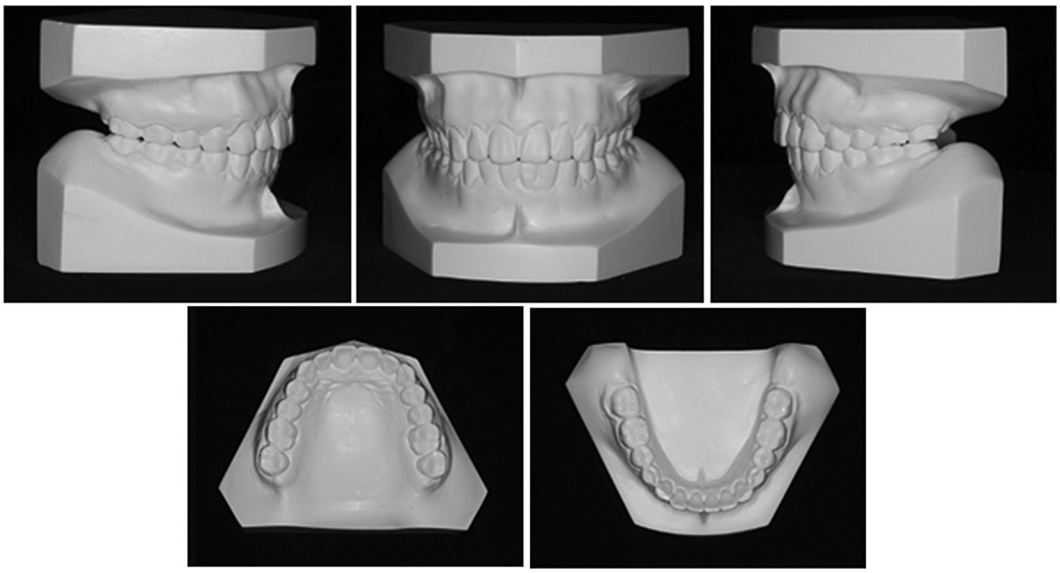

Fig 10. Two-year retention dental casts.

space distal to the second molars to distalize the entire dentition with the aid of skeletal anchorage. In our patient, we implanted 4 miniscrews between the second premolars and the first molars in both arches and completed the distalization in a year.

Traditionally, distalization of the maxillary molars or dentition is difficult after complete eruption of the second molars in nongrowing patients. Headgears and improved Nance and pendulum appliances are used for molar distalization.[19,20] However, these appliances have disadvantages, including poor esthetics, loss of anchorage in the mesial teeth, and dependence on patient compliance. There was no satisfactory approach for distalization of the mandibular dentition before the introduction of skeletal anchorage.

To distalize the dentitions, temporary anchorage devices (TADs) must be placed in an appropriate position. They are preferably implanted at sites with a relatively thick cortical bone layer and at a distance from the tooth roots so that they do not interfere with dental movement. The infrazygomatic crest in the maxilla[9] and the buccal tent area and the retromolar area[21,22] in the mandible are sites located outside the dental arches. Therefore, the space is enough for distal movement of the dentitions, which can be distalized using 1-stage TADs implanted at these sites. Orthodontists also implant miniscrews in the interradicular areas and distalize the molars using 2-stage mini-implants because of the limited interradicular space. For this patient, we implanted the miniscrews in the buccal interradicular areas between the second premolars and the first molars because her interradicular spaces were large enough for the planned tooth movement; furthermore, we completed the distalization of both dentitions without replacement of the miniscrews. However, we tried our best to place the miniscrews as close to the mesiobuccal root of the first molar as possible because we required distal movement.

In addition to an appropriate implant site, 2 important factors influence successful distalization of the dentitions with TADs. First is the survival of the TADs, which function well only when they are stable. Until now, miniplates have been considered superior to miniscrews or mini-implants.[23] Second is the space for the movement of the dentitions, which must be carefully checked for every tooth in the dentition. Sometimes, pneumatization of the maxillary sinus[24] or a cementoma may restrict tooth movement; in such cases, the precise 3-dimensional relationship should be checked with computed tomography. Generally, extraction of all third molars is essential to provide the space for distal movement of the dentition.

CONCLUSIONS

This case report demonstrates a novel technique to treat bimaxillary dentoalveolar protrusion using miniscrews, without extraction of any healthy premolars. This technique can be used to supplement conventional treatment modalities for this type of malocclusion.

REFERENCES

1. Bills DA, Handelman CS, BeGole EA. Bimaxillary dentoalveolar protrusion: traits and orthodontic correction. Angle Orthod 2005;75:333-9.
2. Solem RC, Marasco R, Guiterrez-Pulido L, Nielsen I, Kim SH, Nelson G. Three-dimensional soft-tissue and hard-tissue changes in the treatment of bimaxillary protrusion. Am J Orthod Dentofacial Orthop 2013;144:218-28.
3. Ouyang L, Zhou YH, Fu MK, Ding P. Extraction treatment of an adult patient with severe bimaxillary dentoalveolar protrusion using microscrew anchorage. Chin Med J (Engl) 2007;120:1732-6.
4. Aljhani A, Zawawi KH. The use of mini-implants in en masse retraction for the treatment of bimaxillary dentoalveolar protrusion. Saudi Dent J 2010;22:35-9.
5. Steinhäuser EW. Historical development of orthognathic surgery. J Craniomaxillofac Surg 1996;24:195-204.
6. Chu YM, Bergeron L, Chen YR. Bimaxillary protrusion: an overview of the surgical-orthodontic treatment. Semin Plast Surg 2009;23:32-9.
7. Park JU, Hwang YS. Evaluation of the soft and hard tissue changes after anterior segmental osteotomy on the maxilla and mandible. J Oral Maxillofac Surg 2008;66:98-103.
8. Choo H, Heo HA, Yoon HJ, Chung KR, Kim SH. Treatment outcome analysis of speedy surgical orthodontics for adults with maxillary protrusion. Am J Orthod Dentofacial Orthop 2011;140:e251-62.
9. Ishida T, Yoon HS, Ono T. Asymmetrical distalization of maxillary molars with zygomatic anchorage, improved superelastic nickel-titanium alloy wires, and open-coil springs. Am J Orthod Dentofacial Orthop 2013;144:583-93.
10. Tai K, Park JH, Tatamiya M, Kojima Y. Distal movement of the mandibular dentition with temporary skeletal anchorage devices to correct a Class III malocclusion. Am J Orthod Dentofacial Orthop 2013;144:715-25.
11. 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.
12. Kuroda S, Yamada K, Deguchi T, Kyung HM, Takano-Yamamoto T. Class II malocclusion treated with miniscrew anchorage: comparison with traditional orthodontic mechanics outcomes. Am J Orthod Dentofacial Orthop 2009;135:302-9.
13. Xu TM, Zhang X, Oh HS, Boyd RL, Korn EL, Baumrind S. Randomized clinical trial comparing control of maxillary anchorage with 2 retraction techniques. Am J Orthod Dentofacial Orthop 2010;138:544.e1-9.
14. Roberts WE, Helm FR, Marshall KJ, Gongloff RK. Rigid endosseous implants for orthodontic and orthopedic anchorage. Angle Orthod 1989;59:247-56.
15. Sugawara J, Daimaruya T, Umemori M, Nagasaka H, Takahashi I, Kawamura H, et al. Distal movement of mandibular molars in adult patients with the skeletal anchorage system. Am J Orthod Dentofacial Orthop 2004;125:130-8.

16. Choi BH, Zhu SJ, Kim YH. A clinical evaluation of titanium miniplates as anchors for orthodontic treatment. Am J Orthod Dentofacial Orthop 2005;128:382-4.
17. Park HS, Kwon TG. Sliding mechanics with microscrew implant anchorage. Angle Orthod 2004;74:703-10.
18. Kanomi R. Mini-implant for orthodontic anchorage. J Clin Orthod 1997;31:763-7.
19. Toy E, Enacar A. The effects of the pendulum distalizing appliance and cervical headgear on the dentofacial structures. Aust Orthod J 2011;27:10-6.
20. Caprioglio A, Beretta M, Lanteri C. Maxillary molar distalization: pendulum and fast-back, comparison between two approaches for Class II malocclusion. Prog Orthod 2011;12:8-16.
21. Anhoury PS. Retromolar miniscrew implants for Class III camouflage treatment. J Clin Orthod 2013;47:706-15.
22. Poletti L, Silvera AA, Ghislanzoni LT. Dentoalveolar class III treatment using retromolar miniscrew anchorage. Prog Orthod 2013; 14:7.
23. Janssen KI, Raghoebar GM, Vissink A, Sandham A. Skeletal anchorage in orthodontics—a review of various systems in animal and human studies. Int J Oral Maxillofac Implants 2008; 23:75-88.
24. Vitral RW, da Silva Campos MJ, de Andrade Vitral JC, Santiago RC, Fraga MR. Orthodontic distalization with rigid plate fixation for anchorage after bone grafting and maxillary sinus lifting. Am J Orthod Dentofacial Orthop 2009;136:109-14.