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Miniscrew-assisted customized lingual appliances for predictable treatment of skeletal Class II malocclusion with severe deep overbite and overjet

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This report describes the use of miniscrew-assisted customized lingual fixed appliances in a patient with severe skeletal Class II malocclusion. The patient was a 12-year-old Chinese girl with the chief complaint of protrusive lips and anterior teeth. Her diagnosis included a skeletal Class II relationship with maxillary protrusion, a backward-rotated mandible, a full Angle Class II molar relationship, and severe deep overjet and overbite. Four premolars were extracted, and miniscrew anchorage was placed in the maxillary posterior lingual segment to provide maximum anchorage and to achieve vertical control of the intruding molars. The customized lingual fixed appliance and temporary anchorage devices created a smooth and invisible treatment progress, resulting ultimately in a well-aligned dentition with ideal intercuspation and a dramatically improved profile. The 3-year follow-up examination indicated that the excellent treatment outcome was stable. (Am J Orthod Dentofacial Orthop 2017;152:104-15)

A skeletal Class II malocclusion with severe anterior deep overbite, excessive overjet, and high mandibular plane angle is among the most complex and difficult malocclusions to treat with an orthodontic strategy alone, because of the simultaneous existence of a skeletal discrepancy and the sagittal and vertical discrepancies in the dental arch.[1] In Chinese people, a skeletal Class II malocclusion is often accompanied by a retrusive and clockwise-rotated mandible and micrognathism, leading to a convex facial profile and excessive lower facial height.[2]

The fundamental and most effective treatment for a skeletal Class II malocclusion and a retrusive mandible is surgical relocation of the jaw bone.[2,3] However, such invasive surgical methods are difficult for many families to accept because of the possible surgical risks and high costs. Moreover, this patient, a 12-year-old girl, could have faced a long wait before receiving such surgery.

The demand for esthetic orthodontic appliances and procedures has increased recently. Patients prefer lingual fixed appliances because of their invisibility.[4,5] Customized lingual appliances have become more convenient for orthodontists because of the availability of preadjusted data and the predictability of the procedures, resulting in tooth movement toward the expected target.[6,7] Moreover, a customized archwire can minimize the work of archwire bending for clinicians.[8]

Like the labial technique, temporary miniscrew anchorage has played a role in expanding the applications of lingual appliances, particularly in patients who require maximum anchorage.[8] Miniscrews facilitate anterior tooth retraction and the achievement of anchorage control to correct molar relationships.[9] Miniscrews have also been reported to be useful for vertical control in high-angle patients.[10] Intrusion of the molars enables counterclockwise rotation of the mandible; this aids in the control of the mandibular plane angle, improving the facial profile.[11,12]

In this case report, we describe the use of a customized Incognito lingual appliance (Incognito,

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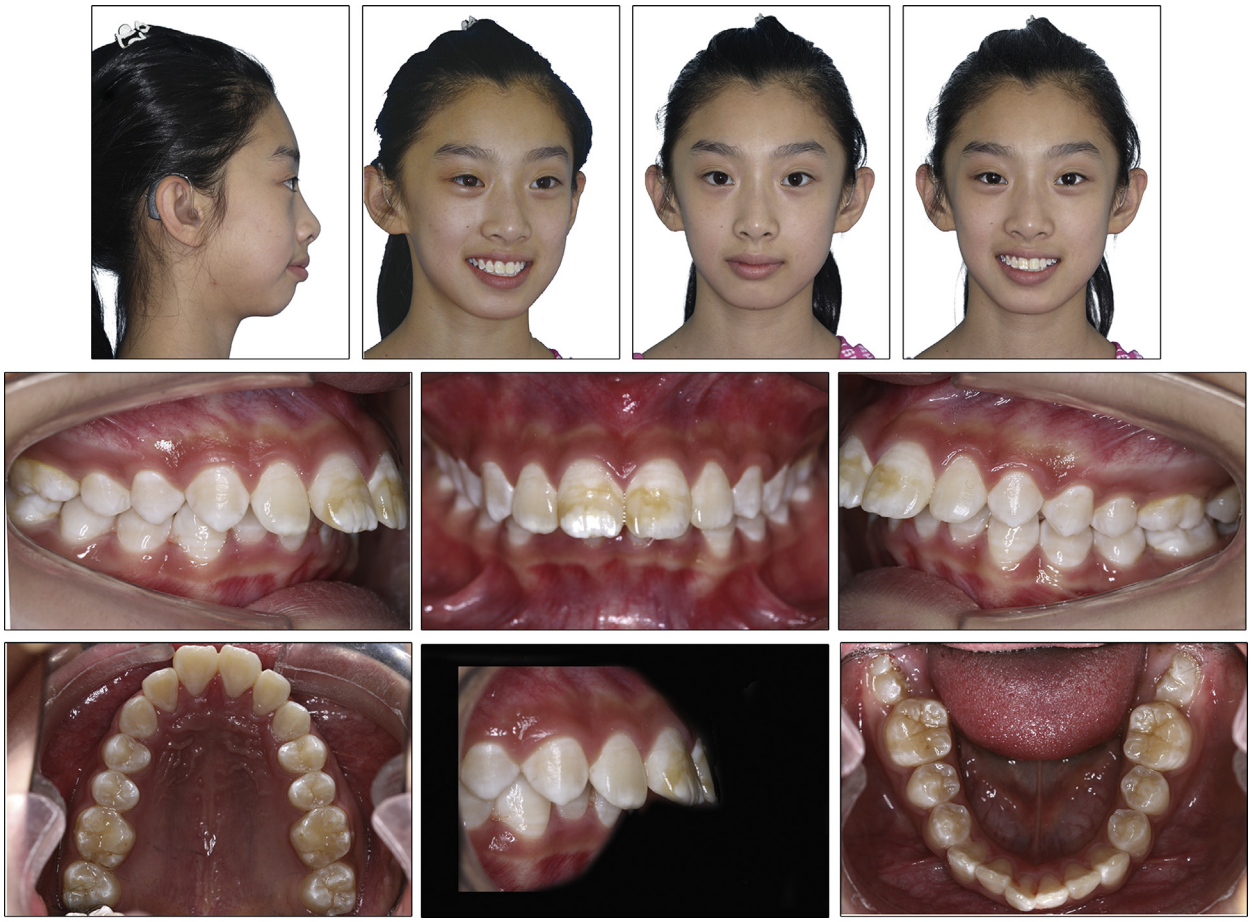

Fig 1. Pretreatment facial and intraoral photographs show protruding mouth, retrognathic mandible, severe anterior deep overbite, and excessive overjet.

Bad Essen, Germany) and miniscrews with extraction of 4 premolars to resolve a skeletal Class II malocclusion, severe anterior deep overbite, excessive overjet, retrusive mandible, and high mandibular plane angle in an adolescent patient. The treatment plan involved primarily anterior retraction and posterior vertical control to improve the overall appearance, including the frontal and lateral views, using miniscrew-assisted nonsurgical correction with a customized lingual fixed appliance. See Supplemental Materials for a short video presentation about this study.

DIAGNOSIS AND ETIOLOGY

The patient was a 12-year-old girl with the chief complaint of protrusive mouth and teeth. She denied any oral habit. Photographs taken before treatment showed a mild asymmetric mandible. A convex profile caused by mandibular retrognathism and maxillary protrusion was noted. The patient's profile also showed increased lower facial height (Fig 1). Intraoral photographs and the dental casts showed that the patient had a full Class II molar relationship, with severe deep overbite, excessive overjet, and mild crowding in the maxillary and mandibular dentitions (Fig 2).

The lateral cephalometric analysis showed a skeletal Class II jaw relationship with mandibular retrusion (ANB, 7.9°) and a high mandibular plane angle (MP/SN, 40.58°). The maxillary incisors were proclined. Both the upper and lower lips were obviously in front of the E-line (Fig 3). No symptom of a temporomandibular disorder was detected. This patient was diagnosed with Class II malocclusion with a skeletal Class II base, high mandibular plane angle, severe deep overbite, and excessive overjet.

TREATMENT OBJECTIVES

The treatment objectives were to (1) normalize the overjet and overbite relationships, (2) improve the facial profile, (3) align and level the dental arches, and (4) correct the molar relationship to Class I.

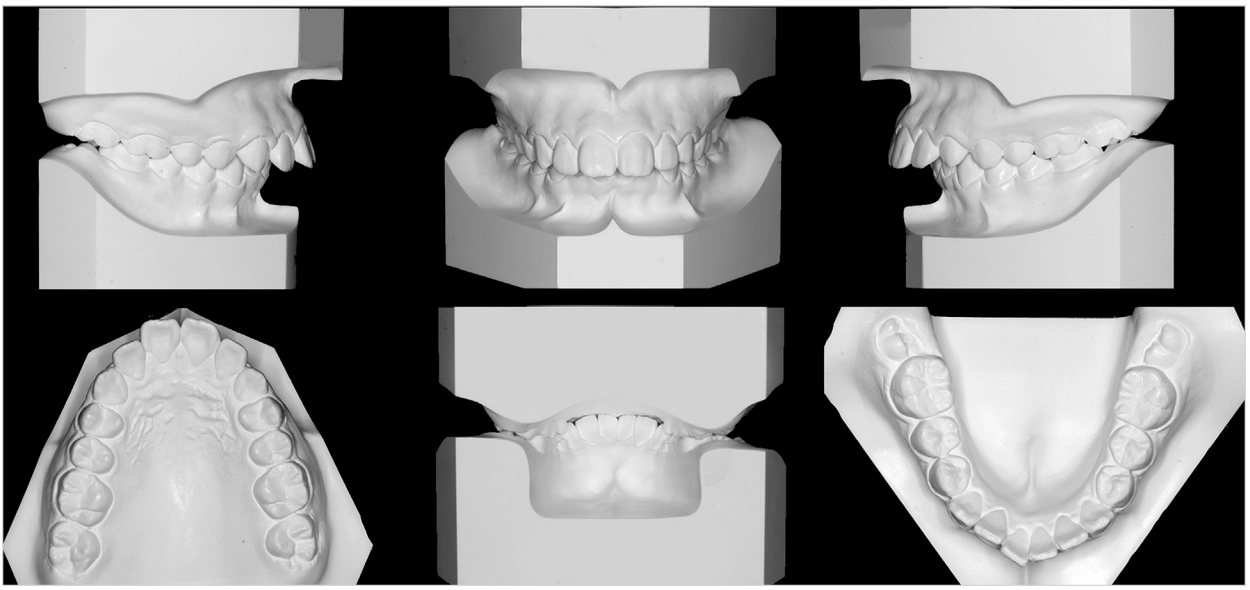

Fig 2. Pretreatment dental casts display full Class II molar relationship.

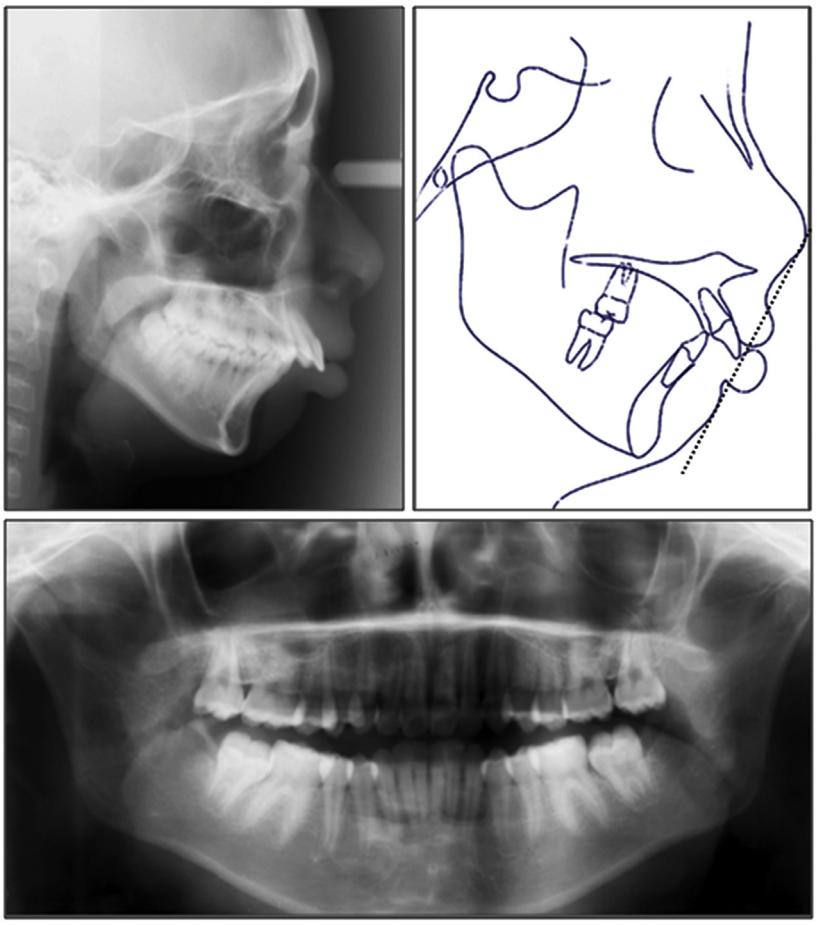

Fig 3. Pretreatment cephalograph, tracing, and panoramic radiograph.

Fig 4. Detailed treatment progression: **A,** lingual fixed appliances applied with 0.016 × 0.022-in nickel-titanium archwires; **B,** space closure with miniscrew-assisted skeletal anchorage. Classic sliding mechanics with a 0.016 × 0.024-in stainless steel archwire were used to close the spaces in both arches.

TREATMENT ALTERNATIVES

Three treatment options were considered for this patient. Because she was a deaf-mute dancer and her parents had high expectations regarding her facial esthetics, a comprehensive orthodontic treatment plan aiming to resolve the malocclusion and skeletal discrepancy was considered. The first option was 2-phase treatment with a functional appliance to move the mandible forward, correcting the mandibular retrusion. Twin-block and Herbst appliances were recommended. However, the patient had passed menarche, and a pretreatment cephalogram showed a degree of cervical vertebral maturation that most likely followed the pubertal growth spurt (stage 3), indicating that she had passed the best time for functional orthodontic treatment. Moreover, a Twin-block appliance is more suitable for patients with an average or low mandibular plane angle. The second option was a labial esthetic fixed appliance with extraction of the maxillary right and left first premolars and retraction of the maxillary anterior teeth to decrease overjet and establish a Class I canine relationship and a full

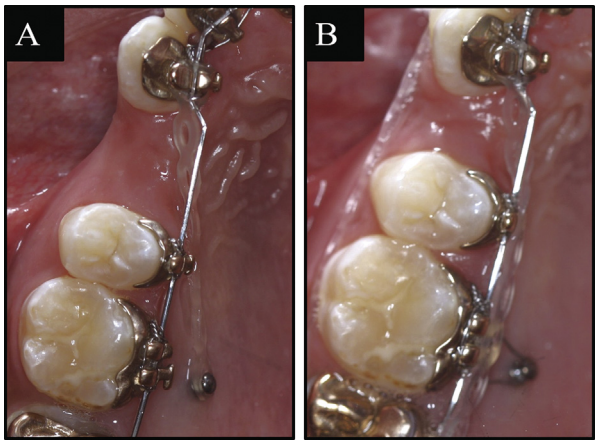

Fig 5. Maxillary lingual miniscrews were used as **A,** direct anchorage to retract anterior teeth or **B,** indirect anchorage to prevent mesial movement and extrusion of the molars.

Class II molar relationship, without Class II elastics or mandibular forward movement. Genioplasty might also be considered to improve the lower facial esthetics, if necessary. The third option was a miniscrew-assisted labial esthetic fixed appliance or lingual fixed appliance with extraction of the maxillary right and left first premolars and the mandibular right and left second premolars to retract the maxillary arch, correcting the deep overbite and excessive overjet, and establishing Class I canine and molar relationships. Considering the invisibility of the appliance, convenience, and high expectations for facial esthetics, the patient and her parents chose the third option with a lingual fixed appliance. The difficulty with this option was that the patient had a high mandibular plane angle with downward and backward rotation of the mandible. An extruding effect on the molars during leveling and the use of Class II elastics to correct the molar relationship were inevitable; however, extruded molars would increase the mandibular plane angle, worsening the patient's profile. Thus, vertical control of the molars was necessary. Furthermore, precise control of the dentition is challenging in cases involving extractions and the use of lingual appliances. With the third option, the use of miniscrew anchorage was explained fully to the patient.

TREATMENT PROGRESS

The patient consented to the final treatment plan, and it was approved by the ethics committee of Peking University School and Hospital of Stomatology, Beijing, China. Her orthodontic treatment began in August 2008. Under local anesthesia, the maxillary first premolars and mandibular second premolars were extracted before bonding. A fully customized Incognito lingual appliance (Incognito) was placed using indirect bonding with a customized bonding tray on both arches.

Nickel-titanium archwires (0.014, 0.016, and 0.016 × 0.022 in) were placed for initial alignment and leveling of both arches (Fig 4, *A*). When the 0.016 × 0.024-in stainless-steel archwire (without extra torque ordered) was placed in both arches, miniscrews (diameter, 1.5 mm; length, 9 mm; Zhongbang Medical Treatment Appliance, Xi'an, China) were inserted on the lingual side of the maxillary posterior segment under local infiltration anesthesia to provide skeletal anchorage.

Classic sliding mechanics with a 0.016 × 0.024-in stainless-steel archwire were used to close the spaces in both arches (Fig 4, *B*). The anterior teeth were moved together with a straight archwire guided by the posterior brackets and tubes. All tiebacks in the maxillary arch were placed on the miniscrews to close the extraction spaces (Fig 5, *A*), or the maxillary first molars were rigidly ligated to the miniscrews to prevent mesial movement and extrusion of the molars (Fig 5, *B*). Class II elastics extending from the buccal buttons of the mandibular second molars to the gingival hooks of the maxillary canines were placed to adjust the molar and canine relationships. After the space-closing stage, final detailing was achieved with 0.0182 × 0.0182-in beta-titanium wires (Fig 6). This full-sized wire provided good torque delivery and second-order expression. We achieved excellent intercuspation and occlusal relationship. The overall active treatment lasted 35 months. At the end of active treatment, the miniscrews were removed. After debonding of the lingual brackets, complete records were taken for treatment assessment (Figs 7-10). Full-time wear of vacuum-formed retainers was suggested.

TREATMENT RESULTS

Assessment of the treatment outcome showed a well-aligned dentition, a harmonious facial balance, and a charming smile. With miniscrew-assisted anchorage, retraction of the maxillary incisors was achieved. Moreover, the anterior deep overbite and excessive overjet were well corrected. Class I molar relationship was achieved. After treatment, the patient had a straight facial profile because the maxillary anterior teeth were retracted and the mandibular plane angle was maintained. The dental casts showed that both the buccal and lingual occlusions and the

Fig 6. Detailing and refinement with the beta-titanium alloy archwire. Vertical elastics between the maxillary and mandibular canines were used.

inclinations of the maxillary incisors were even better than the setup model (Fig 8 and 9). The treatment outcome of this fully customized lingual appliance was better than predicted. Panoramic radiographs taken after treatment showed no obvious apical root resorption, with acceptable root parallelism. The upper lip was slightly behind the E-line, and the lower lip was nearly on the E-line (Fig 10).

The assessment of the treatment outcome showed retraction of the maxillary anterior teeth and intrusion of the mandibular incisors (Fig 11). These changes were further evidenced by the cephalometric analysis, which indicated that the ANB angle had decreased by 2.4°, and the MP/SN value was almost unchanged, the inclination of the maxillary central incisors was decreased by 13.7°, and the Z-angle was increased by 17.7° (Table).

The patient was satisfied with the true invisibility of the whole treatment procedure and the final excellent treatment results. At the 3-year follow-up visit, her treatment outcome had been maintained and was stable (Fig 12).

DISCUSSION

The patient had a skeletal Class II relationship with a retrusive mandible, a Class II molar relationship, severe anterior deep overbite, and excessive overjet. Conventional camouflage orthodontic treatment is usually difficult in a patient with these conditions, because of the difficulty of addressing the problems in the sagittal and vertical dimensions simultaneously. However, this girl was a ballerina, and her parents rejected orthognathic surgery at 18 years of age and wanted lingual bracket treatment for esthetic reasons.[13]

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

Thus, in this case, we applied a fully customized lingual appliance assisted by miniscrew anchorage, which created a well-aligned dentition with ideal intercuspation and a dramatically improved profile. The combined use of miniscrews and the fully customized lingual appliance simplified the whole orthodontic procedure and improved the treatment effect.[14]

Recently, esthetic orthodontic appliances and procedures have become more popular.[15] Many patients favor lingual appliances because of their true invisibility.[16] The customized lingual appliance used in this patient has become more convenient for orthodontists because of the availability of preadjusted data and the predictability of the procedures, resulting in tooth movement toward the expected target.[17] Moreover, the customized archwire can minimize the work of archwire bending for clinicians.[16]

Anchorage control in fixed orthodontic treatment, including the lingual technique, is an important factor affecting the treatment plan and results, especially for patients with high mandibular plane angles.[18] This girl's chief complaint was a protrusive mouth and teeth. The pretreatment profile showed that she had severe maxillary protrusion and mandibular retrusion. Maximum anteroposterior anchorage was thus undoubtedly necessary for her. However, vertical control was also necessary, because of her 40° mandibular plane angle. Thus, miniscrews were placed in the maxillary palatal segments to retract the maxillary anterior teeth, providing strong anchorage with a method similar to that used in labial appliances.[19] During incisor retraction, we added lingual root torque of 10° and a reverse curve of Spee to prevent excessive lingual inclination.[20] The mechanics for an

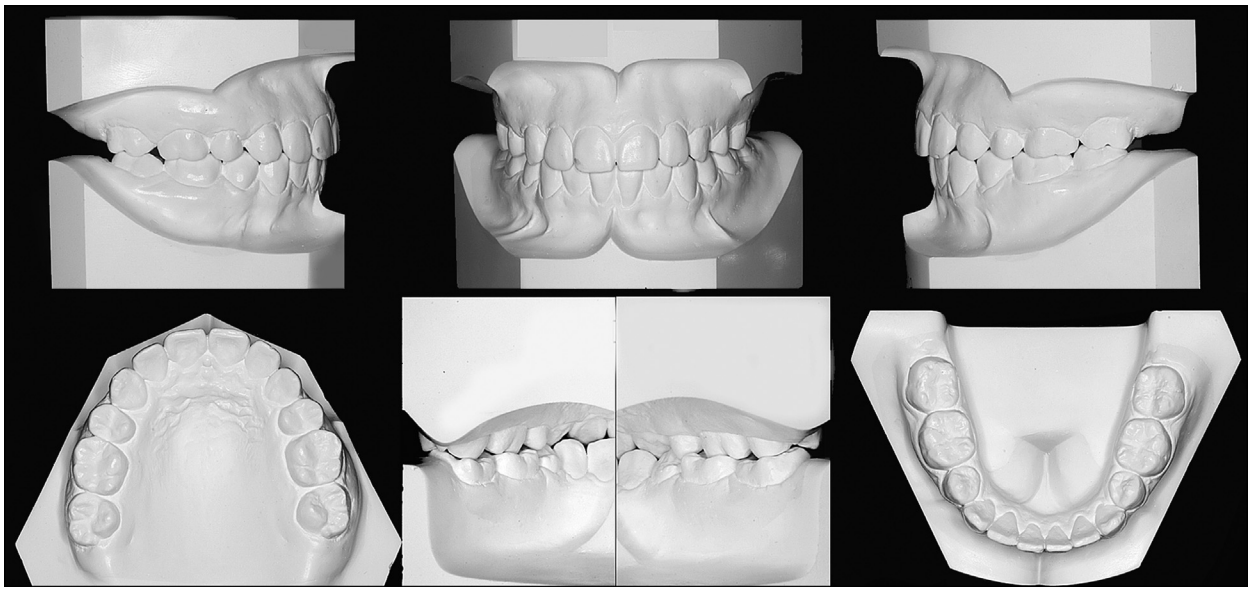

Fig 8. Posttreatment dental casts show well-aligned dentitions and corrected anterior deep overbite and excessive overjet. The lingual occlusion was solid.

Fig 9. Setup model shows alignment and occlusion after extraction of the maxillary right and left first premolars and the mandibular right and left second premolars.

archwire with a reverse curve of Spee include labial inclination and intrusion of anterior teeth, extrusion of premolars, and uprighting of molars. The superimposition indicated that the tipping movement of the maxillary incisors was controlled to some extent. Class II elastics during the space-closing stage were helpful for correction of the molar relationship. However, extrusion and mesial inclination of the mandibular molars are undesired side effects for high-angle patients. The tendency of mesial inclination of the mandibular molars could be neutralized by the uprighting effect of the manibular archwire with the reverse curve of Spee. The tendency of molar extrusion might be neutralized by the intrusive effect of

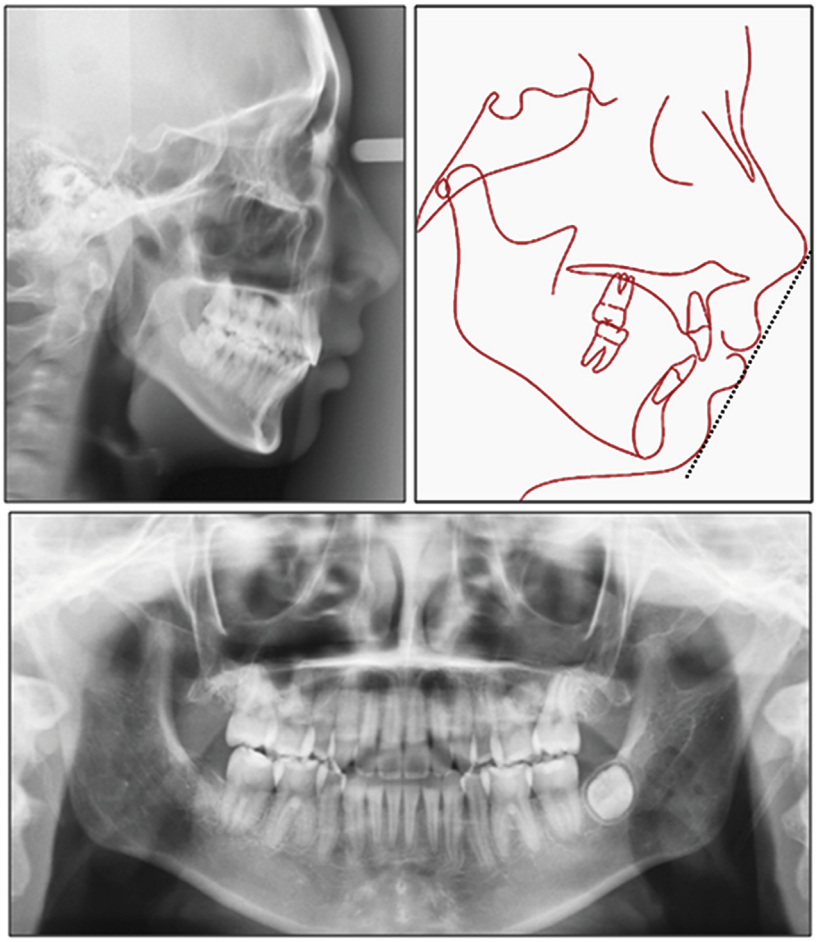

Fig 10. Posttreatment cephalograph, tracing, and panoramic radiograph.

the occlusal pad on the mandibular second molars and the glass ionomer cement temporarily put on the occlusal face of the mandibular first molars (Fig 5. *B*). Even so, extrusion of the mandibular molars still occurred (Fig 11, *C*).

Vertical control is important for high-angle patients. An anterior deep overbite is difficult to correct in patients with a Class II malocclusion because of the effects of skeletal morphology.[21] Thus, the treatment of a malocclusion with a severe deep anterior overbite and a high mandibular plane angle requires careful diagnosis and selection of treatment strategies in accordance with all factors that contribute to the dental problems. The traditional mechanics for correcting a deep overbite include intrusion of anterior teeth and extrusion of posterior teeth. However, this girl had a high mandibular plane angle, and we wanted to prevent molar extrusion. Full customized lingual appliances use a wire that is thicker vertically than horizontally; thus, the vertically oriented wire is effective for vertical control of the dentition. The lingual brackets of the maxillary incisors can also serve as a biteplane for the mandibular anterior teeth, so the lingual technique also has a biteplate effect that can help to intrude the incisors.[22] Arch leveling and overbite control are achieved readily through the biteplate effect of the maxillary anterior brackets during the alignment stage. The location of the point of force application by the lingual brackets over the center of resistance tends to produce small moments that contribute to negative tooth movement effects such as proclination, which is often seen with labial brackets. However, when an intrusive force is applied to the lingual brackets, the crowns of the teeth will rotate in a lingual direction, opposite to the labial brackets. For patients with a Class II molar relationship, deep overbite, and excessive overjet, intrusion of the mandibular incisors can therefore be accomplished by using lingual brackets without the excessive adverse

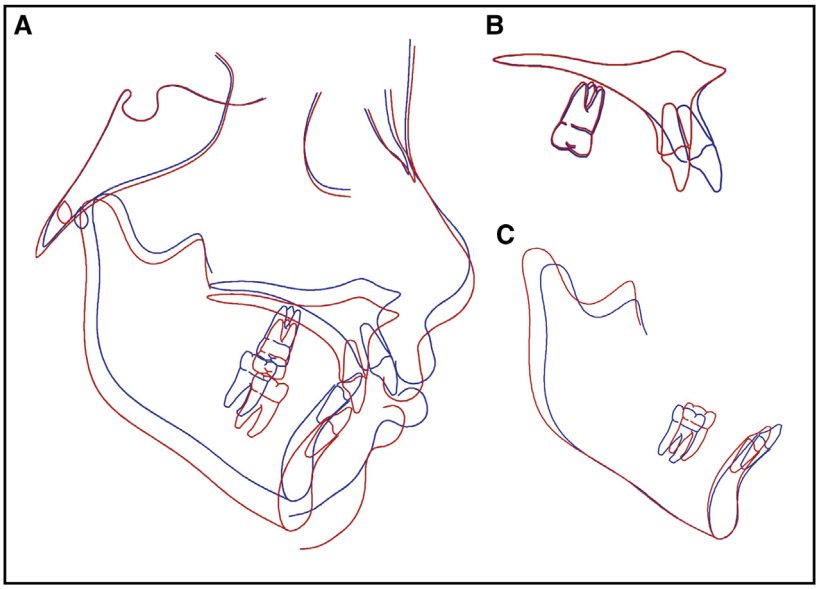

Fig 11. Cephalometric superimpositions showed marked differences between pretreatment (*black*) and posttreatment (*red*); **A,** the SN plane; **B,** the maxillary plane; **C,** the mandibular plane.

Table. Skeletal and dental changes indicated by the cephalometric measurements

	Norm				
Measurement	*Mean*	*SD*	*Pretreatment*	*Posttreatment*	*Difference*
Angular (°)					
SNA	82.8	4.0	83.2	81.6	−1.6
SNB	80.1	3.9	75.3	76.1	0.8
ANB	2.7	2.0	7.9	5.5	−2.4
U1/NA	22.8	5.7	28.5	20.2	−8.3
L1/NB	30.5	5.8	29.5	30.9	1.4
U1/L1	124.2	8.2	114.2	126.8	12.6
U1/SN	105.7	6.3	113.4	99.7	−13.7
MP/SN	32.5	5.2	40.6	40.0	−0.6
MP/FH	31.1	5.6	34.9	35.0	0.1
L1/MP	93.9	6.2	94.5	94.0	−0.5
Z angle	75.0	4.0	56.0	73.7	17.7
Linear (mm)					
U6-MxP	28.0	2.1	28.8	28.3	−0.5
L6-MnP	32.0	2.0	33.8	34.1	0.3

tooth movement often seen with buccal mechanics.[23] We also tried to correct the patient's deep overbite by adding the reverse curve of Spee to the archwire. Furthermore, we applied maxillary miniscrews to achieve posterior vertical control, neutralizing the side effects of intruding incisors. Miniscrew-assisted posterior vertical control improved the patient's retrognathic profile and maintained the mandibular plane angle with no unfavorable clockwise rotation, as indicated by superimposition of the pretreatment and posttreatment images of the mandible.

Torque control has always been an important issue in lingual orthodontics, especially in cases of extraction.[24] Loss of torque control of the maxillary incisors during retraction in patients who have had extractions has been reported to be more likely in lingual orthodontic treatment.[25] It is reported that adverse transversal and vertical bowing effects were seen under en-masse retraction forces in lingual orthodontic treatment, resulting in lingual tipping and extrusion of the anterior dentition. This may be associated with the different biomechanics between lingual and labial orthodontics, because lingual brackets are closer to the center of resistance of the tooth than are labial brackets, resulting in greater lingual crown movement of the maxillary incisors with lingual orthodontics compared with labial orthodontics under identical loads.[25] Torque of the anterior teeth is difficult to correct once the teeth have inclined lingually during retraction.[26] The Incognito appliance has been reported to deliver the planned torque from the laboratory setup to a precise level. Although we paid a great deal of attention to torque control in this patient, we unfortunately lost torque control of the maxillary anterior teeth during space closure. The reason might be that we applied a too-heavy retraction force by elastic tiebacks in both the buccal and palatal sides in the later stage for space closing (buccal tieback plus palatal tieback, 250-300 gN) (Fig 6, *B*). Lingual crown tipping occurred at the

Fig 12. Follow-up at 3 years showed a stable occlusion and facial profile.

end of space closure. Thus, we paid much attention to the refinement of maxillary anterior torque control and overbite correction in the detailing stage, resulting in a longer treatment for this patient. The beta-titanium wires with preadjusted crown labial torque contributed to the correction of the maxillary anterior torque. We added extra labial crown torque to the maxillary incisors. The nearly full-size beta-titanium archwire used in the detailing stage allowed for excellent torque control, preventing the retroclination of the maxillary incisors and the proclination of the mandibular incisors that are typically seen with labial appliances and caused by Class II elastics. Thus, proper force (<200 gN) for en-masse retraction of anterior teeth and an extra torque wire during space closing stage may be necessary. Finally, we achieved obvious retraction of the maxillary anterior teeth, complete leveling of the mandibular arch, and good control of the vertical dimensions. The occlusion and the inclination of the incisors were better than predicted in the setup model.

CONCLUSIONS

A Class II malocclusion with a retrusive mandible, severe anterior deep overbite, and excessive overjet was addressed with a fully customized Incognito lingual appliance, which provided an esthetic, accurate, and effective method. After treatment, the maxillary incisors were retracted, the high mandibular plane angle was maintained, the anterior deep overbite and excessive overjet were corrected, and a predictable Class I occlusion with rigid intercuspation was achieved with the assistance of miniscrews. The patient was satisfied with her straight profile. All outcomes were stable after 3 years, although further follow-up is necessary to evaluate the long-term stability.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at http://dx.doi.org/10.1016/j.ajodo.2016.06.053.

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