Correction of Lip Protrusion with Lingual Brackets and Palatal Anchorage

JANGHOON AHN, DDS, MSD, PHD
YOUNGJU PARK, DDS, MSD, PHD
RYOON-KI HONG, DDS, PHD
SOOJIN KIM, DDS, MS, PHD

Although absolute anchorage is crucial in the treatment of lip protrusion, especially when lingual appliances are used, most skeletal-anchorage devices have disadvantages in such cases. A dental implant or onplant requires laboratory fabrication, a surgical procedure, and a two-to-three-month healing period[1,2] and is difficult to remove after osseointegration.[3] Buccal and lingual miniscrews can loosen and fail during orthodontic force loading because of root proximity and occlusal forces.[4,5] Early versions of miniplates needed flap surgery and a skillful surgical technique for insertion in the buccal or palatal area[6,7]; moreover, the midpalatal mucosa is thick and hard compared to the buccal mucosa[8] and prone to tearing during flap surgery.

More recently introduced palatal miniplate systems such as the Orthoplate* are simple to place in the midpalate without flap surgery. Dental roots are not endangered, and the palatal bone is thick enough for miniscrew placement.[8] In addition, anterior retraction forces are applied at the level of the lingual lever arms, thus avoiding anterior tipping movements.

The Orthoplate consists of mesial and distal retentive arms with miniscrew holes, connected by a raised section with laterally extending arms ending in hooks for the attachment of elastic chain (Fig. 1). Offsetting the connecting plate by about 1mm from the palatal mucosa prevents tissue impingement and allows insertion of the appliance without flap surgery, regardless of the mucosal thickness. The lateral hooks are designed to allow easy engagement of elastic chain while preventing accidental dislodgement. Miniscrews anchoring the plate are usually 1.8mm in diameter and 8-10mm in length.

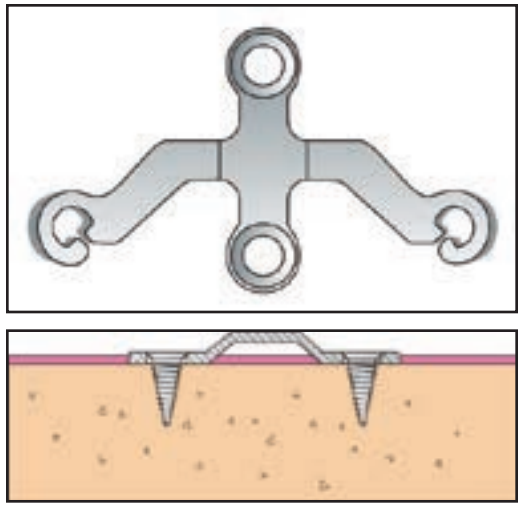

Fig. 1 Orthoplate* palatal miniplate and anchoring miniscrews.

To place the Orthoplate, the operator makes two simple incisions with a No. 12 blade, positions the miniscrews in the mesial and distal holes, and inserts them with a hand driver or a low-speed contra-angle handpiece. A healing ointment and mouthrinse can be prescribed in the event of inflammation around the insertion sites, but mild swelling will not affect the function of the miniplate. After treatment, the plate is easily removed by unscrewing the miniscrews.

*Hubit Co., Gyeonggi-do, Korea; www.ehubit.com.




Dr. Ahn **Dr. Park** **Dr. Hong** **Dr. Kim**

Dr. Ahn is an Associate Professor, Department of Orthodontics, and Dr. Park is a Professor, Department of Oral and Maxillofacial Surgery, Kangnam Sacred Heart Hospital, Hallym University, 948-1, Daerim 1-dong, Yeongdeungpo-gu, Seoul 150-950, Korea. Dr. Hong is Chairman, Department of Orthodontics, Chong-A Dental Hospital, Seoul. Dr. Kim is Director, Upenn Orthodontic Clinic, Seoul. E-mail Dr. Ahn at ajh0225@gmail.com.

In cases where the anterior teeth are retracted to correct protrusion, the linear and angular changes of the incisal and root tips must be accurately predicted and subsequently evaluated. Most orthodontists use Frankfort horizontal (FH)[9] and the McNamara line,[10] which is perpendicular to FH, as reference planes. The FH plane is unreliable, however, because of individual variation in the positions of porion and orbitale.[11,12] A true horizontal line based on natural head position (NHP) and its perpendicular, the nasion true vertical line (NTVL),[13] provides a more reliable guide for evaluation of tooth movement. Soft-tissue changes can be measured relative to Arnett and colleagues' true vertical line (TVL), which passes through subnasale.[14]

The following case shows the use of the Orthoplate in correcting lip protrusion, with sagittal changes of the anterior teeth evaluated relative to NTVL and lip retraction assessed relative to TVL.

Case Report

A 32-year-old female presented with the chief complaints of lip protrusion and crowding (Fig. 2A). She reported no relevant previous treatment except for malar plastic surgery, and her periodontal health was sound. Clinical evaluation showed an upper-incisor display of 2.5mm at rest and lip incompetence in the chin area on mouth closure, with an interlabial gap of 4mm at rest and in centric occlusion. The lips and the upper and lower incisors were protrusive; molar and canine relationships were Class I. Although the patient's upper dental midline was coincident with the facial midline, her lower dental midline was shifted to the left by 2.5mm. She reported mild pain in the right and left masseter muscles and in both TMJ areas on palpation, but no specific TMD was identified.

Cephalometric evaluation (Table 1) indicated a mesocephalic vertical facial pattern with a relatively normal ratio (1:1.96) of upper anterior facial height (Sn-Stm) to lower anterior facial height (Stm-Me'). ANB was normal; the overjet measured 3.5mm, and the overbite 0mm. No canting or facial asymmetry was noted on the frontal cephalogram or in the clinical examination. The distances from NTVL to A-point and B-point were –1.0mm and –5.5mm, respectively (Fig. 2B). Model analysis showed an upper arch-length discrepancy of 4.3mm and a lower discrepancy of 6.2mm. The anterior Bolton ratio was 79.9%, the overall Bolton ratio 93.0%.

Although an anterior segmental osteotomy was recommended for maximum anterior retraction, the patient refused surgical correction, insisting on "invisible" orthodontic treatment only. She did agree to placement of a palatal miniplate for skeletal anchorage. Four-premolar extraction therapy was planned, followed by leveling and alignment and anterior retraction.

A laboratory model setup (Fig. 3) was used to fabricate transfer jigs for customized indirect bonding[15] of .018" × .025" lingual brackets in both arches. Fluid levels were attached to the facebow transfer to orient the articulator (Fig. 4). The four first premolars were extracted three months after bonding.

Fig. 2 A. 32-year-old female patient with lip protrusion and crowding before treatment. B. Linear measurements relative to nasion true vertical line (NTVL, blue line) and true vertical line (TVL, red line): NTVL to A-point, upper incisor root tip, upper incisor tip, lower incisor tip, lower incisor root tip, B-point, and Pog; TVL to upper lip anterior and lower lip anterior.

An .012" nickel titanium mushroom archwire was used for initial leveling and alignment, followed by .012", .014", and .016" stainless steel mushroom archwires over the ensuing 12 months. Two .014" Elgiloy** double springs were welded to an .035" stainless steel round wire and activated every two weeks to upright the lingually tipped lower anterior teeth during the leveling phase (Fig. 5). This archwire was made easier to insert and remove by bending the distal ends of the wire and fitting them in the first-molar lingual sheaths from the distal.

One year after bonding of brackets, an Orthoplate with two miniscrews (1.8mm × 8mm) was inserted in the midpalate under local anesthesia, and lingual lever arms were attached to an

**Rocky Mountain Orthodontics, Denver, CO; www.rmortho.com.

TABLE 1
CEPHALOMETRIC DATA

	Norm	Pretreatment	Post-Treatment
SNA	82.0° ± 2.0°	74.0°	74.0°
SNB	80.0° ± 2.0°	73.0°	73.0°
ANB	2.0° ± 2.0°	1.0°	1.0°
FMA	24.2° ± 4.6°	26.0°	26.0°
Gonial angle	118.6° ± 5.8°	120.5°	120.5°
FH-U1	116.0° ± 5.7°	119.0°	109.0°
Palatal plane-U1	115.4° ± 5.5°	120.0°	111.0°
IMPA	90.0° ± 5.0°	94.0°	82.0°
E-line to upper lip	–1.0mm ± 2.0mm	0.0mm	–1.0mm
E-line to lower lip	2.0mm ± 3.0mm	2.0mm	0.0mm
TVL*-UL	4.9mm ± 1.4mm	5.0mm	4.0mm
TVL-LL	2.5mm ± 1.6mm	3.0mm	2.0mm
TVL-soft-tissue Pog	–2.9mm ± 2.2mm	–4.0mm	–4.0mm
Nasolabial angle	90.3° ± 8.1°	97.0°	99.0°
Chin-throat length	52.0mm ± 6.0mm	42.0mm	48.0mm

*True vertical line, passing through subnasale.

TABLE 2
CHANGES IN MEASUREMENTS RELATIVE TO NASION TRUE VERTICAL LINE (NTVL)*

	Pretreatment	Post-Treatment	Change
NTVL-A	–1.0mm	–1.0mm	0.0mm
NTVL-B	–5.5mm	–5.5mm	0.0mm
NTVL-Pog	–6.0mm	–6.0mm	0.0mm
NTVL-U1 tip	+7.5mm	+3.5mm	–4.0mm
NTVL-U1 root tip	–5.5mm	–6.0mm	–0.5mm
NTVL-L1 tip	+4.0mm	+0.5mm	–3.5mm
NTVL-L1 root tip	–4.5mm	–4.5mm	0.0mm

*Positive measurements are mesial to NTVL; negative measurements are distal to NTVL.

Fig. 3 Model setup mounted on articulator in true horizontal for indirect bonding of lingual brackets.

upper .017" × .025" stainless steel mushroom lingual archwire for anchorage of power chain (Fig. 6). The power chain was replaced at every visit. A lower .016" × .022" stainless steel mushroom archwire was engaged to retract the lower anterior teeth with elastic chain. After completion of upper and lower retraction, vertical intermaxillary elastics were used for final interdigitation and settling. Fixed appliances were removed after 27 months of treatment, and lingual retainers made of .0175" Respond*** dead-soft wire were bonded in both arches.

Post-treatment facial photographs showed a normal profile, with no lip incompetence or perioral muscle strain, as well as proper gingival esthetics and a healthy periodontium (Fig. 7). The upper and lower dental midlines were coincident with the facial midline. There were few skeletal changes in any plane, since the upper and lower molars were not moved vertically and no surgery was performed. Overjet and overbite measured 3mm and 2.5mm, respectively. Both arches displayed good interdigitation, and no interferences were observed during lateral or protrusive movements of the mandible.

Although the patient's premolar-extraction spaces were not fully available for anterior retraction due to the severity of the pretreatment arch-length discrepancies, the anticipated sagittal movement was achieved. About 1mm of anchorage loss occurred in each arch during the initial leveling. After substantial distal movement of the upper incisors, the upper-incisor angle to FH decreased from 119° to 109°, and IMPA from 94° to 82° (Table 1). The upper-incisor tip moved 4mm distally relative to NTVL, while the upper-incisor root tip moved only .5mm distally (Table 2). The lower-incisor tip moved about 3.5mm

***Ormco Corporation, Orange, CA; www.ormco.com.

distally, with no root-tip movement. Upper- and lower-lip retraction was only 1mm relative to TVL; relative to the E-line, the retraction was only 1mm for the upper lip and 2mm for the lower. All mentalis muscle action disappeared, however, and the nasolabial angle increased from 97° to 99° (Table 1). Throat length increased from 42mm to 48mm, probably because the patient lost some weight during treatment.

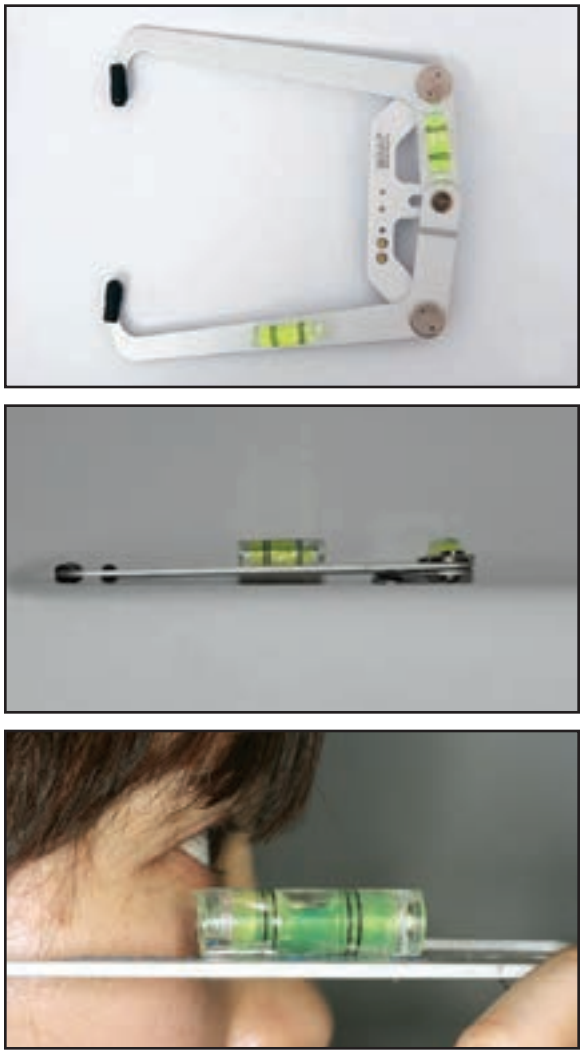

Fig. 4 Facebow transfer using attached fluid levels.

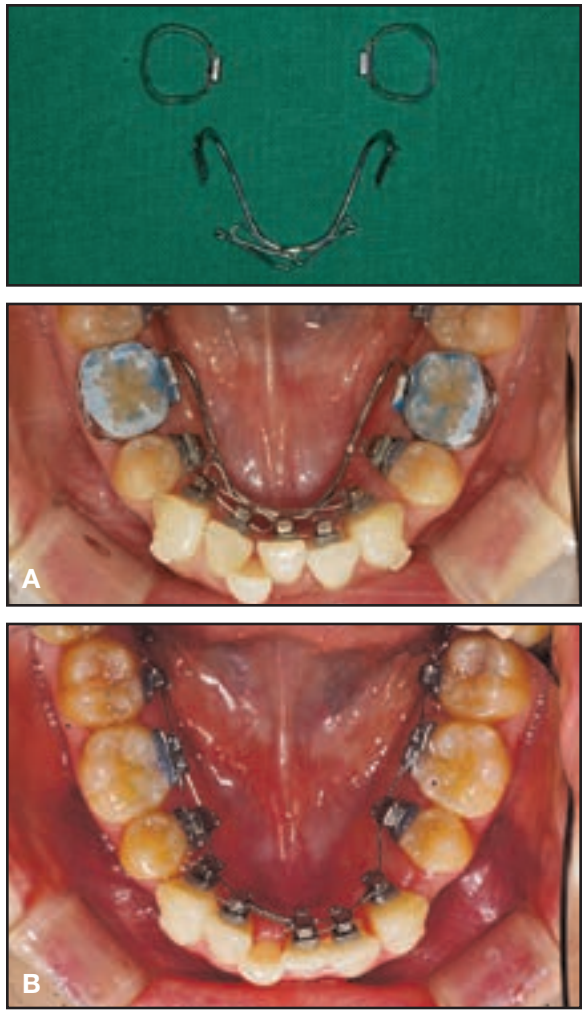

Fig. 5 A. Elgiloy double springs placed in lower arch to relieve anterior crowding. B. After five weeks of lower-incisor uprighting.

Fig. 6 Orthoplate and lingual lever arms placed for anterior retraction.

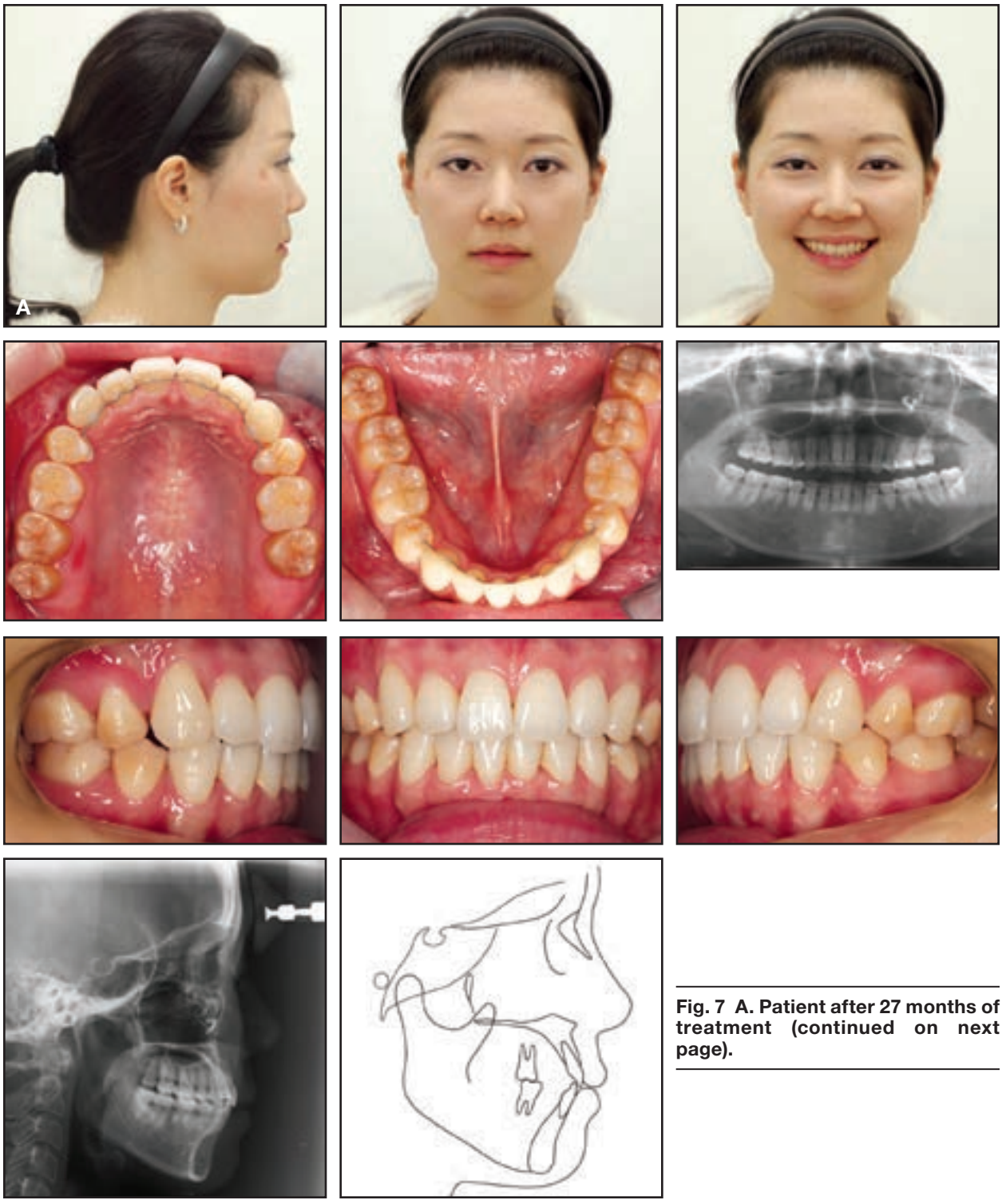

Fig. 7 A. Patient after 27 months of treatment (continued on next page).

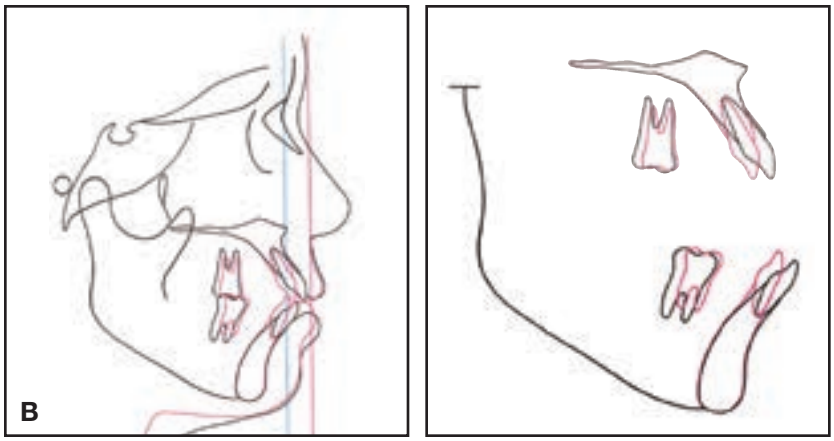

Fig. 7 (cont.) B. Superimposition of pre- and post-treatment cephalometric tracings.

The results were well maintained at the one-year follow-up visit (Fig. 8). After the upper fixed lingual retainer was dislodged by masticatory forces, it was replaced by a removable wraparound retainer.

Discussion

Natural head position is regarded as a reliably reproducible posture for taking cephalograms.[16-19] Our patient's records were obtained in NHP according to the method of Solow and Tallgren: she stood with her feet at shoulder width, with the perioral muscles and lips relaxed and the teeth lightly occluded.[20] A weighted metal chain was included in each lateral cephalogram for tracing TVL and NTVL.

To mount the casts on an articulator in true horizontal, the transfer facebow had to be oriented parallel to the floor. A fluid level attached to the side of the facebow was positioned with the bubble in the center while the patient was in NHP; a fluid level attached to the front of the facebow was used to confirm the horizontal orientation of the external auditory meatuses.

Arnett and colleagues recommended using TVL taken in NHP as a reference line for measuring soft-tissue changes in orthognathic-surgery patients.[14] Because A-point did not change in this case, thus leaving subnasale unchanged, TVL could serve as a reference line for evaluating the soft-tissue effects of anterior retraction. Although only 1mm of sagittal soft-tissue change was observed relative to TVL, the patient's lip protrusion was significantly reduced, so that the anteroposterior positions of the lips were within normal limits at the end of treatment (Table 1). According to Burstone, the average interlabial gap in adolescents with acceptable facial esthetics is 1.8mm in centric occlusion and 3.7mm in rest position, and the size of the interlabial gap is significantly related to lip incompetence.[21] Our patient's interlabial gap decreased from 4.0mm to 1.5mm in centric occlusion, while mentalis and perioral muscle activity were substantially reduced.

The expected bodily movement of the anterior teeth did not occur. Relative to NTVL, the upper-incisor tip moved 4mm and the lower-incisor tip 3.5mm distally, but the root tips showed negligible movement (Table 2). Hong and colleagues reported translational anterior retraction from palatally anchored lever arms placed between the central incisors, 7mm apical to the interproximal bone level.[22] In our patient, the lever-arm position was not verified with a lateral cephalogram, but was probably placed higher or lower than this level, resulting in controlled tipping rather than bodily movement.

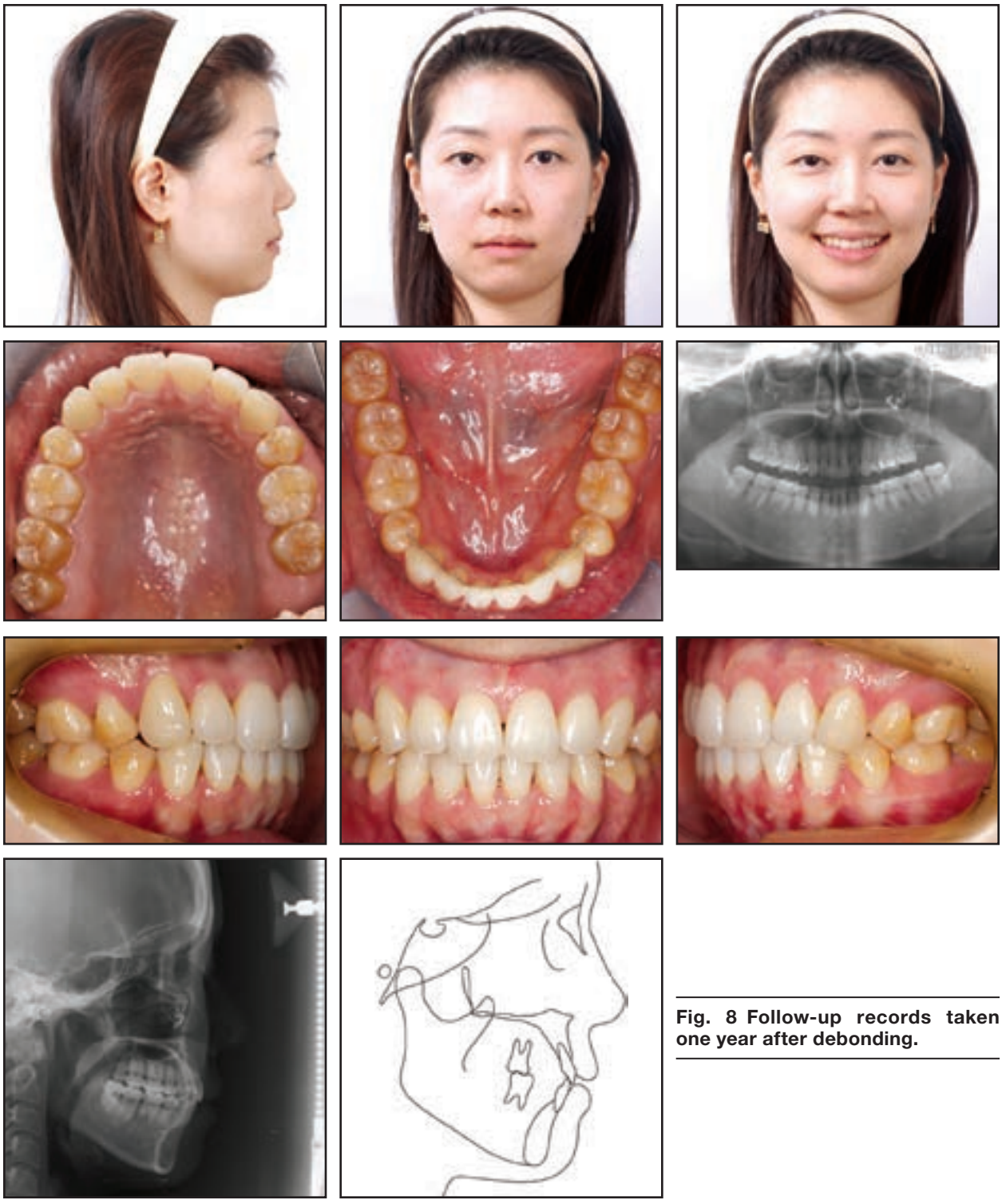

Fig. 8 Follow-up records taken one year after debonding.

REFERENCES

1. Roberts, W.E.; Smith, R.K.; Zilberman, Y.; Mozsary, P.G.; and Smith, R.S.: Osseous adaptation to continuous loading of rigid endosseous implants, Am. J. Orthod. 86:95-111, 1984.
2. Ödman, J.; Lekholm, U.; Jemt, T.; and Thilander, B.: Osseointegrated implants as orthodontic anchorage in the treatment of partially edentulous adult patients, Eur. J. Orthod. 16:187-201, 1994.
3. Block, M.S. and Hoffman, D.R.: A new device for absolute anchorage for orthodontics, Am. J. Orthod. 107:251-258, 1995.
4. Kim, S.H.; Yoon, H.G.; Choi, Y.S.; Hwang, E.H.; Kook, Y.A.; and Nelson, G.: Evaluation of interdental space of the maxillary posterior area for orthodontic mini-implants with cone-beam computed tomography, Am. J. Orthod. 135:635-641, 2009.
5. Kuroda, S.; Yamada, K.; Deguchi, T.; Hashimoto, T.; Kyung, H.M.; and Takano-Yamamoto, T.: Root proximity is a major factor for screw failure in orthodontic anchorage, Am. J. Orthod. 131(suppl. 4):68-73, 2007.
6. Choi, B.H.; Zhu, S.J.; and Kim, Y.H.: A clinical evaluation of titanium miniplates as anchors for orthodontic treatment, Am. J. Orthod. 128:382-384, 2005.
7. Chung, K.R.; Kook, Y.A.; Kim, S.H.; Mo, S.S.; and Jung, J.A.: Class II malocclusion treated by combining a lingual retractor and a palatal plate, Am. J. Orthod. 133:112-123, 2008.
8. Kim, H.J.; Yun, H.S.; Park, H.D.; Kim, D.H.; and Park, Y.C.: Soft-tissue and cortical-bone thickness at orthodontic implant sites, Am. J. Orthod. 130:177-182, 2006.
9. Downs, W.B.: Variations in facial relationships; their significance in treatment and prognosis, Am. J. Orthod. 34:812-840, 1948.
10. McNamara, J.A. Jr.: A method of cephalometric evaluation, Am. J. Orthod. 86:449-469, 1984.
11. Bjerin, R.: A comparison between the Frankfort Horizontal and the sella turcica-nasion line as reference planes in cephalometric analysis, Acta Odontol. Scand. 15:1-12, 1957.
12. Lundström, A. and Lundström, F.: The Frankfort horizontal as a basis for cephalometric analysis, Am. J. Orthod. 107:537-540, 1995.
13. Michiels, L.Y. and Tourne, L.P.: Nasion true vertical: A proposed method for testing the clinical validity of cephalometric measurements applied to a new cephalometric reference line, Int. J. Adult Orthod. Orthog. Surg. 5:43-52, 1990.
14. Arnett, G.W.; Jelic, J.S.; Kim, J.; Cummings, D.R.; Beress, A.; Worley, C.M. Jr.; Chung, B.; and Bergman, R.: Soft tissue cephalometric analysis: Diagnosis and treatment planning of dentofacial deformity, Am. J. Orthod. 116:239-253, 1999.
15. Hong, R.K.; Kim, Y.H.; and Park, J.Y.: A new customized lingual indirect bonding system, J. Clin. Orthod. 34:456-460, 2000.
16. Broca, P.: Sur les projections de la tète, et sur un nouveau procédé de céphalométrie, Bull. Soc. Anthropol. Paris 3:514-544, 1862.
17. Moorrees, C.F.A. and Kean, M.R.: Natural head position: A basic consideration in the interpretation of cephalometric radiographs, Am. J. Phys. Anthropol. 16:213-234, 1958.
18. Peng, L. and Cooke, M.S.: Fifteen-year reproducibility of natural head posture: A longitudinal study, Am. J. Orthod. 116:82-85, 1999.
19. Kim, H.R.; Lee, D.Y.; Kim, K.W.; and Yoon, Y.J.: A study on the reproducibility of the natural head position according to the skeletal malocclusion types and sex, Kor. J. Orthod. 30:307-315, 2000.
20. Solow, B. and Tallgren, A.: Natural head position in standing subjects, Acta Odontol. Scand. 29:591-607, 1971.
21. Burstone, C.J.: Lip posture and its significance in treatment planning, Am. J. Orthod. 53:262-284, 1967.
22. Hong, R.K.; Heo, J.M.; and Ha, Y.K.: Lever-arm and mini-implant system for anterior torque control during retraction in lingual orthodontic treatment, Angle Orthod. 75:129-141, 2004.