

Nonextraction treatment of an open bite with microscrew implant anchorage

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A 16-year-old girl with an anterior open bite was treated with nonextraction therapy that included intrusion of the maxillary and mandibular posterior teeth with microscrew implants. Implants (diameter, 1.2 mm; length, 8 or 6 mm) were placed into alveolar bone near the posterior teeth and used as anchorage for intrusive force. To prevent adverse side effects of buccoversion or linguoversion of the posterior teeth during intrusion, a transpalatal bar and a lingual arch were placed. The 3-mm anterior open bite was corrected in 11 months of treatment, after intrusion of the maxillary and mandibular posterior teeth and autorotation of the mandible. The posterior intrusion relapsed in the early stage of retention, at 8 months; thereafter, no obvious relapse was evident in the vertical position of the molars and the FMA. The treatment mechanics of anterior open bite with posterior intrusion by using microscrew implants were effective but still require a proper retention protocol. (*Am J Orthod Dentofacial Orthop* 2006;130:391-402)

Open bite malocclusion has long been considered one of the most difficult orthodontic problems to correct because its etiology is complicated and multifactorial.^{1,2} Therapies include modification of functional or habitual aberrations, orthopedic treatment, orthognathic surgery, and orthodontic treatment with extrusion of the anterior teeth or intrusion of the posterior teeth.

Until recently, orthognathic surgery was considered the treatment of choice for a severe skeletal open bite.³ The advent of skeletal anchorage has expanded the boundaries of orthodontic treatment.^{4,5} Skeletal anchorage can produce treatment outcomes that cannot be obtained by conventional orthodontic treatment but only from orthognathic surgery. In an earlier report, we showed that the maxillary incisors can be retracted 14 mm against microscrew implants. This is beyond the limit of orthodontic treatment.⁶

Molar intrusion was challenging to orthodontists before the development of skeletal anchorage. Skeletal anchorage, including dental implants,⁷ surgical miniplates,^{5,8} and miniscrew or microscrew implants,^{4,6,9} is now growing in popularity because of the ability to provide absolute anchorage. The intru-

sion of molars with skeletal anchorage produces autorotation of the mandible; this resembles the treatment results of maxillary surgical impaction.

In terms of surgical procedure and costs, microscrew implants are superior to dental implants and the miniplate system. Microscrew implants are small enough to be placed into the alveolar bone, easy to place and remove surgically, and economical compared with other products. These advantages have expanded their clinical applications to many clinical situations.⁹⁻¹⁵ Treatment of anterior open bite after intrusion of molars with miniplates has been reported^{5,8} but not with microscrew implants.

This case report describes the treatment mechanics for anterior open bite with microscrew implants, treatment planning, treatment procedure, and retention.

DIAGNOSIS

A 16-year-old girl with an anterior open bite and a straight profile came for treatment (**Fig 1**). Cephalometric analysis showed an ANB angle of 2°, and a mandibular plane angle (FMA) of 28° (**Table**). She had 3 mm of overjet and an anterior open bite of -3 mm, and was diagnosed with a skeletal Class I open-bite malocclusion.

There was no family history of open bite. The etiology of open bite was assumed to be overgrowth of the maxillary and mandibular alveolar bone. The perpendicular distance from the mesial cusp tip of the maxillary first molar to the palatal plane was 30 mm; the normal value is 24.2 ± 1.9 mm for same age group of Korean girls.¹⁶ The perpendicular distance from the mesial cusp tip of the mandibular first molar to the

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Submitted, March 2005; revised and accepted, July 2005.

0889-5406/\$32.00

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doi:10.1016/j.ajodo.2005.07.014



Fig 1. Pretreatment records show anterior open bite.

Table. Cephalometric measurements

	Pretreatment	Posttreatment	8-month retention	2-year retention
SNA angle (°)	83	83	83	83
SNB angle (°)	82	84	82	82
ANB angle (°)	1	-1	1	1
FMA (°)	28	24	25.5	25.5
PFH/AFH	57/82 (0.70)	58/79 (0.73)	58/80 (0.73)	58/80 (0.73)
Frankfort horizontal to occlusal plane (°)	6	6.5	6.5	6.5
U1 to FH (°)	118	121.5	120	120
IMPA (°)	90	87	88	88
Z angle (°)	76	82	81	81
Upper lip to E line (mm)	0	-0.5	0	0
Lower lip to E line (mm)	2	0.5	0.5	0.5

PFH/AFH, Ar to mandibular plane/menton to palatal plane.

mandibular plane was 38 mm; the normal value is 33.8 ± 2.0 mm.¹⁶ Maxillary and mandibular anterior alveolar bone also showed overgrowth; the distance from the tip of the maxillary incisor to the palatal plane

was 32 mm, compared with a normal value of 28.5 ± 2.6 mm,¹⁶ and the distance from the tip of the mandibular incisor to menton was 47 mm, compared with a normal value of 43.2 ± 2.2 mm.¹⁶

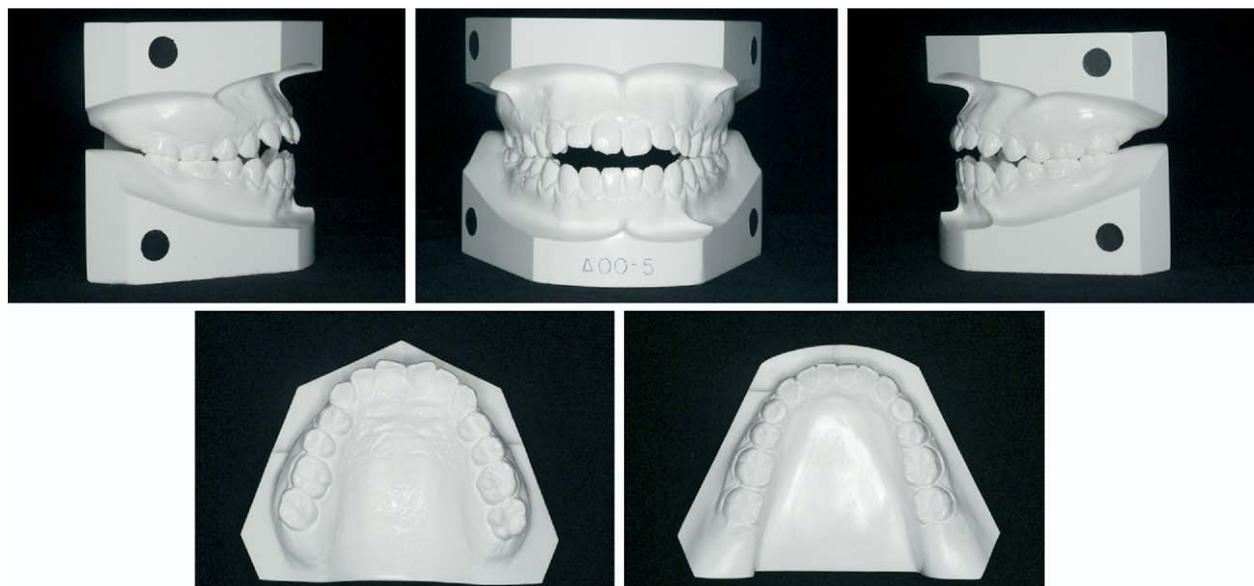


Fig 2. Pretreatment dental casts.

Intraorally, the patient had Class I canine and molar relationships (Fig 2). The posterior area had a considerable mesial inclination, especially at the mandibular teeth, and there was no occlusal contact from first premolar to the other side. Arch-length discrepancies in the maxillary and mandibular arches were 3 and 0 mm, respectively. The patient had a lowered tongue posture and a flat sound during speech. The tongue was thrust through an interincisal gap during swallowing.

TREATMENT OBJECTIVES

Six treatment objectives were identified: (1) maintain facial balance, (2) intrude maxillary and mandibular posterior teeth in the alveolar bone which showed excessive overgrowth, (3) establish ideal overbite and overjet, (4) resolve crowding, (5) eliminate the tongue-thrust habit, and (6) strengthen masticatory muscle tone to improve retention.

TREATMENT ALTERNATIVES

The first treatment option was to use microscrew implants to intrude the posterior teeth in both arches and close the anterior open bite. The ease of the surgical procedure and the expected good treatment effects led the patient to choose this option.

The second alternative was multiloop edgewise archwire therapy. Its treatment effects include extrusion of anterior teeth and uprighting of posterior teeth.² Because of a tendency for more relapse of extrusion than intrusion in young patients,¹⁷ the complexity of wire bending, and the requirement for elastics, this option was declined.

The third alternative was segmental maxillary posterior impaction surgery. Surgical segmental impaction of the posterior teeth was necessary to obtain autorotation of the mandible and closure of the anterior open bite. Presurgical orthodontic treatment would need to include alignment of the crowded anterior teeth and creation of space between the canines and the premolars for surgical osteotomy of the posterior maxilla.

The fourth alternative was total maxillary impaction surgery. The superior impaction of the maxilla could also produce autorotation of the mandible and obtain a positive anterior bite. The patient declined these 2 alternatives because of the extensive surgical procedures.

TREATMENT PLANNING

Because the patient had an acceptable profile and minimal arch-length discrepancies, nonextraction treatment was planned. The anterior bite would be closed by intruding the posterior teeth rather than extruding the anterior teeth, because this procedure is reportedly more prone to relapse.¹⁷ In this patient, the anterior and posterior dental heights were excessive compared with Korean norms.¹⁶ Intruding the posterior teeth seemed more rational than extruding the anterior teeth. Microscrew implants would be placed in the posterior alveolar bone to provide anchorage to intrude and upright the posterior teeth.

To establish a precise treatment plan and to calculate the exact amount of tooth movement, mounted diagnostic casts were used. After mounting the casts on an articulator, the heights of the cusp tips from the base

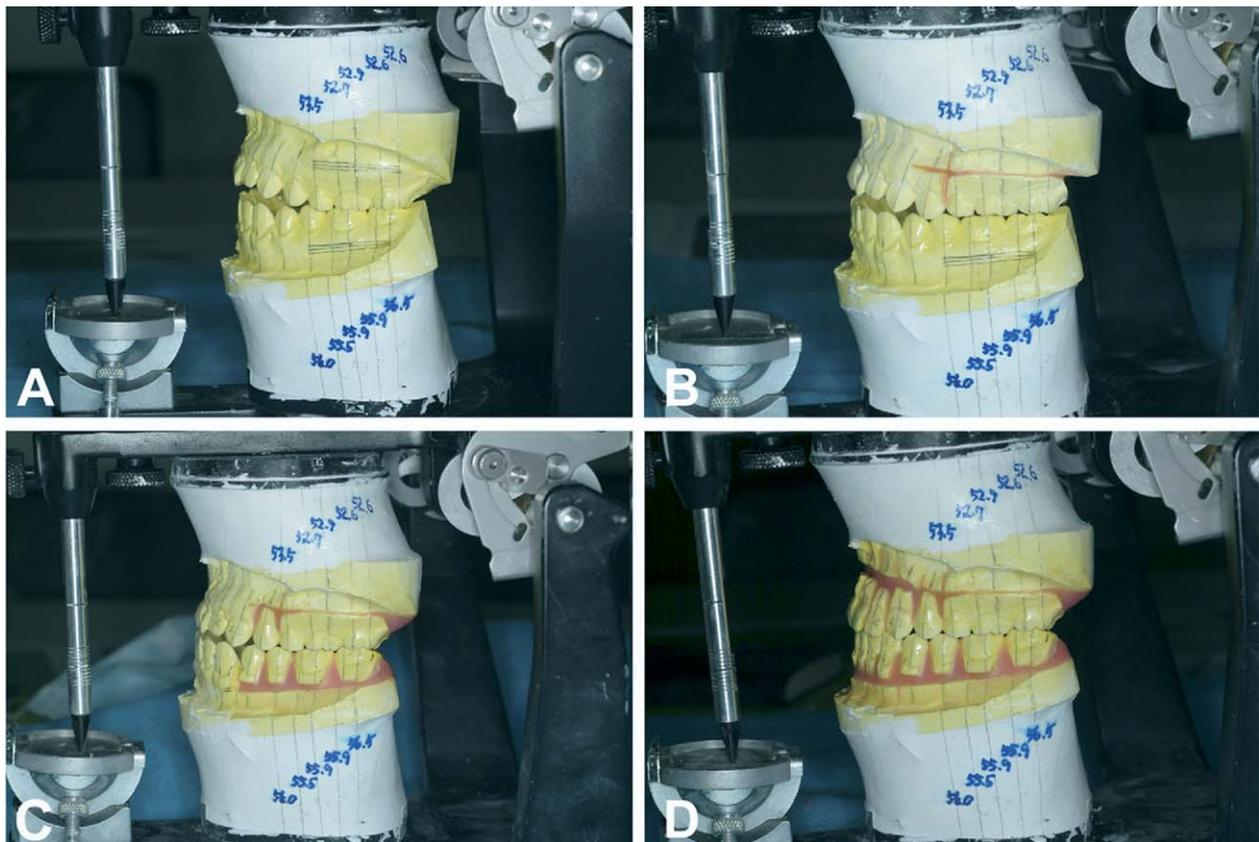


Fig 3. Diagnostic setup: **A**, height of cusp measured on mounted models; **B**, intrusion of maxillary posterior teeth; **C**, uprighting and intrusion of mandibular posterior teeth; **D**, alignment of maxillary anterior teeth and lingual tipping of mandibular incisors to finalize occlusion.

of the articulator were measured (Fig 3). The provisional amount of intrusion was marked on the casts. The maxillary posterior tooth segment was cut and positioned superiorly 2 mm. The next step was uprighting and slightly intruding the mandibular posterior teeth. The decision about the amount of intrusion was made on the basis of maintaining the cant of the occlusal plane. The alignment of the anterior teeth can be followed. It was decided that the maxillary anterior teeth needed to be aligned with a slight labioversion, and the mandibular anterior teeth needed to tip distally. Because the vertical position of the maxillary incisors was different from that of the canines, the maxillary incisors were extruded to the level of the occlusal plane.

Biomechanics of open-bite treatment with microscrew implants

Treatment planning steps included fabrication of diagnostic setup casts with articulator mounting. In the diagnostic setup, the maxillary and mandibular molars

should be intruded until a suitable amount of anterior overbite is achieved. During molar intrusion, the maxillary and mandibular anterior teeth will come into contact with each other. To prevent trauma from the occlusal contact and to increase overbite and overjet, the mandibular incisors should be retracted or the maxillary incisors proclined. These procedures can be simplified by grinding off the crowns of the posterior teeth in the mounted casts. When deciding on the proclination of the maxillary incisor, the facial profile should be considered. If distal retraction of the maxillary anterior teeth is needed to improve the profile, distal force can be applied from the maxillary microscrew implants to the canines. In this situation, the mandibular anterior teeth need more retraction than planned distal movement to facilitate the overjet and overbite increase.

Treatment mechanics include intruding and uprighting the posterior teeth. The maxillary microscrew implants can be placed into palatal alveolar bone between the first and second molars, and the mandib-

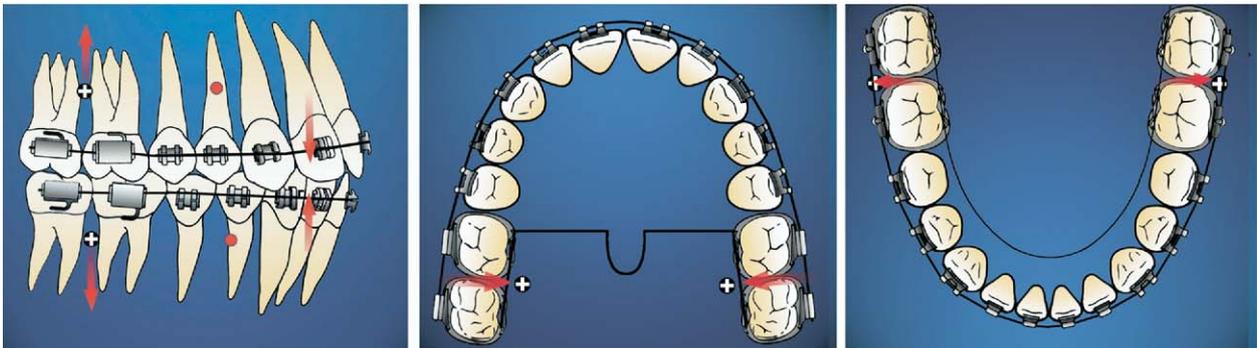


Fig 4. Biomechanics showing closing of anterior open bite after intrusion force at molars.



Fig 5. **A,** Placement of microcrew implants into palatal alveolar bone between first and second molars. Intrusive force was applied from microcrew implants to hooks on transpalatal bar, placed to prevent linguoversion of maxillary molars. **B,** Microcrew implants between mandibular first and second molars from which intrusive force was applied, and lingual arch to prevent buccal tipping of molars. **C,** At 8 months, anterior open bite was closed.

ular microcrew implants in the buccal alveolar bone. The intrusion force applied on either the buccal or the palatal side might produce buccoversion or linguoversion of the posterior teeth. This movement can be prevented by placing a transpalatal bar or a lingual arch (Fig 4). The outcomes of intrusion force include intru-

sion of the posterior teeth, which results in passive closure of the mandibular plane and correction of the anterior open bite, and the side effects of buccoversion or linguoversion of the posterior teeth. Because adverse tooth movement is controlled during intrusion by a transpalatal bar and a lingual arch, the posterior teeth



Fig 6. Posttreatment records (11 months).

can be intruded even with a light archwire. Therefore, the intrusion of the posterior teeth and the alignment of the anterior teeth can be performed at the same time during the early stage of treatment.

Intrusion of the posterior teeth induces counterclockwise autorotation of the mandible, which closes the anterior open bite. To facilitate this, the microcrew implants need to be placed into the bone distal to the center of resistance of the whole dentition. The intrusive force distal to the center of resistance effectively produces a clockwise moment on the maxillary dentition and a counterclockwise moment on the mandibular dentition. These moments efficiently contribute to closure of the anterior open bite. To prevent traumatic occlusal contact of the anterior teeth, it might be necessary to retract the mandibular dentition distally. This can be performed by applying force from the microcrew implants to the mandibular canines or

premolars while the anterior tooth segment is ligated together. This distal movement helps to deepen the anterior overbite.

TREATMENT PROGRESS

A microcrew implant (diameter, 1.2 mm; length, 8 mm; Osteomed, Addison, Tex) was placed into the palatal alveolar bone between the maxillary first and second molars on both sides (Fig 5, A). A mandibular microcrew implant (diameter, 1.2 mm; length, 6 mm; Osteomed) was placed into the buccal alveolar bone between the mandibular first and second molars (Fig 5, B). Detailed surgical procedures were illustrated and discussed in previous reports.^{10,11} To prevent linguoversion of the maxillary posterior teeth during intrusive force applied on the palatal side, a transpalatal bar was placed. A mandibular lingual arch was used to prevent buccoversion of the mandibular posterior teeth during

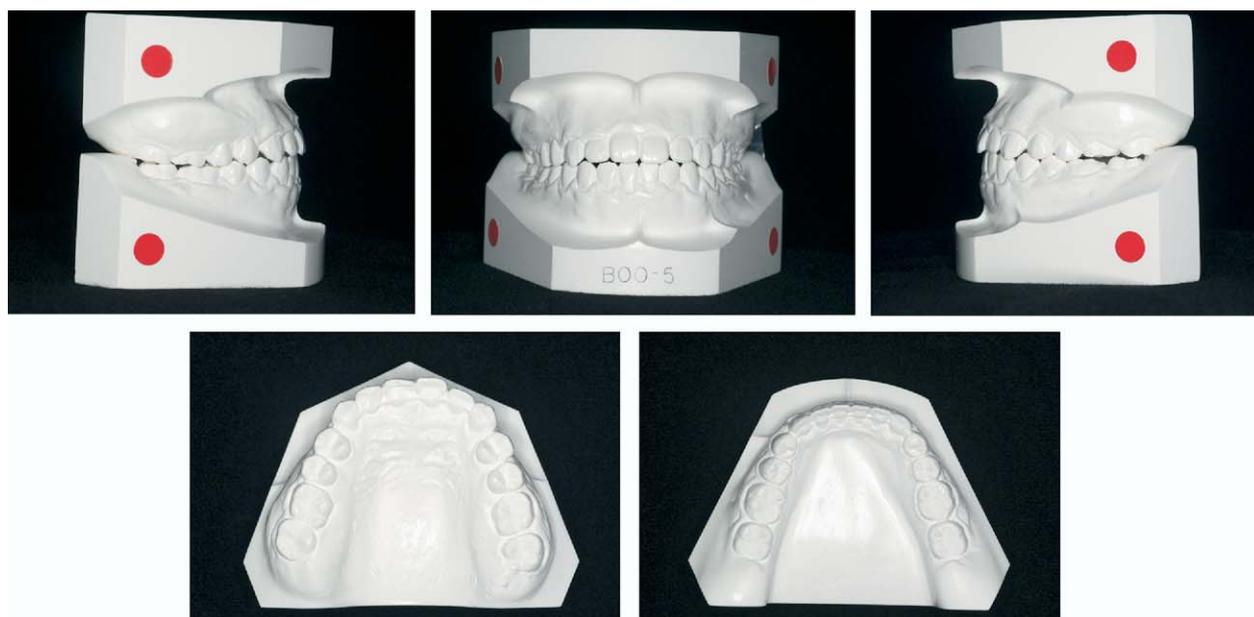


Fig 7. Posttreatment dental casts.

intrusive force application. A .022-in fixed preadjusted edgewise appliance was banded and bonded, and a .016 nickel-titanium archwire was placed. After 1 month of treatment, an intrusive force of 100 g was applied to palatal hooks that extended from the transpalatal bar and to the buccal tube welded on the mandibular first molars on each side. At 4 months of treatment, the anterior teeth were aligned and .017 × .025-in beta-titanium alloy archwires were placed. At 6 months of treatment, .017 × .025-in stainless steel archwires were placed, and intrusive forces were applied continuously. At 8 months of treatment, the anterior open bite was closed with autorotation of the mandible (Fig 5, C). The intrusive forces were applied continuously even after closing to overcorrect the anterior open bite.

The patient was instructed to clench her posterior teeth while swallowing and to push her tongue against her hard palate. This was to increase masticatory muscle force and correct her tongue thrust habit.

After 11 months of treatment, the treatment was finished with a normal overbite of the anterior teeth and a slight disclusion of the posterior teeth. The disclusion in the posterior teeth was created for overcorrection. After treatment, lingual retainers were bonded from first premolar to first premolar in the mandibular arch and from canine to canine in the maxillary arch, and an additional maxillary circumferential retainer was delivered.

All microscrew implants stayed firm throughout the treatment. After treatment, they were removed by unscrewing without anesthesia.

TREATMENT RESULTS

A 1.5-mm overbite was obtained after intrusion of the maxillary and mandibular molars (Figs 6 and 7). The mandible showed autorotational closure; accordingly, the FMA was reduced from 28° to 24°. The occlusal plane showed little change, but it steepened slightly (0.5°) after more intrusion of the maxillary molars than the mandibular molars. The posterior teeth showed disclusion at debonding; this was left to overcome the expected relapse of the posterior intrusion. The facial profile changes were not conspicuous. Class I canine and molar relationships were obtained. There was no obvious evidence of root resorption.

To prevent relapse of the intruded posterior teeth, a vertical chin cap was provided, and chewing exercises were prescribed to strengthen the masticatory muscles. Lingual retainers were bonded canine to canine in the maxillary arch and first premolar to first premolar in the mandibular arch.

In the retention process, the disclusion on the posterior teeth settled down quickly after 2 months of retention. At 8 months of retention, there was a loss of anterior tooth contact—a minimal amount of relapse (Fig 8). To obtain the anterior contact, lingual buttons were bonded to the maxillary central incisors and

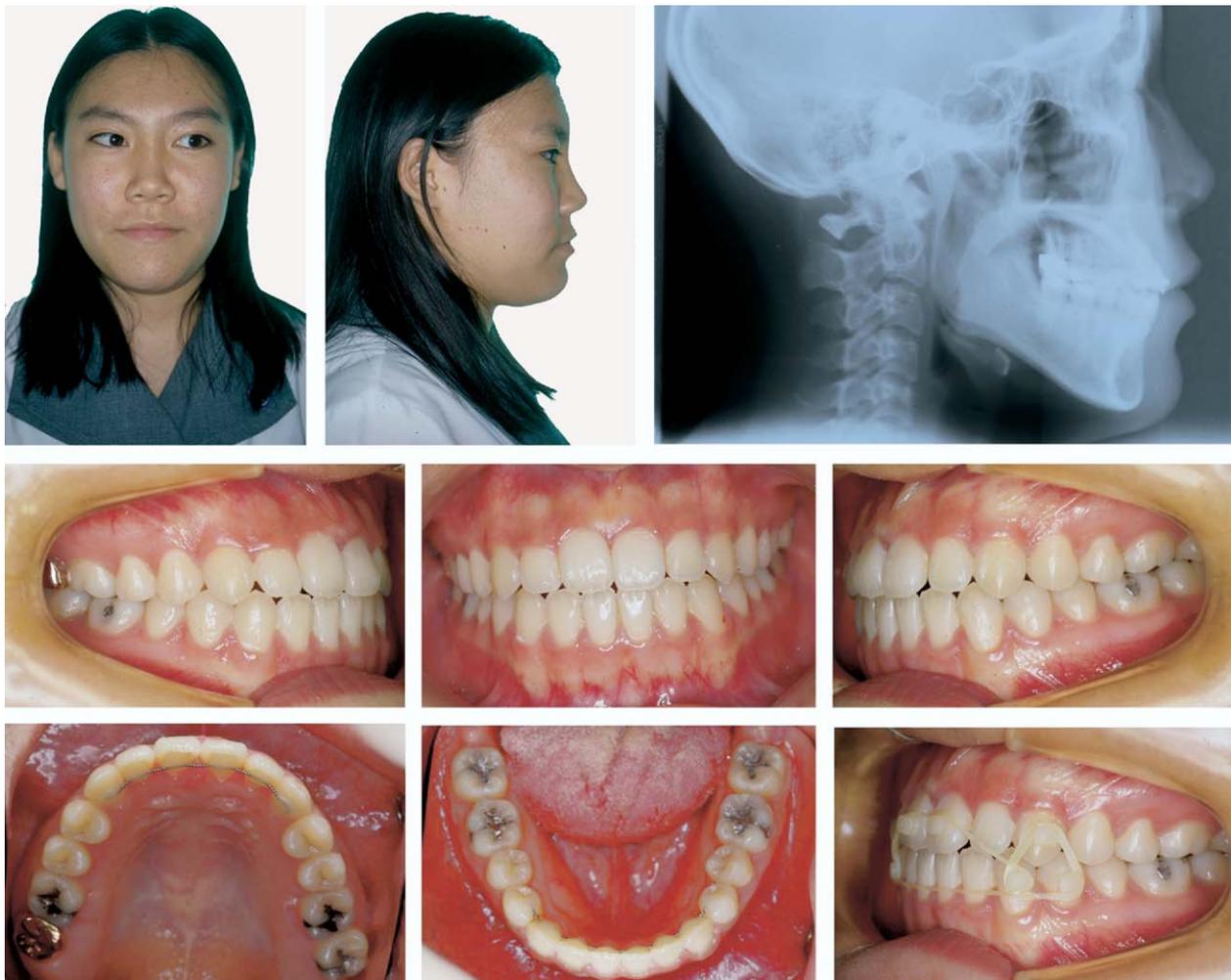


Fig 8. Retention records at 8 months.

canines and the mandibular canines and first premolars, and vertical elastics were used to obtain best fit of the occlusion. Because of the lingual bonded retainers, there were no obvious side effects. After a month of elastic use, the buttons were removed. To maintain the angulation of the canines, labial fixed retainers were bonded between the canines and the premolars in the maxillary arch. Tongue exercises were prescribed during the retention period. Two-year retention records showed good retention without obvious relapse (Figs 9 and 10).

The pretreatment and posttreatment cephalometric superimposition (Fig 11) showed the uprighting and intrusion of the posterior teeth and resultant autorotational closure of the mandible. The maxillary incisors showed slight labioversion, and the mandibular incisors were tipped lingually. The intruded

posterior teeth showed a slight relapse in the superimposition between posttreatment and 8-month retention (Fig 12). The reason for this might be loss of occlusal contact between the maxillary and mandibular posterior teeth or a relapse tendency of the intrusion. Accordingly, the mandibular plane showed a slight opening during the first 8 months of retention. After that, there was no change in the FMA and vertical position of the posterior teeth between the 8-month and the 2-year retention superimpositions (Fig 13).

DISCUSSION

The bite closed rapidly with progressive intrusion of the posterior teeth in both arches. It took only 8 months to obtain a positive overbite. The application of an intrusive force distal to the center of resistance of the



Fig 9. Two-year retention intraoral photos.

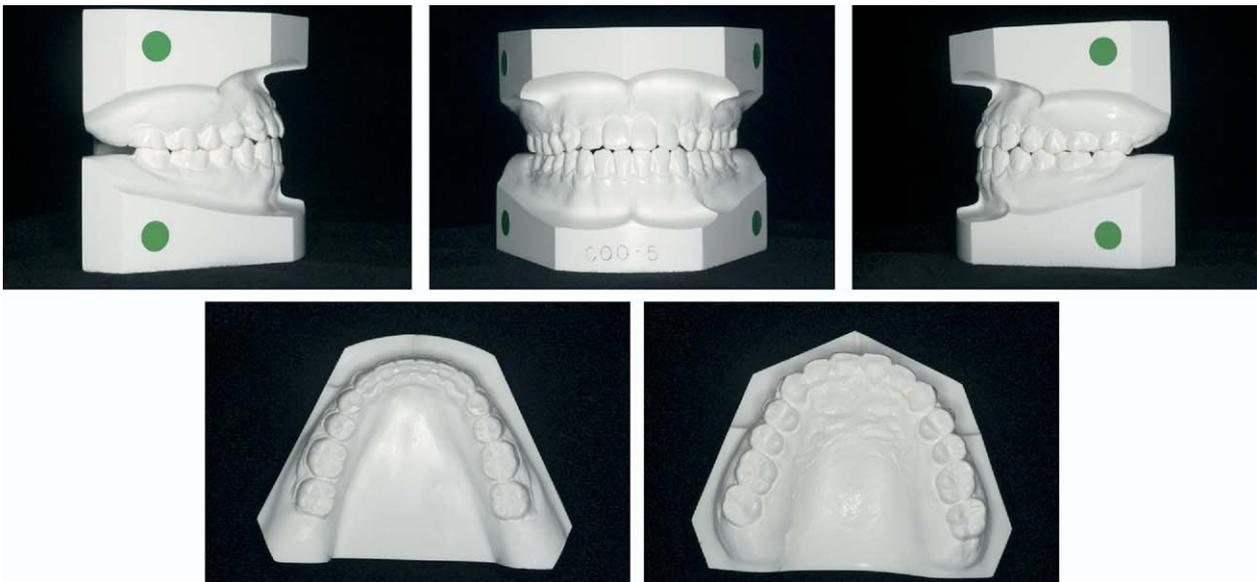


Fig 10. Two-year retention models.

dentition produced a clockwise moment at the maxillary dentition and a counterclockwise moment at the mandibular dentition. These movements were effective in closing the anterior open bite. Small vertical changes at the posterior teeth can produce profound changes in the anterior area. Only 1 mm intrusion at the posterior teeth can produce 3 to 4 mm forward and upward movement of the chin.¹⁸

Passive anterosuperior movement of the anterior teeth during autorotation was predicted on the assumption that the center of the condyle was the rotational

axis of the mandibular autorotation. The rotational axis of the mandible has been reported as variable in maxillary surgical impaction.¹⁹ Therefore, the amount of passive anterior movement of the mandibular incisors during autorotation can differ from patient to patient. It is impossible to predict these changes in treatment planning; decisions must be made during treatment to accommodate them. If there is more forward movement of the mandibular incisors during autorotation than expected, they should be retracted more, or the maxillary incisors should be moved

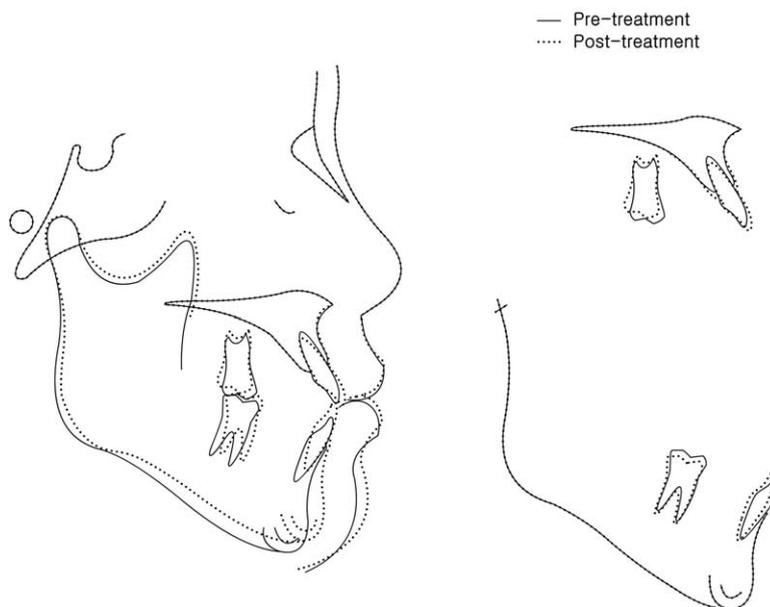


Fig 11. Pretreatment and posttreatment cephalometric superimposition.

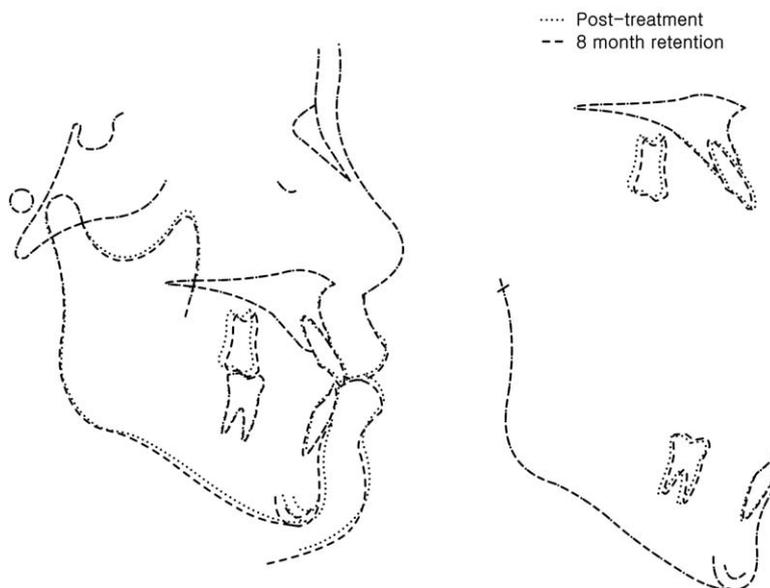


Fig 12. Posttreatment and 8-month retention cephalometric superimposition.

forward; the facial profile should be considered when deciding between the 2.

Open bite is a difficult malocclusion correction to retain. To minimize relapse in this patient, the posterior teeth were intruded to an overcorrected vertical position. The overcorrected intrusion, however, quickly settled because of lack of occlusal contact. This might

be explained by the absence of occlusal contact in the posterior segment after treatment or the relapse tendency of intruded molars in the early stage of retention.

When evaluating the treatment results retrospectively, if we retract the mandibular dentition more distally, we can obtain greater overjet and overbite. This might help minimize clinical relapse in overbite

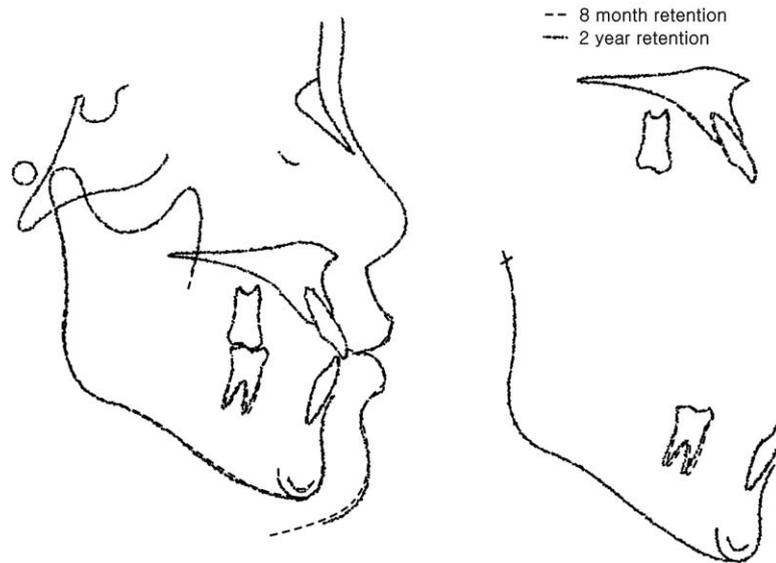


Fig 13. Eight-month and 2-year retention cephalometric superimposition.

treatment. As we mentioned before, the posterior teeth had settled at 2 months of retention. Even after meeting the opposing teeth, the posterior teeth had a slight additional relapse until the FMA was opened by 1.5° at 8 months of retention. The FMA's initial 28° was reduced to 24° by autorotation of the mandible after posterior intrusion, and it rebounded to 25.5° during 8 months of retention. After that, there was no change in the vertical position of the posterior teeth or the FMA. A report by Sugawara et al²⁰ showed that one third of mandibular molar intrusions relapse during the first year of retention. They suggested that overcorrection might be a way to overcome relapse. Because of the short treatment time, there was no time for retention of the posterior intrusion during treatment. A prolonged treatment time might be helpful. Maintaining the microscrew implants for a while after treatment might be recommended. Not only during treatment, but also during retention, muscle exercises should be prescribed to equalize the functional force. The development of a proper retention protocol for molar intrusion in open-bite treatment is a task for the future.

A reason for placing the microscrew implants into buccal alveolar bone in the mandibular arch is to provide better accessibility. Furthermore, the possibility of tongue irritation with lingually placed micro-screw implants supports their placement into the buccal alveolar bone. The mandibular buccal alveolar bone is more than 3 mm thick and is thus a good site for microscrew implant placement.^{21,22} Three-millimeter thick alveolar cortical bone and a 10° to 20° angular

placement of the microscrew implant were determined to be important factors for preventing root damage. By placing the microimplants with angulations, clinicians can increase the implant surface area that is in contact with cortical bone. Six-millimeter microscrew implants can be placed in the cortical bone.

The distance between roots of the maxillary first and second molars is much smaller on the buccal side than on the palatal,²² because the molars have 2 buccal roots and 1 palatal root. Additionally, the firm masticatory palatal mucosa, which has a strong resistance to inflammation, might support microimplants placed into the palatal alveolar bone. The soft tissue is thick in the palate and varies from site to site. The thickness of the soft tissue should be measured, and the length of the microimplants should be selected to compensate for soft-tissue thickness and to provide a suitable length of bone contact. The new microimplants designed for palatal placement are longer than those designed for buccal placement.²³

The implants used in this study were surgical microscrews that do not have a special attachment on the head for elastic materials. A ligature wire hook was twisted onto the neck of the screw and bent to form a hook to connect the elastics. The new microimplant system has a button on the head for attaching elastics, which provide better versatility for orthodontic treatment.²³

The forces applied from the buccal and palatal sides produce third-order problems in the posterior tooth segment. A transpalatal bar and a lingual arch were placed to prevent torque problems. There were differ-

ences in third-order forces between the maxillary first and second molars during treatment, because the second molars were not connected to the transpalatal bar, and the palatal intrusive force was transmitted buccally through the archwire to the second molars. This force produced buccal tipping of the second molars. The first molars connected with the transpalatal bar did not tip during intrusion. To correct torque differences between the first and second molars, lingual cleats were attached on the palatal surface of the second molars, and an intrusion force was applied from the microscrew implants. To minimize torque discrepancy in the posterior teeth, the transpalatal bar and the lingual arch can be extended from the first to the second molars (Fig 4).

CONCLUSIONS

Microscrew implants can provide suitable anchorage for intrusion of the maxillary and mandibular posterior segment. This produces rapid closure of an anterior open bite along with mandibular autorotation. The treatment mechanics for correcting anterior open bite with microscrew implants are effective. However, even with overcorrection and several methods of retention, there is still concern about retention, and a proper retention protocol should be developed.

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