AJO-DO

Vertical control of a Class II deep bite malocclusion with the use of orthodontic mini-implants

Min-Ho Jung
Seoul, Korea

To improve the facial profile of a Class II patient with chin deficiency, orthodontists have traditionally used incisor retraction or jaw surgery. Recently, a new technique was introduced that uses orthodontic mini-implants to intrude the incisors and rotate the mandibular plane counterclockwise. In patients with deep bite, heavy anterior occlusal contact can make it difficult to use intrusion for profile improvement. This case report shows the successful treatment of a patient with Class II deep bite and chin deficiency by means of intrusion of the maxillary and mandibular dentition with multiple orthodontic mini-implants. (Am J Orthod Dentofacial Orthop 2019;155:264-75)

For an adult or late adolescent patient with a retrognathic mandible and protrusive lip profile, 2 options have been available to improve the profile. The first involves retraction of the maxillary incisors, which can improve both the occlusion and the protrusive lip profile. The second requires orthognathic surgery to reposition the maxilla and mandible.

Since the introduction of orthodontic mini-implants (OMIs), various types of tooth movement have been reported with the use of them as anchorage.[1-3] There are many advantages of OMI anchorage: they do not require patient compliance, they are easy to place and remove, they are small in size and inexpensive, and they allow the orthodontist the freedom to place them in various locations.[4] Counterclockwise rotation of the mandible via intrusion of the dentition with the use of OMIs has been reported in open bite cases.[3,5,6] Intrusion of posterior teeth could improve overbite, decrease anterior facial height, and produce forward movement of the chin. In the case of patients with a skeletal functional Class II relationship with chin deficiency, these changes are beneficial for facial esthetics. If the patient has a deep overbite, treatment is more complicated because a deep bite interrupts the counterclockwise rotation of the mandible.

The present case report describes the intrusion of total dentition using OMIs to improve chin retrusion in a Class II deep bite patient. To rotate the mandible counterclockwise in a deep bite patient, the anterior teeth must be more intruded than the posterior teeth. OMIs successfully provided adequate anchorage for this tooth movement.

DIAGNOSIS AND ETIOLOGY

A healthy girl aged 14 years 9 months visited the clinic to receive treatment for her crowded dentition and protrusive lip profile. Her medical history was nonspecific. Menarche occurred 2 years and 9 months previously, and her height had increased 3 cm during the past year.

The patient exhibited lip incompetency and a gummy smile on clinical examination (Fig 1). The incisal show at rest was slightly excessive (4.0 mm). Intraoral photographs showed a large overjet (4.5 mm), deep overbite (5.0 mm), mild to moderate crowding, mild gingival inflammation, and mild midline deviation. The lower left canine exhibited a buccal crossbite. A mild functional Class II interarch relationship was observed in the premolar area, but the molar relationship was Class I (Fig 2). The patient had experienced temporomandibular joint (TMJ) pain several times in the past year. But when the TMJ symptoms were evaluated, there was no clicking, limitation in mouth opening, or pain. There was no other specific dental or medical history.

Department of Orthodontics, Dental Research Institute and School of Dentistry, Seoul National University, Seoul, Korea.
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Address correspondence to: Min-Ho Jung, Orthodontic Clinic, 3rd Fl, Tae-nam B/D, Cham-won Ro 3 Gil 40, Seo-cho Gu, Seoul 06510, Korea; e-mail, fortit@chol.com.
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Fig 1. Pretreatment intraoral and facial photographs.

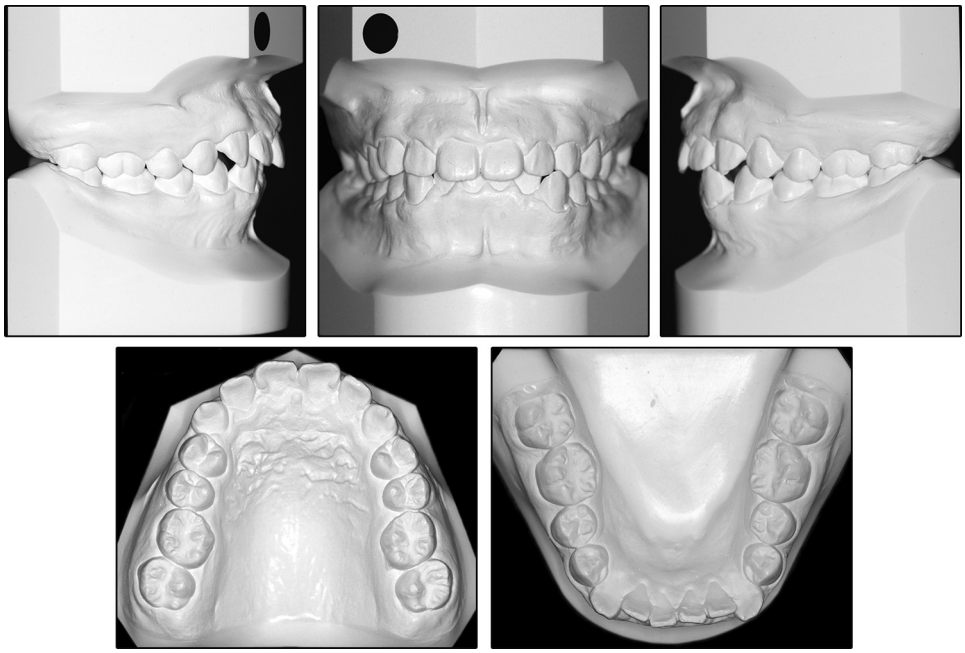

Fig 2. Pretreatment study models.

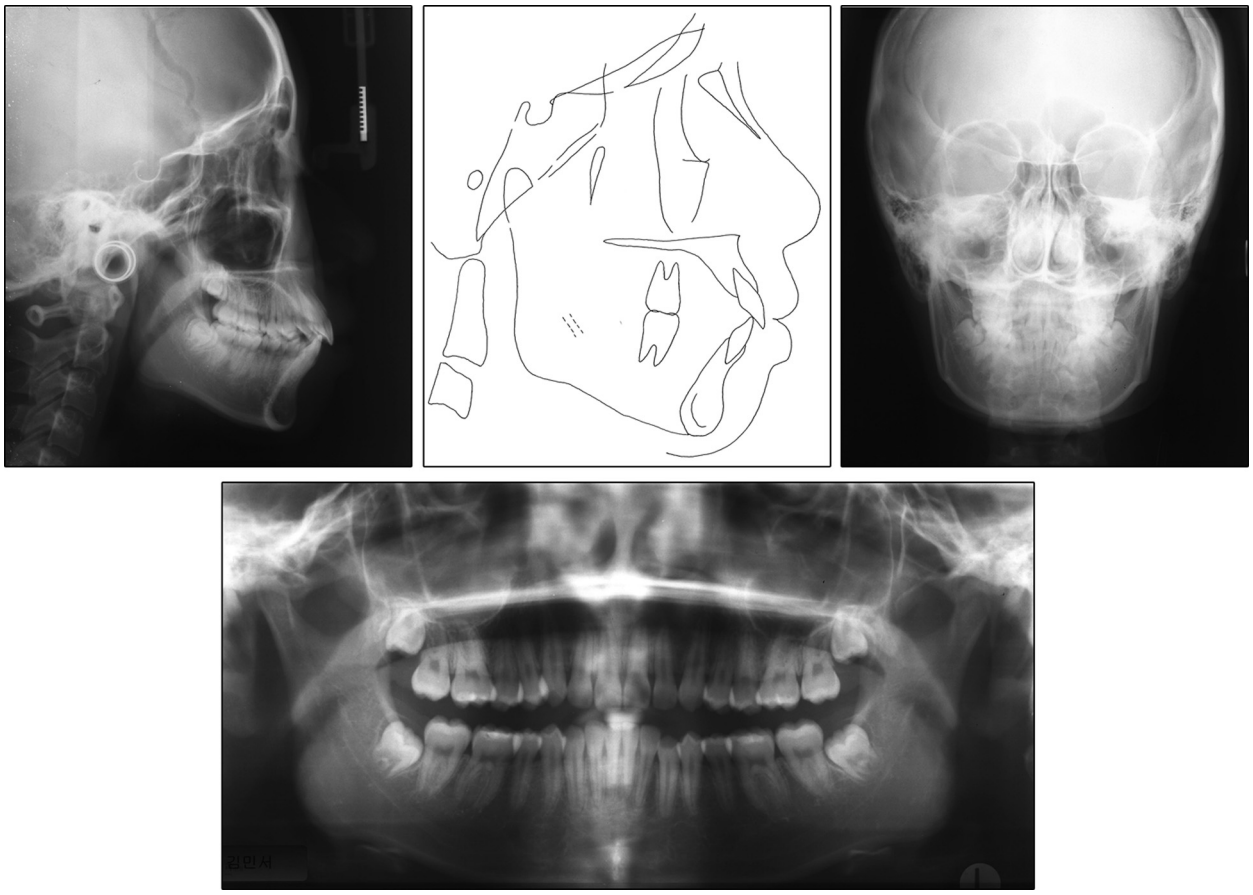

Fig 3. Pretreatment radiographs and tracing.

The patient's vertical skeletal pattern was within normal limits, but the sagittal pattern was Class II (ANB 6.3°). Labial inclination of the lower incisor (IMPA 101.6°) and lip protrusion to the esthetic line (upper lip to esthetic line: 1.8 mm; lower lip to esthetic line: 4.0 mm) are shown in Figure 3 (Table). The main reason for lip protrusion seemed to be the anterior-posterior jaw relationship, because the inclination of the upper incisor was normal. The vertical skeletal pattern was within normal limits (Bjork sum 393.7°, facial height ratio 69.9%, ANS-menton, 75.5 mm). Condylar morphology and alveolar bone height were normal in the panoramic radiograph. All of the third molars were developing. The patient had mild facial asymmetry and lip canting in the frontal facial photograph and posterior-anterior cephalogram, but she and parents did not notice them.

TREATMENT OBJECTIVES

Because the patient's main concern was a protrusive lip profile and gummy smile, the primary objective was to improve the lip profile and decrease incisor exposure. The additional objectives were to improve the overbite and overjet, establish a Class I molar and canine relationship, eliminate dental crowding, and correct the dental midline deviation. Correction of the buccal crossbite and improvement of lip incompetency were also required.

TREATMENT ALTERNATIVES

Because the patient exhibited a sagittal skeletal discrepancy, double-jaw surgery including a maxillary Le Fort I impaction with distal setback and advancement genioplasty was one possible treatment option. In addition, upper second and lower first premolar extractions or interproximal stripping with molar distalization with the use of OMIs[7] could be used to control dental protrusion and incisor axis during presurgical orthodontic treatment. The patient and parents did not want a surgical intervention.

Because of the age of the patient at the first visit, the use of jaw growth modification treatment was not

Table. Cephalometric measurements

Measurement	*Before treatment*	*After treatment*	After retention
Bjork sum (°)	393.7	389.7	390.8
Facial height ratio (%)	69.9	73.0	71.0
ANS-Me (mm)	75.5	71.2	72.4
ANB (°)	6.3	2.8	3.6
A to N perpendicular (mm)	5.6	4.9	4.9
Pog to N perpendicular (mm)	−2.4	2.8	1.8
U1 to FH (°)	113.1	112.3	112.1
U1 to SN (°)	101.7	101.6	101.4
L1 to Apog (mm)	6.6	1.2	2.1
U6 to PP (mm)	28.8	27.5	28.0
U1 to PP (mm)	34.2	32.4	32.7
L6 to MP (mm)	39.6	38.6	38.6
L1 to MP (mm)	49.2	42.7	43.8
IMPA (°)	101.6	103.9	103.7
Interincisal angle (°)	123.6	124.1	124.3
Nasolabial angle (°)	99.8	99.1	100.0
Upper lip to E-line (mm)	1.8	−2.3	−1.7
Lower lip to E-line (mm)	4.0	−2.0	−0.8

FH, Frankfort horizontal plane; *SN*, sella-nasion plane; *PP*, palatal plane; *MP*, mandibular plane; *IMPA*, incisor-mandibular plane angle; *OP*, occlusal plane.

possible. To improve her lip profile orthodontically, retraction of the incisors was needed. Because her incisor torque was not excessive and the nasolabial angle was within normal limits, the required amount of incisor retraction was limited. For this reason, second premolar extraction was chosen to improve crowding and lip protrusion.

Because previous studies have shown that intrusion of posterior teeth with the use of OMIs could produce counterclockwise rotation of the mandible and forward positioning of the chin,[3,8] it was decided to try for profile improvement. Because this patient had a deep overbite, the needed amount of intrusion was larger for the anterior than posterior teeth for this treatment. Furthermore, the patient's upper occlusal plane (UOP) to FH plane angle was smaller (8.3°) than the Korean norm. To minimize flattening of the UOP, the major target of intrusion was the lower rather than upper incisors.

After discussion with the patient and her parents, upper and lower second premolar extraction and OMI placement to intrude the upper and lower arches were finally planned.

TREATMENT PROGRESS

The patient preferred ceramic brackets, so 0.022-inch preadjusted edgewise ceramic brackets (Clarity; 3M

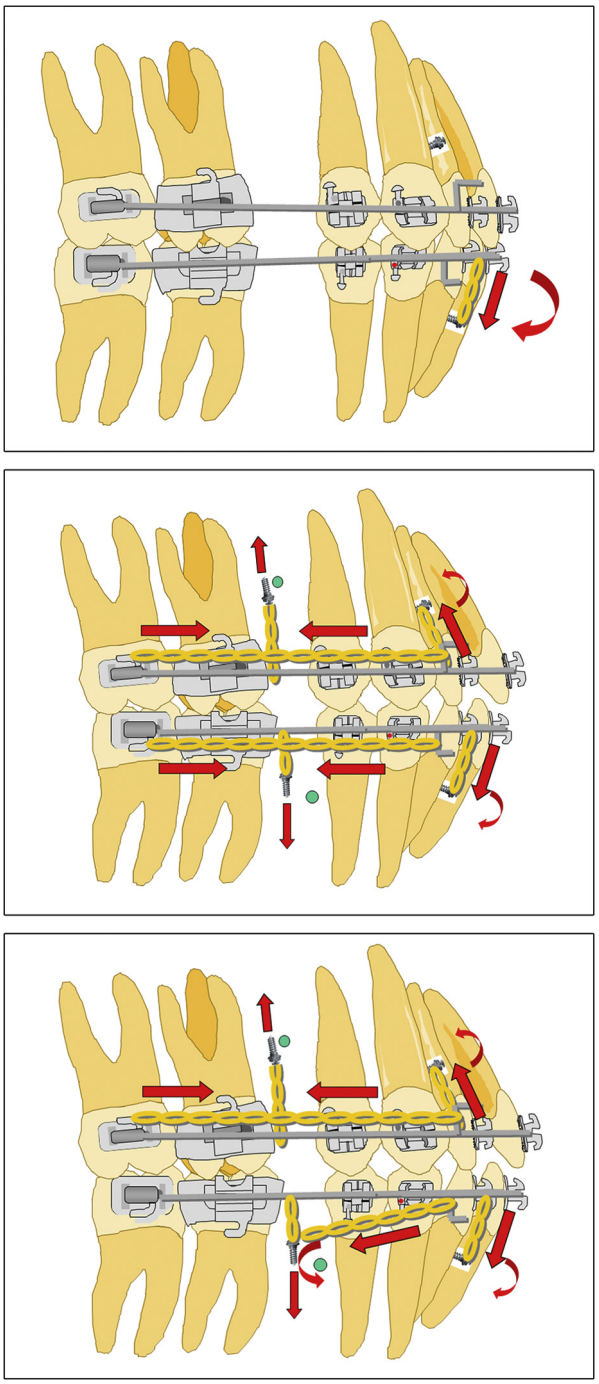

Fig 4. Schematics of the force vector during treatment. **A,** Intrusion was started in the lower anterior region. **B,** Total arch intrusion and retraction of the anterior teeth using the second premolar extraction spaces were initially planned. **C,** During space closure and intrusion, edge-to-edge bite was produced by the counterclockwise rotation of the mandible and proclination of the lower incisors. To improve overjet and lower incisor torque, lower incisor retraction with the use of OMIs was carried out.

Fig 5. Posttreatment intraoral and facial photographs.

Unitek, Monrovia, Calif) were placed on the labial side of the entire dentition. The archwire sequence progressed from 0.014-inch nickel titanium wire to 0.019 × 0.025-inch stainless steel working wire. Premolar extraction was performed during the initial leveling.

At the final stage of leveling, OMIs (Mplant U2, diameter 1.5 mm, length 7.1 mm; Biomaterials Korea, Seoul, Korea) were placed on the buccal alveolar bone between the root of the lateral incisor and canine and at the second premolar extraction site. After 4 weeks of OMI placement, an intrusive force was applied on the working wire.

Initially, intrusion of the lower anterior teeth progressed and after achievement of a shallow overbite, intrusions of the upper and lower whole dentition was implemented. Retraction of the anterior teeth was also performed during the intrusion (Fig 4).

A greater amount of incisor intrusion was planned in the lower arch to minimize flattening of the UOP inclination. During intrusion of the anterior teeth, incisor inclination was increased, especially in the lower arch. In addition, intrusion of the entire dentition caused the counterclockwise rotation of the mandible and, as a result, edge-to-edge bite of the incisors was observed during retraction. To improve overjet and incisor inclination, more retraction was needed in the lower arch. Because the OMIs were already placed, the treatment plan was easily altered with no difficulty (Fig 4, *B* and *C*).

After the patient entered high school, she had some difficulty keeping appointments because of her busy schedule. Furthermore, her family moved to another city. The number of missed appointments was 10 and the total treatment period was 37 months.

Before bracket removal, upper and lower lingual fixed retainers were placed. After debonding, the patient was given a circumferential retainer for the upper arch and a Hawley retainer for the lower arch. Because one of the main outcomes of her treatment was reduction in lower anterior facial height, for posttreatment stability the patient was instructed to squeeze her teeth together (clenching exercise) 5 times for 1 minute every night.[9,10]

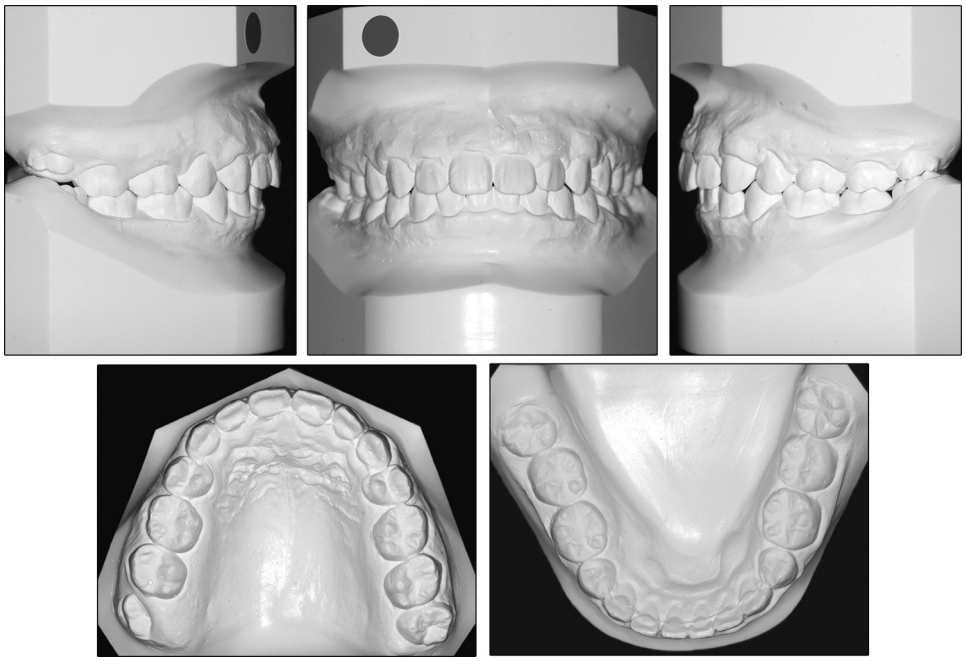

Fig 6. Posttreatment study models.

TREATMENT RESULTS

Intraoral photographs showed a Class I canine and molar relationship, adequate overbite and overjet (Figs 5 and 6), improved midline deviation, and well aligned teeth. Mild gingival inflammation due to poor oral hygiene was observed, but no noticeable white spot lesions were found. Facial photographs showed improvement of the facial profile and lip incompetency. The patient's gummy smile was also improved.

The final panoramic radiograph confirmed mild root resorption in anterior teeth (Fig 7). The posttreatment cephalometric analysis showed a significant decrease in anterior facial height and counterclockwise rotation of the mandibular plane. The Bjork sum decreased from 393.7° to 389.7°. Distance from the ANS to the menton decreased from 75.5 mm to 71.2 mm. The maxillary and mandibular incisors were retracted significantly, but incisor angulation change was minimal. The amount of lower molar intrusion was only 1 mm, but the amount of lower incisor intrusion (lower incisor to mandibular plane) was 6.5 mm in mandibular superimposition (Fig 8; Table). There was also a slight intrusion of the entire upper dentition. Pogonion moved forward a large amount by counterclockwise mandibular rotation. The distance from the pogonion to the nasion perpendicular line increased 5.2 mm.

After 14 months of retention, the patient visited the clinic for a check-up. Her occlusion was stable, but a slight increase of the overbite was observed (Figs 9 and 10). The upper right third molar erupted more and the buccal cusp tip could be clinically observed. Cephalometric superimposition showed a minor relapse of the mandibular plane due to extrusion of the upper molars (Figs 8 and 11; Table). Slight extrusion of the upper and lower incisors was also observed. The patient stated that she had not performed the clenching exercise at all.

DISCUSSION

Treatment of chin deficiency and protrusion

Class II malocclusion frequently accompanies chin deficiency. A deficient chin worsens lip protrusion.[11] In a growing adolescent, growth modification treatment can be performed to improve chin deficiency, although its long-term skeletal effectiveness is controversial.[12,13] If the patient's residual growth is not sufficient enough to use growth modification treatment, it is more difficult to improve chin deficiency through orthodontic treatment.

The treatment of an open bite with posterior teeth intrusion had been one of the most difficult of orthodontic treatments, but after the introduction of OMIs, many studies showed predictable and stable results.[3,5,6] During intrusion treatment, the forward movement of the chin area by counterclockwise mandibular rotation could be observed. This is helpful to improve the patient profile in chin deficiency patients. Surgical treatment of Class II chin

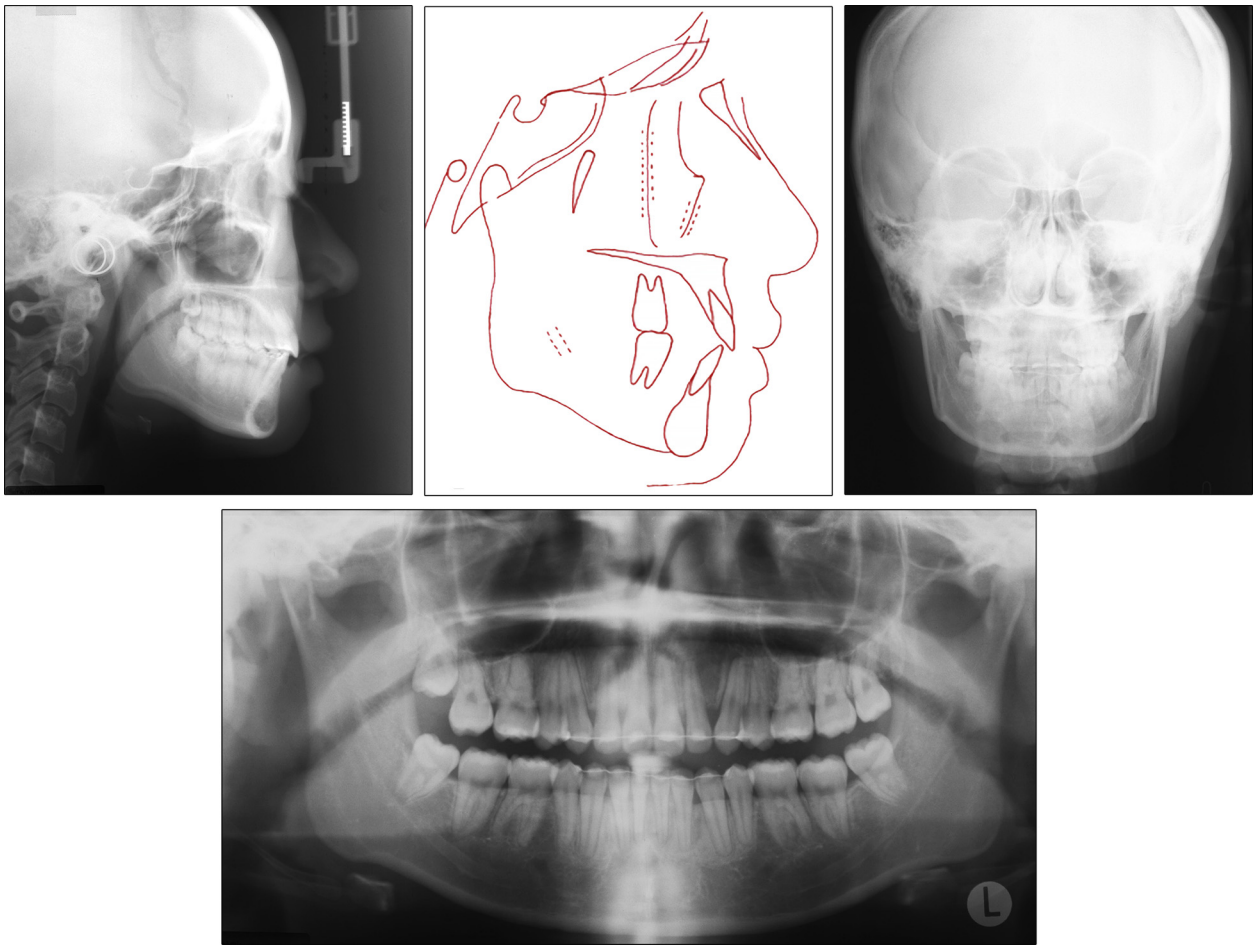

Fig 7. Posttreatment radiographs.

deficiency patients with the use of Le Fort I impaction surgery is sometimes performed to achieve similar facial changes.[14,15] If we consider that the average amount of surgical chin area advancement in severe Class II adult patients is ~3-5 mm,[16,17] the chin position improvement in this patient was quite large. There was also mandibular growth during treatment (Fig 8, *C*) which helped to improve the profile.

Previous studies that examined the effect of posterior tooth intrusion showed that if only the upper molars are intruded, the lower molars tend to extrude.[18-20] Therefore, it is more desirable to control the upper and lower molars simultaneously to decrease posterior vertical dimension efficiently.

The amount of upper incisor retraction was 3.1 mm on the occlusal plane, and the amounts of lip protrusion improvement (to the E-line) were 4.1 mm (upper lip) and 6.0 mm (lower lip). The amount of retraction was similar or slightly greater than the earlier study that evaluated effect of second premolar extractions,[7] but improvement of lip protrusion was much greater owing to the mandibular rotation.

Intrusion of anterior teeth

If a Class II chin deficiency patient has a deep overbite, it is more difficult to improve the patient profile with the use of posterior teeth intrusion, because the patient's overbite is already excessive. Intrusion of posterior teeth will produce traumatic occlusion on the anterior teeth. To prevent such a side-effect during treatment, the anterior teeth should be intruded more than the posterior teeth.

There have been 2 case reports on the treatment of Class II deep bite patients with chin deficiencies by means of intruding the entire dentition, but there were several differences from them in the present case. In the report by Paik et al, the authors used transpalatal arch and palatal OMIs to intrude the upper dentition.[21] In the report by Wang et al, OMIs were placed in the anterior and posterior buccal alveolar bone in the

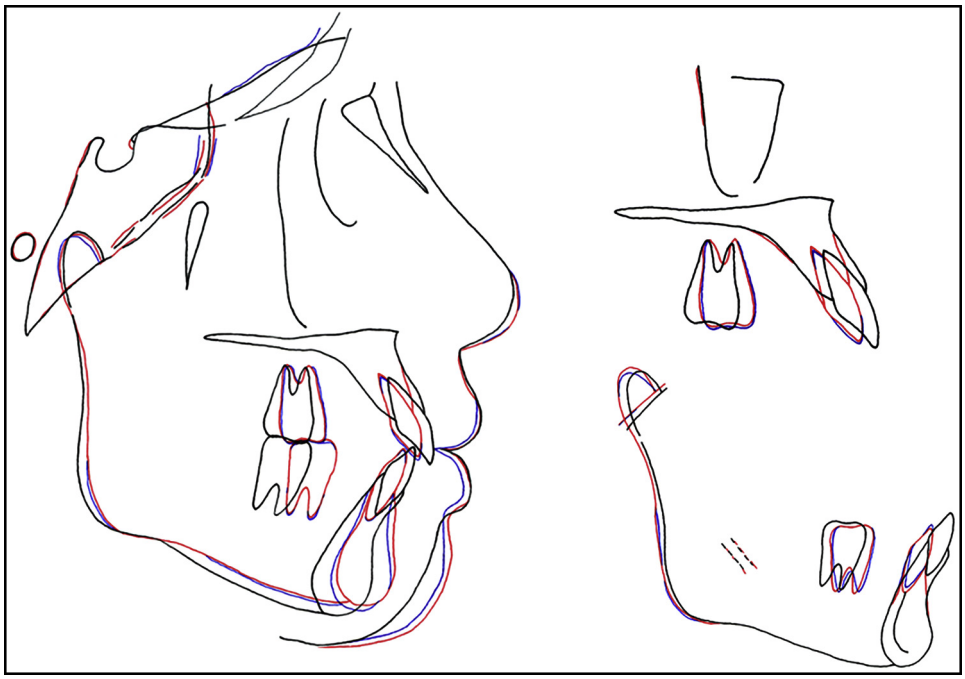

Fig 8. Superimposition of pretreatment (*black*), posttreatment (*red*), and postretention (*blue*) lateral cephalograms: **A,** overall; **B,** maxilla; **C,** mandible.

maxillary arch for intrusion.[22] In both of those cases, OMIs were not used in lower arch. Although the lower incisors exhibited intrusion through a reverse curved archwire, active intrusion of the lower dentition was not planned in those cases.

Assuming that the center of mandibular rotation is located in the condyle, the amount of incisor movement is greater than the molar movement (Fig 12). For this reason, the amount of incisor intrusion should be much larger than molar intrusion in this kind of treatment.

If the patient has a steep occlusal plane angle and gummy smile, a large amount of upper incisor intrusion can be a useful treatment option. But if the UOP angle is normal or small, upper anterior intrusion should be carefully planned not to produce flat smile arc.[23] Because a large amount of incisor intrusion was required in the present deep bite case, lower anterior OMIs were inevitable.

Anterior teeth intrusion can be obtained with the use of OMIs positioned in the labial alveolar bone. If the intrusion force vector is located anterior to the center of resistance of the incisors, incisor torque can be increased during intrusion (Fig 13, *A*).[22] In our patient, a large amount of lower incisor intrusion was implemented, and as a result, lower incisor torque was increased significantly. Furthermore, counterclockwise rotation of the mandible produced anterior movement of the lower incisors, and as a result, edge-to-edge incisor relationship was produced. Originally, the extraction of upper and lower second premolars was planned because the amount of incisor protrusion was small. Considering the changes of incisor position and torque by means of intrusion, lower first premolar extraction was the better option in this case.

The incisor axis can be controlled by OMI position as well as by the force vector during intrusion. If the pretreatment incisal inclination is small, as in some Class II division 2 cases, anterior positioning of the force vector (Fig 13, *A*) would be helpful to produce an adequate incisor axis. If the incisor torque increase is undesirable, the OMIs and the force vector position should be located more posteriorly (Fig 13, *B*).[24]

Relapse of intrusion treatment

Because the major treatment goal was counterclockwise mandibular plane rotation by means of intrusion, the stability of the treatment result largely depended on the prevention of extrusion after treatment. To

Fig 9. Intraoral and facial photographs 14 months after debonding.

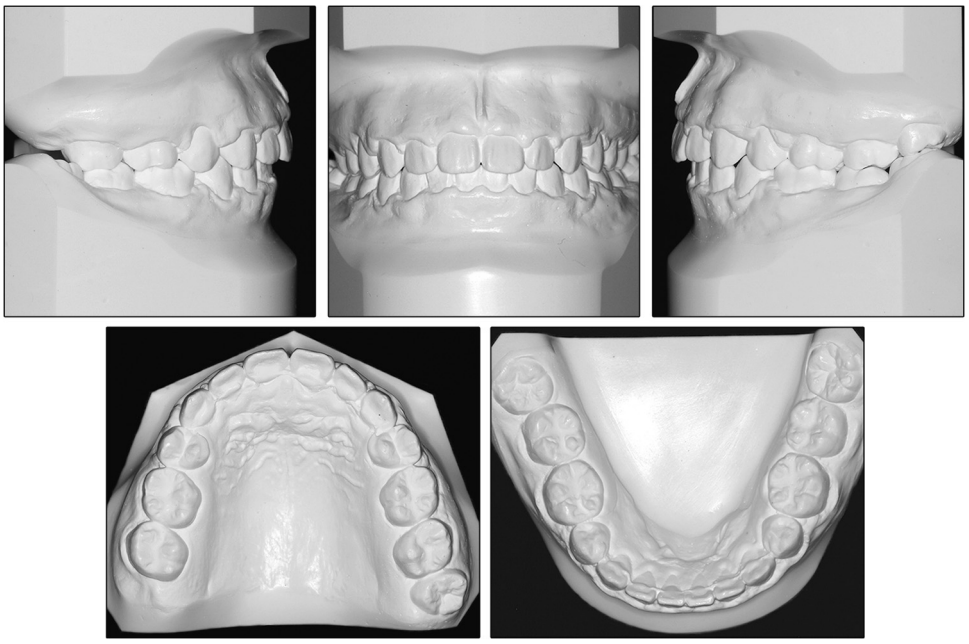

Fig 10. Study models 14 months after debonding.

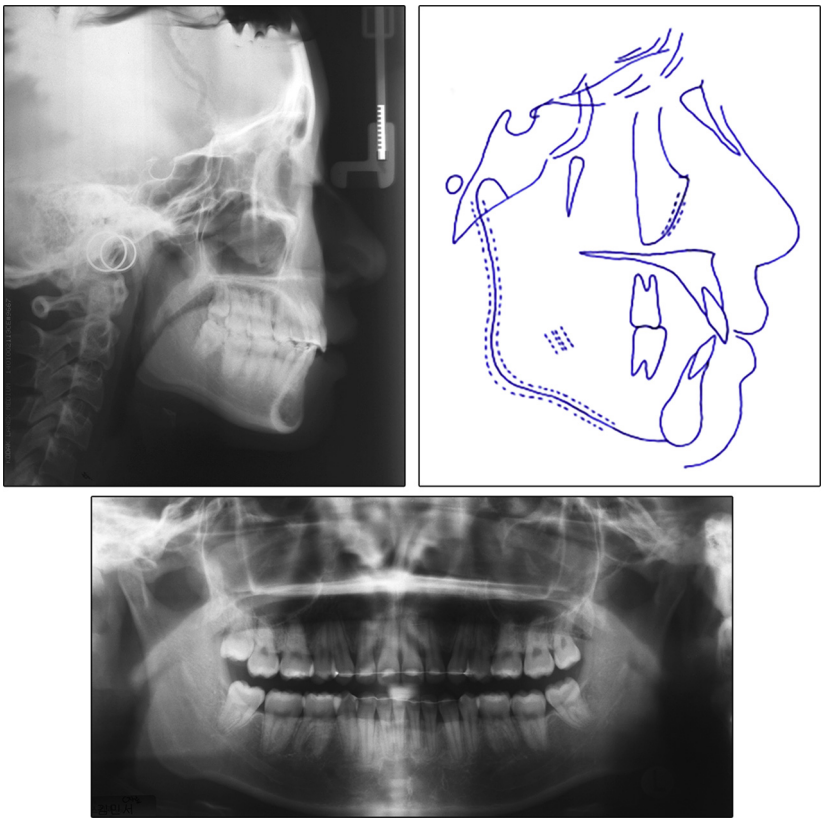

Fig 11. Radiographs 14 months after debonding.

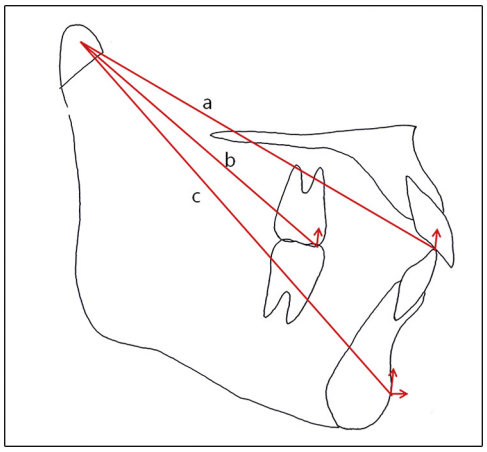

Fig 12. A schematic of mandibular rotation. Because the center of mandibular rotation is located in the condyle, the amount of incisor movement (a) is always larger than the amount of molar movement (b). For the same reason, the amount of pogonion movement (c) is much larger. Counterclockwise mandibular rotation also produces anterior movement of the pogonion. Reduction of lower anterior facial height and forward movement of the pogonion can improve chin deficiency synergistically.

minimize vertical relapse, the patient was instructed to perform clenching exercises,[9,10] but the patient's cooperation was poor. Differently from most open bite patients, she did not consider her malocclusion to be severe, and it seemed that she was not afraid of relapse.

The relapse rates of posterior intrusion in previous studies were 10.2%-30.4% over a period of 1-4 years.[18,25-29] In our patient, similar relapses (0%-38.5%; Table) were observed during the 14-month retention period.

In the earlier studies, there were differences in retention strategy. One study used tongue training and a posterior bite plate,[28] another used a posterior bite plate with night elastics to the OMIs for 6 months,[18] and others did not mention any special retention strategies to prevent open bite relapse. The differences among the retention methods have yet to be clearly determined.

Other considerations during OMI intrusion treatment

During the treatment of the present case, 8 OMIs were placed at various sites to provide intrusion and retraction forces and it was fortunate that all of the

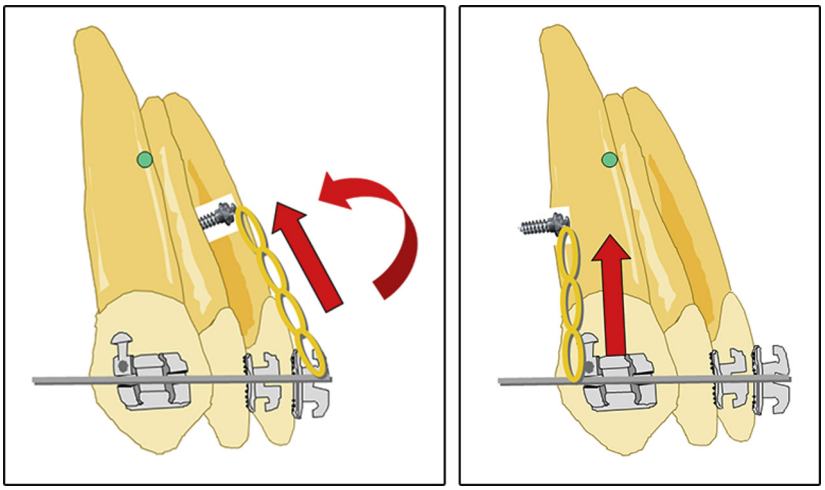

Fig 13. Schematics of the force vector for anterior intrusion. **A,** If the OMI is placed between the central and lateral incisors and an elastomeric chain is placed in the central incisor bracket, labial inclination of the incisors would be increased because the force vector passes anterior to the center of resistance (*green dot*) of the anterior segment. **B,** If the OMI and the force vector are placed posterior to the canine, incisor torque change would be minimal.

OMIs were successful. Because a recent meta-analysis showed the average failure rate of OMIs to be greater than 10%,[30] using multiple OMIs could possibly have resulted in many OMI failures during treatment.

Although a recent review article showed that the intrusion of molars with the use of OMIs did not cause an adverse periodontal response or more severe root resorption than conventional mechanics,[31] the intrusion can cause root resorption. A recent randomized clinical trial observed ~1 mm of resorption during 2.5 mm of intrusion in the center of resistance.[22] In our patient, mild blunting was observed in the panoramic radiograph. Careful observation during intrusion treatment is required.

CONCLUSIONS

If the patient with chin deficiency is a late adolescent or a young adult, jaw growth modification treatment is not an option. But intrusion of the whole dentition can be considered because forward movement of the chin area can be obtained by counterclockwise mandibular rotation. This case report shows such a treatment successfully improving a patient's profile, despite the patient's deep bite. A large amount of incisor intrusion was required, and careful adjustment of intrusion is needed to prevent a flat smile arc and obtain adequate incisor show.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.ajodo.2018.08.016.

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