Case Report

Active vertical control with skeletal anchorage for optimizing facial profile in a severe Class II high-angle protrusion case

Johnny Liaw[a]; Shin-Huei Wang[b]; Hou-Kun Chen[c]; Yi-Jane Chen[d]

ABSTRACT

This case report describes the nonsurgical management of a patient with a Class II skeletal pattern, retrognathic mandible, steep mandibular angle, maxillary vertical excess, and lip incompetence. The treatment approach involved orthodontic mechanics supported with skeletal anchorage to achieve maximal intrusion and retraction of the dentition. A novel elastic hanging rack appliance, supported by midpalatal miniscrews, was used. A maximal anchorage setup for active vertical control on both arches was illustrated. Significant improvement in the facial profile was achieved with optimal occlusion. Cephalometric analysis revealed successful incisor retraction and intrusion, as well as a forward rotation of the mandible. The treatment outcome illustrates the impact of active vertical control on orthodontic camouflage treatment for severe protrusion. (*Angle Orthod*. 2025;95:227–239.)

KEY WORDS: Active vertical control; Hyperdivergency; Protrusion; Skeletal anchorage; Miniscrew

INTRODUCTION

Protrusion, a common malocclusion in the Asian population, is characterized by a convex facial profile and protrusive lips resulting from anterior positioning of the alveolar bone and/or anterior teeth, which can lead to lip incompetence and mentalis strain.[1] When combined with an underlying skeletal discrepancy, a comprehensive approach involving orthognathic surgery and orthodontic treatment may be recommended.[2] However, some patients may choose orthodontic camouflage treatment as a nonsurgical alternative. It is important to consider various factors that can impact the extent of improvement in the facial profile, such as the severity of the skeletal discrepancy, soft tissue thickness and responsiveness, limitations in tooth movement, and individual growth potential.

Adult patients with a high mandibular plane angle and Class II skeletal pattern, retrognathic mandible, and increased soft tissue thickness may be very challenging to treat without orthognathic surgery. This case report highlights the active vertical control in orthodontic camouflage treatment for severe maxillary protrusion. A maximal anchorage setup of intrusion and retraction with miniscrews was introduced with the emphasis on incisor torque control and boundaries of tooth movement.

Diagnosis and Etiology

A 26-year-old female patient presented to the clinic regarding concerns of severe protrusion, lip incompetence, gummy smile, and a retrognathic mandible. Upon examination, she had a convex lateral facial profile (Figure 1). The nasolabial angle measured approximately 90°, with an upturned alar base. Lip incompetence was noted with a 5.4-mm gap between the lips at rest. The lower lip appeared everted, resulting in a deep labiomental fold. The mandible exhibited a retrognathic position with significant chin retrusion. The frontal facial view showed no obvious asymmetry. The incisor display at lip repose was 5.5 mm. Although capturing a picture of the patient demonstrating a full smile showing excessive gingival display was challenging, the presence of a gummy smile was confirmed during clinical examination and remained a concern.

Intraorally, the arch length discrepancy was 4.5 mm in the upper and 2 mm in the lower arch. The right maxillary

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Accepted: June XX, 2024. Submitted: April XX, 2024.
Published Online: August 22, 2024

Figure 1. Pretreatment intraoral and extraoral photographs.

deciduous canine was retained. Overjet and overbite were both 5.5 mm. Bilaterally, canines and molars exhibited an end-on Class II relationship (Figure 2).

The panoramic radiograph revealed a congenitally missing maxillary right canine and bilateral mandibular mesioangularly impacted third molars (Figure 3, Table 1). Endodontic therapy was noted in the maxillary left lateral incisor and both mandibular second premolars. A lateral cephalogram indicated a severe Class II relationship with a high mandibular plane angle (ANB: 13°; SN-MP: 50.7°). The maxillary incisors appeared retroclined (U1-SN: 85.3°). Both the upper and lower lips protruded beyond the E-line (E-line/UL: 6.5 mm, E-line/LL: 8.0 mm). The ratio of upper anterior facial height (UAFH: 40.2%) and lower anterior facial height (LAFH: 59.8%) indicated an increased LAFH.

The patient was diagnosed with hyperdivergent skeletal Class II malocclusion, mandibular retrognathism, and lip incompetency. There might be a genetic basis of the hyperdivergent craniofacial pattern, which may contribute to the retrusive chin.

Treatment Objectives

The treatment objectives included Class II correction to achieve appropriate overbite and overjet, and facial profile improvement. To address the protrusion and effectively manage lip incompetence, it was important to consider the vertical reduction in addition to sagittal retraction.

Treatment Alternatives

The most suitable treatment approach for this patient would involve a combination of orthognathic surgery and orthodontic treatment. Le Fort I maxillary setback and impaction, along with bilateral sagittal split osteotomy (BSSO) for mandibular advancement, were recommended to address the skeletal discrepancy.[2] However,

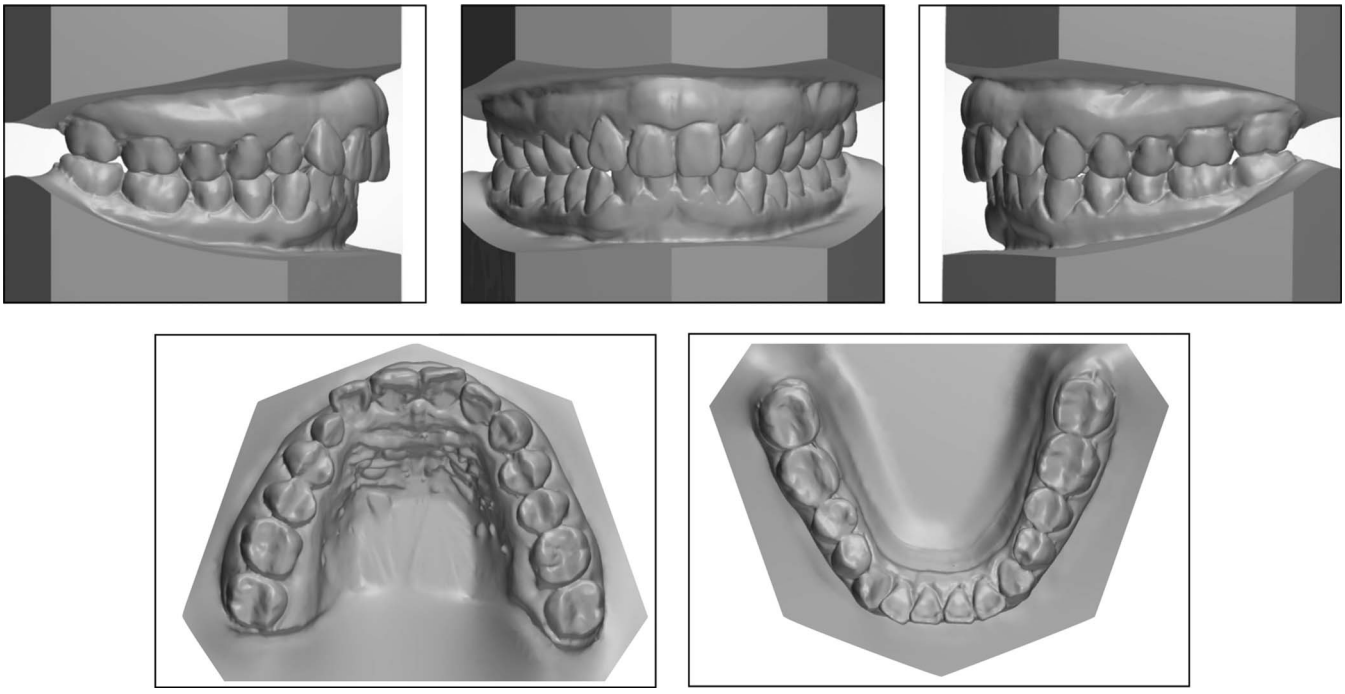

Figure 2. Pretreatment study models.

the patient declined the surgical option and requested camouflage treatment instead.

With the understanding of limitations in achieving optimal treatment outcomes, the patient chose the nonsurgical camouflage option. The maxillary left first premolar, the retained maxillary right deciduous canine and bilateral mandibular second premolars would be extracted for facial profile reduction.

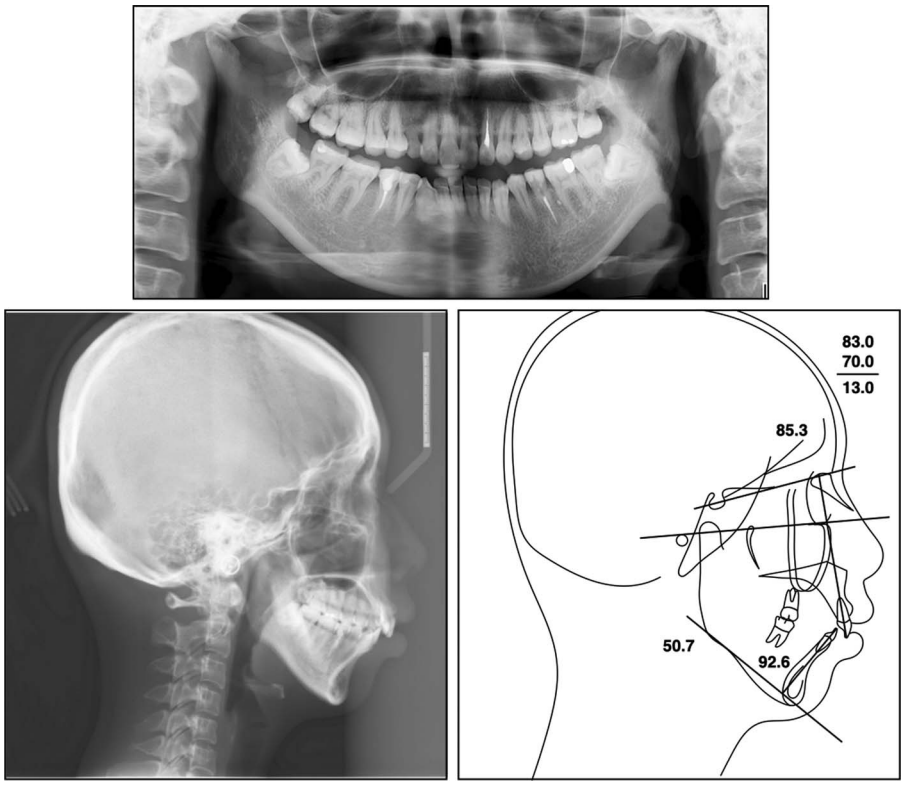

Figure 3. Pretreatment panoramic radiograph and lateral cephalogram.

Table 1. Cephalometric Measurements

	Taiwanese Norms	Pretreatment	Posttreatment
SNA (°)	81.5 ± 3.5	83.0	83.0
SNB (°)	77.7 ± 3.2	70.0	71.0
ANB (°)	4.0 ± 1.8	13.0	12.0
SN-MP (°)	33.0 ± 1.8	50.7	47.8
U1-NA (mm)	3.9 ± 2.1	−2.5	−9.0
U1-SN (°)	108.2 ± 5.4	85.3	87.2
L1-NB (mm)	6.6 ± 2.8	11.5	6.5
L1-MP (°)	96.8 ± 6.4	92.6	90.7
E-LINE/UL (mm)	−1.1 ± 2.2	6.5	3.0
E-LINE LL (mm)	0.5 ± 2.5	8.0	0.5

Treatment Progress

After extractions and initial strap-up, both arches were aligned with 0.016-inch nickel titanium (NiTi) archwires. Bilateral upper buccal miniscrews (Mico One, PS 2 × 10 mm, Huang Ya Biomedical Technology LTD, Taipei, Taiwan) were inserted in the first month for maximal retraction. Anterior subapical (AS) miniscrews (Mico One, NS 2 × 10 mm, Huang Ya Biomedical Technology) were inserted in both arches in the fourth month for gummy smile correction and overbite control.

After 15 months of treatment, all the spaces were successfully closed on 0.016 × 0.022-inch stainless steel (SS) wire (Figure 4). However, the patient's lateral facial profile showed limited improvement. Bilateral dental relationships remained Class II, with insufficient overjet for further retraction of the maxillary arch. This could be attributed to inadequate control of incisor torque during the retraction of the maxillary incisors. To address this issue, an additional 30° of palatal root torque was applied to the anterior portion of the maxillary archwire.

In the 23rd month, buccal shelf (BS) miniscrews (Mico One, PS 2 × 10 mm, Huang Ya Biomedical Technology) were installed bilaterally between the

Figure 4. Bilateral buccal miniscrews were utilized for maximal retraction. Anterior subapical miniscrews were inserted for gummy smile correction and overbite control. Profile improvement in the 15th month after complete space closure was limited.

Figure 5. Bilateral buccal shelf miniscrews were inserted in the 23rd month to retract the whole mandibular dentition to increase overjet for further retraction of the whole maxillary dentition.

mandibular first and second molars to retract the entire mandibular dentition and facilitate further distalization of the maxillary dentition (Figure 5). The upper buccal miniscrews were transplanted to the infrazygomatic crest (IZC) with a closed method to reinforce further intrusion and distalization of upper arch. To optimize upper total arch intrusion on both buccal and palatal sides, two midpalatal miniscrews (Mico One, PS 2×8 mm, Huang Ya Biomedical Technology) were placed 7 mm apart and an elastic hanging rack appliance was constructed with a 0.036-inch SS wire to apply intrusive forces to the maxillary posterior teeth from the palatal side (Figure 6).

Additionally, a lingual arch constructed with 0.028-inch SS wire was bonded to the lingual surface of the lower dentition to prevent buccal flaring of the mandibular molars in response to the intrusive force exerted from the BS miniscrews (Figure 7). The goal of the intrusive force applied to the mandibular posterior teeth was to correct any compensatory supererupption of the mandibular molars. By the 30th month, successful molar intrusion was achieved in both arches, leading to forward rotation of the mandible.

In the 34th month, all of the miniscrews and the elastic hanging rack appliance were removed. The treatment was finished after an additional 10 months of final detailing. Vacuum-formed clear retainers were provided immediately after debonding. The patient was instructed to wear them full-time for the initial six months, followed by nighttime use.

Treatment Results

The entire treatment duration was 43 months (Figures 8 and 9). The occlusion was corrected to a Class I dental relationship with optimal overjet and overbite.

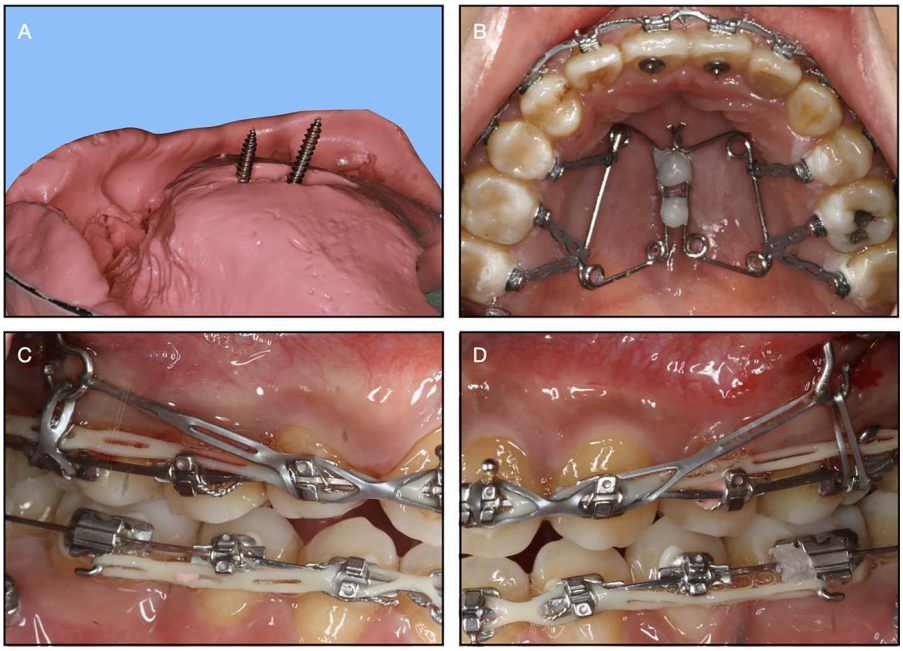

Figure 6. In the 27th month, an elastic hanging rack supported by two palatal miniscrews was fabricated. (A) The dental cast was poured with two miniscrews inserted in the impression as analogs. (B) An elastic hanging rack appliance was installed. (C) and (D) The original buccal miniscrews were repositioned to IZC with submerged position and a wire extension made of 0.028 SS wire. IZC indicates infrazygomatic crest.

The facial profile showed significant improvement due to the combined effects of intrusion and retraction in both arches.

The panoramic radiograph showed some root resorption and root parallelism within normal range (Figure 10). Cephalometric superimpositions revealed that the maxillary incisors were retracted by 7.9 mm and intruded by 1.9 mm at the incisal edge level, while retracted by 8.6 mm and intruded by 1.7 mm at the apex level. The maxillary first molars were moved distally 1.5 mm and intruded 2.3 mm. In the mandibular arch, the incisors were retracted 5.5 mm and intruded 1.0 mm at the incisal edge level, while retracted 4.7 mm and intruded 2.0 mm at the apex level. The mandibular first molars were uprighted and extruded 1.5 mm. The mandibular plane angle decreased by 2.9° (from 50.7° to 47.8°), and the LAFH reduced by 1.9 mm. Pg moved upward 1.9 mm and forward 3.9 mm. The SNB angle increased from 70° to 71°, while the ANB angle decreased from 13° to 12°. The maxillary incisors were effectively retracted with bodily movement and appropriate torque control (U1-SN angle: from 85.3° to 87.2°). The mandibular incisors were uprighted (IMPA: from 92.6° to 90.7°) to achieve a harmonious lower face.

Controlled tipping of the maxillary incisors was evident in the midtreatment stage, which did not show much upper lip retraction (Figure 11). Torque of the maxillary incisors was restored with a third order bend in the maxillary 0.017 × 0.025 TMA wire and an intrusive force from the AS miniscrew. Although intrusion of the maxillary molars was observed, the mandible failed to rotate forward because of compensatory supereruption of the mandibular molars and incisor interference caused by lingual tipping of the maxillary incisors. Active vertical control was achieved by overall intrusion of both arches and torque recovery of the maxillary incisors.

After debonding, periodontal surgery was conducted 4 months later to remove the residual bony protuberance, which appeared to be an exostosis (Figure 12).

Two-year postretention records indicated further improvement in upper lip protrusion, which could be attributed to the combined effects of surgical bony reduction of the protuberance and neuromuscular adaptation (Figure 13).[3]

DISCUSSION

Protrusion can be addressed with four premolar extraction to reduce lip protrusion. When protrusion is associated with severe skeletal discrepancy, a combined approach of orthognathic surgery and orthodontic treatment may be recommended. However, some patients cannot accept the surgical approach and request camouflage orthodontic treatment. Ultimately, the choice of treatment approach depends on the severity of the dental protrusion, skeletal factors, patient preferences, and professional judgment of the orthodontist.

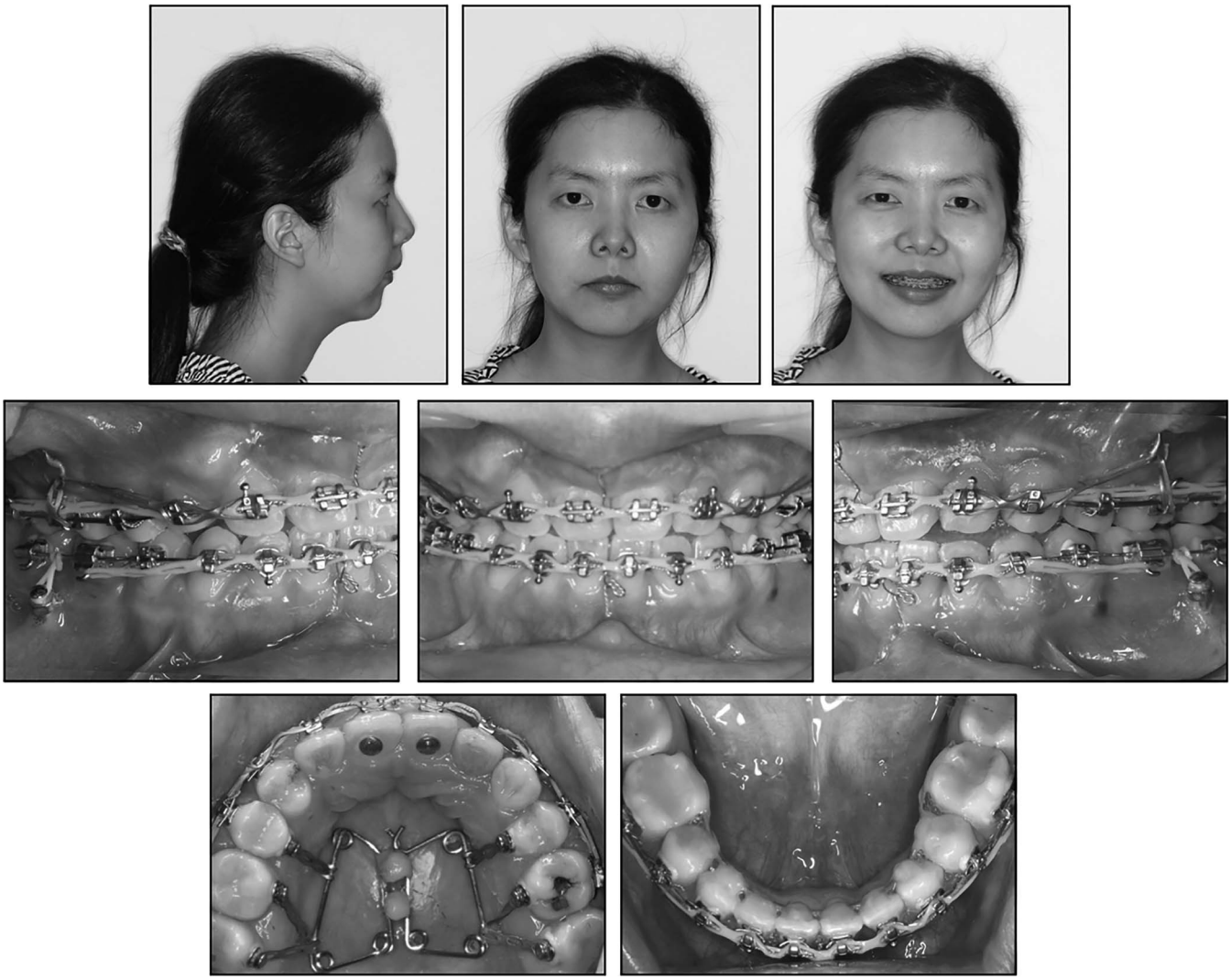

Figure 7. Intrusive forces were applied to the mandibular posterior teeth by attaching the elastomeric chains from bilateral buccal shelf miniscrews to the mandibular archwire. A lingual arch made of 0.028 SS wire was bonded in the 28th month to prevent the side effect of tipping the mandibular molars buccally.

Skeletal anchorage can reduce protrusion with maximal anchorage.[3,4] If additional retraction is desired after complete space closure, repositioning of interdental miniscrews might be considered as there could be interference between the miniscrews and the moving roots. The application of IZC or BS miniscrews can be alternatives as they are positioned outside the dental root area, which makes total arch distalization possible.[5,6]

To address the patient's concern regarding a gummy smile, an AS miniscrew was inserted to intrude the maxillary incisors.[7,8] The combined intrusion and retraction force system generated by IZC, BS, and AS miniscrews, helped in retracting and intruding the teeth without excessive uprighting during space closure, as the line of action of the intrusive component was in front of the center of resistance of the incisors.[6]

Protrusive patients with thick lips and mentalis strain may experience a less noticeable improvement of their facial profile after incisor retraction.[3,9] The muscle strain needs to be relieved before initiating profile reduction.

Active vertical control aims at reducing the LAFH by intruding the dentition, resulting in an upward movement of the occlusal plane and forward rotation of the mandible to enhance chin projection.[6,10,11] It is crucial to prevent compensatory supererupption of the mandibular molars while intruding the maxillary molars. Hence, double-arch intrusion might be indicated for active vertical control.[12] Additionally, it is essential to avoid incisor interferences, considering overjet, overbite, and torque control. Also, control can be facilitated by the forward movement of the mandibular molars through de-wedging. However, the desired amount of profile reduction needs to be considered at the same time.

Figure 8. Posttreatment intraoral and extraoral photographs.

Regarding the biomechanics for active vertical control, combined intrusion and retraction was accomplished utilizing upper posterior miniscrews and AS miniscrews in both dental arches. However, the midtreatment cephalogram after complete space closure indicated minimal upper lip retraction, which may be attributed to suboptimal soft tissue response, potentially influenced by increased lip thickness. Bilateral BS miniscrews and IZC miniscrews were introduced to establish a combined intrusion and retraction force system in both arches after complete space closure. Cephalometric superimpositions revealed intrusion of mandibular first molars, which previously exhibited compensatory supereruption in the midtreatment cephalogram. Consequently, forward rotation of the mandible occurred as a result, following the active vertical control.

A midpalatal miniscrew-supported temporary anchorage device with an elastic hanging rack was designed to intrude the maxillary arch from the palatal side.[6] Two midpalatal miniscrews were installed 7 mm apart, using a contra-angle micromotor engine driver (e-driver, Osstem Implant Co., LTD, Seoul, Korea). An impression was taken, and a cast was poured with the miniscrews inserted as analogs. A 0.036-inch SS wire was utilized to construct the elastic hanging rack appliance, which was then connected to midpalatal miniscrews and secured with ligature wires. Flowable composite resin was applied to cover the ligature wire and heads of the miniscrews to prevent irritation. Intrusive forces can be applied at any point along the wire framework without additional miniscrews. This system took advantage of the two midpalatal miniscrews, which were strategically placed in an area of optimal bone quality, compared to the dentoalveolar region. However, the disadvantages of this technique are additional chair time and laboratory work.

Should there be any potential interferences between the moving roots and the existing miniscrews, a repositioning procedure could be performed to move IZC

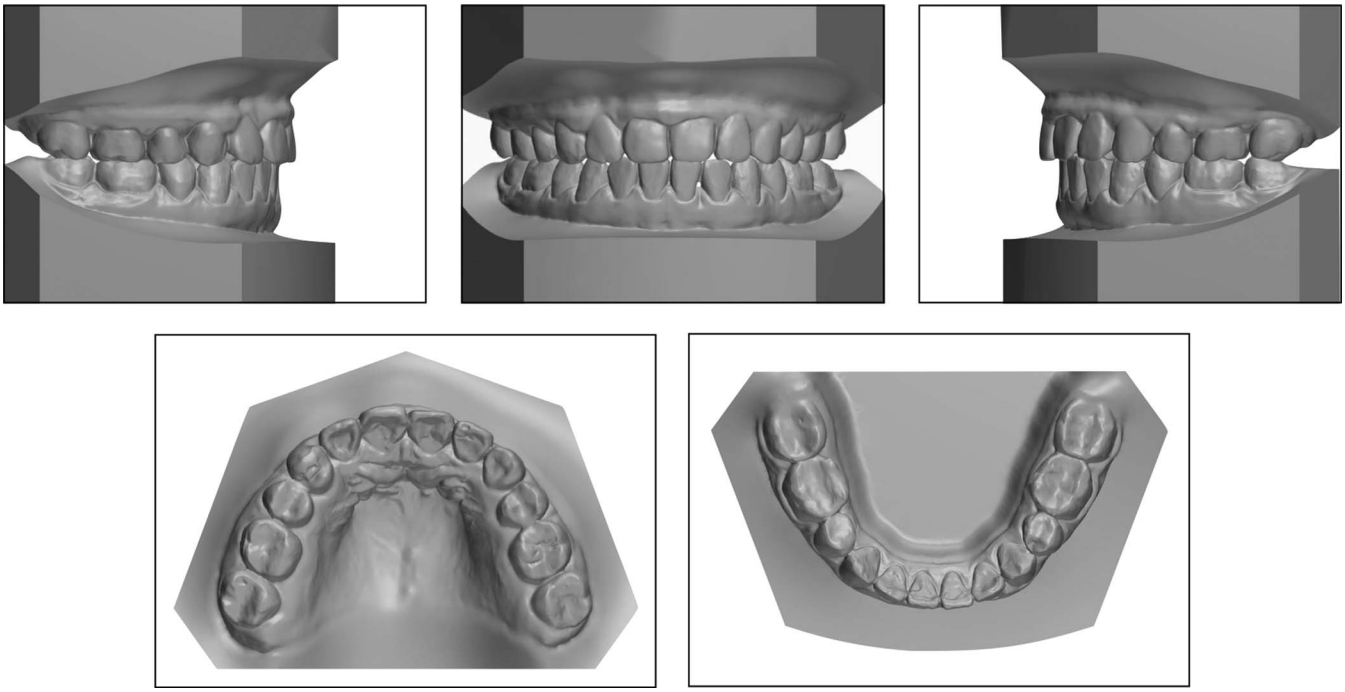

Figure 9. Posttreatment panoramic radiograph and lateral cephalogram.

miniscrews more buccally and apically.[6] For those patients with a shallow vestibule, a 0.028-inch SS wire could be bent and positioned beneath the platform of the IZC miniscrews to serve as an extension for attaching elastics to intrude and retract the entire maxillary arch. The intrusive forces were applied on both the buccal and palatal sides to prevent tipping of the maxillary posterior teeth.

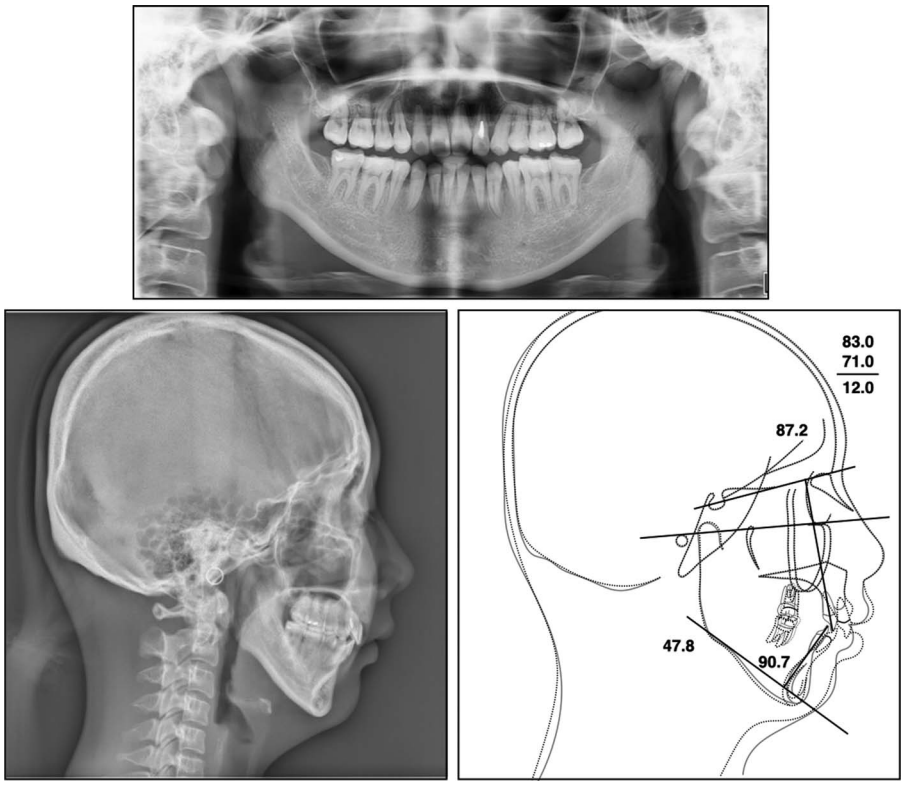

Figure 10. Posttreatment study models.

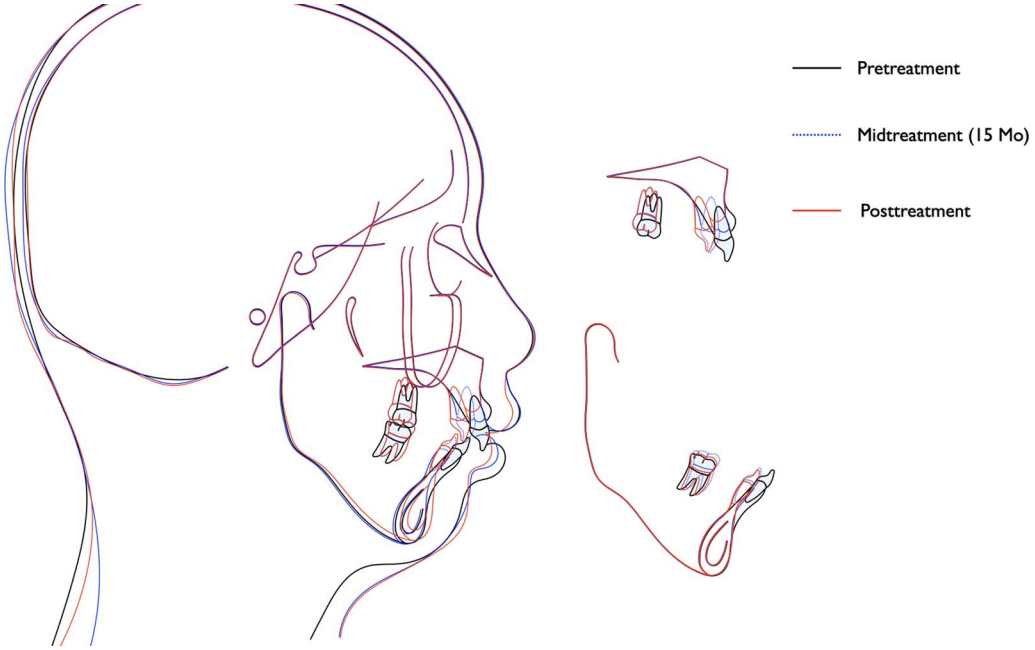

Figure 11. Cephalometric superimposition of pretreatment, midtreatment, and posttreatment cephalograms.

To achieve intrusive mechanics in the mandibular posterior area, an elastic chain from the BS miniscrews to the mandibular archwire was used to apply intrusive forces. Simultaneously, a retraction force was applied using elastic chain connecting the mandibular anterior teeth to the BS miniscrew, which made the line of action above the center of resistance of the entire mandibular arch. This resulted in a forward rotation of the mandibular

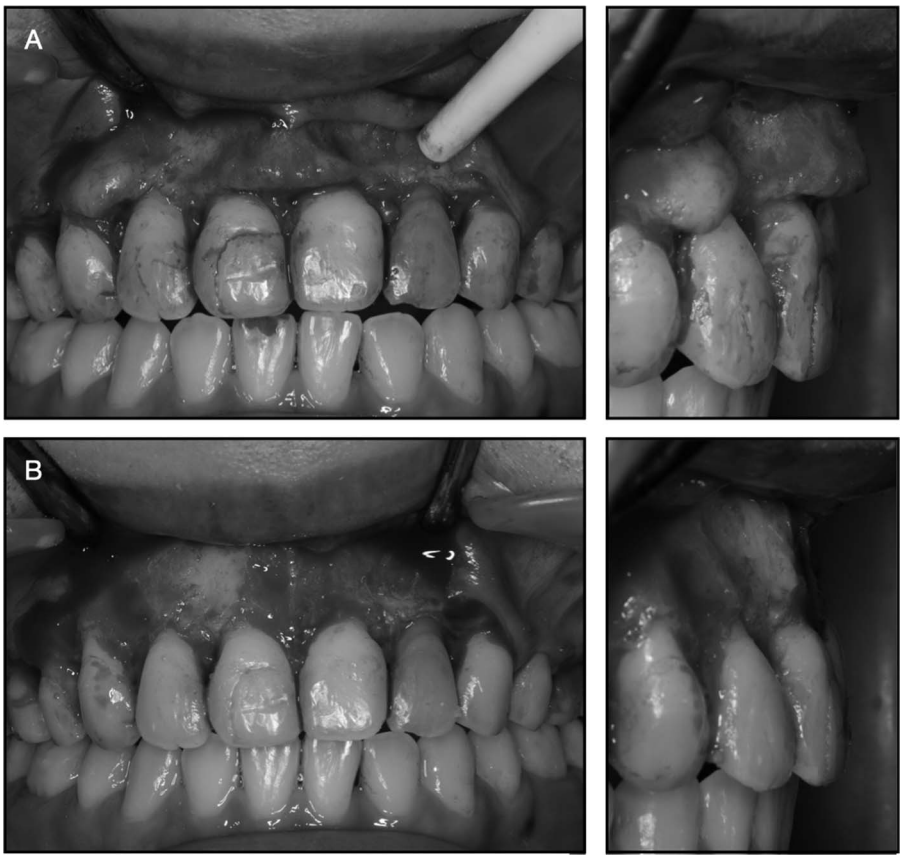

Figure 12. The residual bony protuberance was removed during periodontal surgery.

Figure 13. Progressive facial profiles in (A) pretreatment, (B) midtreatment (20th month), and (C) posttreatment and (D) two-year postretention.

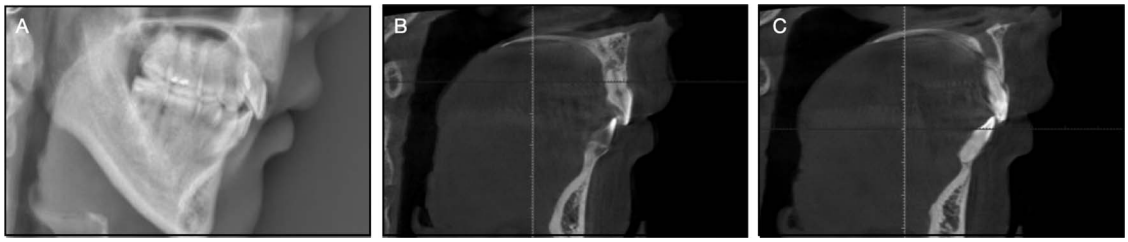

Figure 14. (A) The lateral cephalogram revealed the incisor roots behind the lingual cortical plate. (B) A sagittal section of the CBCT image exhibited intact lingual cortical plates behind the incisor roots. (C) The maxillary incisor roots were retracted behind the incisive canal. CBCT indicates cone beam computed tomography.

dentition, which intruded the mandibular posterior teeth, while the mandibular AS miniscrew intruded the mandibular incisors. However, it was challenging to design an effective balancing mechanism on the lingual side of the mandibular posterior teeth. To prevent buccal flaring of the mandibular posterior teeth, a lingual arch made of 0.028-inch SS wire was bonded. Additionally, the use of a heavier archwire with lingual crown torque

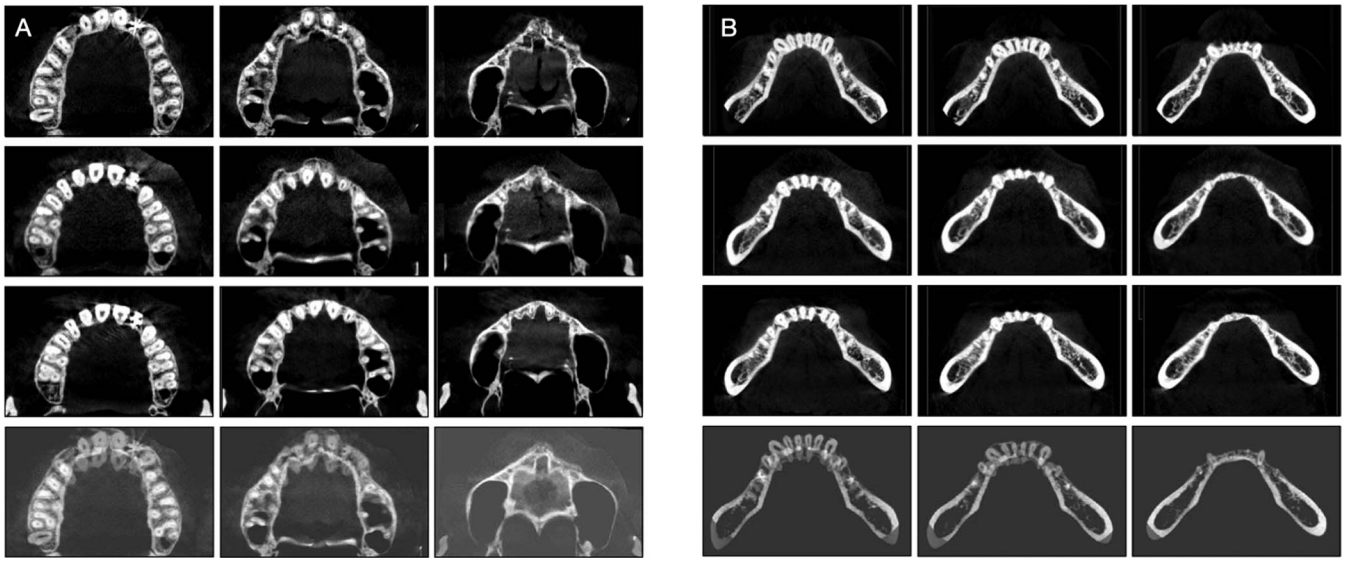

Figure 15. Despite the appearance of the (A) maxillary and (B) mandibular incisor roots outside the lingual cortical plate, the continuity of the lingual cortical plate remains clear. Axial sections of pretreatment (first row), posttreatment (second row), and follow-up CBCT were taken at the following levels: CEJ level (left column), 5-mm above CEJ (middle column), and 10-mm above CEJ (right column). Superimposition of pretreatment and posttreatment CBCT images show the extent of root movement (bottom row). CEJ indicates cemento-enamel junction.

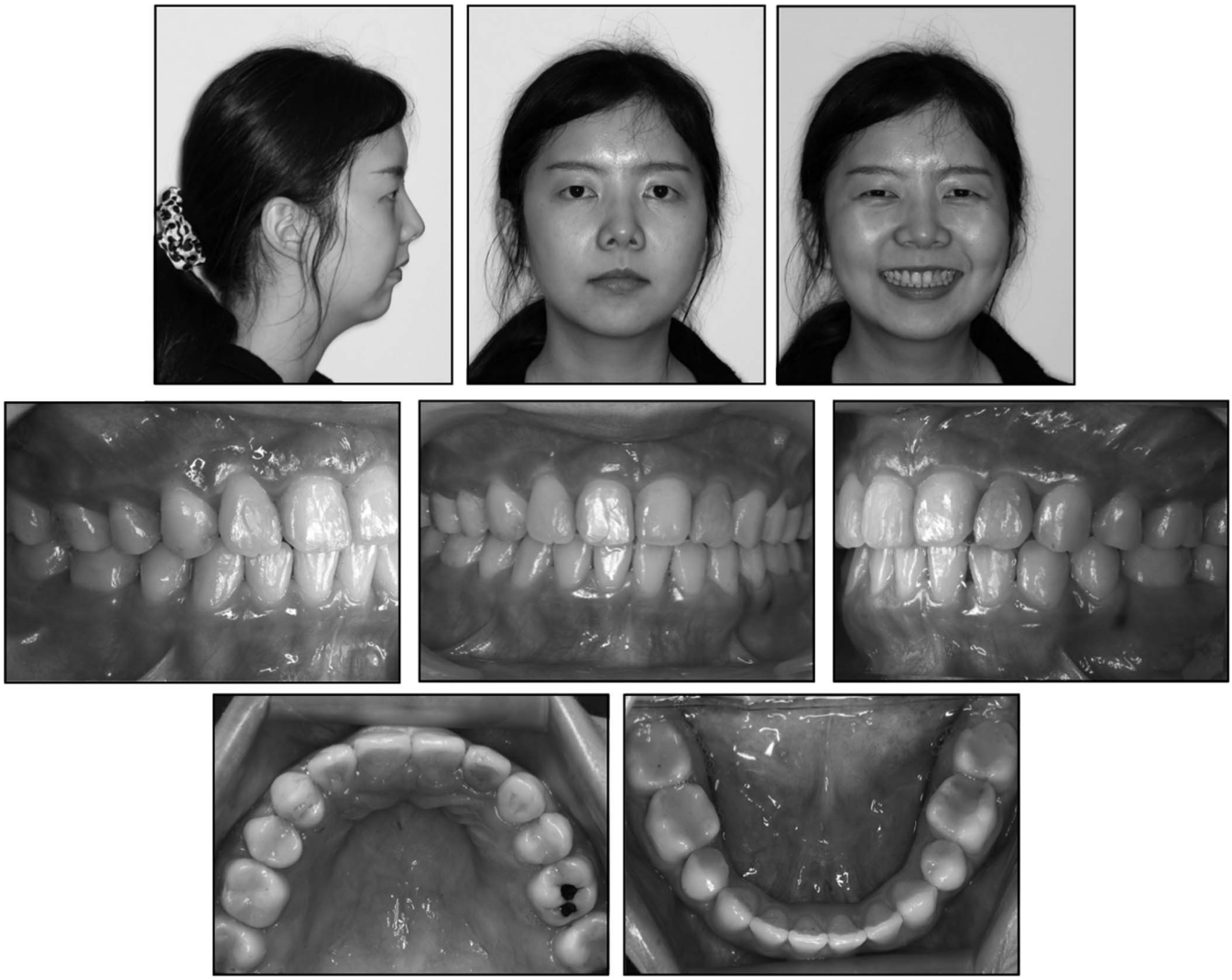

Figure 16. Postretention facial and intraoral photographs.

and constriction could be considered. The total treatment time was excessively long due to inadequate active vertical control in both arches at the beginning of treatment. Reporting of this case serves to further elucidate keys to successful active vertical control and helps improve treatment efficiency in the future.

It is crucial to assess the integrity of the palatal cortical plate behind the maxillary incisors and the lingual cortical plate behind the mandibular incisors, though periodontal evaluation showed normal results. CBCT images demonstrated complete bony coverage, despite the presence of prominent roots causing a scalloped bony contour, which made the incisor roots appear to be outside of the alveolar bone on the posttreatment cephalogram (Figures 14 and 15).[6] The size of the inicsive canal appeared to be large in the pretreatment CBCT image. The posttreatment CBCT image revealed the incisor roots had been retracted, bypassing the incisive canal. The incisive canal appeared very close to the labial cortical plate after treatment. This finding was not previously documented in existing research on the incisive canal.[13–15] Further studies are warranted to explore different scenarios and implications.

The stability of this treatment appeared to be good at the two-year retention check (Figure 16). In a study by Kang et al. on the stability of the vertical dimension after total arch intrusion, 41% relapse of the upper incisor and 30% relapse of the lower anterior facial height were reported.[16] Intrusion of the maxillary molars did not show significant relapse.

CONCLUSIONS

- With a combined intrusion and retraction force system supported by skeletal anchorage in both arches, and the application of an elastic hanging rack appliance supported by mid-palatal miniscrews, significant improvement of the facial profile

and occlusion can be achieved nonsurgically in a severe hyperdivergent Class II malocclusion patient with a retruded chin and lip incompetence.
- The importance of skeletal anchorage for sagittal, vertical, and torque control was emphasized for achieving optimal outcomes, providing an alternative option for patients who prefer nonsurgical treatment. Long-term follow-up is necessary to assess the stability of the treatment outcomes.

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