*Case Report*

# Combined distalization and lingual cortex remodeling during mandibular growth for facial profile improvement: a case report

**Hai-Van Giap[a]; Ji Yoon Jeon[a]; Joo-Hee Chun[a]; Kee-Joon Lee[b]**

**ABSTRACT**
Borderline crowding poses a challenge in deciding whether or not to prescribe premolar extraction. This case report describes the two-phase nonextraction orthodontic treatment of an 11-year-old girl with a hyperdivergent skeletal Class I pattern exhibiting anterior crowding and moderate lip protrusion. The initial phase of treatment included maxillary and mandibular expansion to correct the transverse discrepancy as an early intervention. Subsequently, comprehensive treatment was initiated at the age of 13 years, with fully erupted permanent second molars and growth potential remaining. Phase II treatment involved a second round of maxillary expansion, followed by simultaneous bimaxillary total arch intrusive distalization, using interradicular, temporary skeletal anchorage devices to correct dental crowding and improve the facial profile. Although the limited retromolar space posed a challenge to mandibular tooth distalization, gradual bone remodeling was observed in the lingual cortex of the mandibular body, enabling sufficient orthodontic tooth movement without noticeable side effects. After 4 years 3 months of treatment, her dental crowding was relieved, with significant improvement in the facial profile and proper occlusion. The treatment outcomes remained stable 2 years 4 months after retention. (*Angle Orthod*. 2024;94:353–365.)

**KEY WORDS:** Bone remodeling; Mandibular posterior lingual cortical plate; Simultaneous total arch distalization and intrusion

## INTRODUCTION

Decision-making regarding the appropriate treatment modality, timing for extraction, or use of nonextraction approaches is challenging when treating growing patients displaying dental crowding.[1] Nonextraction treatment is often preferred by patients. In such cases, achieving harmony between the patient's facial features and occlusion requires strategic alignment in the treatment plan.

To correct mild to moderate dental crowding and minimal skeletal discrepancy, expansion and molar distalization with temporary skeletal anchorage devices (TSADs) can be effective and predictable treatment approaches that do not require tooth extraction.[2] However, additional treatment options should be considered for improving the facial profile if dental crowding coexists with lip protrusion. Although unlimited orthodontic distalization is not possible given the posterior anatomical limit,[3,4] alveolar bone can regenerate and may potentially ensure the safety of this treatment.[5,6]

This case is that of an 11-year-old girl who presented with anterior crowding and lip protrusion. To correct dental crowding and improve the facial profile, the patient underwent two-phase nonextraction orthodontic treatment by maxillary expansion and bimaxillary total arch intrusive distalization. Although the limits of the posterior alveolar housing pose a challenge to total arch distalization in the mandible, this case report presents evidence of bone remodeling in the posterior cortex of the mandibular lingual cortical plate, allowing adequate distalization of the teeth with minimal adverse effects.

### Diagnosis and Etiology

An 11-year-old female patient complained of dental crowding and sought orthodontic consultation. No history of systemic diseases or developmental anomalies was recorded.

The first two authors contributed equally to this work.

[a] Postgraduate Student, Department of Orthodontics, Institute of Craniofacial Deformity, College of Dentistry, Yonsei University, Seoul, Republic of Korea.
[b] Professor, Department of Orthodontics, Institute of Craniofacial Deformity, College of Dentistry, Yonsei University, Seoul, Republic of Korea.
Corresponding author: Kee-Joon Lee, DDS, MSD, PhD, Professor, Department of Orthodontics, Institute of Craniofacial Deformity, Yonsei University College of Dentistry, No. 723, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Republic of Korea
(e-mail: orthojn@yuhs.ac)

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**Figure 1.** Pretreatment photographs.

The initial examination revealed dental crowding of 9 mm and 5 mm in the maxillary and mandibular dentition, respectively. Extraoral photographs revealed a convex profile with minor lip protrusion, and the dental midlines were coincident with the facial midline (Figure 1). Intraoral examination indicated a mixed dentition with mild Class II molar and canine relationships. The patient had rotated lateral incisors and ectopically erupted canines in the maxillary arch. The mandibular arch displayed a severe deep curve of Spee on both sides, with crowding of the anterior teeth. Additionally, a narrow maxillary arch was

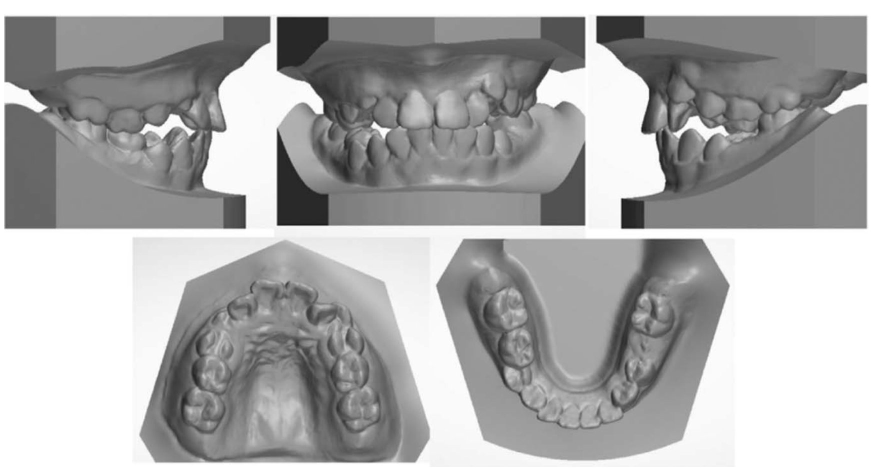

**Figure 2.** Pretreatment dental models.

**Table 1.** Cephalometric Analysis Measurements[a]

| Measurement | Value | | |
|---|---|---|---|
| | | Phase II Treatment | |
| | Phase I Treatment, Pretreatment | Pretreatment | Posttreatment |
| SNA angle (°) | 82.5 | 82.0 | 80.2 |
| SNB angle (°) | 78.0 | 79.0 | 81.0 |
| ANB angle (°) | 4.5 | 3.1 | −0.8 |
| Wits appraisal (mm) | −2.5 | −4.6 | −5.2 |
| SN to mandibular plane (°) | 36.3 | 42.5 | 38.7 |
| FMA (°) | 31.9 | 34.2 | 30.6 |
| Bjork sum (°) | 400.3 | 402.5 | 398.7 |
| AFH (mm) | 126.9 | 133.9 | 138.4 |
| U1 to SN (°) | 110.4 | 114.0 | 115.6 |
| IMPA (°) | 90.6 | 87.1 | 91.7 |

[a] AFH indicates anterior facial height. (SNA: Sella-Nasion-A point, SNB: Sella-Nasion-B point, ANB: A point-Nasion-B point, SN: Sella-Nasion, FMA: Frankfort-Mandibular plane Angle, IMPA: Incisor-Mandibular plane Angle)

noted, with compensated labiolingual inclinations of the maxillary and mandibular molars (intercanine and intermolar widths at the crown level of 35.7 mm and 44.4 mm in the upper arch and 29.0 mm and 39.6 mm in the lower arch, respectively). The overjet and overbite were 3 mm and 1.5 mm, respectively. The patient exhibited good oral hygiene (Figures 1 and 2).

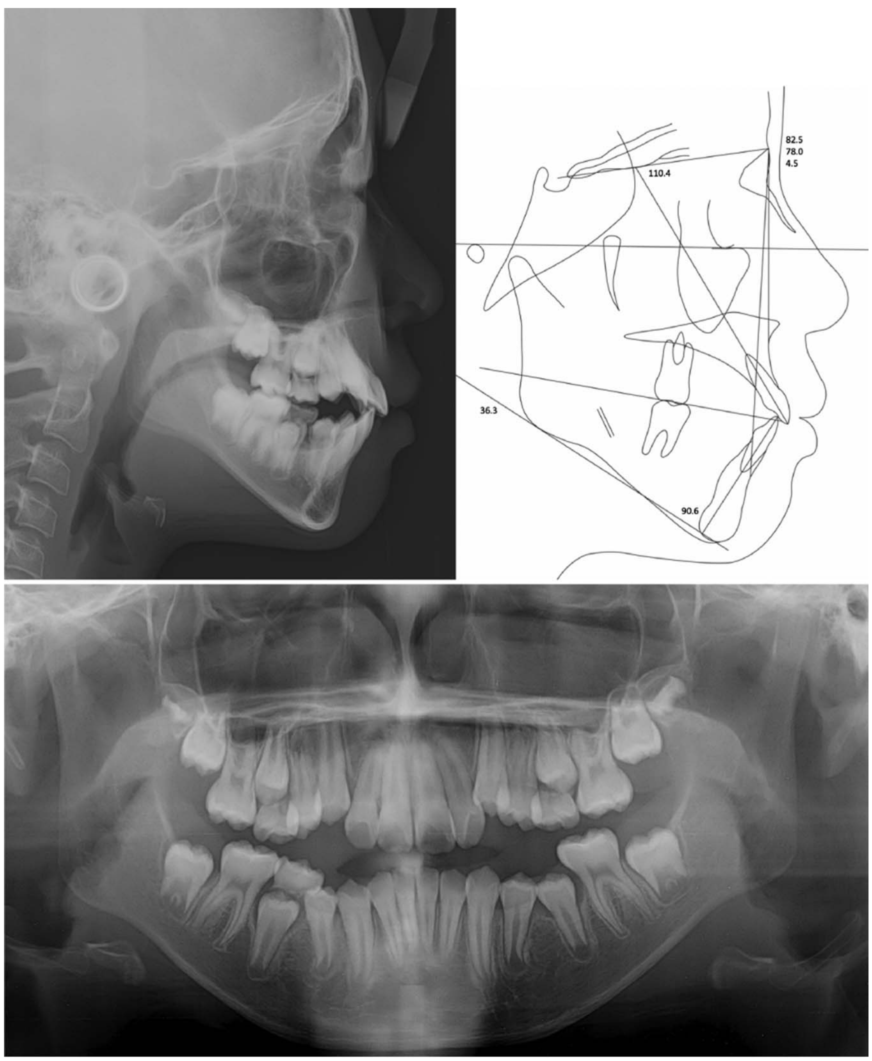


**Figure 3.** Pretreatment radiographs and cephalometric tracing.

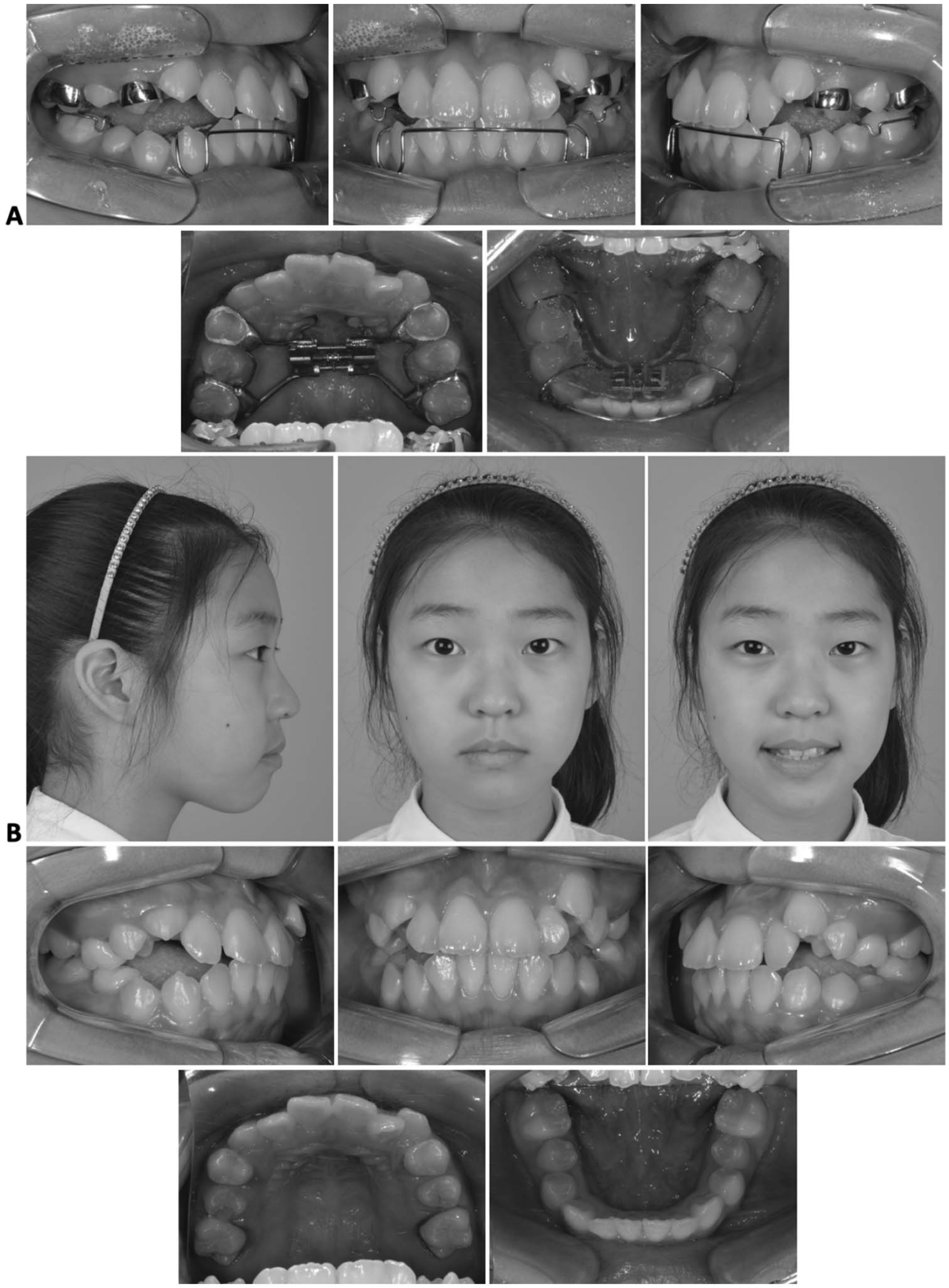


**Figure 4.** Images obtained during phase I treatment (A) and at the end of phase I treatment (B).

Lateral cephalometric analysis revealed a hyperdivergent Class I skeletal pattern with normal labiolingual inclination of the upper and lower incisors (Table 1). The patient was at the third to fourth cervical vertebral maturation stage, ie, circumpubertal (Table 1; Figure 3). A panoramic radiograph showed no congenitally missing teeth or signs of abnormal permanent tooth eruption (Figure 3).

Based on these findings, the patient was diagnosed with a hyperdivergent skeletal Class I malocclusion with a transverse discrepancy.

**Treatment Objectives**

The treatment objectives were to correct the dental crowding, establish proper occlusion, and improve the patient's facial esthetics.

**Treatment Alternatives**

Two treatment options were presented to the patient and her parents:

1. Extraction of four first premolars would address dental crowding and offer a quicker treatment with

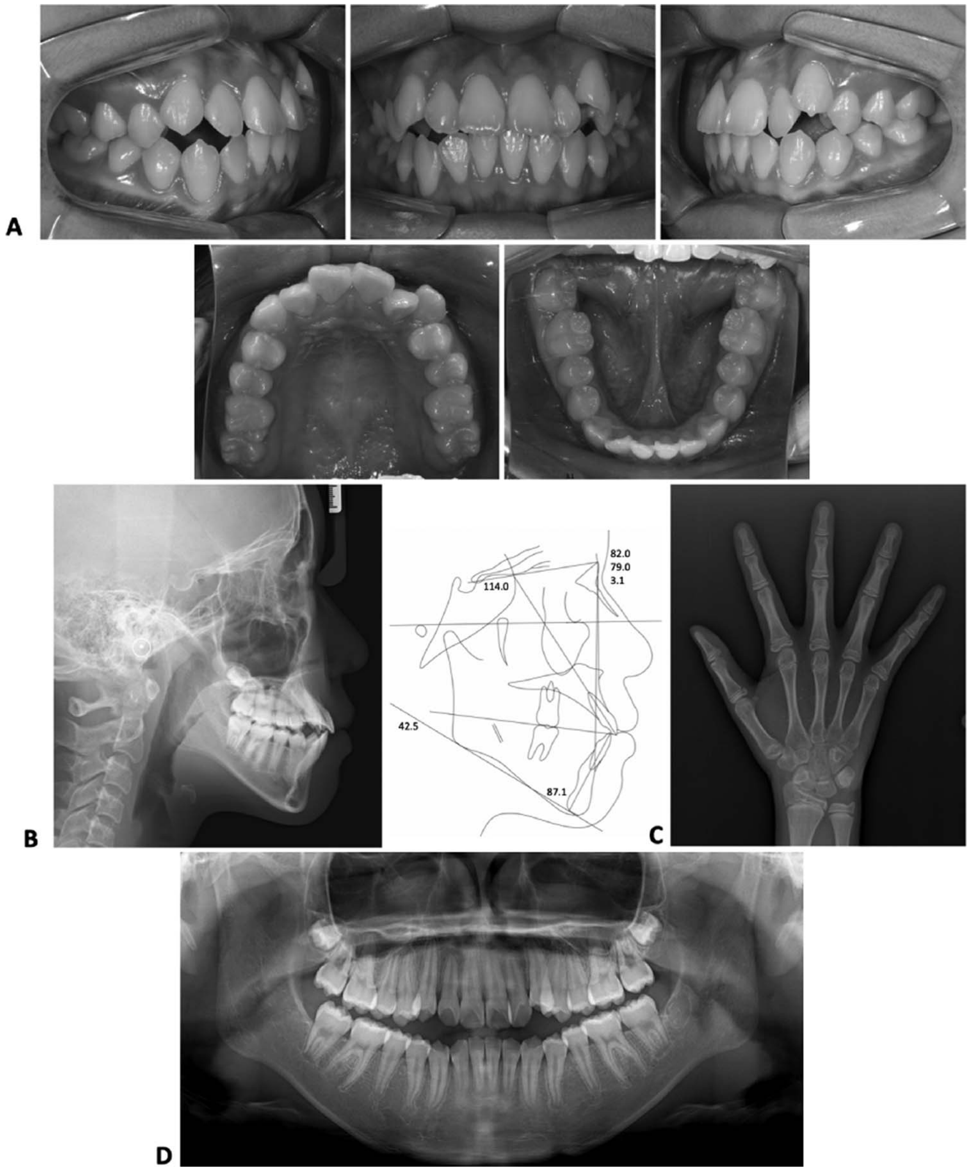


**Figure 5.** Radiographs and cephalometric tracing at the initiation of phase II treatment.

an improved facial profile. However, challenges might have arisen in closing the extraction spaces with upright incisors, particularly in the mandibular arch.

2. As the patient and her parents did not want tooth extractions, a nonextraction approach was considered to address the patient's chief complaint of dental crowding. Due to the patient's premenarchal status, this treatment plan would involve two phases, early intervention and comprehensive treatment, and the arch length deficiency would be resolved by transverse and anteroposterior arch expansion. However, this option required a longer treatment period, and potential side effects such as relapse and bony dehiscence had to be considered.[7]

## Treatment Progress

Miniscrew-assisted rapid palatal expansion (MARPE) was used for phase I treatment. Compared to conventional rapid palatal expansion, MARPE has been found to play a critical role in preventing the buccal displacement of anchor teeth within the basal bone during consolidation, ensuring periodontal safety with a more stable treatment outcome. Consequently, the negative side effects of maxillary expansion, including thinner buccal bone plates, changes in the crestal bone levels of the banded teeth, and short-term skeletal relapse, were eliminated.[7,8] A Schwartz appliance was used to address the space deficiency in the mandibular arch (Figure 4A).

The MARPE device was delivered with two TSADs (self-drilled type, 1.8 mm in diameter and 7.0 mm in length; Orlus, Ortholution, Seoul, Republic of Korea)

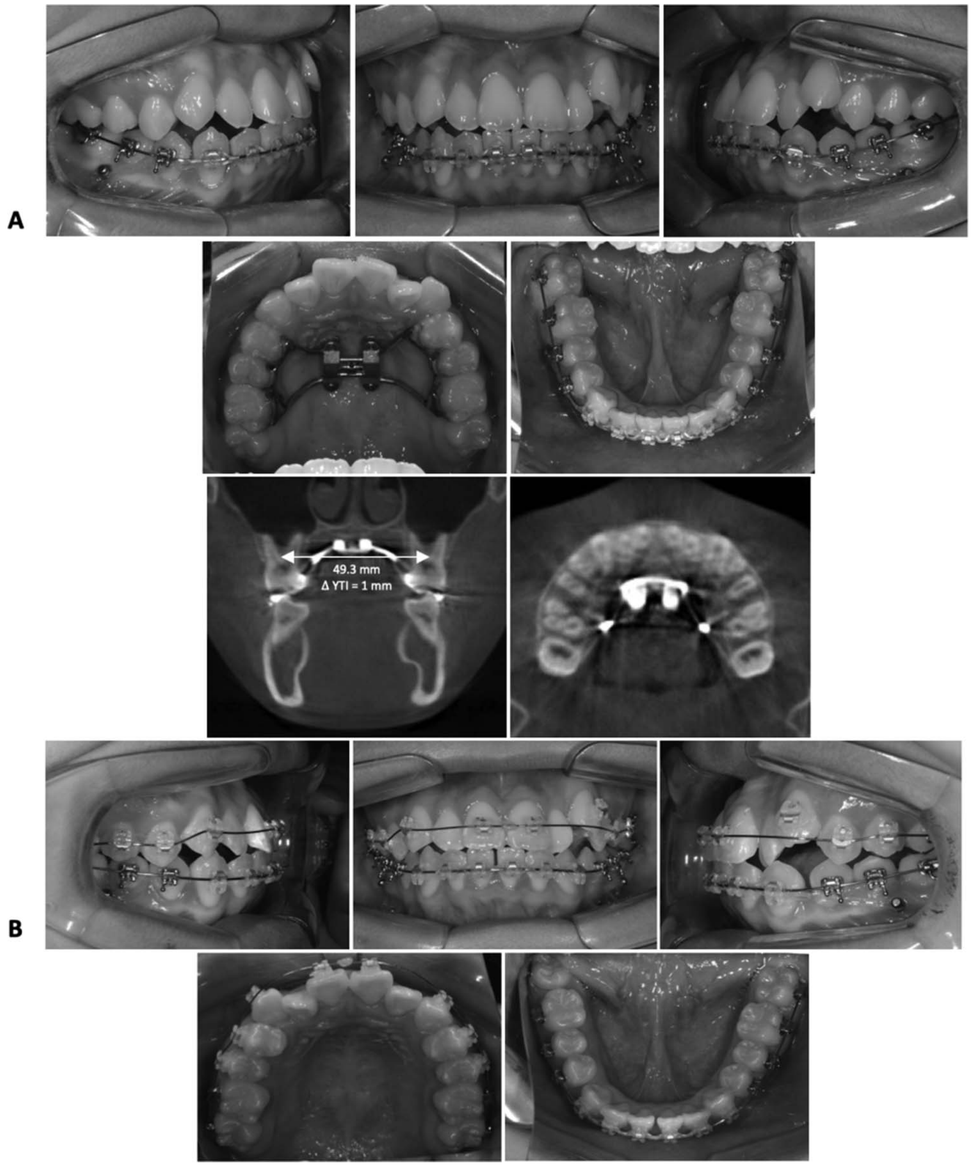


**Figure 6.** Intraoral photographs and CBCT images taken during phase II treatment. (A) Maxillary expansion. (B) Leveling and alignment.

on the anterior side of the jackscrew, and the first premolars and the first molars were utilized as anchor teeth (Figure 4A). The patient was instructed to turn the jackscrew one quarter-turn (0.2 mm/turn) once daily for the MARPE device and once every 5 days for the Schwartz appliance. After 14 days, midpalatal suture separation was confirmed by a periapical radiograph. Active expansion was performed for 40 days to ensure contact between the palatal cusps of the maxillary posterior teeth and the buccal cusps of the corresponding mandibular teeth, followed by 3 months of consolidation and bone formation.

Upon the completion of phase I, dental crowding was successfully reduced in both the upper and lower arches, with proper eruption of the second premolars. Comprehensive treatment was planned after the eruption of the second molars to monitor skeletal and facial growth (Figure 4B).

Phase II treatment was initiated when the patient was 13 years old. At this time point, aside from the chief complaint of dental crowding, the patient wanted to improve her facial esthetics.

The patient was rediagnosed with a hyperdivergent Class I skeletal and dental relationship with growth potential (Table 1; Figure 5). The arch length deficiencies were 5.5 mm and 2.5 mm in the maxilla and mandible, respectively, with normal labiolingual inclination of the incisors. Residual transverse deficiency with labiolingual inclination compensation of maxillary and mandibular molars was noted (Table 1; Figure 5).

The phase II treatment plan included maxillary expansion to regain space, followed by retraction of

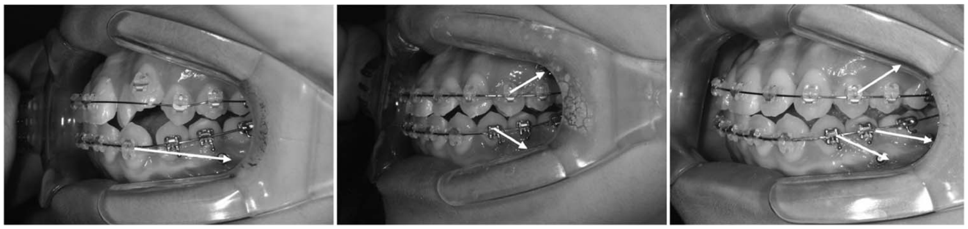

**Figure 7.** Force system involving linear horizontal and vertical vectors adjusted during phase II treatment.

the maxillary and mandibular dentition. In addition, to eliminate lip incompetency in this hyperdivergent, growing patient, it was imperative to prevent an excessive increase in the vertical dimension by active vertical control in the bimaxillary dentition.[9] Consequently, the target movements were posterosuperior displacement of the maxillary dentition and posteroinferior displacement of the mandibular dentition.

Comprehensive treatment was initiated with the second phase of maxillary expansion using the MARPE appliance. In the maxilla, MARPE was applied using two TSADs on the anterior and posterior sides of the jackscrew and was activated using the same protocol as the one described above for 5 weeks, followed by 6 months of consolidation. Postexpansion cone beam computed tomography (CBCT) images revealed an increase in the maxillary intermolar width to 49.3 mm; the maxillomandibular transverse differential index (Yonsei transverse index [YTI])[10] was noted as 1 mm (Figure 6A). Next, the maxillary and mandibular arches were aligned using a self-ligating bracket system with a 0.018-inch Roth prescription (Clippy-C, Tomy Inc, Katsushika, Japan) (Figure 6). TSADs (1.8 mm in diameter and 7.0 mm in length; Orlus, Ortholution, Seoul, Republic of Korea) were placed in the buccal interradicular space between the second premolar and the first molar in each

**Figure 8.** Posttreatment photographs.

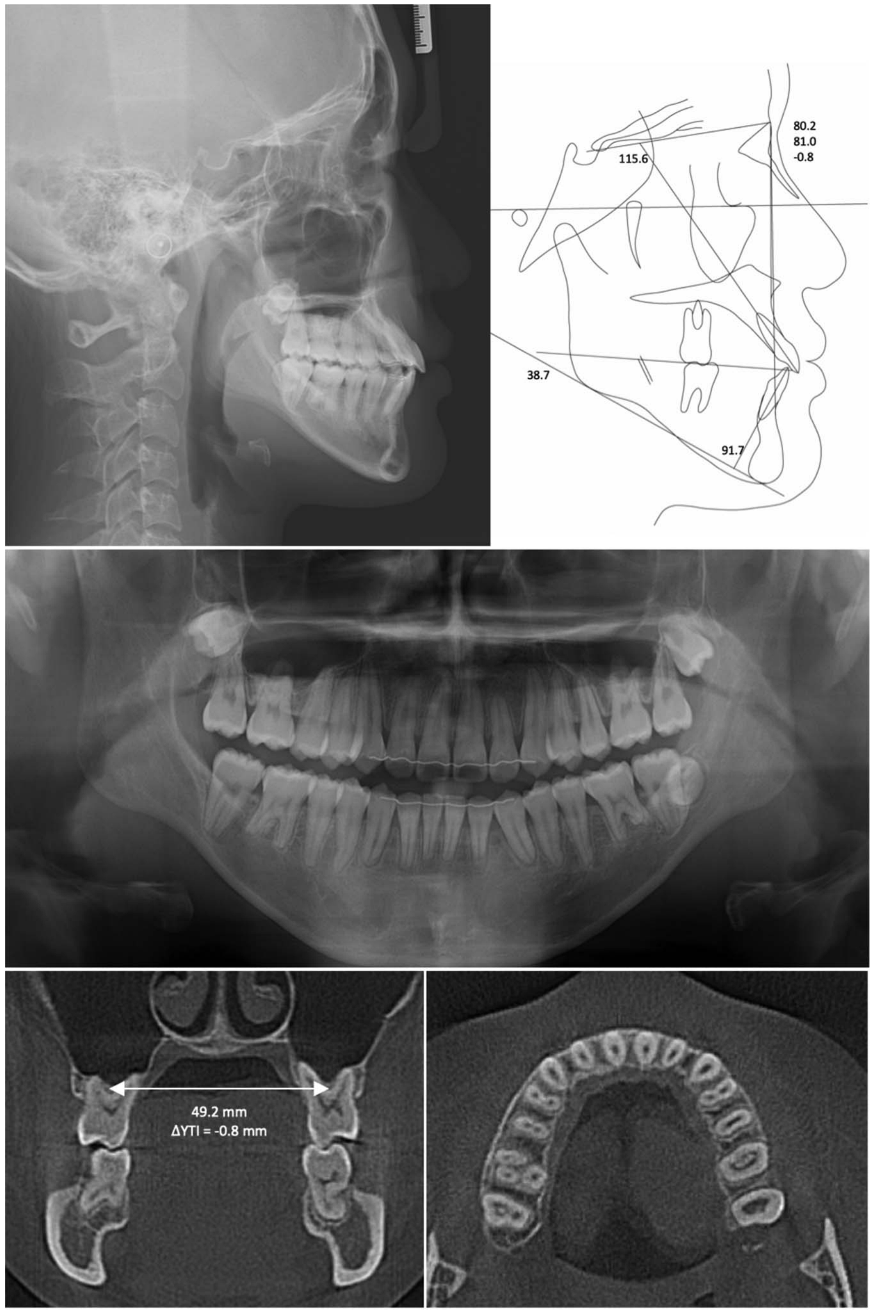


**Figure 9.** Posttreatment radiographs and cephalometric tracing.

quadrant (Figures 6B and 7). Oblique upward lines of force of 200 g were applied along with stiff 0.016 × 0.022-inch stainless steel working wires for simultaneous bimaxillary total arch intrusion and distalization. The amount and direction of the total arch movement and torque of the anterior teeth were closely monitored and controlled throughout the treatment.[11] During active treatment, TSADs were strategically relocated to prevent root interference while achieving adequate distal tooth movement.[12] In the mandible, bilaterally dual TSADs were later used to enhance force control and optimize total arch movement while minimizing occlusal plane rotation. Dual TSADs have been reported to lead to a resultant force vector closer to the center of resistance of the mandibular dentition, thus increasing the efficiency of the treatment process (Figure 7).[13]

After 43 months of active treatment, anteroposterior movement of the teeth was completed, and the finishing stage lasted for 8 months, with intermaxillary box elastics in use to seat the occlusion. The appliances and TSADs were removed after 4 years 3 months of treatment, and fixed lingual retainers were


**Figure 10.** Serial CBCT images of the mandibular incisors at the initiation of phase II (A) and posttreatment (B).

delivered in both arches. A maxillary circumferential retainer was delivered with instructions for all-day wear for the first 6 months, followed by nighttime use thereafter (Figure 8).

## Treatment Results

The second phase of nonextraction treatment successfully resolved the patient's chief complaint regarding dental crowding and her facial profile while significantly eliminating lip incompetence. The occlusion was appropriately aligned with adequate overjet and overbite, and the dental midline was coincident with the facial midline, resulting in stable occlusion. At the end of the treatment, no noticeable gingival recession or tooth mobility was observed; however, minor root resorption in the mandibular incisors and first molars was noted and monitored (Figures 8 through 10).

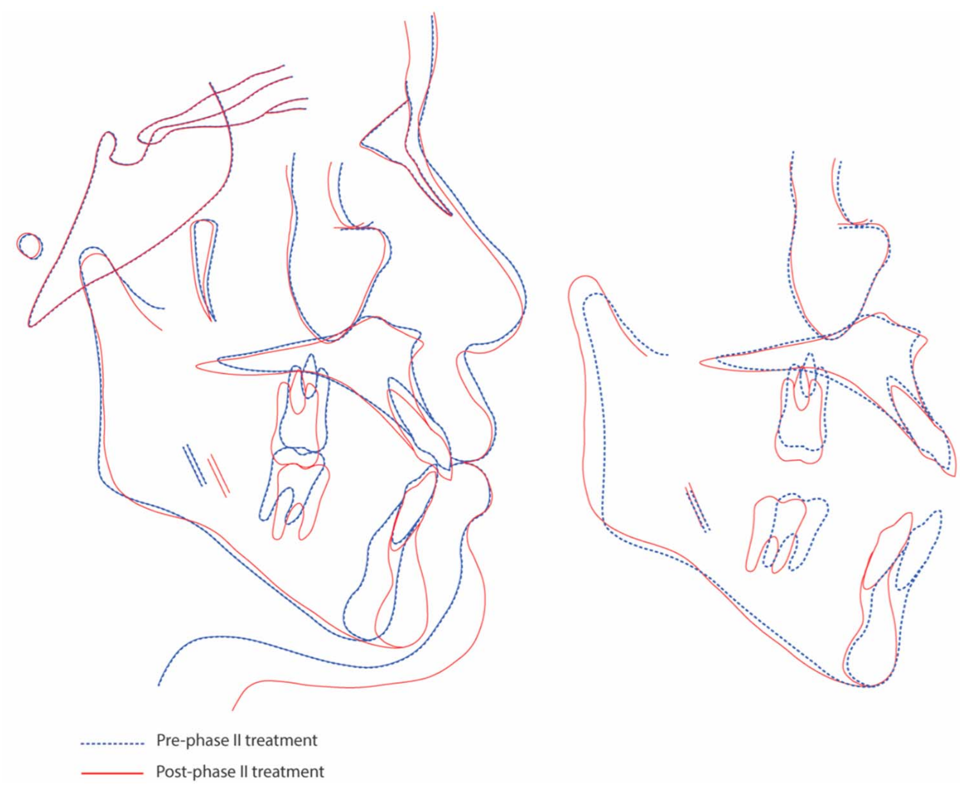


**Figure 11.** Superimposition of the pre– and post–phase II treatment tracings.

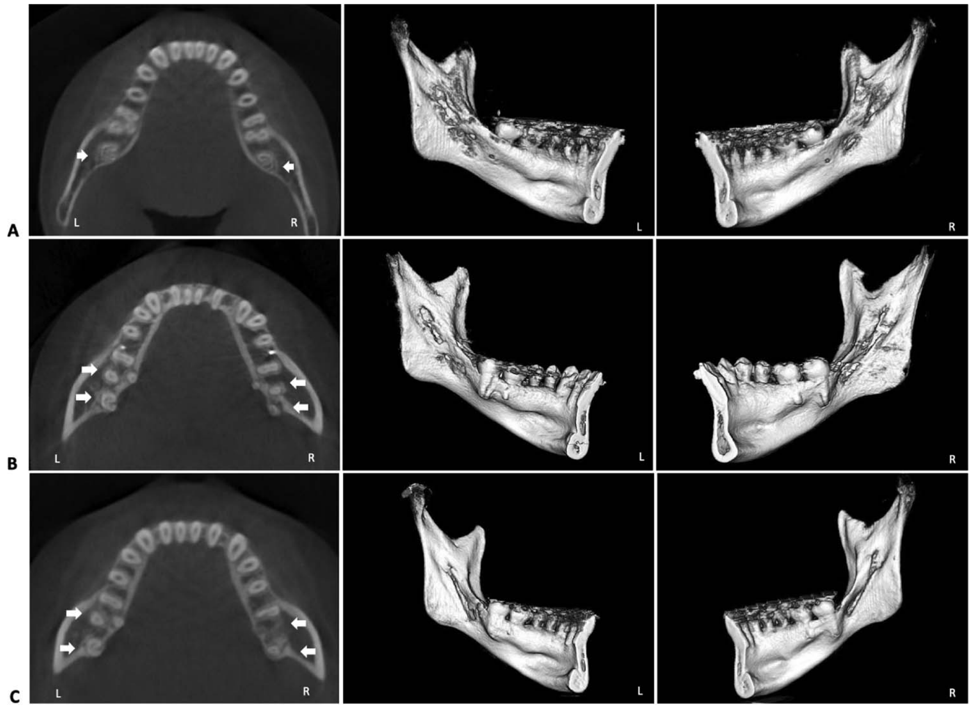


**Figure 12.** Serial CBCT images and three-dimensional reconstruction images taken during phase II treatment. (A) At initiation. (B) During mandibular tooth distalization. (C) Posttreatment.

Cephalometric analysis and superimposition revealed limited vertical growth with a counterclockwise rotation of the mandible. Her chin prominence increased significantly, contributing to the improvement of her facial profile. The maxillary incisor was proclined slightly labially, while the mandibular incisor had a normal labiolingual inclination. The mandibular dentition was distalized by 5 mm and intruded by 2 mm (Table 1; Figures 8 through 11).

Posttreatment CBCT revealed stable transverse expansion with no obvious adverse effects (Figure 9). Serial CBCT images and three-dimensional reconstruction images taken during phase II treatment revealed significant bone remodeling surrounding the mandibular molars (Figure 12). During distalization, bone dehiscence was observed in the lingual alveolar bone of the mandibular molars. However, no root exposure or gingival recession was observed (Figure 12B). The images in Figure 12B and C, obtained at an interval of 1 year 9 months, exhibit the bone regeneration ability of this growing patient. At the end of the treatment, the lingual surfaces of the roots were recovered to some extent, with new alveolar bone being present (Figure 12C).

At 2 years 4 months after retention, the results remained stable (Figure 13). The stability of transverse expansion was confirmed (intercanine and intermolar widths at the crown level of 46.9 mm and 58.3 mm in the upper arch and 37.7 mm and 47.8 mm in the lower arch, respectively).

## DISCUSSION

One of the primary goals of orthodontic treatment is to achieve a harmonious balance between the patient's facial features and occlusion, which necessitates appropriate orthodontic tooth movement. However, anatomical limitations, such as the cortical plate of the alveolar bone, can restrict the extent of tooth movement.[3,4] Excessive movement into the cortical bone can have negative consequences, including bone dehiscence and root resorption. The occurrence of palatal and lingual alveolar bone dehiscence during the retraction of maxillary and mandibular anterior teeth has been documented by several authors, and the potential for recovery is debatable.[5,14–16] The ability of bone remodeling in the mandibular posterior lingual cortical plate to facilitate effective total arch distalization with minimal adverse effects in a growing patient has not been previously reported.

Previous studies have demonstrated the possibility of cortical bone remodeling and bone apposition following orthodontic tooth movement.[5,6,15,17–19] Some factors are considered favorable for bone regeneration. According to previous studies, the biotype of the labiolingual dimension of the gingiva is a significant morphological factor in determining the protection of teeth from possible inflammation or trauma caused by bone dehiscence.[5,18–20] Bae et al.[5] assumed that if the gingival biotype was thick and healthy with a potential periodontal ligament, regeneration of alveolar bone could be observed regardless of the degree

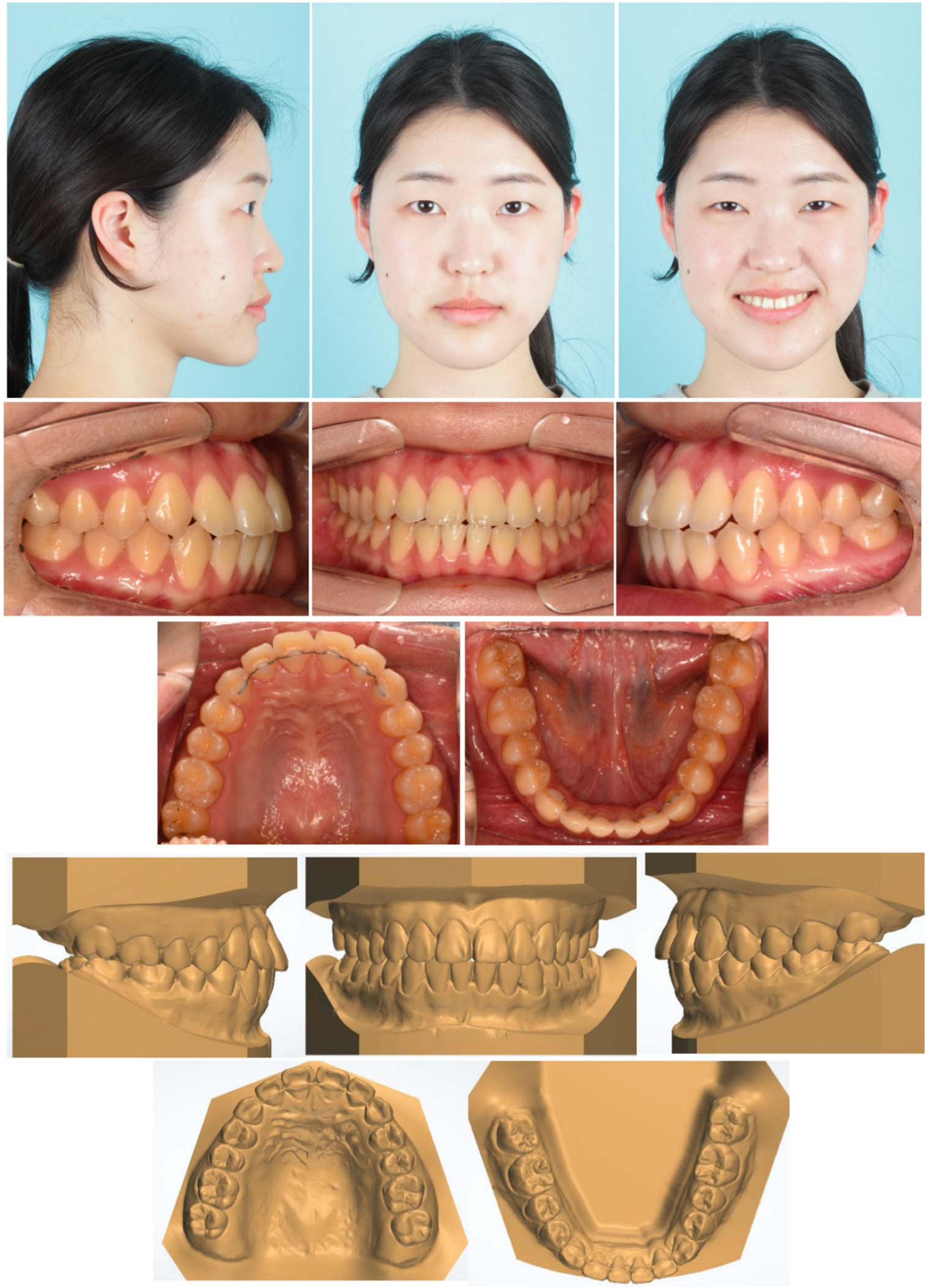

**Figure 13.** Facial and intraoral photographs and dental models obtained at the follow-up visit, 2 years 4 months after retention.

of tooth movement. Additionally, long-term light-force activation and bodily tooth movement were proposed to allow optimal adaptation of the alveolar bone, reducing the risk of adverse effects.[6,17,21] However, it seems difficult to detect bone regeneration immediately after dehiscence occurs during incisor retraction, and a recovered root surface with a well-defined cortical plate has been reported several years after the termination of active treatment.[5] Growth potential can be a favorable factor that can aid in achieving efficient orthodontic tooth movement by more active cell proliferation, differentiation, and bone formation in younger patients than in adults.[18,19] In this patient, interim bone dehiscence occurred on the lingual surface of the mandibular molars with minor root resorption in the mandibular first molars during total arch distalization. However, significant bone regeneration around the exposed root surface was observed at the end of the treatment, without any tendency toward root exposure, gingival recession, or tooth mobility

(Figure 12). The successful adaptation and regeneration of the alveolus surrounding the distal root of the second molars, followed by root movement, were noted. Eventually, considerable distalization of the mandibular dentition was successfully achieved with minimal side effects due to the regeneration potential of this growing patient (Figures 8 and 9). Nevertheless, it must be considered that this type of remodeling may be subject to individual response, which may be limited in adult patients.[17–19,22]

One of the most marked changes in this patient was the increase in chin prominence. Despite the patient's hyperdivergent growth pattern, simultaneous bimaxillary total arch intrusion effectively suppressed vertical dentoalveolar growth within the basal bone, resulting in the redirection of the growth pattern with counterclockwise rotation of the mandible and increased chin prominence. Eventually, vertical facial growth was restricted.[9,11] Skeletal growth modification, combined with coincident, normal vertical growth of the lip, effectively eliminated lip incompetence and improved the patient's facial profile without performing extractions (Table 1; Figures 8 through 11).

Active treatment took 4 years 3 months and resulted in significant improvements in the patient's dental crowding, facial esthetics, and occlusion (Figure 8). The age of the patient at treatment completion, 17 years for this patient, is considered to be an important factor in ensuring the long-term stability of the treatment outcome as insignificant growth would be expected thereafter (Figure 9).[17] The patient expressed satisfaction with the results, and the 2-year 4-month follow-up records confirmed the stability of the treatment results (Figure 13). The patient is undergoing retention follow-up, and the third molars may be extracted in a timely fashion before becoming unfavorably impacted.

## CONCLUSIONS

- Gradual bone remodeling in the mandibular posterior lingual cortical plate of a growing patient enabled adequate total arch distalization despite anatomical limitations.
- The alveolar bone surrounding the dental roots was properly remodeled as an adaptation process, which consequently resulted in the successful distalization of the mandibular dentition with minimal side effects.
- The implementation of light-force and strategic-force systems to induce bodily tooth movement, along with adequate skeletal growth, could be a critical factor for success in such cases.

## ACKNOWLEDGMENT

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