*Case Report*

# Recovery of multiple impacted maxillary teeth in a hyperdivergent Class I patient using Temporary Skeletal Anchorage Devices and augmented corticotomy

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**ABSTRACT**
Treatment of multiple impacted teeth is challenging. Three-dimensional treatment planning can help in delivering a better outcome. This case report presents a patient with an incomplete dental transposition between the canine and lateral incisor of the maxillary right side associated with the impaction of a dilacerated right central incisor. Using a two-stage surgical exposure and augmented corticotomy, the patient's occlusion and smile esthetics were significantly improved, and Class I occlusal relationships with optimal overjet and overbite were achieved after 50 months of orthodontic treatment. Thirty-month posttreatment records revealed a stable result. (*Angle Orthod.* 2018;88:107–121)

**KEY WORDS:** Distalization; Impaction; C-tube; Corticotomy; Mini-tube appliance

## INTRODUCTION

Tooth impaction in the maxillary anterior region is a common dental anomaly. Genetic and local factors are associated with the etiology.[1,2] Previous studies[3,4] have shown that when there is an impacted central incisor, the ipsilateral lateral incisor root is displaced about 5 mm distally compared with the contralateral lateral incisor's normally positioned root. Wasserstein et al.[5] and Brin et al.[6] presented cases with an impacted maxillary central incisor and incomplete transposition between the canine and the lateral incisor due to trauma of the incisor region.

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For multiple impactions, clinicians typically use a three-dimensional evaluation of tooth positions, developing a treatment sequence of surgical exposures, appropriate anchorage, and appropriate biomechanics. Multiple impactions increase the complexity of orthodontic treatment and lengthen the overall treatment period.[7]

This case report describes a patient with an incomplete dental transposition between the canine and lateral incisor of the maxillary right side associated with an impaction of the dilacerated right central incisor. Two stages of surgical crown exposure, orthodontic traction, and augmented corticotomy were used to successfully move the multiple impacted teeth into proper position.

### Diagnosis and Etiology

An 11-year-old boy came in with a complaint of delayed eruption of the maxillary right anterior teeth and a high canine (#23). He had a history of dental trauma involving intrusion of one or more deciduous teeth when the patient was 2 years old. He was referred by an orthodontist in the Philippines to the authors' hospital for subsequent treatment.

Pretreatment facial photographs showed a straight profile, chin slightly deviated to the right side, and insufficient maxillary incisor exposure. Intraoral examination showed a late mixed dentition with noneruption of teeth 11 through 13, end-to-end molar relationship, severe anterior crowding, a high canine (#23), and

**Figure 1.** Pretreatment facial and intraoral photographs.

retention of teeth 53 and 75. The patient presented with bonded brackets. Some had debonded (Figures 1 and 2).

The diagnosis was a hyperdivergent skeletal Class I, with multiple impactions, facial asymmetry to the right side, and dental Class II occlusion with upright maxillary and mandibular incisors (Figure 3A,B; Table 1).

The panoramic radiograph and cone-beam computed tomography image (CBCT) demonstrated the complex impacted state of teeth 11 through 13 and insufficient alveolar bone levels in the maxillary anterior. Tooth 11 was impacted, with a 90° distal-in rotation, showing its crown toward the palatal surface and its root apex just below the floor of the nose and in the cortical bone of the anterior nasal spine (ANS). The root of tooth 11 was dilacerated with complete apex formation.

The morphology and position of tooth 11 were easily visible even in the lateral cephalometric radiograph. Teeth 12 and 13 were in incomplete transposition, with a palatal position of tooth 12 and labial position of tooth 13. The root apex of tooth 12 was also dilacerated (Figures 3C and 4).

## Treatment Alternatives

The following treatment options were considered:

- Extraction of the impacted anterior teeth, orthodontic treatment, and restoration with prostheses or implants when growth rate declined or stopped.
- Orthodontic treatment to open space followed by recovery of the impactions with the closed eruption technique.

The family selected option 2: to bring the impacted teeth into the arch. It was assumed that preservation of all the anterior teeth would provide much more benefit

**Figure 2.** Pretreatment dental casts.

to this young patient over his life span. Extremely thin alveolar bone around the lower anterior dentition was another reason not to extract premolars, despite possible proclination of the anterior teeth during treatment. The infrabony defects around the impacted teeth could be improved by orthodontic tooth movement and associated alveolar bone growth. The patient and his parents were informed of the possibility of subsequent bone graft treatment in case of a remaining bone defect.

### Treatment Objectives

The treatment objectives were to (1) recover the impactions, bringing along the alveolar bone, (2) correct the transposition of the lateral incisor and canine, (3) relieve the crowding and procline the maxillary and mandibular incisors, (4) correct the maxillary and mandibular dental midlines, and (5) establish proper occlusion.

### Treatment Progress

After debonding the preexisting appliances, new ceramic self-ligation brackets (0.22-inch, Roth prescription; Quickler, Forestadent, Pforzheim, Germany) were placed on the maxillary posterior and mandibular teeth. To distalize the maxillary posterior teeth, two C-tube orthodontic microplates (Jin Biomed Co, Bucheon, Korea) with extension arms and three fixation screw holes were placed in between the maxillary second premolar and first molar.

Adequate space was achieved for aligning the maxillary anterior teeth and for recovery of the impacted teeth. Afterward, the rotated left lateral incisor and canine were aligned by means of 0.016-inch nickel-titanium (Ni-Ti) archwires. Leveling was continued with a $0.016 \times 0.025$-inch rectangular Ni-Ti archwire, followed by a $0.016 \times 0.022$-inch rectangular stainless-steel (SS) archwire.

Bracket slots were aligned to accept a $0.019 \times 0.025$-inch SS archwire. Then a closed eruption surgical exposure was performed. As a result of the severe displacement of the incomplete transposition and three-dimensionally entangled impactions, two stages of surgical exposure were necessary. The first stage was to expose the lateral incisor and canine (Figure 5). The incisions were made on the labial surface in the maxillary anterior region, raising full-

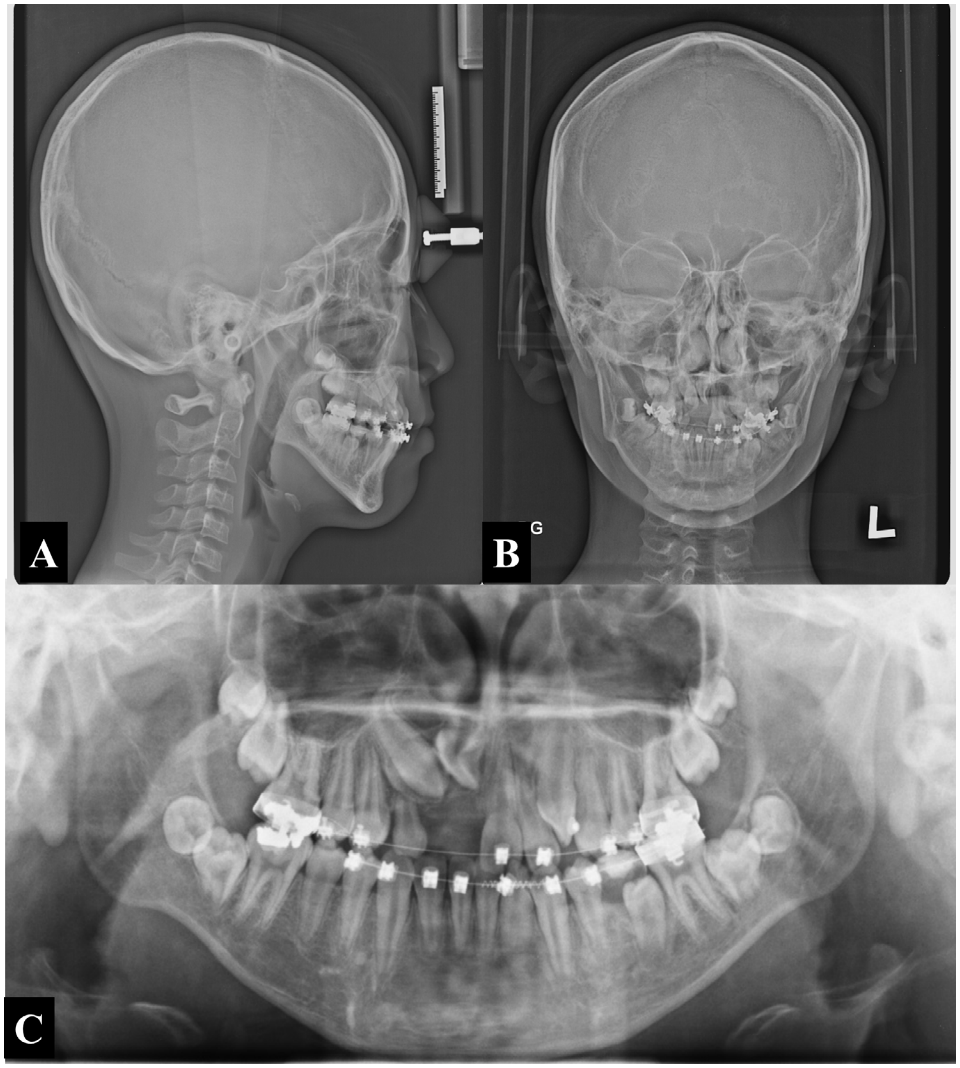


**Figure 3.** Pretreatment radiographs: (A) lateral cephalogram; (B) postero-anterior cephalogram; and (C) panoramic radiograph.

thickness flaps. The palatal surface was minimal. Buttons with pre-secured ligature wires were bonded to the palatal surface of the lateral incisor and the labial surface of the canine. To reinforce the archwire, an orthodontic mini-plate with extension arms and two fixation screw holes was placed in the maxillary central area. The buttons with ligature wires were tied to the main archwire, and the orthodontic mini-tube was connected to the main archwire passively by a rigid wire and resin. To use the closed-eruption technique, the flaps were repositioned and sutured, ligature wires protruding through the mucosa. The soft tissues healed in 2 weeks, and traction of the impacted teeth began. First, the orthodontic force was applied to move the lateral incisor mesially and the canine distally (Figure 6). Ten months later, the crowns of the impacted teeth appeared, enabling correction of transposed lateral incisor and canine.

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

| | Ave (Male) | PreTx | PostTx | 30-Months Retention |
|---|---|---|---|---|
| SNA, ° | 82.5 | 76 | 75 | 75 |
| SNB, ° | 80.4 | 70 | 72 | 72 |
| ANB, ° | 2.1 | 4 | 3 | 3 |
| Wits appraisal, mm | −2.24 | −2 | 1.5 | −1 |
| SN to MP, ° | 30.3 | 51 | 51 | 50 |
| U1 to SN, ° | 107.8 | 90 | 106 | 110 |
| L1 to MP, ° | 96.3 | 73 | 75 | 78 |
| Upper lip to E-line, mm | −1 | −2 | −2 | −2 |
| Lower lip to E-line, mm | 1 | 3 | 0 | 1 |

[a] Ave indicates average; PreTx, pretreatment; and PostTx, posttreatment.

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The second stage of surgical exposure was performed for traction to the central incisor. A palatal incision and full-thickness mucoperiosteal flaps were performed. A button with a pre-secured ligature wire was bonded to the labial surface of the 90° rotated


**Figure 4.** Pretreatment three-dimensional cone-beam computed tomographic images of the maxillary anterior region: (A) sagittal images; (B) axial image; and (C) frontal image.

**Figure 5.** Intraoral photo at 7 months after initiating treatment. First surgical exposure and lingual button bonding of teeth 12 and 13 were performed.

central incisor. After healing, traction of the central incisor began. To apply a proper vertical force vector, the C-tube plate with extension arms and two fixation screw holes was placed in the mandibular central area (Figure 7). After 14 months of traction, the crown of the rotated central incisor emerged. Buttons and brackets on the incisors and canine were replaced by mini-tube appliances (MTA, Hubit Co, Seoul, Korea) (Figure 8A). The teeth were aligned by continuous light force with the mini-tube appliance and a 0.014-inch Ni-Ti archwire (Biostarter, Forestadent Co, Pforzheim, Germany) (Figure 8).

After the central incisor was de-rotated, the patient was referred to the periodontist for bone augmentation of the maxillary right anterior region. Demineralized bone graft (Bio-Oss, Geistilich Pharma, Wolhusen,

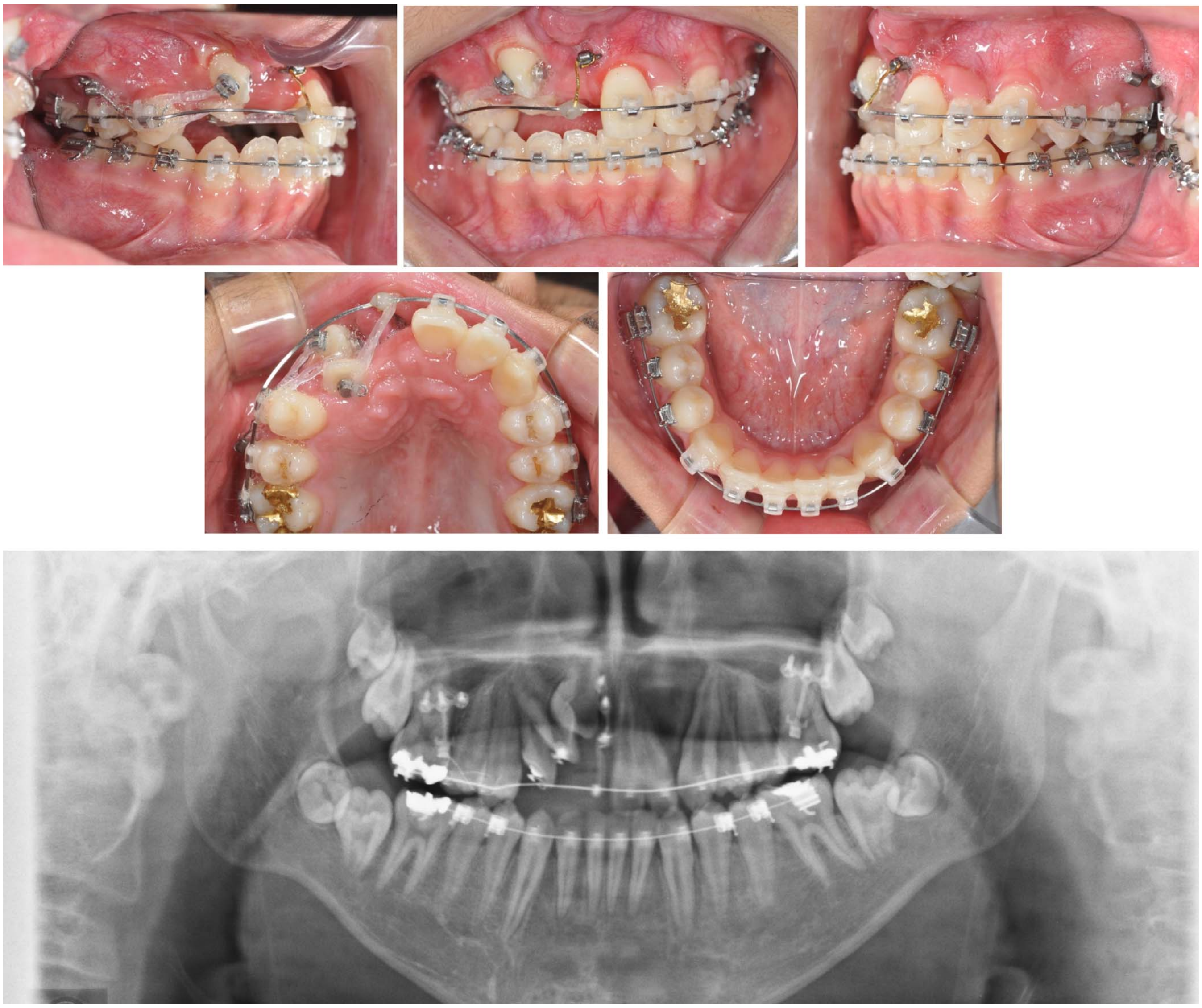

**Figure 6.** Intraoral photos and panoramic radiograph at 7 months after starting traction of teeth 12 and 13.

Swiss) and a collagen membrane (Genoss Co, Suwon, Korea) were used to cover any fenestrations or thin plate to increase the bony support for the teeth and the overlying soft tissues. The flap was repositioned and sutured, and 2 weeks later orthodontic tooth movement resumed.

At 40 months of treatment, the three impacted teeth were brought closer to alignment. For torque control of the lateral incisor, a high-torque prescription bracket (0.22-inch, 13°; Damon-Q, Ormco Co, Orange, Calif) was bonded upside down. To apply the torqueing moment, a 0.019 × 0.025-inch beta-titanium alloy archwire with an L-loop was inserted (Figure 9). Leveling was performed with a 0.019 × 0.025-inch SS archwire in both arches. At completion, the brackets and orthodontic microplates were removed, and fixed retainers were placed on the maxillary and mandibular anterior teeth. Total treatment time was about 50 months.

## Treatment Results

An incomplete transposed canine and impactions of the right lateral incisor and central incisor were successfully corrected into proper alignment within healthy periodontium using a combination of serial surgical exposures and bone augmentation. Intraoral examination and a dental cast analysis showed a Class I canine and molar relationship with proper overbite and overjet. A subtle torque discrepancy between the central incisors and lateral incisors was observed. The exposed anterior teeth had acceptable gingival contour, except for the right lateral incisor. During treatment, the patient had compromised oral

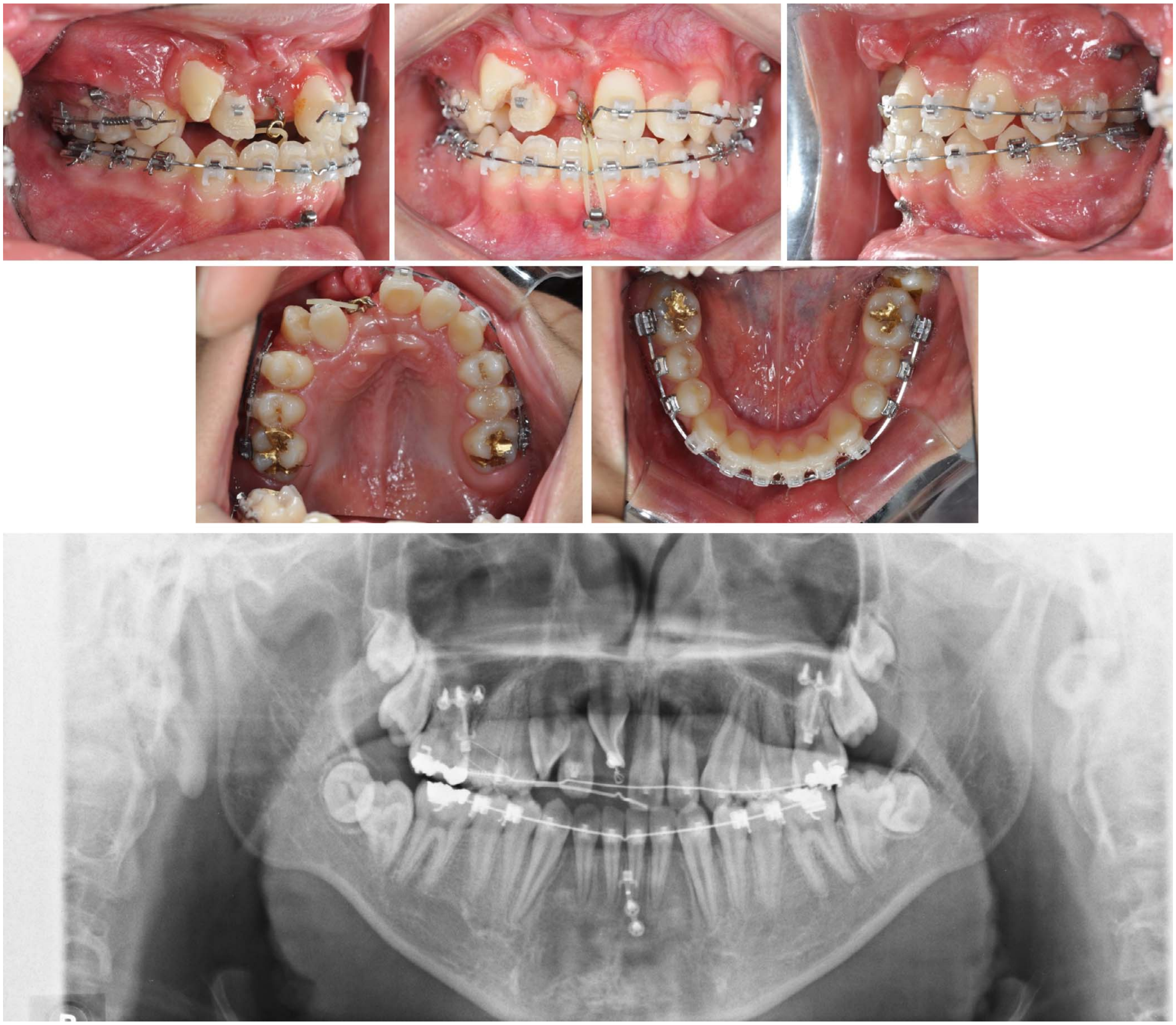

**Figure 7.** Intraoral photos and panoramic radiograph at 18 months after second surgical exposure and lingual button bonding of tooth 11.

health, which resulted in dental caries on several teeth (Figures 10 and 11).

The posttreatment lateral cephalometric analysis showed sagittal and vertical growth with skeletal changes (ANB, 3°; SN-MP, 51°). The inclination of the maxillary incisors was slightly proclined (U1 to SN, 106°) and was the same as the inclination of the mandibular incisors (IMPA, 75°). The patient's facial profile was maintained (Figure 12A; Table 1).

The panoramic radiograph at posttreatment showed increased vertical alveolar bone levels in the maxillary anterior region compared to the initial panoramic radiograph, a finding that was attributed to the eruption of the impacted teeth. Although dilacerated, the roots were well aligned, without significant root resorption (Figure 12C).

In the area of bone augmentation, dentoalveolar changes surrounding the maxillary anterior teeth were seen in the CBCT scans (Figure 13). Bone augmentation increased the continuity of the labial alveolar bone and the periodontal support that surrounded the labial root surface of the anterior teeth. The labial crestal bone height and alveolar bone thickness were increased despite the stress concentration during the anterior torqueing forces.

At a 30-month posttreatment examination, the patient maintained stable occlusion with no significant relapse, despite a late mandibular growth tendency. There were no noticeable changes of gingival contour or crown height of the anterior teeth. The labial crestal bone height and alveolar bone thickness were well preserved (Figures 14 through 16; Table 1).

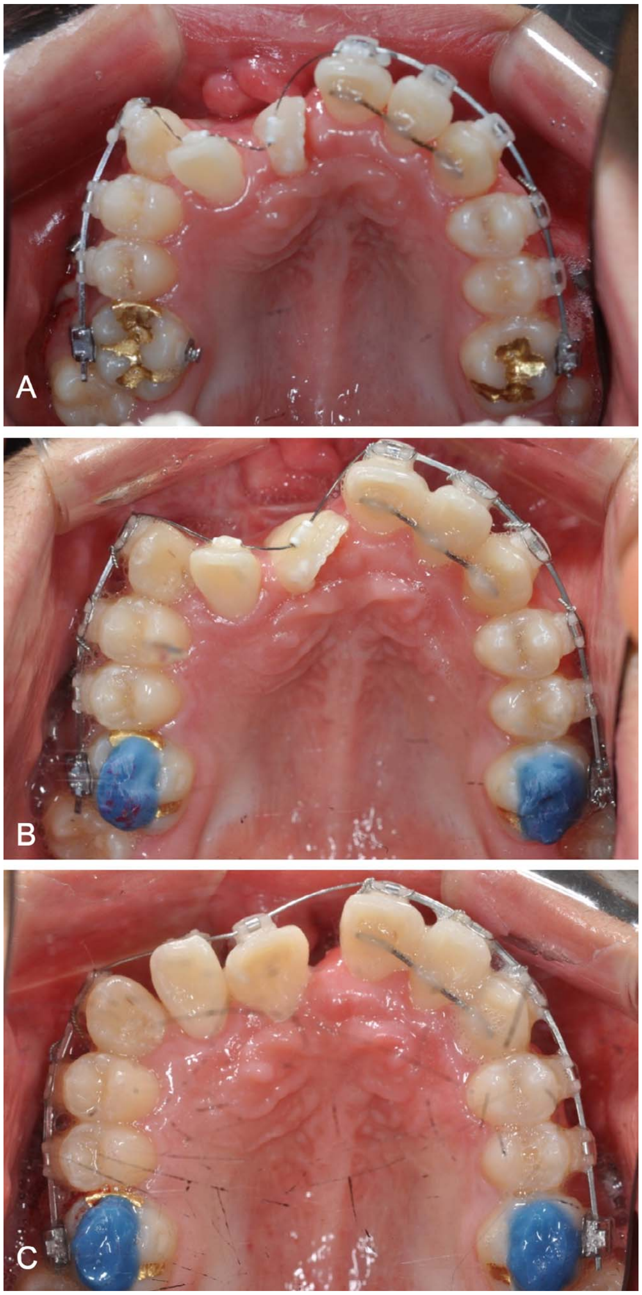


**Figure 8.** Treatment progress intraoral photos: (A) 30 months, mini-tube appliances with 0.014-inch NiTi wire placed; (B) 33 months; and (C) 36 months.

## DISCUSSION

Maxillary canine and lateral incisor transposition is found as often as canine and first premolar transposition.[8–12] The canine erupts mesiolabially or fully mesial to the lateral incisor, leading to incomplete transposition. The apices of the teeth typically remain in their original positions and the crowns in the transposed position. Previous studies demonstrate this relationship between the transposition of a lateral incisor and canine and the associated impacted central incisor. Wasserstein et al.[5] reported that the canine's path of eruption on the same side as the impacted central incisor is deviated in about 40% of the subjects.

The case described presented multiple impacted teeth in the maxillary anterior region, with incomplete transposition, labial impaction of the canine, and palatal impaction of the lateral incisor, with a deep, palatally impacted incisor, the apex of which was in the cortical bone of ANS and had a dilacerated root curved in a labiolingual direction. Considering the impaction depth, the mesiodistal position of the individual tooth, the collective position of the teeth, root proximity, root dilacerations, risk of root resorption, surgical operation, eruption path, and the necessary traction mechanics, serial surgical exposures under local anesthesia were performed.

The first surgical exposure for teeth 12 and 13 was carried out on the labial side with a minimally invasive incision on the palate. Teeth 12 and 13 were impacted more shallowly and labially than tooth 11. The vertical incision of the labial flap was done minimally just to bond the buttons. For the correction of the incomplete transposition, two horizontal forces in the opposite direction were applied before any vertical eruption force. A distal directional force was needed to tooth 13 and a mesial directional force with rotation control was needed to tooth 12.

During the horizontal force application, orthodontic mini-plates were used for indirect anchorage. The C-tube microplate in the maxillary central area was used to reinforce the archwire in the interbracket region to avoid deformation due to the traction force on the two impacted teeth. The other C-tube plate in the maxillary posterior area was applied for anchorage against the distal traction force of the canine.

The second surgical exposure for tooth 11 was performed in the palate. At the same time, a C-tube plate was inserted in the mandibular midline area, and the C-tube in the maxillary central area was removed so it would not be an obstacle. The root of tooth 11 was in a labio-palatal direction, dilacerated, and in the cortical bone area of ANS. The risk of traction failure was higher than that of teeth 12 and 13 as a result of the root position and morphology. Chaushu et al.[13] treated 64 impacted incisors with a 90% overall success rate. However, treatment failures increase when the incisors have dilacerated roots.[14] Moreover, the curved root can affect adjacent teeth or penetrate the labial cortical plate, with sequelae of pulpal and periapical problems.[15,16] A light vertical eruption force was applied by elastics between the ligature wire of the button and mini-plate in the mandibular midline area. During the initial traction period, only a vertical force without rotation was applied to avoid the cortical plate and to prevent root resorption.

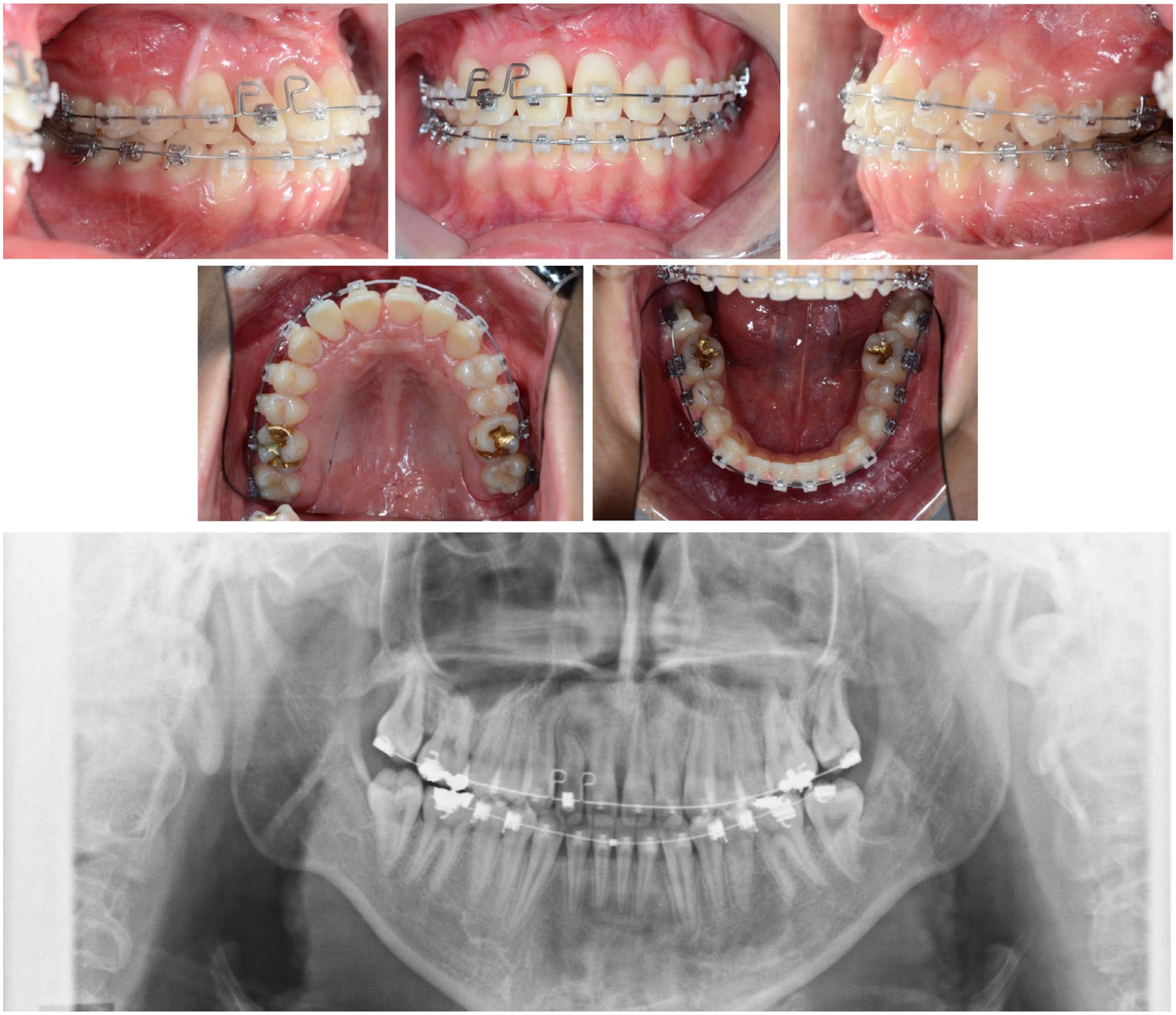

**Figure 9.** Intraoral photos and panoramic radiograph at 40 months of treatment.

After exposure of the crowns, mini-tube appliances were bonded to align the severely rotated incisors. As a result of the crossbite of the lateral incisor and the 90° distal-in rotation of the central incisor, conventional brackets could not be bonded. In this situation, ligating to the main archwire carried a risk of distortion because of the long interbracket dimension. The mini-tube appliances were 0.7-mm-diameter and 3-mm-long metal tubes that were covered with 0.3-mm resin for esthetics. Because of the small size, the mini-tube appliances could be bonded to the tooth surface. By overlaying a small round archwire in the incisor region, a light force was applied to induce bone apposition and to minimize risk of dehiscense.[16,17] The inevitable increase in the applied force with increased diameters of archwires was thereby avoided. In addition, the roots of the incisors were dilacerated, and there was concern that the apices could touch the cortical plate and cause root resorption during torque application. Use of a round archwire avoided unwanted root movement.

Another important contributor to the successful treatment result was good gingival contour. Vermette et al.[18] reported the presence of gingival scarring in 90% of open exposure cases. The closed eruption technique is reported[19] to result in better esthetics and periodontal health. To improve the eruption prognosis of the teeth as well as the periodontal health, some surgical procedures were necessary. The canine had erupted out of the thin and mobile oral mucosa, with gingival scarring and compromised alveolar housing. Because of insufficient anterior alveolar bone height and thickness, bone augmentation using Bio-Oss was

**Figure 10.** Posttreatment facial and intraoral photographs.

performed after the complete recovery of the impacted teeth. Bio-Oss is one of the most widely used xenograft materials and is a hydroxyapatite crystal of bovine origin.[20] It has well-established satisfactory outcomes in periodontal regeneration.[21] Surgical traction with augmented corticotomy and bone grafting resulted in an acceptable gingival contour and alveolar bone support during the retention period.[22–24]

## CONCLUSIONS

- Challenged with a case involving incomplete transposition between a canine and lateral incisor associated with an impaction of the adjacent central incisor, the orthodontist can consider repositioning the teeth to their normal position with good bone support and soft tissue health.
- Careful diagnosis, appropriate biomechanics, and biologic management of the tissues were supported with three-dimensional analyses.
- Evaluation included the impacted depth, the mesiodistal position of individual teeth, the collective positions of all the teeth involved, root proximity, root dilacerations, risk of root resorption and fenestration, surgical traction method, the traction mechanics, and the need for additional periodontal surgery.
- The outcome was esthetic, with harmonious occlusal relationships.

## ACKNOWLEDGMENT

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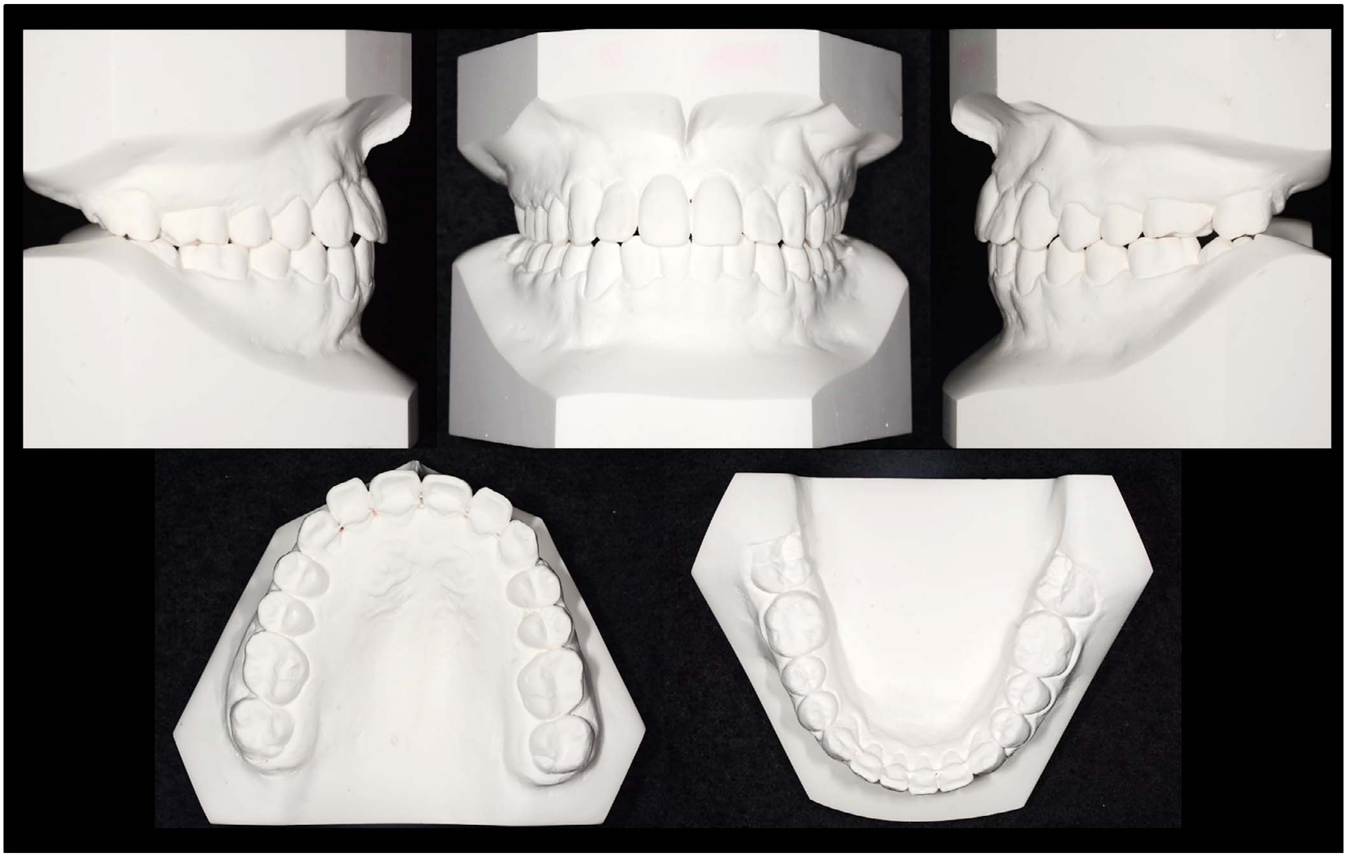

**Figure 11.** Posttreatment dental casts.


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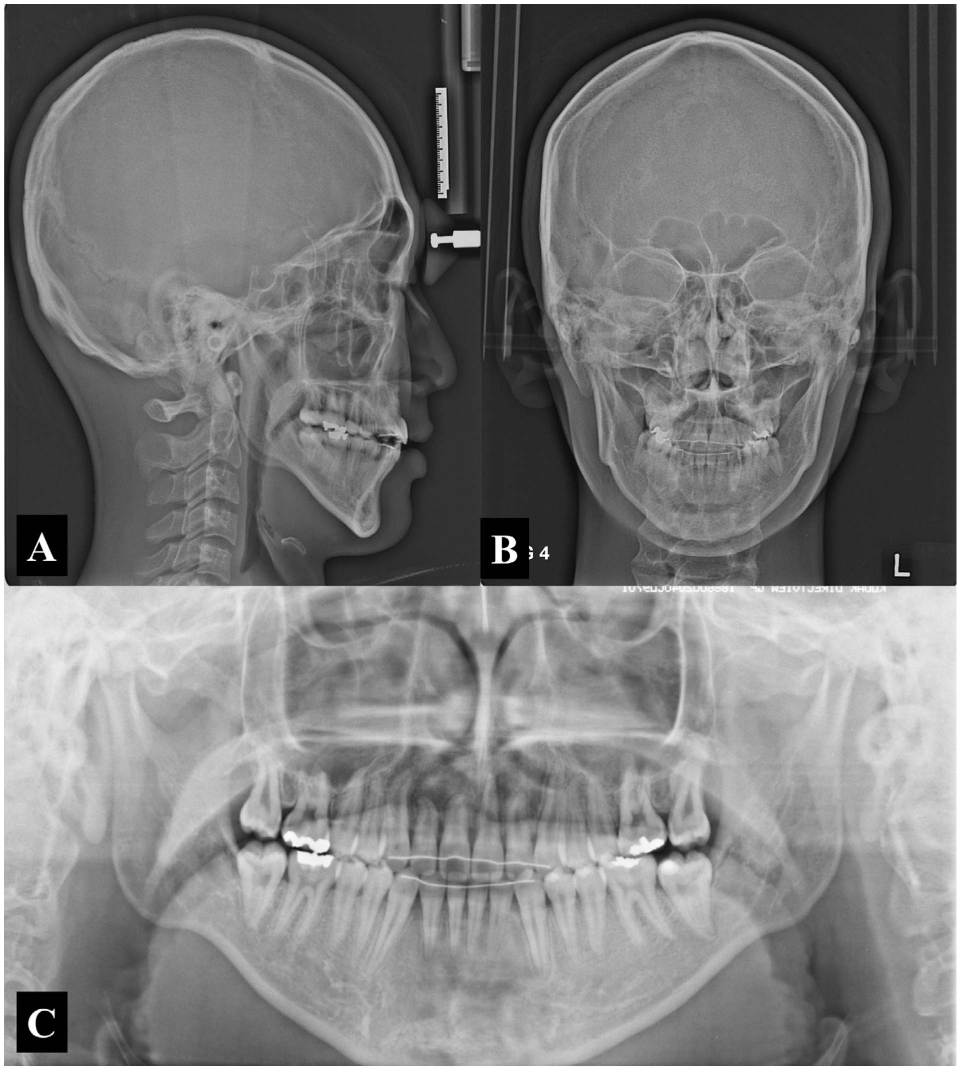


**Figure 12.** Posttreatment radiograph: (A) lateral cephalogram; (B) postero-anterior cephalogram; and (C) panoramic radiograph.

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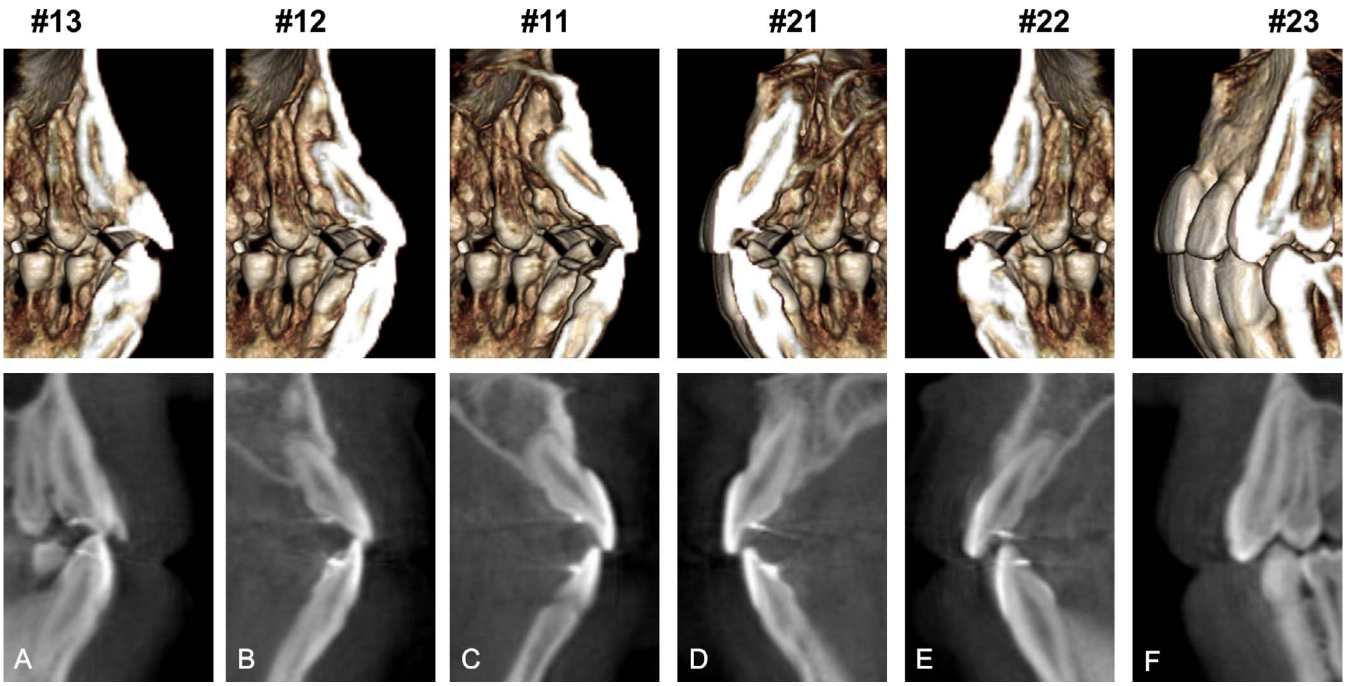


**Figure 13.** Three-dimensional cone-beam computed tomographic sagittal images of upper six anterior teeth after treatment.

**Figure 14.** Thirty-month posttreatment facial and intraoral photographs.

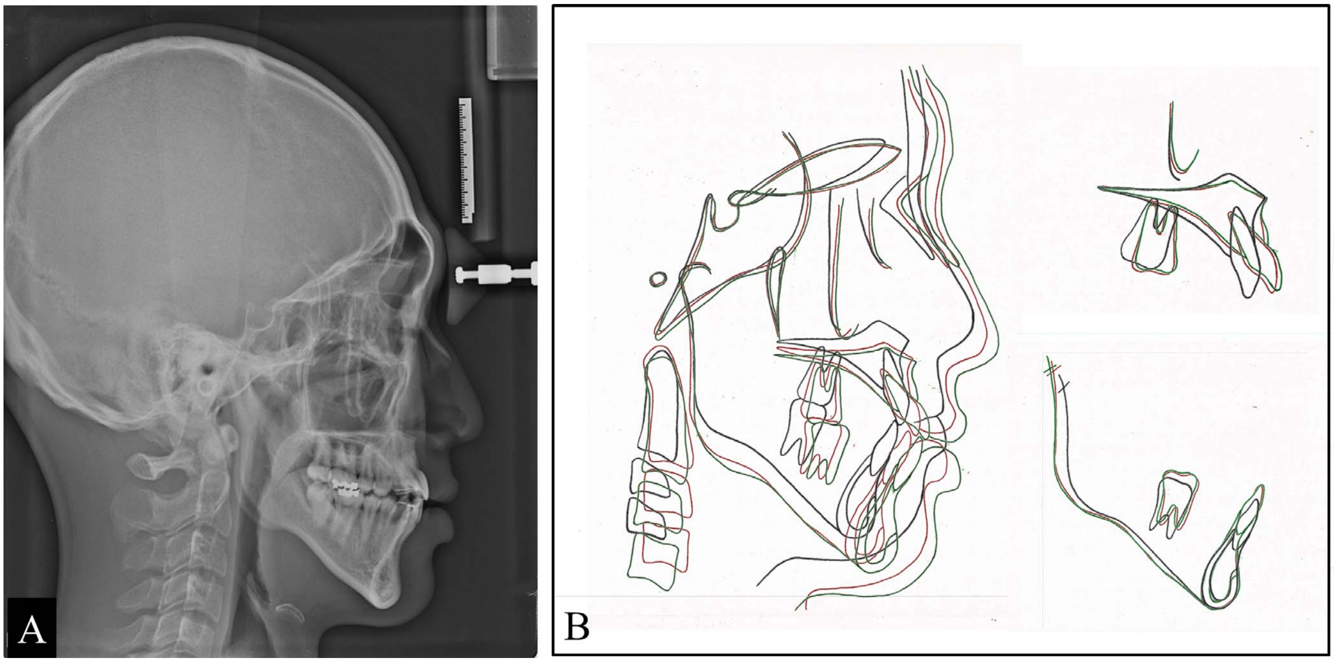


**Figure 15.** Lateral cephalogram: (A) 30 months posttreatment; (B) Superimposition between pretreatment (black), posttreatment (red), and 30-month posttreatment (green).

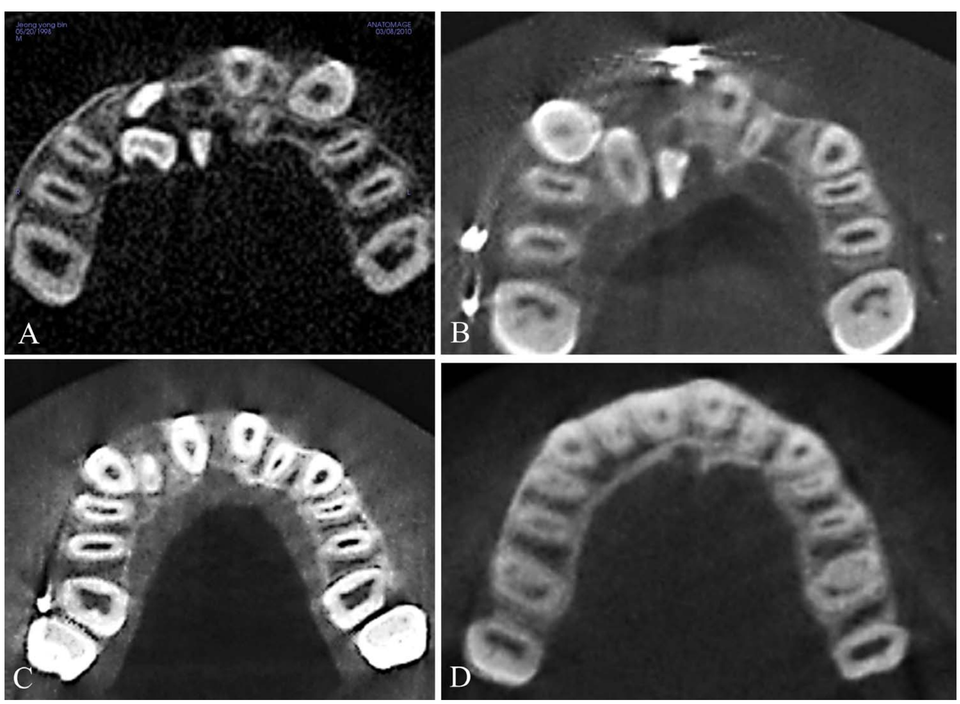


**Figure 16.** Axial images of CBCT: (A) pretreatment; (B) 3-month treatment period; (C) 31-month treatment progress; and (D) 30 months posttreatment.