Case Report

Early replacement of ankylosed first molar via mesial root movement facilitates bone formation and normal eruption of the third molar

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ABSTRACT

Ankylosis of a molar during active growth leads to a significant vertical bone defect, extrusion of the opposing molar, and inclination of adjacent teeth. Treatment timing is an essential factor for the patient's quality of life. Early extraction of the ankylosed molar and protraction of the second molar is challenging because of the difficulty of tooth movement and the uncertainty of the normal eruption of the third molar. In view of the uncertainty of eruption of the mandibular third molar, it is essential to assess the potential for eruption according to the developmental stage of the third molar and to secure sufficient space for eruption. In this case report, a girl with an ankylosed right mandibular first molar and an advanced vertical bone defect was treated via early extraction of the ankylosed molar along with the intrusion of the maxillary molar and mesial root movement of the second molar before the initiation of third molar root formation. Restoration of the vertical bone defect was noted at the end of treatment. In addition, spontaneous eruption of the third molar was observed, which was in contrast to the mesioangular impaction of the contralateral third molar. This case emphasizes the importance of treatment timing to increase the chance of utilization of the third molar. (*Angle Orthod.* 2021;91:843–855.)

KEY WORDS: Impacted third molar; Bone defect; Tooth eruption; Ankylosis; Root movement

INTRODUCTION

Ankylosis of a molar may take place without any predisposing history, in both the primary and permanent dentition.[1] Ankylosis of a permanent molar during active growth can be detrimental because it causes a significant vertical bone defect, extrusion of the opposing molar, and inclination of adjacent teeth if left untreated.[2] In addition, less invasive treatment modalities such as an occlusal buildup or subluxation to displace the molar would not be indicated because of the possibility of reankylosis.[3] Early extraction of the ankylosed molar and protraction of the second molar are conceivable. However, the technical difficulty of tooth movement and the uncertainty regarding the normal eruption of the third molar must be considered. Therefore, the selection of the proper treatment modality at the best treatment time is crucial for the patient's quality of life later on. Regarding the possibility of the eruption of the mandibular third molar, it is essential to understand the eruption potential according to the developmental stage of the third molar and to secure sufficient space for eruption, both of which are related to the timing of treatment.

The extraction of sound premolars has often been used in orthodontics, mainly for the resolution of space deficiency and/or facial esthetic concerns. In addition, in cases with severe dental caries and related apical pathology, a dental anomaly, and/or periodontal disruption, extraction of the molar has been described. In cases with a third molar with acceptable shape and position, a sound first or second permanent molar can be extracted for orthodontic purposes.

If the space between the ascending ramus and the distal side of the second molar is sufficient, the chance of third molar eruption may increase.[4] According to previous reports, the position of an unerupted third molar was modified after second molar extraction.[5,6]

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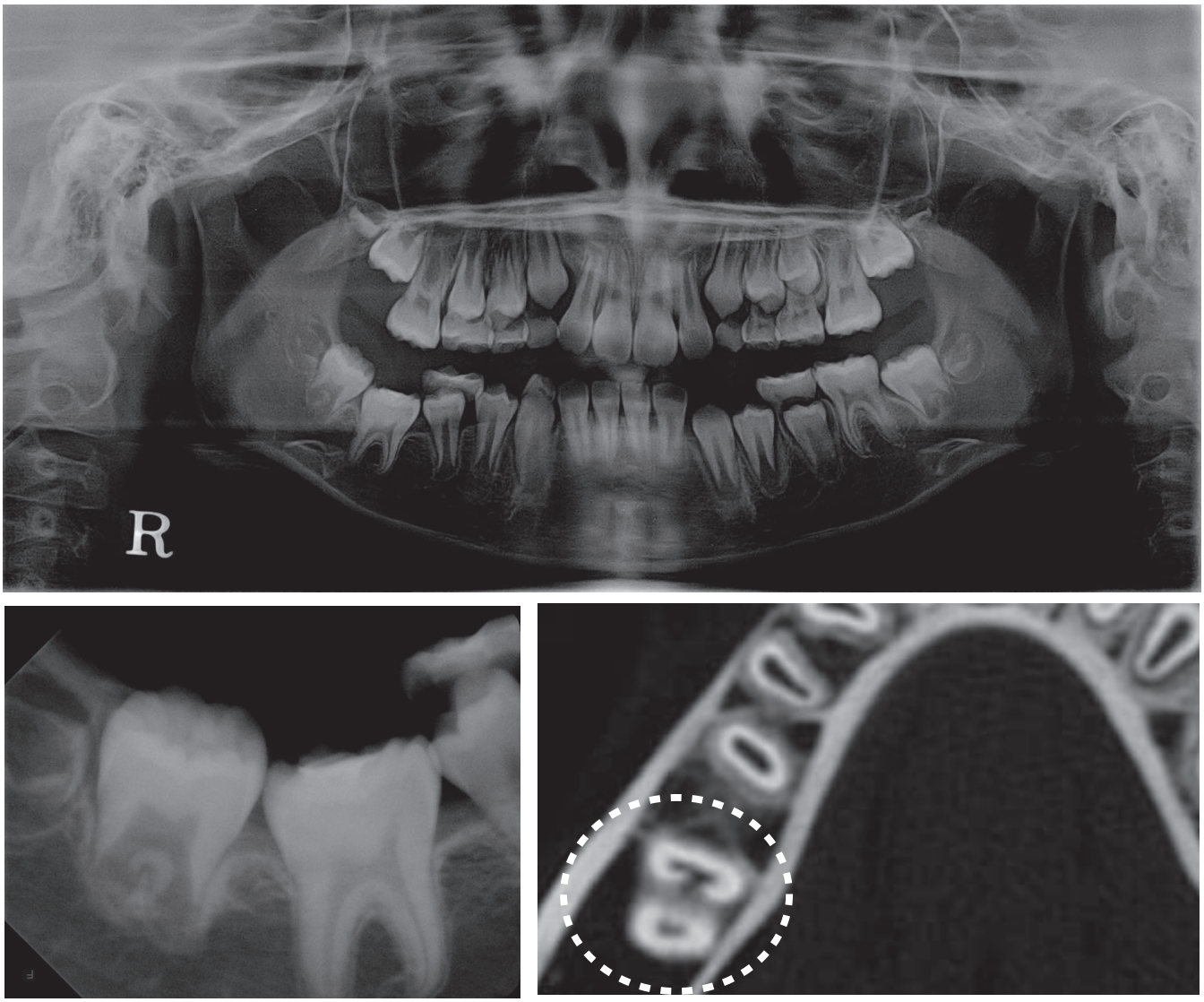

Figure 1. Panoramic, periapical, and cone-beam computed tomography images taken at age 9 years, 7 months. The dotted circle indicates the ankylosed area at the mandibular right first molar.

This is a case report of an early pubertal patient with an ankylosed mandibular first molar on the right side. She had four developing third molar tooth germs, one in each quadrant. This report focuses on the induced migration and eruption of the third molar tooth germ following the intentional extraction of the ankylosed tooth and mesial root movement of the second molar.

CASE REPORT

Diagnosis and Etiology

An 11-year-old girl visited the orthodontic department because of delayed eruption of the mandibular right first molar. Previously forced eruption had been attempted by another dentist for about 2 years with failure of the tooth to move. Forced eruption was reattempted with surgical subluxation for 6 months, which was also ineffective. The patient was then referred to the orthodontic department for comprehensive treatment. According to the previous radiographic examination including panoramic and cone-beam computed tomography images (Figure 1), a discontinuity of the dental hard-tissue structure on the mesial root of the right mandibular molar was observed, which was considered as determinant of ankylosis.

On intraoral examination, the patient showed severe Class II canine and premolar relationships on the right side. The maxillary right posterior teeth were slightly extruded, causing occlusal plane canting. In addition, she had a deep overbite and mild crowding in the maxilla. The mandibular midline was shifted to the right

Figure 2. Pretreatment intraoral and extraoral photographs.

side due to the teeth's being tipped toward the submerged molar (Figure 2). She had not yet reached menarche, implying residual growth that would exacerbate the vertical bone defect. Third molars were developing in each quadrant, but the Nolla stage was about 4, indicating incomplete formation of the crown. Notable mesial tipping of the mandibular third molar germs was also noted. The lateral cephalometric analysis indicated mild skeletal Class II and a normal vertical relationship with ANB = 4.5° and a mandibular plane angle of 33.7°. The upper incisors were tipped lingually and lower incisors were flared labially (U1 to SN, 97.5°; IMPA, 101.1°; Figure 3). She was diagnosed as skeletal Class II with an ankylosed mandibular first molar.

Treatment Objectives

The treatment objectives of this patient were (1) establishment of functional occlusal contact on the right side, (2) restoration of the vertical bone defect, and (3) correction of the Class II malocclusion.

Treatment Plan

For the ankylosed mandibular first molar, further subluxation was not considered appropriate because of a previous history of failure and possible reankylosis. Considering her age, an increase in the vertical defect was anticipated. Therefore, early extraction of the ankylosed molar and active protraction of the second molar were considered the treatment of choice.

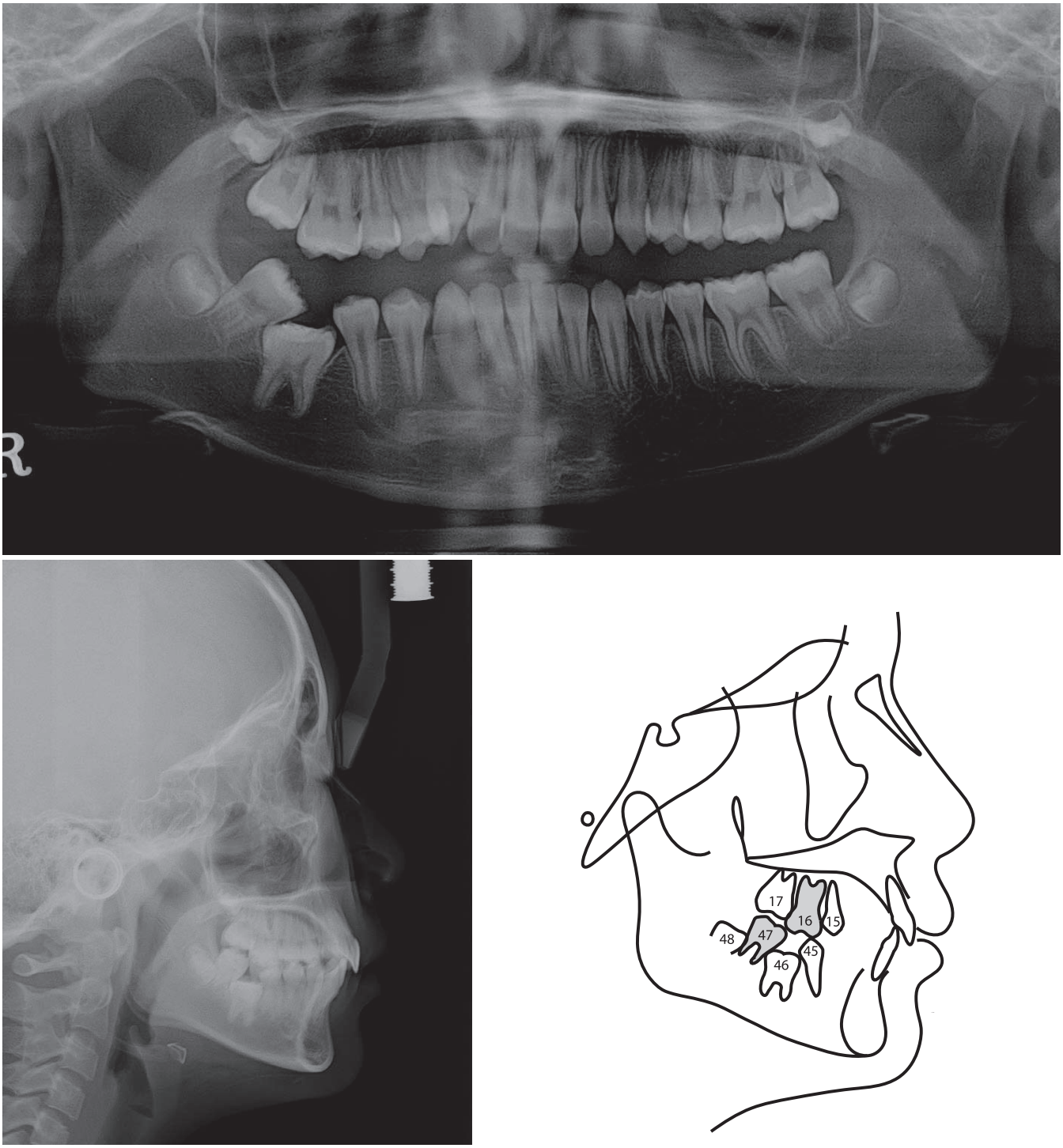

Figure 3. Pretreatment panoramic and lateral cephalometric radiographs and tracing.

Because the patient had an acceptable lateral profile, the plan was to maintain the anteroposterior position of the incisors with minor correction of the axes and vertical positioning of the maxillary incisors. In addition, corrections of the mandibular dental midline deviation and Class II canine and molar relationships on the right side were needed by rotating the mandibular arch to the left side. Hence, the treatment plan consisted of the following:

1. Intrusion of the maxillary right second premolar and first molar to flatten the maxillary occlusal plane.

Figure 4. Five months later. The maxillary right first molar and second premolar had been intruded. Intrusion was done with two TADs, one on the buccal and one on the palatal sides. The ankylosed mandibular right first molar had been extracted at this time.

Orthodontic miniscrews were planned to assist the treatment.

2. Extraction of the ankylosed mandibular first molar and alignment of the mandibular arch.
3. Protraction of the right mandibular second molar to the first molar extraction space and further rotation of the mandibular dentition to the left side for midline correction.
4. Monitoring the eruption of the mandibular right third molar and active alignment when indicated.

Treatment Alternatives

As described, subluxation and attempted forced eruption of the ankylosed tooth ended in failure; therefore, saving the first molar was no longer an option. Usually, extraction of the permanent molar requires prosthodontic restoration. Prosthodontic replacement could shorten the treatment period as compared with orthodontic treatment, but it required a dental prosthesis and could also result in complete impaction of the mandibular right third molar. Also, narrowing of the alveolar ridge at the edentulous space would be evident over time, which would make placement of the implant fixture very challenging later on.

Considering the severe Class II molar relationship on the right side, unilateral extraction of the maxillary right first premolar was also considered. However, the Class II relation was mostly attributable to the distal inclination of the mandibular second premolar; extraction of the upper premolar would exacerbate the arch asymmetry.

Then, the next step was to move the second molar forward to the first molar position, expecting the second and third molars to replace the first and second molars, respectively. It was anticipated that orthodontic tooth movement could induce restoration of the alveolar bone defect at the extraction site and increase the space for third molar eruption. However, anterior root movement of the mesially tipped second molar would require a long treatment period and, still, there would be uncertainty regarding third molar development. Despite the long treatment and observation time, orthodontic movement was chosen to eliminate the need for an additional dental prosthesis. The third molar would be under supervision until it reached the occlusal level and, if needed, adjunctive orthodontic treatment could be performed.

Treatment Progress

Two temporary anchorage devices (TADs; 1.8 mm in diameter, 7.0 mm in length; Oruls, Seoul, Korea) were placed on the buccal and palatal sides between the maxillary right first molar and second premolar for segmental intrusion. After 5 months, the maxillary teeth were intruded, and interocclusal clearance was obtained (Figure 4). Subsequent extraction of the ankylosed mandibular first molar was performed and mandibular tooth alignment was accomplished with conventional orthodontic brackets (Clippy M, Tomy, Tokyo, Japan). The root axis of the mandibular second molar was controlled with a helical loop made with 0.016 $\times$ 0.022-inch stainless-steel wire (Figure 5). Four months after leveling and alignment of the mandibular arch, mesial traction of the mandibular right second molar, along with midline correction, were started with TADs. TADs were placed between the mandibular first and second premolars bilaterally (Figure 6). After 23 months of active treatment, the appliances were removed, except for a palatal appliance at the maxillary right first and second molars. The mandibular right second molar showed good occlusal contact with opposing teeth, and the Class II molar relationship and midline deviation were corrected. Lingual bonded retainers were bonded from canine to canine in both arches, and the palatal

Figure 5. The helical loop was placed in front of the mandibular second molar to control the axis of the mandibular right second molar.

appliance was maintained to hold the molars until mandibular third molar eruption occurred (Figures 7 and 8).

Periodic recalls were performed to monitor mandibular third molar eruption clinically and radiographically. Spontaneous eruption of the mandibular right third molar was confirmed at the age of 16 years. Five years after debonding (at the age of 19 years), maturation of the third molar root was observed on the panoramic radiograph (Figure 9).

RESULTS

The mandibular right second molar effectively replaced the first molar and the third molar was successfully brought into proper occlusion (Figure 10). Comprehensive treatment was finished at age 14. The superimposition showed intrusion of the maxillary posterior teeth and mesial movement of the mandibular second molar (Figure 11). During the periodic recalls, the right mandibular third molar continued to move forward (Figure 12). Figure 13 demonstrates the eruption pathway of the third molar according to the treatment stages.

DISCUSSION

Extraction of the permanent first molar is not a common treatment option unless it has serious pathology such as severe dental caries, remarkable periodontal involvement, and/or an apical lesion.[7] After extraction, the space can be closed with orthodontic tooth movement or maintained with a dental prosthesis. The amount of movement needed may be a determinant in decision making. When the patient visited the orthodontic department at the age of 11, the ankylosed molar had caused serious sequelae, including a vertical alveolar bone defect, mesial tipping of the right mandibular second molar, distal migration of the adjacent premolars, and extrusion of the maxillary molar. For the occlusal transition from severe Class II to proper Class I relationships, a large amount of mesial movement of the mandibular right posterior segment was crucial. Therefore, the requirements for a

Figure 6. TADs were placed for maxillary cant correction, protraction of the right mandibular second molar, and midline correction of the mandibular dentition.

Figure 7. Posttreatment intraoral and extraoral photographs.

significant amount of root movement, subsequent bone formation on the mesial side of the second molar, and development of the third molar were the main issues in clinical decision making. To use the faster bone remodeling and favorable bone formation along with the mesialization of molars,[8] radical treatment, including extraction of the ankylosed molar, was finally chosen.

At debonding, the right mandibular second molar replaced the mandibular first molar properly. In addition, the transition from a full-cusp Class II to Class I premolar relationship was confirmed. On the cephalometric radiograph, a total of 7 mm of displacement of the crown and 15 mm of displacement of the root apex of the second molar were noted, indicating remarkable mesial root movement. Lee et al.,[9] in a similar case, suggested extraction of the ankylosed molar and subsequent root movement of the adjacent molar to restore the surrounding tissue and maintain the teeth. Accordingly, the vertical defect of the alveolar bone was restored after moving the second molar to the ankylosed first molar area. Hence, mesial root movement was also justified.

The development of the third molar was regularly monitored during the retention period. Because of the lack of root development, invasive surgical opening was not attempted. Instead, close monitoring of the root development was crucial for possible intervention for molar uprighting. Surprisingly, however, after 2 years, at the age of 16, the right mandibular third molar naturally erupted in contact with the distal surface of the second molar.

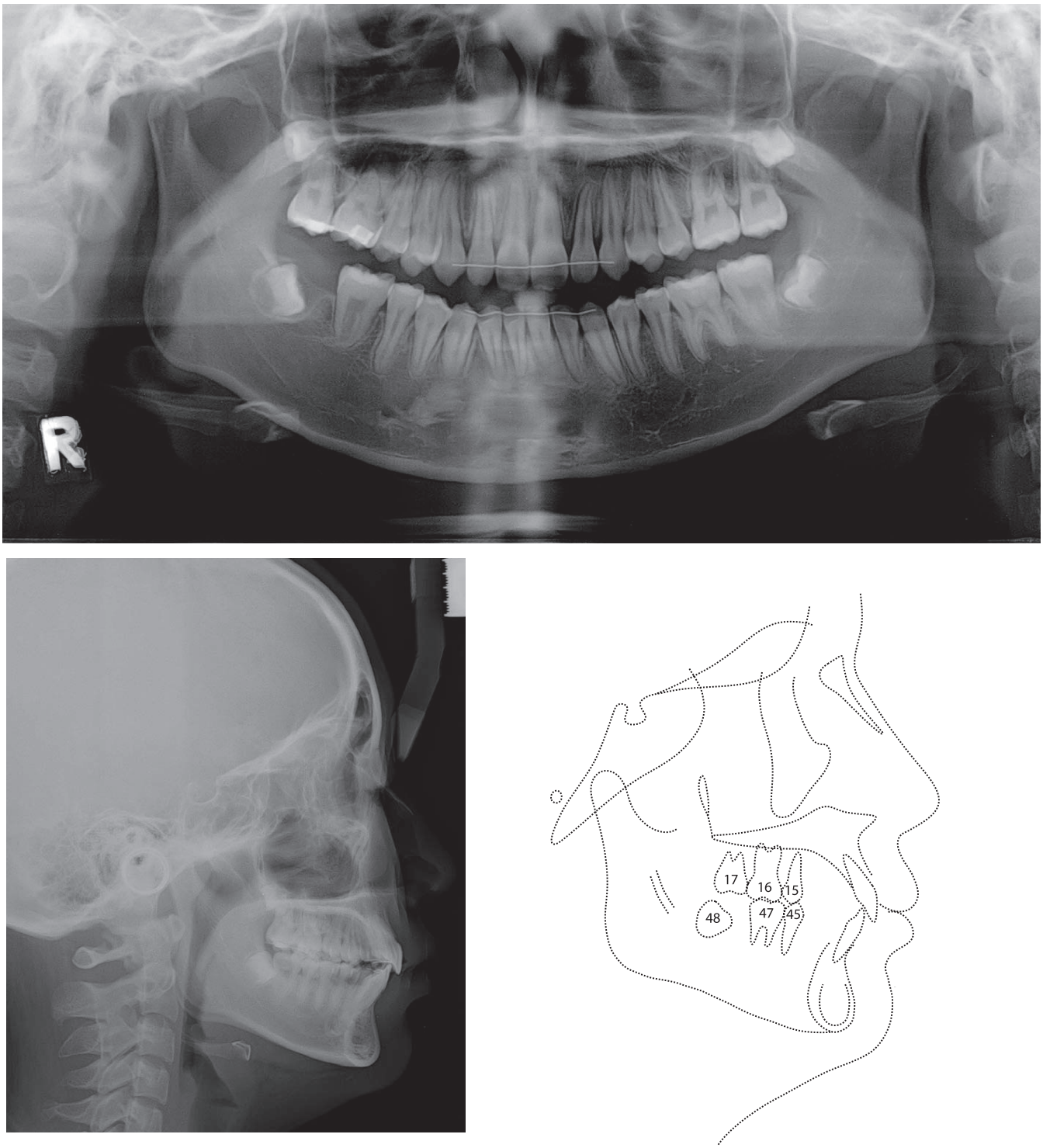

Figure 8. Posttreatment panoramic and lateral cephalometric radiographs and tracing.

There are various theories about the mechanism of tooth eruption.[10,11] The gubernaculum dentis, root formation, tooth crown, and dental follicle play an essential role in tooth eruption. Cahill and Marks[10] reported that the dental follicle was the only structure that affected tooth eruption. The dental follicle enlarged the eruption pathway by bone resorption and formed new bone at the base of the bony crypt. The coronal part of the dental follicle was responsible for alveolar bone resorption and the basal part for alveolar bone formation.[11] Through retrospective study, many researchers reported that most mandib-

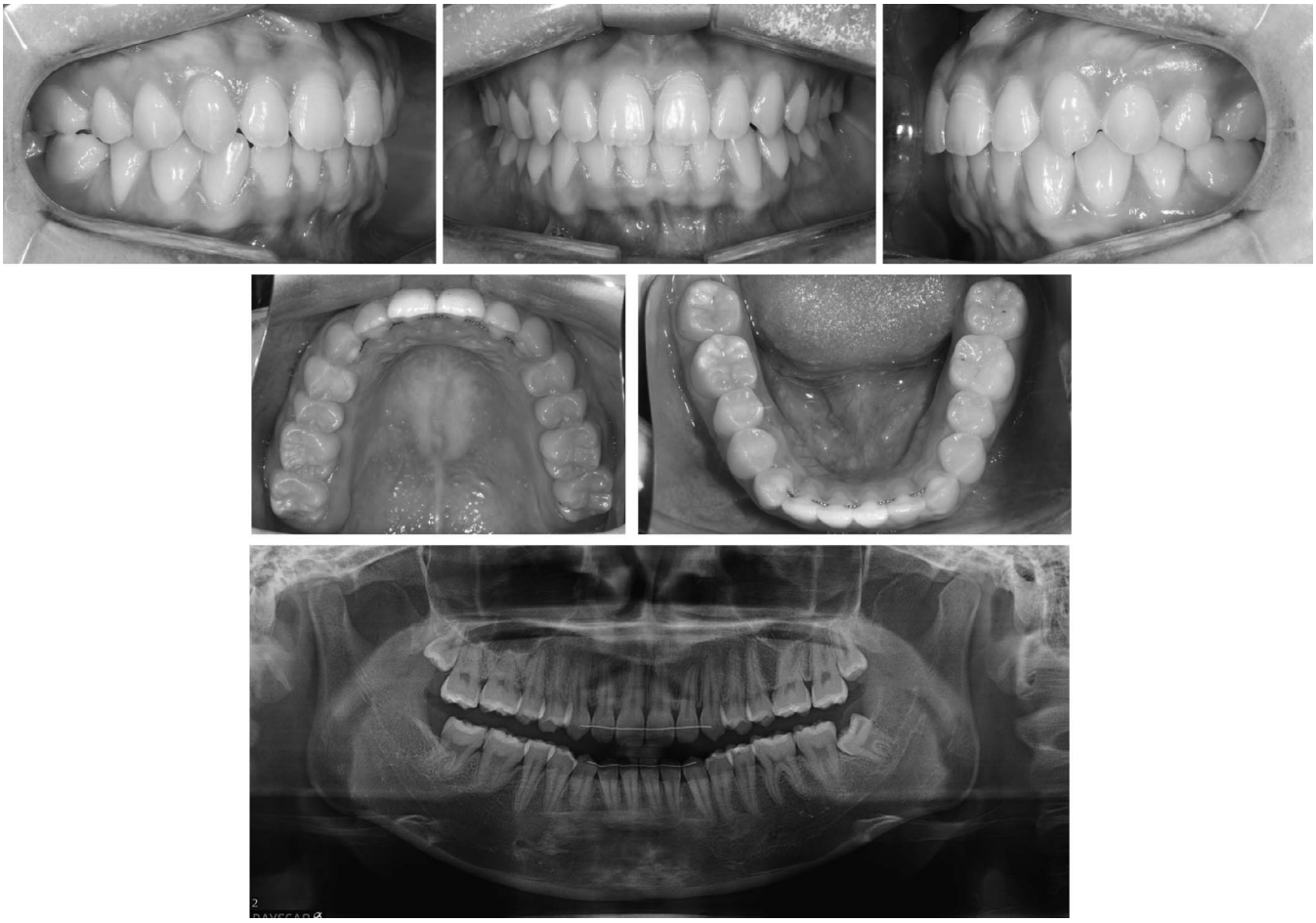

Figure 9. Intraoral photographs and panoramic radiograph 5 years after debonding.

ular third molars replaced the second molars appropriately in second molar extraction cases.[12,13] However, De-la-Rosa-Gay et al.[13] found that the older the patient or the higher the Nolla stage, the less successfully teeth erupted. In addition, Russell et al.[14] showed that having enough space did not guarantee the eruption of an impacted mandibular third molar. Despite the controversy over the effect of root maturation on the successful eruption of impacted third molars, the present case clearly exhibited a difference between the right and left sides. Because the right side showed very favorable eruption, it is conceivable that creating sufficient space on the mesial side may have contributed to normal eruption. In contrast, the left third molar was fully impacted at the end of treatment (Figure 12). Eruption of the tooth resulted from the tight coordination of both the bone resorption on the occlusal side and root formation apically. Also, it is known that induction of bone resorption on the occlusal side is a centrally regulated process by multiple secretory cytokines, including colony-stimulating factor, interleukin, and so forth, which may have happened during the follow-up period.[15] Hence, early mesial displacement of the mandibular right second molar may have contributed to normal eruption of the third molar. The superimposition of the panoramic views depicts the eruption pattern of the respective right and left third molars (Figure 13).

In summary, it can be claimed that protraction of the right mandibular second molar created a favorable environment for third molar development. The tooth germ of the mandibular third molar was in the early stages of development (less than Nolla stage 4). As mentioned previously, the eruption of the tooth was regulated by the dental follicle, starting when calcification of the crown was completed. The third molars of the patient followed this timetable.

In addition, the left mandibular canal was limiting the development of the third molar root. Typically, the basal part of the dental follicle produces the alveolar bone and facilitates eruption. In this patient's case, the left third molar could not erupt, and bone formation below the dental follicle might have affected the

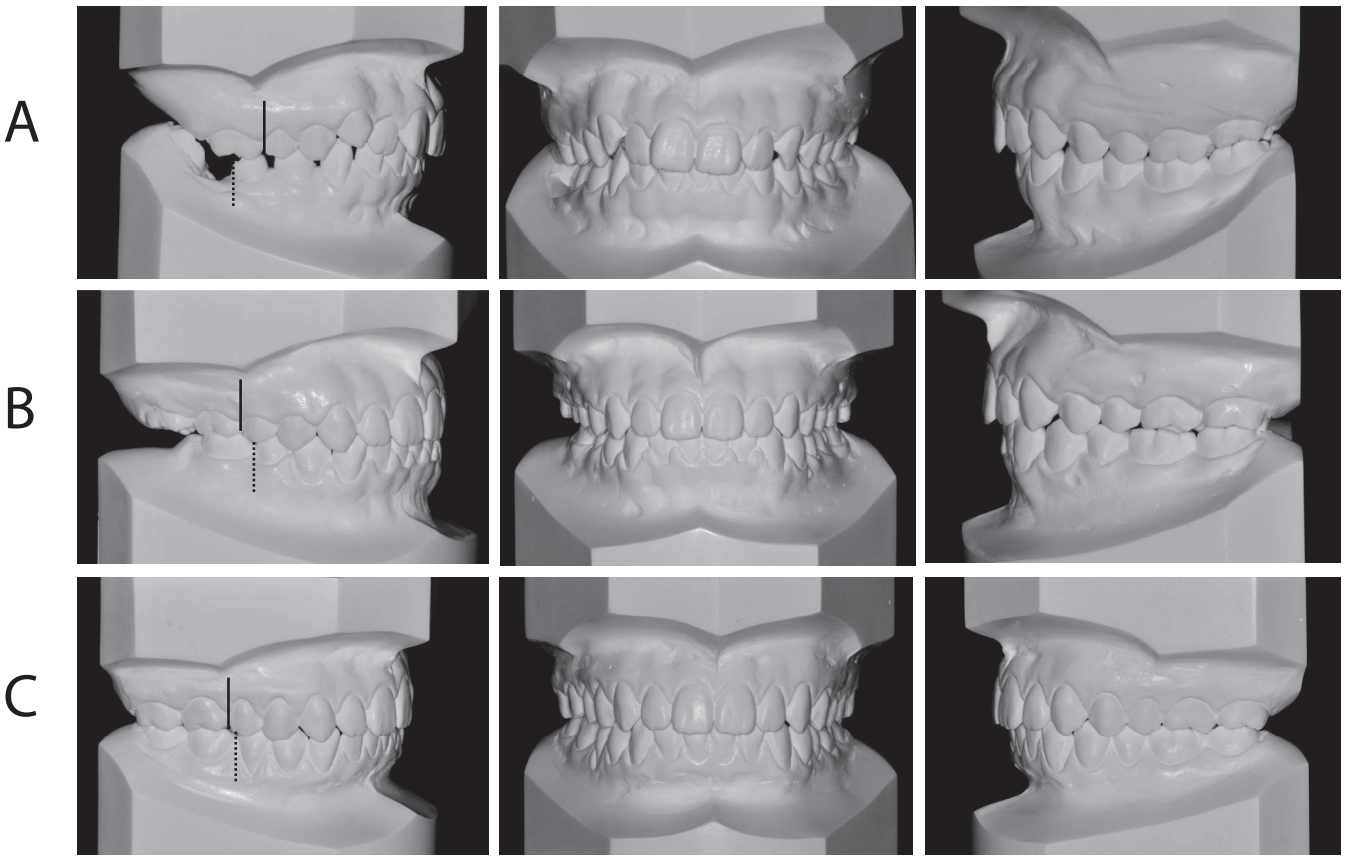

Figure 10. (A) Pretreatment, (B) posttreatment, and (C) retention models. Black line, distal surface of the maxillary right second premolar; dotted line, distal surface of the mandibular right second premolar.

position and shape of the mandibular canal (Figure 12). This pattern was similar to a previous study showing that when eruption failed, the roots grew inferiorly to penetrate the mandibular canal.[11]

Overall, active orthodontic treatment in this case contributed to (1) restoration of the vertical bone defect, (2) correction of the severe Class II relationship, and (3) normal root development and eruption of the third molar, eliminating the need for any prosthetic rehabilitation of the defect observed in the beginning.

CONCLUSIONS

- In this case report, the right mandibular third molar successfully erupted in a proper position by itself after protraction of the second molar.
- For the third molar to erupt successfully, enough space was essential.
- A favorable intraosseous movement of the tooth germ occurred when the development was in its early stage.
- By early replacement with the adjacent second molar, the alveolar bone defect of the ankylosed first molar was restored.

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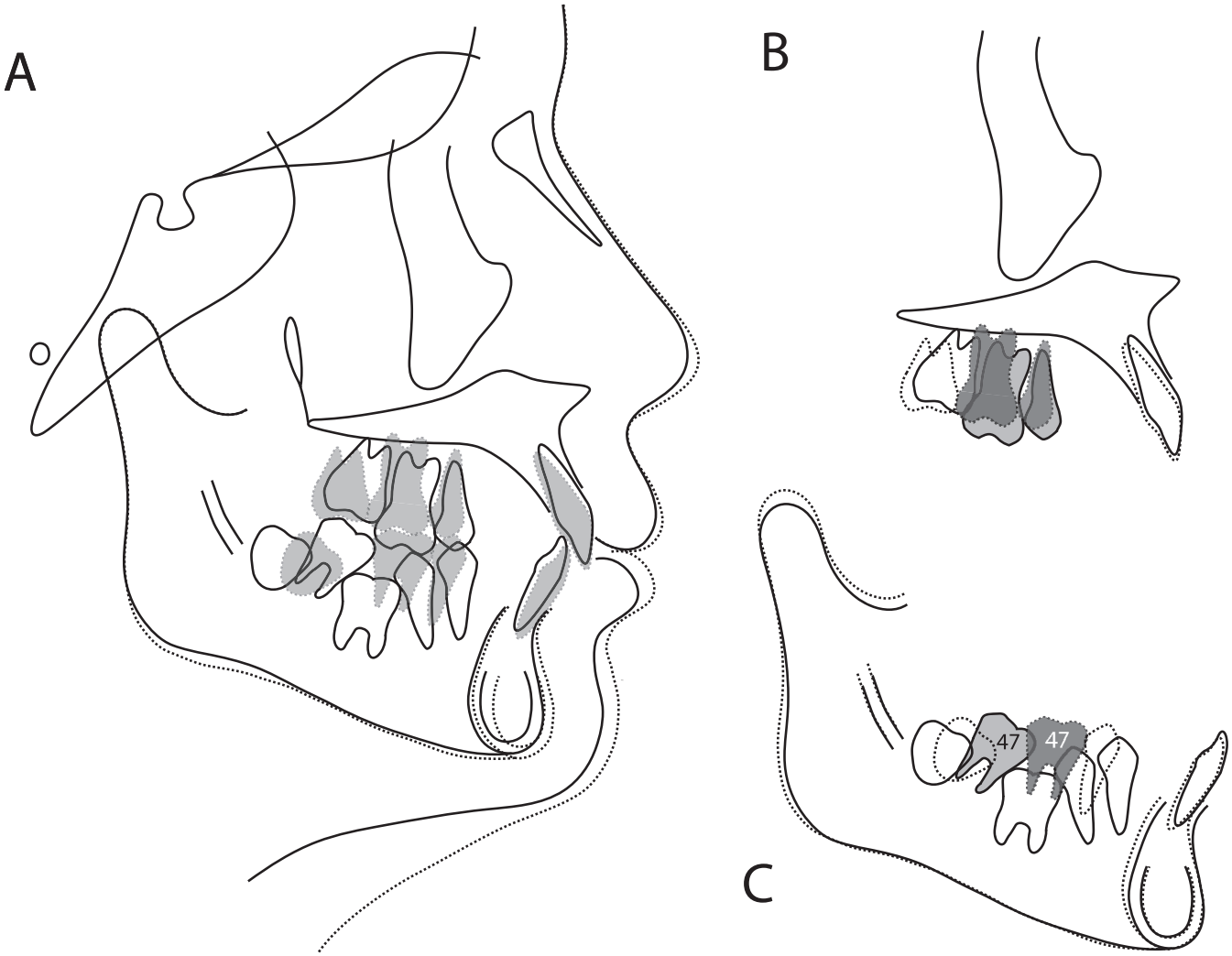

Figure 11. Cephalometric superimposition by the structural method. (A) Cranial base superimposition. (B) Maxillary superimposition. (C) Mandibular superimposition. Black, pretreatment; dotted, posttreatment.

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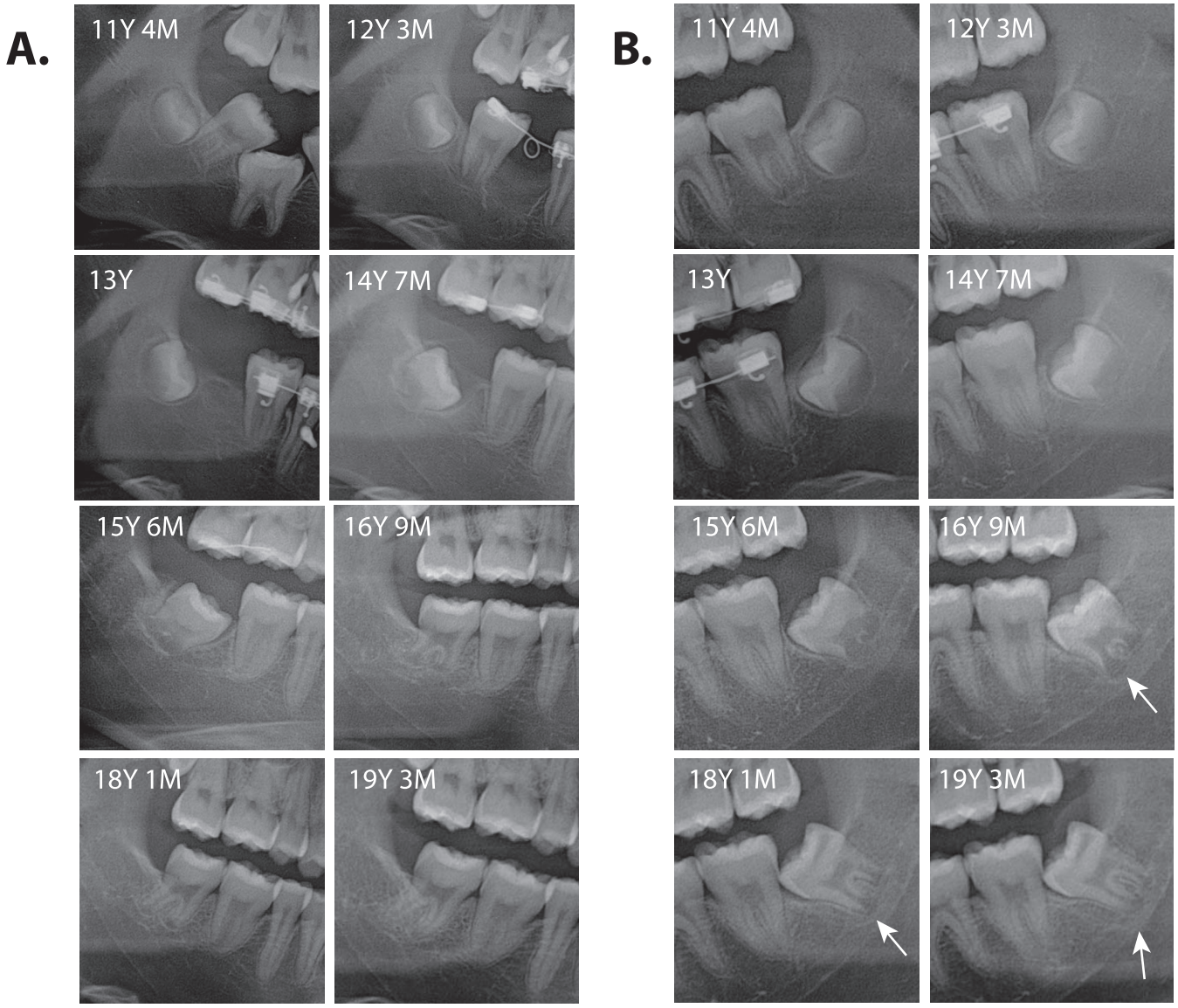

Figure 12. The progress of the development of the mandibular third molar. The follicle of the third molar began to build the eruption pathway as it expanded. As the root developed, the third molar moved forward and upward. The right third molar moved to the distal surface of the second molar by itself and erupted naturally. In contrast to the right side, the left third molar was impacted, and the shape and position of the inferior alveolar nerve canal were affected by the roots of the left mandibular third molar (white arrows).

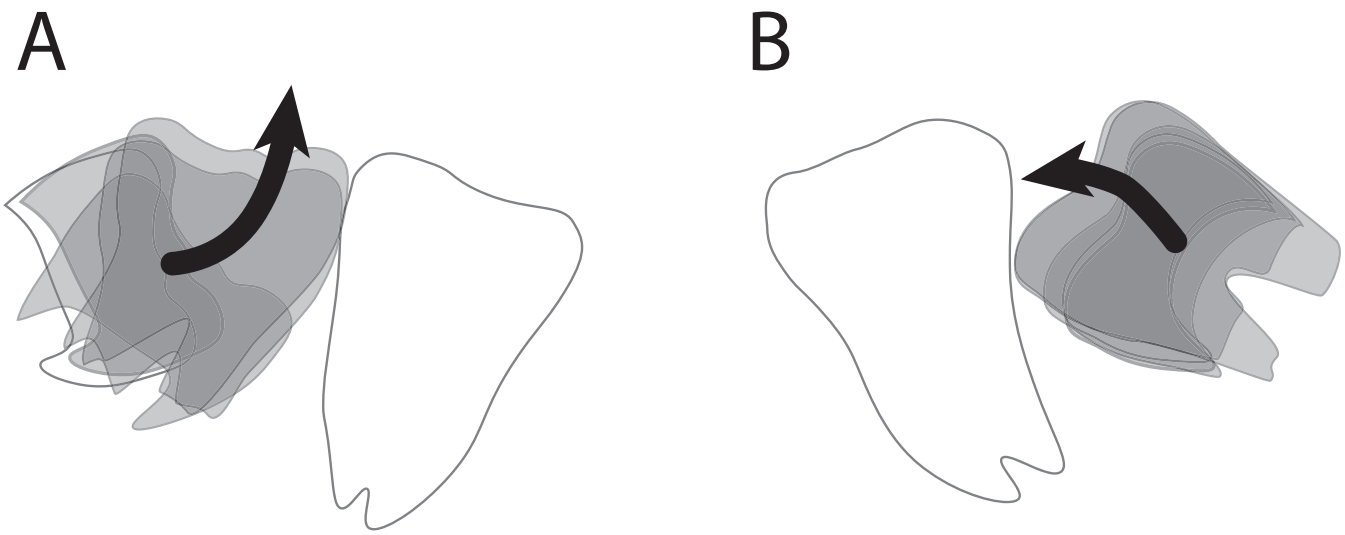

Figure 13. Eruption pathway of the right (A) and left (B) mandibular third molars superimposed on the second molar at the following ages: 14 years, 4 months; 14 years, 7 months; 15 years, 6 months; 16 years, 9 months; 18 years, 1 month.