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CASE REPORT

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A modified serial extraction method in a patient with crowding and a congenitally missing mandibular left second premolar

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Abstract

Background: In pediatric orthodontic treatment, determining the optimal treatment strategy is often challenging. Decisions such as whether to extract teeth and when to initiate orthodontic treatment have been debated for many years. Furthermore, when congenitally missing teeth are present asymmetrically, the selection of a treatment strategy becomes even more complex. **Case**: A 6-year-11-month-old girl presented with a chief complaint of crowding in the mandibular anterior region. Facial profile examination showed mild protrusion of both the upper and lower lips and a retrusive mandible. The mandibular left first molar was impacted against the mandibular second primary molar, resulting in disturbed eruption and posterior discrepancy. The mandibular midline was deviated 2.5 mm to the left relative to the facial midline. The mandibular incisor axes were inclined toward the left, and space deficiency was noted. Crowding was present in the mandibular anterior region, suggesting a future risk of space deficiency in the mandibular arch. Panoramic radiography revealed that the mandibular left second premolar was congenitally missing. Based on these findings, the patient was diagnosed with a skeletal Class II malocclusion associated with a congenitally missing mandibular left second premolar, mandibular posterior discrepancy, and midline deviation. **Conclusions**: Early intervention allowed for the implementation of an early extraction protocol in this case. A treatment strategy using Bionator therapy enabled effective control of overbite while simultaneously promoting favorable mandibular growth and improving arch length discrepancy, thereby compensating for the limitations of serial extraction alone and resulting in an efficient treatment outcome. In addition, treatment was completed without the need for a second treatment phase using a multibracket system. Completing treatment during the growth period suggests that this approach may be applicable to similar cases involving congenitally missing teeth.

Keywords

Early extraction; Functional orthodontic appliance; Congenitally missing teeth

1. Introduction

Congenitally missing teeth are one of the most common dental malformations, with a prevalence in permanent dentition that varies globally [1, 2]. The reported prevalence of congenitally missing teeth ranges from 2.3% to 15.7% in Europe, 2.7% to 7.8% in Northern Europe, and 0.2% to 16.2% in Asia [2]. In Japan in particular, congenitally missing teeth are observed in approximately 10% of individuals. The condition is more common in the mandible than in the maxilla. With respect to tooth type, the mandibular second premolar is most commonly affected, followed by the mandibular lateral incisor, the maxillary second premolar, and the maxillary lateral incisor [3]. Congenitally missing teeth are often detected on panoramic radiographs obtained during childhood. Clinical management requires careful diagnosis based on the number and location of the missing teeth as well as the occlusal relationship, to determine whether to retain the corresponding primary teeth and subsequently manage the space prosthetically after their exfoliation, to close the space orthodontically, or to extract the primary teeth at an early stage and close the space accordingly.

However, definitive prosthetic rehabilitation of sites of congenitally missing teeth is often complicated, as the missing teeth are often located in unfavorable positions [4]. Therefore, when congenitally missing teeth are identified at a young age, proactive space closure should be considered, as it may help prevent potential complications associated with congenitally missing teeth, including malocclusion, periodontal tissue damage, insufficient alveolar bone growth, reduced masticatory function, and speech impairment [2]. Furthermore, when

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congenitally missing teeth are present asymmetrically, consideration should be given to achieving bilateral symmetry during treatment, whenever possible, to improve the efficiency of orthodontic treatment. In cases where patients present with severe crowding, tooth extraction may need to be considered.

Serial extraction (SE) has been used to resolve severe dento-alveolar disproportion in the mixed dentition [5–8]. The earliest documented attempts at SE were reported in the mid-18th century [9, 10]. Treatment using SE was subsequently repopularized in the 1950s and 1960s by Tweed and Kjellgren [7, 11].

SE can be defined as the correctly timed, planned removal of certain primary and permanent teeth in patients with mixed dentition and dento-alveolar disproportion [12]. However, the indications for SE have been limited because of its recognized disadvantages, such as deepening of overbite [6, 10, 13]. This report describes a skeletal Class II malocclusion with a congenitally missing mandibular left second premolar, mandibular posterior discrepancy, and midline deviation, treated with SE in combination with a functional orthodontic appliance with care taken to prevent deterioration of the overbite, resulting in a favorable treatment outcome.

2. Case presentation

A 6-year-11month-old girl presented with her parents, with a chief complaint of crowding in the mandibular anterior region. She had no previous history of orthodontic treatment or other notable medical history. The family history included dental crowding in her father. Facial profile examination showed mild protrusion of both the upper and lower lips and a retrusive mandible. Both maxillary first molars had not yet erupted. The mandibular left first molar was impacted against the mandibular second primary molar, resulting in an eruption disturbance and posterior discrepancy. The primary molar relationship was classified as a bilateral mesial step. The mandibular midline was deviated 2.5 mm to the left relative to the facial midline. The mandibular incisor axes were inclined toward the left, and space deficiency was noted in the region of the mandibular left lateral incisor, which had erupted lingually. Crowding was present in the mandibular anterior region. According to Ono's regression equation [14], the mandibular arch length discrepancy was calculated to be −2.5 mm. The mesiodistal crown widths of all four mandibular incisors were relatively large, suggesting a future risk of space deficiency. Panoramic radiography revealed that the mandibular left second premolar was congenitally missing (Figs. 1,2). Cephalometric analysis showed an ANB (angle between the AN line and NB line) angle of 5.0°, indicating a mild skeletal Class II relationship, and an FMA (Frankfort-mandibular plane angle) of 35.0°, consistent with a high-angle case. The mandibular incisors showed labial inclination and protrusion (FMIA (Frankfort-mandibular incisor angle) = 48.0°, L1 (Lower central incisor) to NB (line extending from nasion to point B) = 7.5 mm) (Fig. 3, Table 1).

Based on these findings, the patient was diagnosed with skeletal Class II malocclusion associated with a congenitally missing mandibular left second premolar, mandibular posterior discrepancy, and midline deviation.

Diagnostic variances were as follows: Skeletal Class II relationship, crowding of the mandibular anterior teeth, mandibular midline deviation, posterior discrepancy, a congenitally missing mandibular left second premolar, a high-angle skeletal pattern, and anticipated severe space deficiency.

3. Treatment plan

In the present case, the mesiodistal crown widths of the mandibular anterior teeth were excessive, and further worsening of space deficiency was anticipated. In addition, protrusion of both the upper and lower lips was observed. Although the maxillary anterior teeth had not yet erupted, the mandibular anterior teeth already exhibited labial inclination and protrusion, suggesting that non-extraction alignment would be difficult. We typically use a level anchorage system for multibracket treatment; we evaluated the anteroposterior position of the mandibular anterior teeth from L1 to NB, in both adults and children, and determined target values accordingly. The anteroposterior treatment goal for the mandibular incisors was set at an L1 to NB distance of 6 mm, and the target interincisal angle was set at 131° [15]. Furthermore, because the mandibular left second premolar was congenitally missing, treatment planning aimed to maintain bilateral symmetry as much as possible by performing early SE of all first premolars except the mandibular left first premolar.

Given the relatively large ANB angle of 5.0°, indicating a skeletal Class II relationship, early premolar extraction carries the risk of deepening the overbite. Therefore, a Bionator appliance was used in combination to promote forward mandibular growth and to increase the vertical dimension. Furthermore, for the second phase of treatment, multibracket treatment was initially planned following re-evaluation. However, after confirming the patient's compliance and occlusal condition, treatment with a removable tooth positioner or aligner was planned instead, if feasible.

One alternative treatment option considered was a non-extraction approach. In this scenario, improvement of the skeletal Class II relationship (ANB +5.0°) would be addressed during growth using a Bionator appliance to achieve skeletal correction. For dental management, the mandibular left second primary molar would be preserved; if root resorption progressed to the point where the tooth could no longer be preserved, prosthetic rehabilitation of the corresponding site was planned during adolescence or later. To address the space deficiency, transverse and anteroposterior expansion of both the maxillary and mandibular arches would be performed to gain space. However, in the present case, the patient exhibited a high-angle skeletal pattern, mandibular anterior crowding, labial inclination of the mandibular anterior teeth, lip protrusion, and posterior discrepancy. A non-extraction approach was therefore considered infeasible.

Another alternative treatment option that we considered was to extract the teeth at the beginning of the second treatment phase. However, extracting teeth immediately before initiating multibracket therapy would prolong the duration of the second treatment phase and increase treatment complexity. Accordingly, we planned to perform early SE during the transitional

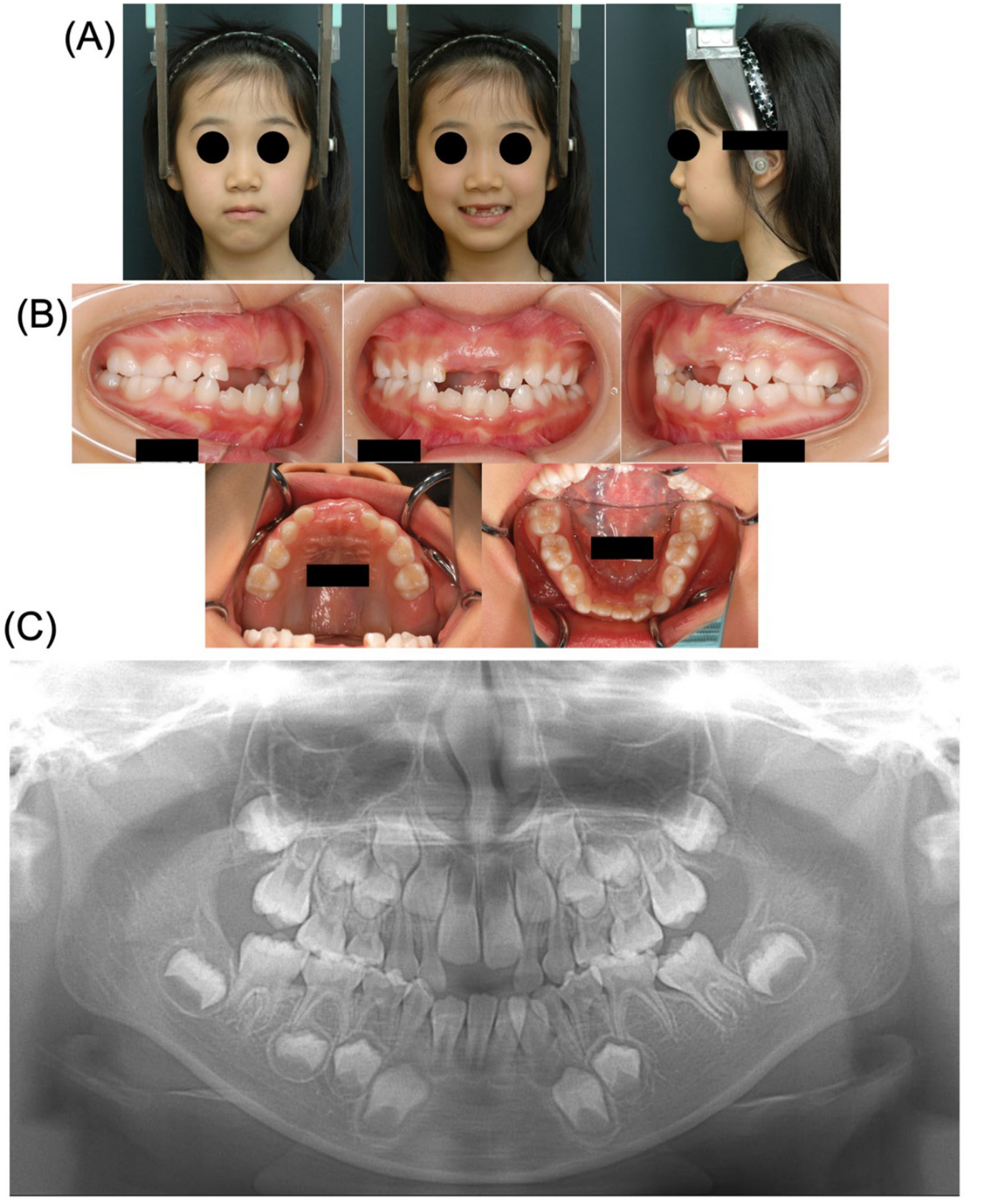


FIGURE 1. Findings at initial presentation (6 y 11 m). (A) Facial photographs. (B) Intraoral photographs. (C) Panoramic radiograph.

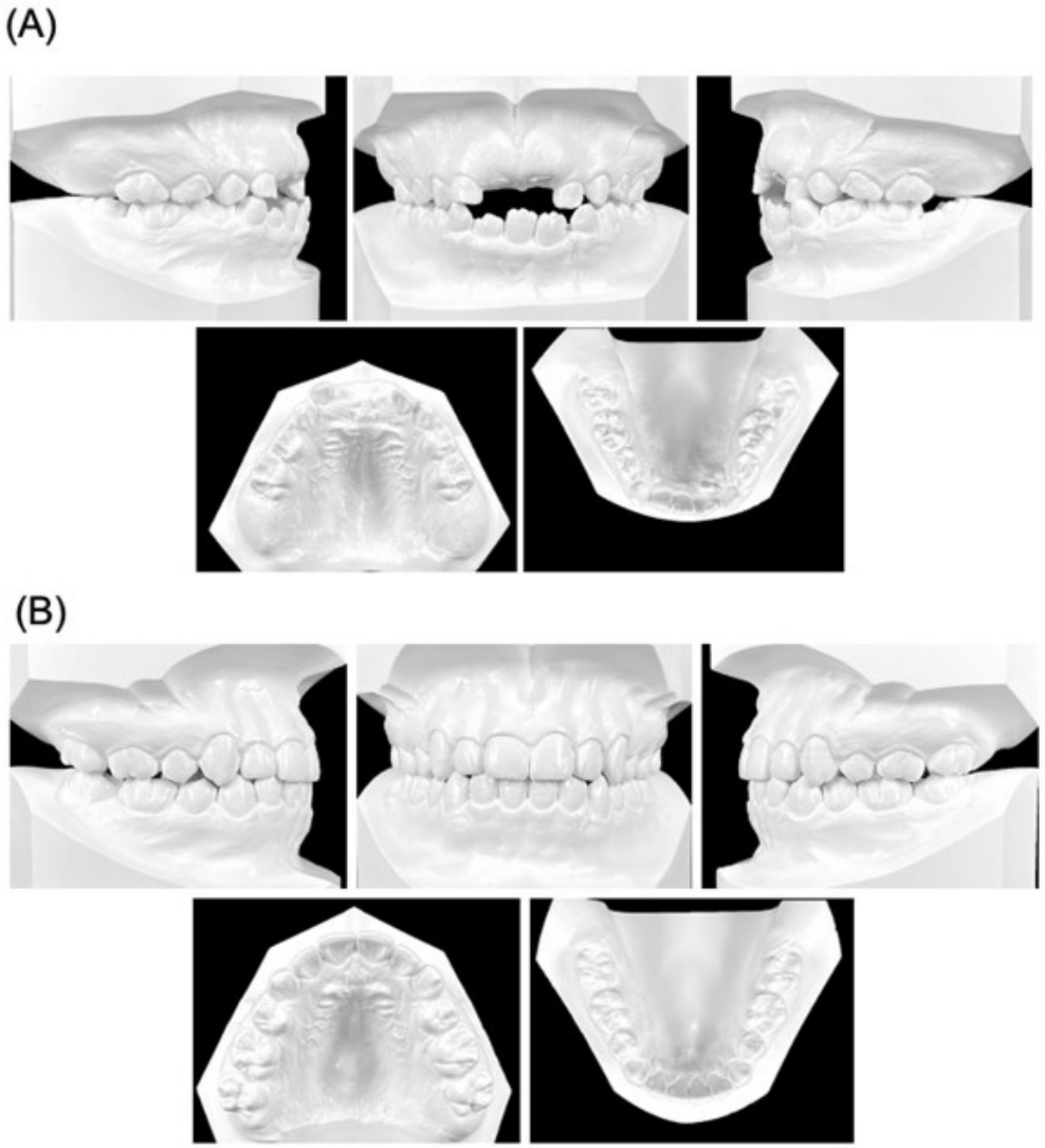


FIGURE 2. Dental cast findings. (A) Initial presentation (6 y 11 m). (B) End of dynamic treatment (14 y 1 m).

dentition in combination with a functional orthodontic appliance to guide the eruption of the permanent teeth.

3.1 Course of treatment

Initially, caries control and oral hygiene instructions were provided. Early extractions were carried out following the standard SE sequence (C → D → 4); however, in the mandibular dentition, the treatment protocol was modified because of the congenitally missing tooth. To shift the mandibular dental midline to the right, the mandibular right primary canine was first extracted, after which a lingual arch was placed in the mandibular arch, and the mandibular anterior teeth were moved rightward using a sectional arch. Simultaneously, a separating module was inserted between the mandibular left second primary molar and the first molar to upright the mandibular left first molar (Fig. 4). By the time the mandibular right and left first primary molars had been extracted, the mandibular canines on both sides had already erupted, resulting in insufficient eruption space for the first premolars. Therefore, hemisection of the mesial roots of the mandibular right and left second primary molars was performed to guide the eruption of the first premolars (Fig. 5). After eruption of the first premolars, the mandibular right first premolar and the distal roots of the mandibular right and left second primary molars were extracted to facilitate the eruption of the mandibular right second premolar (Fig. 5). At that time, an increase in overbite was observed; therefore, a Bionator appliance was introduced to increase the vertical dimension and improve the skeletal Class II relationship (Fig. 4). The

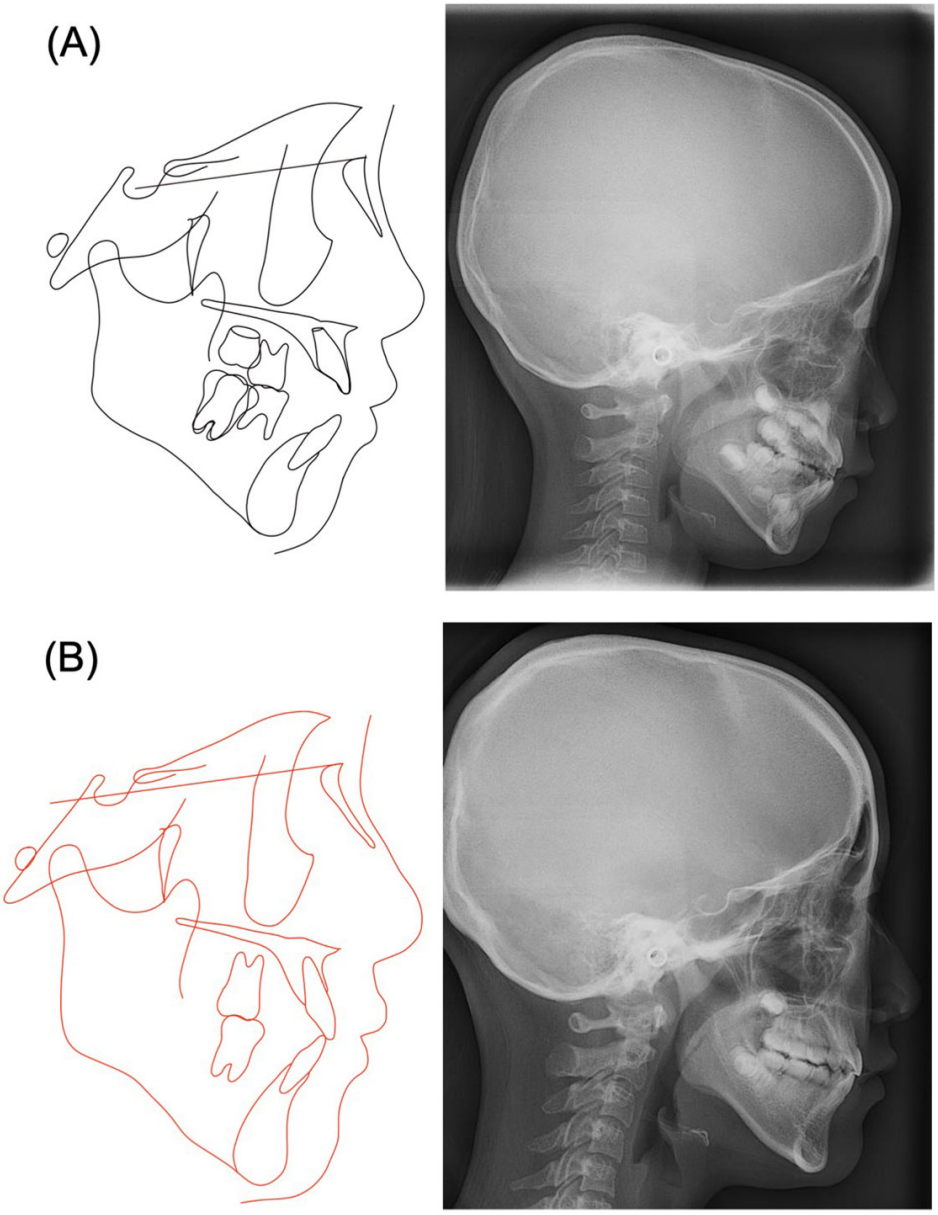


FIGURE 3. Lateral cephalometric radiograph. (A) Initial presentation (6 y 11 m). (B) End of active treatment (14 y 1 m).

TABLE 1. Cephalometric analysis results.

	Before treatment (6 y 11 m)	Before BN therapy (9 y 6 m)	After BN therapy (10 y 10 m)	End of treatment (14 y 1 m)	After retention (16 y 8 m)
∠SNA (°)	76.0	76.0	76.0	76.5	76.5
∠SNB (°)	71.0	72.5	73.5	74.0	74.5
∠ANB (°)	5.0	3.5	2.5	2.5	2.0
∠FMA (°)	35.0	35.0	35.5	36.0	36.0
U1 to NA (mm/°)	Not available	5.0/30.0	3.0/18.0	5.0/22.0	6.0/24.5
L1 to NB (mm/°)	7.5/32.0	4.5/20.0	5.5/19.0	6.5/25.0	7.5/27.5
∠FMIA (°)	48.0	63.0	63.0	57.0	57.0
Interincisal angle (°)	Not available	127.0	141.0	130.0	126.0

BN, Bionator therapy; y, year; m, month; SNA, angle between the sella (S), nasion (N), and subspinale point A (A); SNB, angle between the SN line and supramentale point B (B); ANB, angle between the AN line and NB line; FMA, Frankfort-mandibular plane angle; NA, line from the nasion to point A; NB, line from the nasion to point B; FMIA, Frankfort-mandibular incisor angle; U1, Upper central incisor; L1, Lower central incisor.

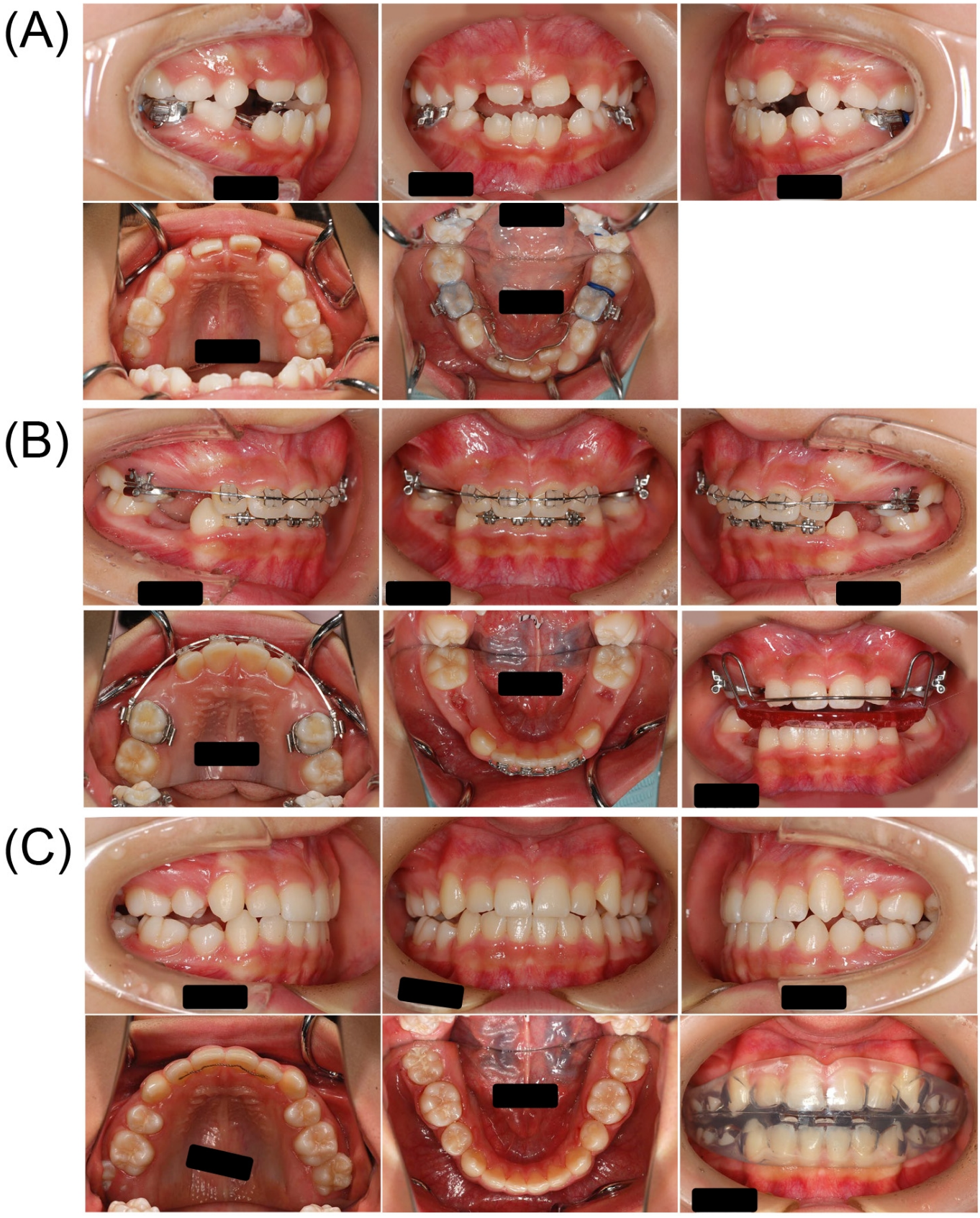


FIGURE 4. Treatment progress. (A) Rightward movement of the mandibular midline and uprighting of the mandibular left first molar (7 y 2 m). (B) Completion of sectional arch therapy and placement of the Bionator appliance (9 y 5 m). (C) Completion of Bionator therapy and placement of the tooth positioner (12 y 0 m).

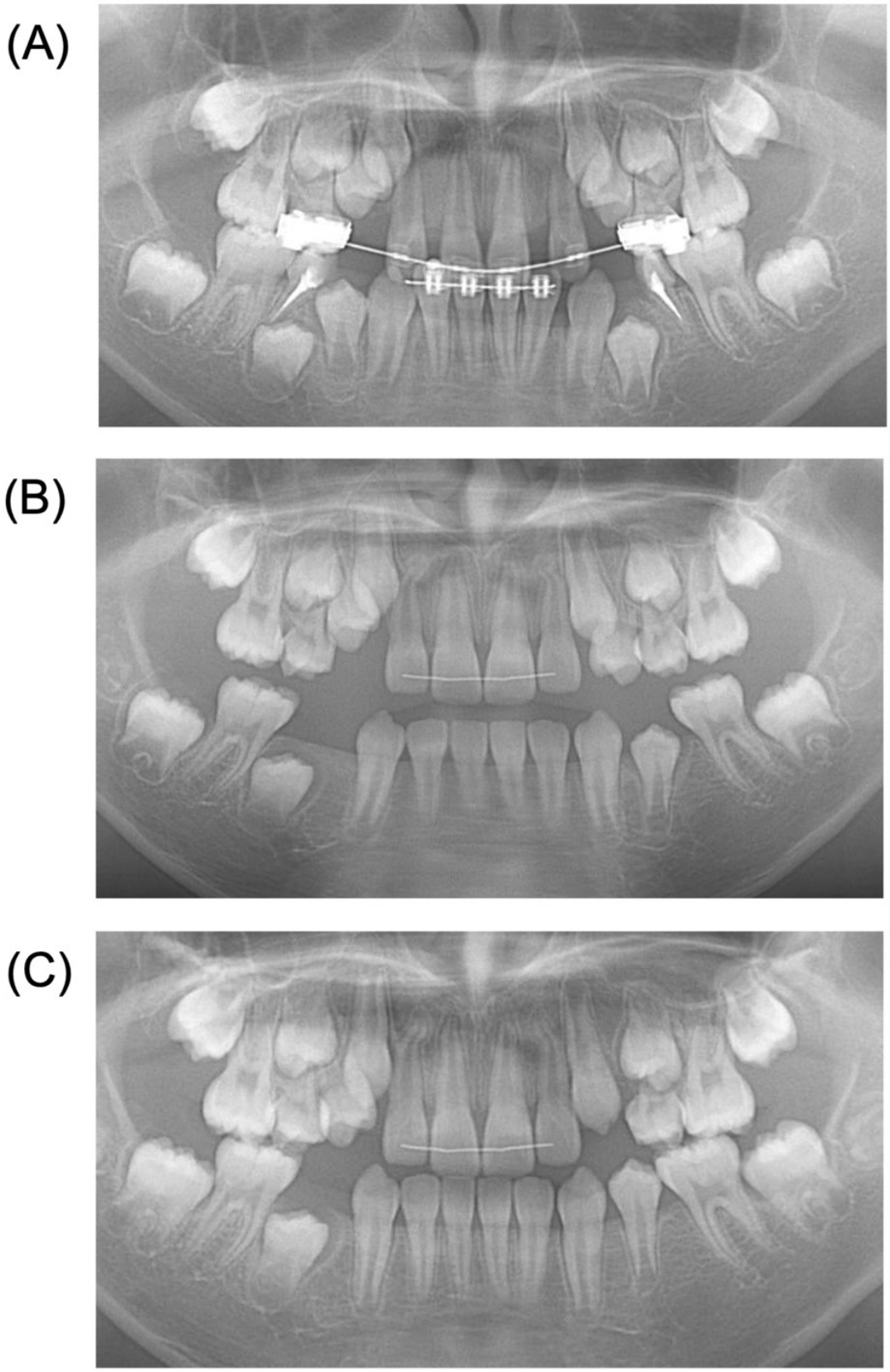


FIGURE 5. Treatment progress as observed on panoramic radiographs. (A) Early hemisection of the mesial roots of the mandibular right and left second primary molars to facilitate distal eruption of the mandibular first premolars. (B) Because of the congenitally missing mandibular left second premolar, the mandibular left first premolar was not extracted, and its eruption was guided distally. The mandibular right first premolar had already been extracted. (C) The maxillary left first premolar was extracted, with planned extraction of the maxillary right first premolar.

Bionator was used for 1 year and 4 months. During this period, the lateral teeth were replaced and the second molars began to erupt. Although improvement in overbite and overjet was achieved subsequently, stable occlusion was not obtained because the lateral teeth were still in the process of erupting. For the second phase of treatment, a multibracket treatment was initially planned, however, due to the father's job transfer, the family had to move to a distant location, so a tooth positioner "Pre-Finisher®" (TP Orthodontics, Tokyo, Japan) was used instead after confirming the patient's compliance and occlusal condition (Fig. 5). A tooth positioner was therefore used to promote occlusal settling (Fig. 4). The patient was instructed to use the tooth positioner for at least 13 h per day for 24 months. After occlusal settling was achieved, posterior interdigitation and a favorable interincisal angle were confirmed. The tooth positioner was then discontinued, and wraparound retainers were placed in both the maxillary and mandibular arches for 2 years.

3.2 Treatment results

Facial photographs taken after the completion of treatment (14 y 1 m) showed good bilateral symmetry. In the profile view, the mandibular retrusion and mild protrusion of both the upper and lower lips observed at the initial presentation were improved, resulting in a favorable facial appearance. Intraoral examination after the completion of treatment showed correction of the dental midline deviation, with appropriate overbite and overjet achieved. In addition, Angle Class I relationships were obtained in the premolar and molar regions, resulting in stable occlusion (Figs. 2,6). Root parallelism was satisfactory, with no significant root resorption or periodontal problems. The maxillary right and left third molars remained impacted in the bone. Cephalometric analysis revealed no change in the angle between the sella (S), nasion (N), and subspinale point A (A) (SNA), while forward and downward growth of the mandible was observed due to the use of the Bionator appliance, resulting in an increase in the angle between the SN line and supramentale point B (B) (SNB) and an improvement in ANB from 5.0° at the initial presentation to 2.5° at the end of treatment. The FMA showed no substantial change, increasing from 35.0° to 36.0°. Interestingly, the U1 (Upper first incisor) to NA (line from the nasion to point A) angle changed from 30.0° to 18.0° during Bionator therapy, indicating substantial lingual tipping of the maxillary anterior teeth. Subsequently, with the use of the tooth positioner, the angle increased to 22.0°, reflecting labial tipping. The L1 to NB distance ultimately reached 6.5 mm, which was close to the predetermined treatment goal. The FMIA remained unchanged before and after Bionator therapy at 63.0°; however, following the use of the tooth positioner, the angle decreased to 57.0° at the end of treatment, indicating labial tipping of the mandibular anterior teeth and approaching the Japanese normative value. Consequently, the interincisal angle increased from 127.0° before Bionator therapy to 141.0° after Bionator therapy, and subsequently decreased to 130.0° at the end of treatment (Figs. 3,7, Table 1). A favorable occlusal relationship was maintained for 2 years and 7 months after the completion of treatment (Fig. 8) and for 8 years and 7 months post-treatment, demonstrating long-term stability (Fig. 9).

4. Discussion

4.1 Treatment planning in pediatric orthodontics

In pediatric orthodontic treatment, determining the most appropriate treatment strategy can often be challenging. Because children are still growing, prioritizing skeletal correction during the growth period may reduce the need for a second treatment phase and shorten the overall treatment duration [16]. In our clinical practice, particularly in cases involving maxillary protrusion, deep overbite, and crowding, overbite control is given the highest priority. In other words, space-related problems, including crowding, are addressed while simultaneously controlling the overbite. This treatment sequence is considered effective in advancing pediatric orthodontic treatment. We believe that overbite control represents a critical step in terms of saving both time and labor and should be prioritized over transverse expansion. Based on this concept, treatment in the present case prioritized correction of the deep overbite, while skeletal improvement was supported through mandibular growth and an increase in occlusal vertical dimension. At the same time, because the mandibular left second premolar was congenitally missing and there was substantial space deficiency, early extraction of the contralateral first premolar was necessary to guide the eruption of the posterior teeth and facilitate alignment. In cases such as this one, where a modified treatment strategy was required because of a congenitally missing tooth, early improvement of the overbite allows for effective space control through occlusal guidance strategies, including active interproximal reduction of primary teeth and hemisection [17, 18]. This approach can contribute to the effective resolution of mandibular crowding. Furthermore, previous reports have indicated that slice cutting and hemisection are most appropriately performed at approximately 8 to 9 years of age [18]. The timing of treatment in the present case was therefore also considered appropriate.

Skeletal correction in the present case was achieved using a functional orthodontic appliance. Functional orthodontic appliances have been reported to improve overjet and overbite and to promote mandibular growth to some extent; however, their effectiveness is strongly influenced by the patient cooperation and varies among individuals [19]. To date, various functional appliances have been developed. Representative appliances include the Herbst appliance [20], Bionator [21, 22], Activator [23], and Frankel appliance [24]. In addition, functional appliances consisting of separate maxillary and mandibular components include the Twin Block appliance [25] and the Bite Jumping Appliance [26–29]. Among these options, the Bionator–a removable monoblock appliance originally introduced by Balters *et al.* [30]—was selected for the present case. One of its advantages is that it allows skeletal correction while enabling dental adjustments and guiding posterior tooth eruption through selective trimming of the resin. In our clinical practice, the Bionator is frequently used for this purpose. Regarding the effect of the Bionator on mandibular advancement and growth, Almeida *et al.* [31] and

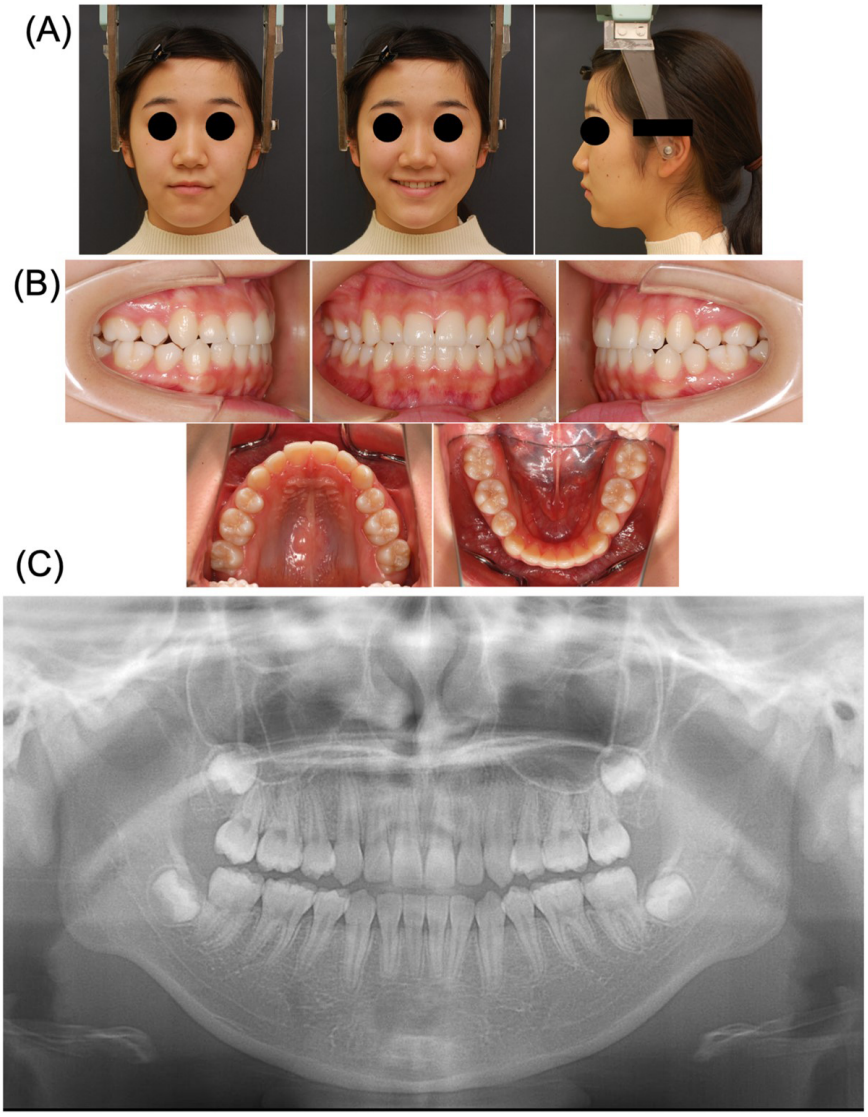


FIGURE 6. Findings at the end of dynamic treatment (14 y 1 m). (A) Facial photographs. (B) Intraoral photographs. (C) Panoramic radiograph.

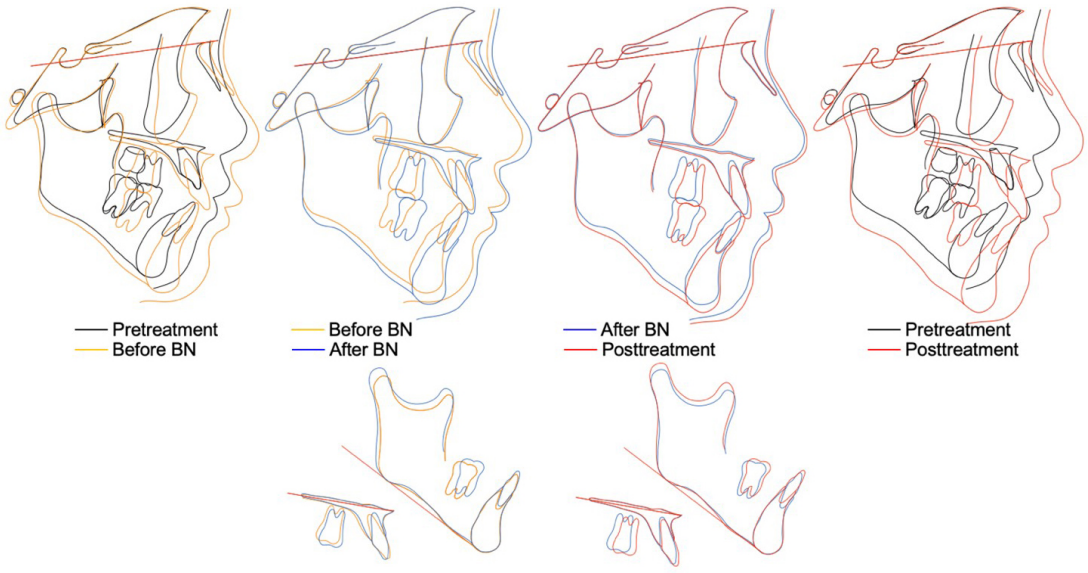


FIGURE 7. Superimpositions of pretreatment (black; 6 y 11 m), before Bionator therapy (orange; 9 y 6 m), after Bionator therapy (blue; 10 y 10 m), and posttreatment (red; 14 y 1 m). BN, Bionator therapy.

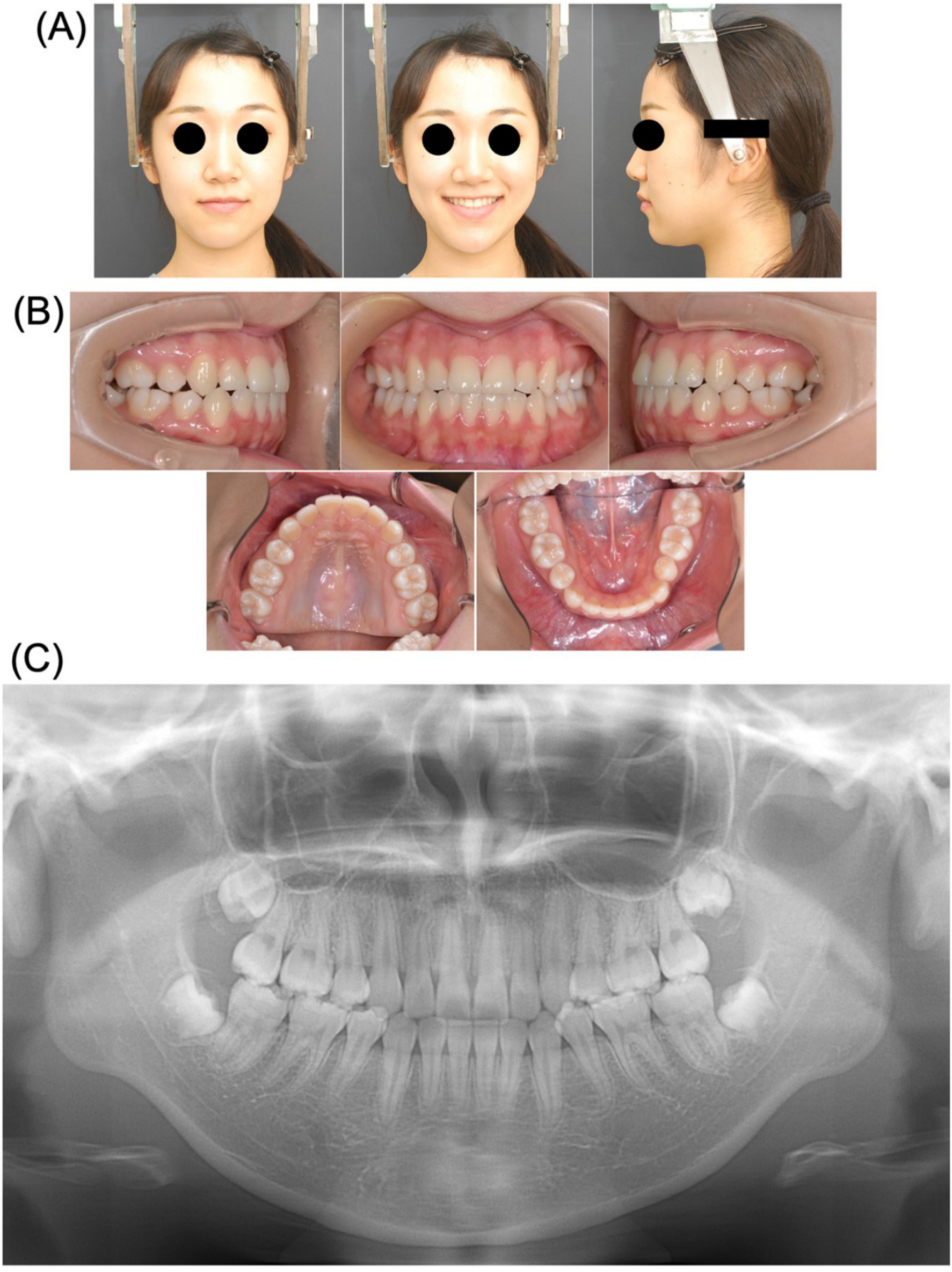


FIGURE 8. Findings at 2 years and 7 months of follow-up posttreatment (16 y 8 m). (A) Facial photographs. (B) Intraoral photographs. (C) Panoramic radiograph.

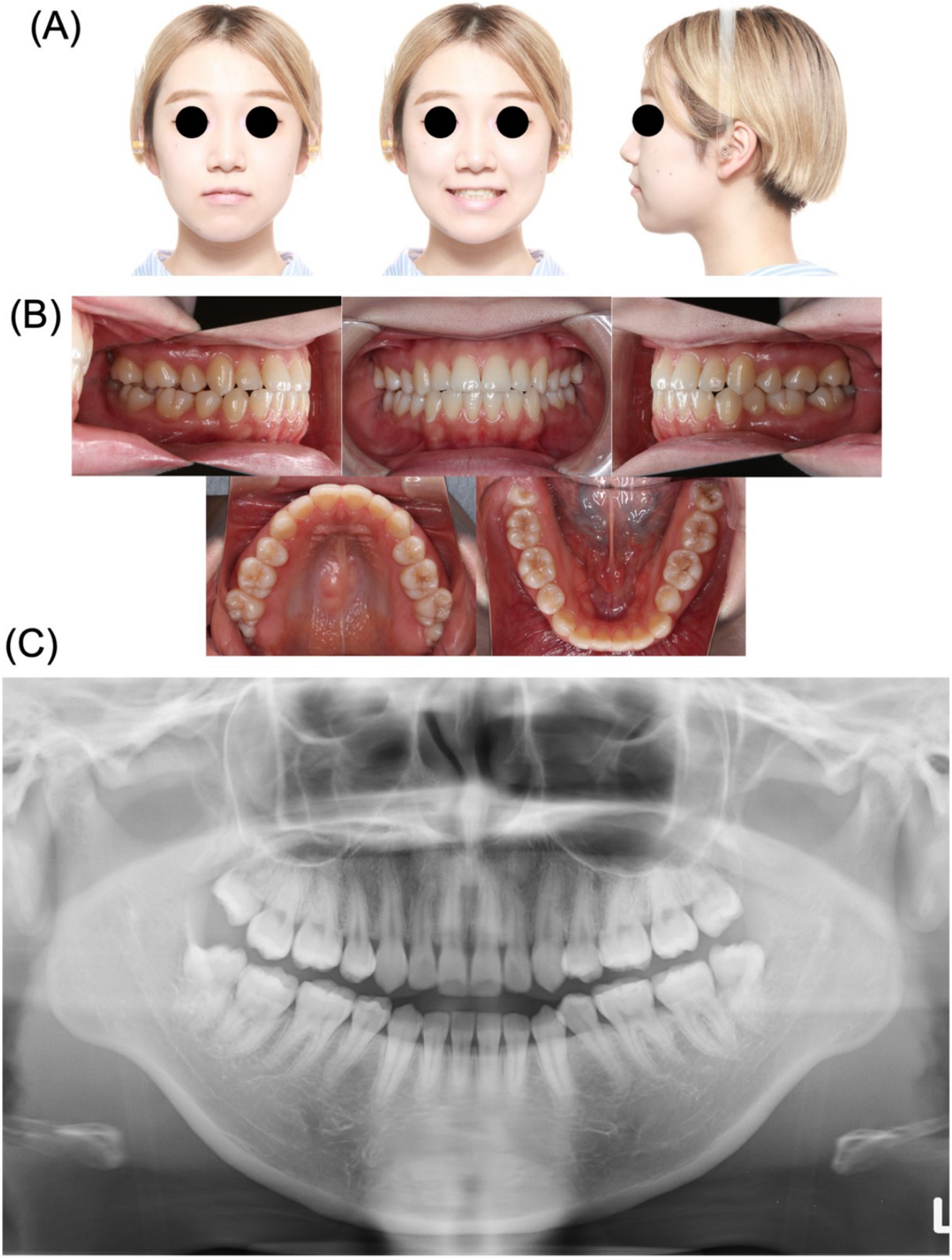


FIGURE 9. Findings at 8 years and 7 months of follow-up posttreatment (22 y 8 m). (A) Facial photographs. (B) Intraoral photographs. (C) Panoramic radiograph.

Illing *et al*. [32] reported significant effects on mandibular growth. Accordingly, in the present case, the Bionator was used to improve the skeletal Class II relationship, and favorable outcomes were achieved without the need for a second treatment phase with a multibracket (fixed appliance) system. Furthermore, no recurrence of crowding was observed 8 years and 7 months after treatment completion, indicating favorable long-term stability.

This dual orthodontic technique, which simultaneously addresses skeletal and dental correction, is considered advantageous. We refer to this approach as the Minimum Multibracket System (M.M.B.S.) and apply it as a treatment strategy during the mixed dentition period. A key element of this approach is bite control. Although we usually use the Bionator, the approach may also be applied using other functional orthodontic appliances, provided that forward positioning of the mandible and adequate bite control can be achieved. Furthermore, the subsequent use of a tooth positioner allows for efficient and effective treatment in terms of both time and appliance use. This approach may eliminate the need for finishing treatment with a multibracket system or substantially shorten its duration, thereby offering potential advantages for both patients and dentists.

4.2 Early extraction and the use of functional orthodontic appliances

The ideal timing for initiating orthodontic treatment has long been a subject of debate. When a patient in the early mixed dentition presents with severe crowding due to substantial arch-length discrepancy and has been diagnosed as requiring tooth extraction as part of the treatment plan, a decision must be made as to whether premolar extraction should be performed early during the mixed dentition or later after premolar eruption in the permanent dentition. Regardless of the timing, the purpose of tooth extraction is to create sufficient space to properly align the teeth within the basal bone [7, 33]. Early extraction is commonly associated with SE. When SE is performed, teeth are extracted sequentially in the order of C, D, and 4, while monitoring tooth eruption. The advantages of SE include: (1) utilization of physiologic tooth movement; (2) reduction in overall treatment duration, particularly the duration of multibracket therapy; (3) improved stability of treatment outcomes; (4) shortening of the retention period; and (5) improvement in oral hygiene [5, 7, 8, 11, 34]. On the other hand, its disadvantages include: (1) an increased risk of deep overbite; (2) lingual inclination of the mandibular anterior teeth; (3) persistence of residual spaces; and (4) alterations in tongue function [6, 10, 13]. These limitations restrict the indications for SE.

SE is primarily indicated for severe crowding associated with Class I malocclusion. However, Dewel [35] stated that "in cases with severe skeletal Class II discrepancies, treatment should primarily focus on Class II orthopedic correction, with SE serving as an adjunctive procedure". Thus, in cases with abnormal maxillomandibular relationships (*e.g.*, Class II and Class III malocclusions), SE programs must be implemented with great caution, with the understanding that skeletal malocclusions should be corrected using appliances before completion of the permanent dentition [6]. Because the present case was diagnosed as skeletal Class II, it would not ordinarily be considered an appropriate indication for SE. However, to compensate for the inherent disadvantages of SE, the treatment strategy combined extraction with a functional orthodontic appliance capable of advancing the mandible and increasing the occlusal vertical dimension. For this reason, the present approach was intentionally defined as early extraction combining SE with a functional orthodontic appliances, rather than SE alone.

When premolars are extracted at an early stage, changes in intercanine width can also be a matter of debate. In non-extraction orthodontic treatment, intercanine width may be increased, which has led to the assumption that intercanine width naturally increases during growth. However, Moorrees *et al*. [36] concluded that the intercanine width of the mandibular deciduous teeth increases by about 3 mm during the replacement of the mandibular anterior teeth, but then gradually decreases and eventually returns to a width comparable to that observed at approximately 7–8 years of age. Similar findings have been reported in Japanese populations. These studies have shown that the mandibular primary intercanine width continues to increase until approximately 9 to 10 years of age, coinciding with the replacement of primary canines by the permanent canines. Subsequently, the intercanine width gradually decreases and stabilizes at a level comparable to that observed at around 7 to 8 years of age [37]. Thus, Graber *et al*. [6] stated that expecting an increase in mandibular intercanine arch width through the use of orthodontic appliances after 10 to 11 years of age is inconsistent with current understanding of growth and development. Therefore, in the present case, early extraction-oriented treatment was initiated at 7 years of age and was associated with maintenance of the mandibular intercanine width. This approach helped prevent relapse, including recurrence of crowding, without the need for excessive transverse expansion, and allowed for efficient treatment.

4.3 Use of a tooth positioner during the second treatment phase

At the finishing stage of orthodontic treatment, various approaches are available for establishing an optimal functional occlusion.

In the present case, after completion of Bionator therapy (at 10 years and 10 months of age), the patient's father was transferred for work, making it difficult to continue regular monthly visits. Nevertheless, further occlusal settling was required, which would normally necessitate tooth movement using a multibracket appliance, along with careful oral hygiene management. Therefore, it was decided to continue treatment using a removable appliance. Recently, removable appliances have been reported to be more aesthetically acceptable and better tolerated by patients [38]. Among removable options, aligners and tooth positioners are commonly considered. It has been reported that aligners may allow better maintenance of periodontal health compared with fixed appliances [39]. However, because aligners are fabricated separately for the maxillary and mandibular arches, they have disadvantages, including difficulty in establishing proper interarch occlusion

and the need to apply relatively large forces during insertion and removal, which may reduce ease of use.

In contrast, the tooth positioner, introduced in 1945, is fabricated from an elastic material, allowing easy insertion and use [40, 41]. There have been reports that, during the finishing stage of orthodontic treatment, tooth positioners can correct minor discrepancies associated with bracket positioning, increase the number of interarch occlusal contacts, and facilitate correction of the axial inclination of the anterior teeth [41, 42]. In addition, as a monoblock appliance, the positioner is designed to allow the maxillary and mandibular molars to occlude in an Angle Class I relationship, and has therefore been used to guide the mandible into a Class I relationship [43]. However, treatment outcomes with a positioner are known to be influenced by patient compliance [44], which represents an inherent limitation of removable appliances. In the present case, the patient demonstrated good compliance during Bionator therapy, and the elastic material of the positioner was considered advantageous for maintaining adequate appliance fit during tooth movement. Therefore, a tooth positioner was selected for the present case. The absence of fixed appliances during adolescence may have provided practical advantages for both the patient and the dentist.

In the present case, a prefabricated tooth positioner was used. When a plaster was poured into the tooth positioner, the interincisal angle measured on the resulting cast was 127° (Fig. 10). At the initiation of tooth positioner use, the patient's interincisal angle was 141.0°. Because the target value was set at 131°, the tooth positioner was applied with the intention of achieving slight overcorrection. As a result, tooth movement proceeded in accordance with the tooth positioner setup, leading to labial inclination of the maxillary and mandibular anterior teeth. At the completion of treatment, the interincisal angle had decreased to 130°, indicating a favorable interincisal angle.

4.4 Limitations

This report has some limitations that should be considered. First, because this is a single case report, the results cannot be generalized to a broader patient population, and careful patient selection is therefore essential. Second, the treatment strategy used in this case relies on patient compliance, and long-term follow-up is necessary to assess treatment outcomes and durability.

5. Conclusions

Early intervention allowed for the implementation of early extraction in the present case. The favorable treatment outcome was associated with the combined use of the Bionator for overbite control and mandibular advancement during growth and early extraction performed at an appropriate stage of dental development. The treatment strategy in this case enabled simultaneous management of the skeletal and dental components of malocclusion, including overbite and arch length discrepancy, thereby compensating for the limitations of SE alone and resulting in an efficient treatment outcome. In addition, treatment was completed without the need for a second treatment phase using a multibracket system. Furthermore, the occlusion remained stable even after 8 years and 7 months, demonstrating long-term stability. Regarding early tooth extraction, case selection is important, and treatment must be carried out with great care. However, this strategy allows for complete treatment during the growth and development period, and can be applied even in cases such as this one involving congenitally missing teeth.

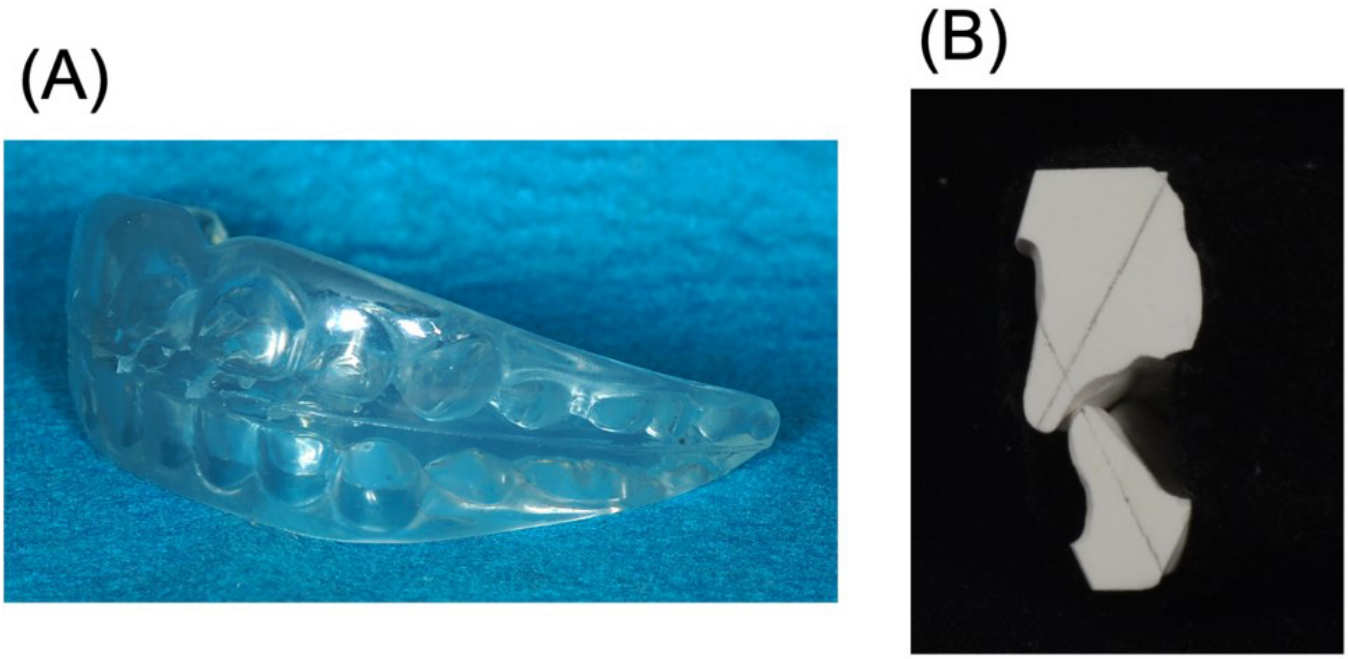


FIGURE 10. Use of a tooth positioner. (A) Photograph of the tooth positioner. (B) Plaster cast of the tooth positioner, showing an interincisal angle of 127°.

ABBREVIATIONS

SE, serial extraction; SNA, angle between the sella (S), nasion (N), and subspinale point A (A); SNB, angle between the SN line and supramentale point B (B); ANB, angle between the AN line and NB line; FMA, Frankfort-mandibular plane angle; NA, line from the nasion to point A; NB, line from the nasion to point B; FMIA, Frankfort-mandibular incisor angle; U1, Upper first incisor; L1, Lower first incisor; M.M.B.S., Minimum Multibracket System.

AVAILABILITY OF DATA AND MATERIALS

Data sharing does not apply to this article, as no new datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTIONS

MaT, TSa and MiT—performed the treatment and conceptualization. SK, TSe, YK, NS, YA and RH—provided help and advice on the manuscript. KM—managed the project. All authors contributed to the editorial revision of the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The need for ethical approval was waived by the ethics committee of Aichi Gakuin University School of Dentistry, as this was a case report. Written consent for publication and presentation of this case was obtained from the patient and her parents.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Khalil A, Alrehaili R, Almatrodi R, Koshak A, Tawakkul B, Almuqati T, *et al*. Congenitally missing lateral incisors: prioritizing space closure whenever feasible. Cureus. 2024; 16: e74471.

[2] Rakhshan V. Congenitally missing teeth (hypodontia): a review of the literature concerning the etiology, prevalence, risk factors, patterns and treatment. Dental Research Journal. 2015; 12: 1–13.

[3] Yamasaki Y, Iwasaki T, Hayasaki H, Saitoh I, Tokutomi J, Yawaka Y, *et al*. Frequency of congenitally missing permanent teeth in Japanese children. The Japanese Journal of Pediatric Dentistry. 2010; 48: 29–39. (In Japanese)

[4] Carter NE, Gillgrass TJ, Hobson RS, Jepson N, Meechan JG, Nohl FS, *et al*. The interdisciplinary management of hypodontia: orthodontics. British Dental Journal. 2003; 194: 361–366.

[5] Gianelly AA. Crowding: timing of treatment. The Angle Orthodontist. 1994; 64: 415–418.

[6] Graber TM. Serial extraction: a continuous diagnostic and decisional process. American Journal of Orthodontics. 1971; 60: 541–575.

[7] Kjellgren B. Serial extraction as a corrective procedure in dental orthopedic therapy. Acta Odontologica Scandinavica. 1948; 8: 17–43.

[8] Boley JC. Serial extraction revisited: 30 years in retrospect. American Journal of Orthodontics and Dentofacial Orthopedics. 2002; 121: 575–577.

[9] Bishara SE, Jakobsen JR, Treder JE, Stasl MJ. Changes in the maxillary and mandibular tooth size-arch length relationship from early adolescence to early adulthood. A longitudinal study. American Journal of Orthodontics and Dentofacial Orthopedics. 1989; 95: 46–59.

[10] Ringenberg QM. Influence of serial extraction on growth and development of the maxilla and mandible. American Journal of Orthodontics. 1967; 53: 19–26.

[11] Brandt S. JPO interviews Dr. Charles H. Tweed. The Journal of Practical Orthodontics. 1968; 2: 11–19.

[12] Dewel BF. Prerequisites in serial extraction. American Journal of Orthodontics. 1969; 55: 533–539.

[13] Dewel BF. A critical analysis of serial extraction in orthodontic treatment. American Journal of Orthodontics. 1959; 45: 424–455.

[14] Ono H. [Mesiodistal crown width of primary and permanent teeth and their correlations within the dental arch]. Journal of the Stomatological Society, Japan. 1960; 27: 221–234. (In Japanese)

[15] Kambara T, Nagaya K, Hayami H, Kinoshita M, Ohsaki Y, Kawamoto T. Analysis of mandibular incisor position in Japanese adults: assessment based on the Holdaway ratio. Journal of Osaka Dental University. 2006; 40: 153–158. (In Japanese)

[16] Goto Y, Tabuchi M, Takahashi M, Hayashi K, Sato T, Miyazawa K, *et al*. Application of modified serial extraction in a patient with crowding accompanied by congenitally missing right maxillary first premolar and left mandibular second premolar. The Aichi-Gakuin Journal of Dental Science. 2016; 54: 115–126. (In Japanese)

[17] Northway WM. The nuts and bolts of hemisection treatment: managing congenitally missing mandibular second premolars. American Journal of Orthodontics and Dentofacial Orthopedics. 2005; 127: 606–610.

[18] Valencia R, Saadia M, Grinberg G. Controlled slicing in the management of congenitally missing second premolars. American Journal of Orthodontics and Dentofacial Orthopedics. 2004; 125: 537–543.

[19] Koretsi V, Zymperdikas VF, Papageorgiou SN, Papadopoulos MA. Treatment effects of removable functional appliances in patients with Class II malocclusion: a systematic review and meta-analysis. European Journal of Orthodontics. 2015; 37: 418–434.

[20] Pancherz H. Treatment of Class II malocclusions by jumping the bite with the Herbst appliance. A cephalometric investigation. American Journal of Orthodontics. 1979; 76: 423–442.

[21] Balters W. [Results of controlled spontaneous healing of orthodontic anomalies]. German Dental Journal. 1960; 15: 241–248. (In German)

[22] Almeida MR, Henriques JF, Almeida RR, Almeida-Pedrin RR, Ursi W. Treatment effects produced by the Bionator appliance. Comparison with an untreated Class II sample. European Journal of Orthodontics. 2004; 26: 65–72.

[23] Williams S, Melsen B. The interplay between sagittal and vertical growth factors. An implant study of activator treatment. American Journal of Orthodontics. 1982; 81: 327–332.

[24] Fränkel R. The treatment of Class II, Division 1 malocclusion with functional correctors. American Journal of Orthodontics. 1969; 55: 265–275.

[25] Mills CM, McCulloch KJ. Treatment effects of the twin block appliance: a cephalometric study. American Journal of Orthodontics and Dentofacial Orthopedics. 1998; 114: 15–24.

[26] Sander F. [Indication for the use of the double advancement plate]. Practical Orthodontics. 1988; 2: 209–222. (In German)

[27] Sander F, Lassak C. The modification of growth with the jumping-the-bite plate compared to other functional orthodontic appliances. Advances in Orthodontics. 1990; 51: 155–164. (In German)

[28] Sander F, Weinreich A. The bite-jumping-appliance. German Stomatology. 1991; 41: 195–198. (In German)

[29] Sander F, Wichelhaus A. Skeletal and dental changes during the use of the

bite-jumping plate. A cephalometric comparison with an untreated Class-II group. Advances in Orthodontics. 1995; 56: 127–139. (In German)

[30] Balters W. Effects of power or formative irritation in therapy of malocclusion. Dental World. 1952; 7: 437–441. (In German)

[31] Rodrigues de Almeida-Pedrin R, Rodrigues de Almeida M, Rodrigues de Almeida R, Pinzan A, Ferreira FPC. Treatment effects of headgear biteplane and Bionator appliances. American Journal of Orthodontics and Dentofacial Orthopedics. 2007; 132: 191–198.

[32] Illing HM, Morris DO, Lee RT. A prospective evaluation of Bass, Bionator and Twin Block appliances. Part I—the hard tissues. European Journal of Orthodontics. 1998; 20: 501–516.

[33] Little RM. The effects of eruption guidance and serial extraction on the developing dentition. Pediatric Dentistry. 1987; 9: 65–70.

[34] O'Shaughnessy KW, Koroluk LD, Phillips C, Kennedy DB. Efficiency of serial extraction and late premolar extraction cases treated with fixed appliances. American Journal of Orthodontics and Dentofacial Orthopedics. 2011; 139: 510–516.

[35] Dewel BF. [Serial extraction in orthodontics: origins and American concepts]. Spanish Journal of Orthodontics. 1971; 1: 13–28. (In Spanish)

[36] Moorrees CFA, Fanning EA, Gron AM. The consideration of dental development in serial extraction. The Angle Orthodontist. 1963; 33: 44–59.

[37] Tsujino K, Machida Y. A longitudinal study on the growth and development of the dental arch width from childhood to adolescence. The Japanese Journal of Pediatric Dentistry. 1997; 35: 670–683. (In Japanese)

[38] Rossini G, Parrini S, Castroflorio T, Deregibus A, Debernardi CL. Efficacy of clear aligners in controlling orthodontic tooth movement: a systematic review. The Angle Orthodontist. 2015; 85: 881–889.

[39] Jiang Q, Li J, Mei L, Du J, Levrini L, Abbate GM, *et al*. Periodontal health during orthodontic treatment with clear aligners and fixed appliances: a meta-analysis. The Journal of the American Dental Association. 2018; 149: 712–720.e12.

[40] Kesling HD. The philosophy of the tooth positioning appliance. American Journal of Orthodontics and Oral Surgery. 1945; 31: 297–304.

[41] Cometti PD, English JD, Kasper FK. Efficacy of the mini tooth positioner in improving orthodontic finishes. American Journal of Orthodontics and Dentofacial Orthopedics. 2019; 155: 844–850.

[42] Wells NE. Application of the positioner appliance in orthodontic treatment. American Journal of Orthodontics. 1970; 58: 351–366.

[43] Barnett JW. The centric relation tooth positioner. Its use as a finishing appliance for modern orthodontics. Journal of Clinical Orthodontics. 1978; 12: 24–37.

[44] Park Y, Hartsfield JK, Katona TR, Roberts WE. Tooth positioner effects on occlusal contacts and treatment outcomes. The Angle Orthodontist. 2008; 78: 1050–1056.

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