Case Report

Extraction of the lateral incisors to treat maxillary protrusion: Quantitative evaluation of the stomatognathic functions

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ABSTRACT

To treat morphological abnormalities, impaction, and severe malposition of the teeth, the lateral incisors are sometimes extracted, followed by orthodontic space closure. This procedure often requires special consideration, not only with regard to esthetics but also for functional issues. However, thus far, few reports that have performed a functional evaluation in such cases. The purpose of this article is to report the successful treatment of an adult patient with a Class II division 1 malocclusion who was treated with extraction of the upper lateral incisors. The female patient, aged 23 years and 6 months, had a chief complaint of maxillary incisal protrusion and crooked teeth. In this patient, the upper lateral incisors were extracted to fulfill the patient's strong request, followed by orthodontic treatment using edgewise appliances. A high-pull J-hook headgear on the lower dental arch was used to prevent further labial inclination of the lower incisors. The total active treatment period was 37 months. The resulting occlusion and a satisfactory facial profile were maintained during a 4-year retention period. Additionally, this treatment did not affect the stomatognathic functions as assessed by the following criteria: range of the incisal path or condylar motion during maximal open-close movement, protrusive excursion, lateral excursion, and the chewing test. In conclusion, extraction of the upper lateral incisors can be an effective treatment choice when the upper lateral incisors are dwarfed, are nonvital, or demonstrate severe malposition. (*Angle Orthod.* 2013;83:341–354.)

KEY WORDS: Lateral incisor; Stomatognathic function; J-hook headgear

INTRODUCTION

Most patients seeking orthodontic treatment have a chief complaint of functional and/or esthetic deformities due to misalignment of the maxillary anterior teeth. In such patients, the extraction of maxillary anterior teeth has generally been avoided, as it may create an esthetic problem associated with specific orthodontic considerations because of its relationship with malocclusion. On the other hand, the maxillary lateral incisor is known to be one of the teeth that is most commonly congenitally absent,[1,2] with 1.3% of the population lacking at least one of these teeth.[3] Furthermore, orthodontists sometimes face situations where they are compelled to extract maxillary incisors for various reasons, such as the presence of peg-shaped, severely malpositioned, or impacted teeth, or because of root resorption due to ectopically positioned maxillary canines. In addition, there have been cases of incisor extraction followed by space closure.[4,5] Orthodontic space closure, using the canines to replace the absent maxillary lateral incisors, is one of the common treatment options used to provide a better

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Figure 1. Pretreatment facial and intraoral photographs.

Figure 2. Pretreatment dental casts.

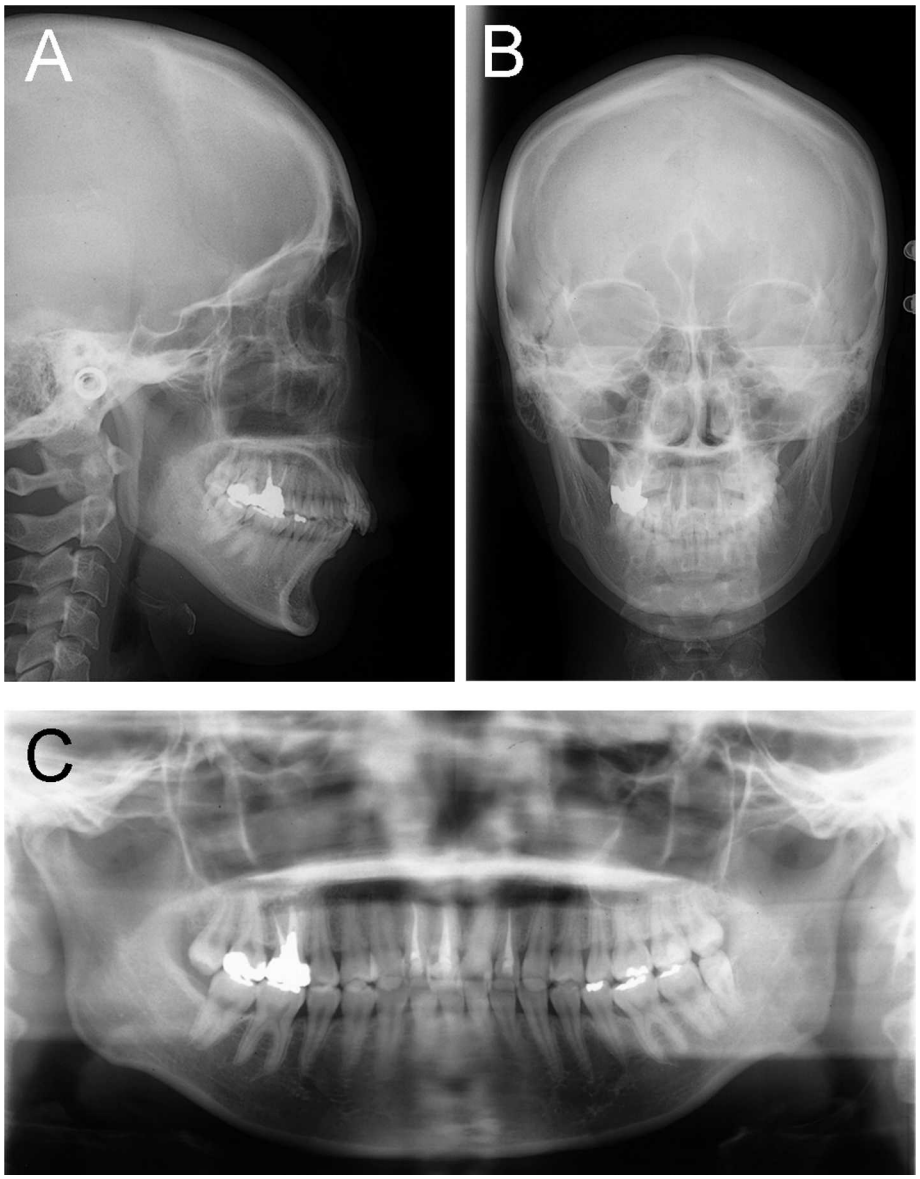

Figure 3. Pretreatment cephalograms and a panoramic radiograph. (A) Lateral cephalogram. (B) Posteroanterior cephalogram. (C) Panoramic radiograph.

esthetic outcome. However, the substitution of canines for lateral incisors drastically modifies the functional occlusion, as there is no potential for canine guidance during jaw movement excursions. Consequently, treatment planning for patients with maxillary space closure requires consideration of both functional and esthetic aspects.[6–9] There have been some reports of successful morphological or esthetic changes after canine substitution,[2,10,11] but no reports have described the functional considerations of the occlusion changes.

The aim of this case report is therefore to present a functional assessment after orthodontic treatment with the extraction of the maxillary lateral incisors in a patient with maxillary protrusion. We assessed the stomatognathic function, condylar motion, and jaw movement to evaluate the gnathological changes obtained after orthodontic treatment.

CASE REPORT

A female patient, aged 23 years and 6 months, came to the outpatient dental clinic of Okayama University Hospital. Her chief complaints were protruding upper incisors and crooked teeth (Figures 1 through 3). She had a symmetrical face, a convex profile, and an acute nasolabial angle. She also suffered from circumoral musculature strain on lip closure. An excessive overjet of 6.9 mm with Angle Class II molar relationships on both sides was also observed. In addition, an excessive curve of Spee of

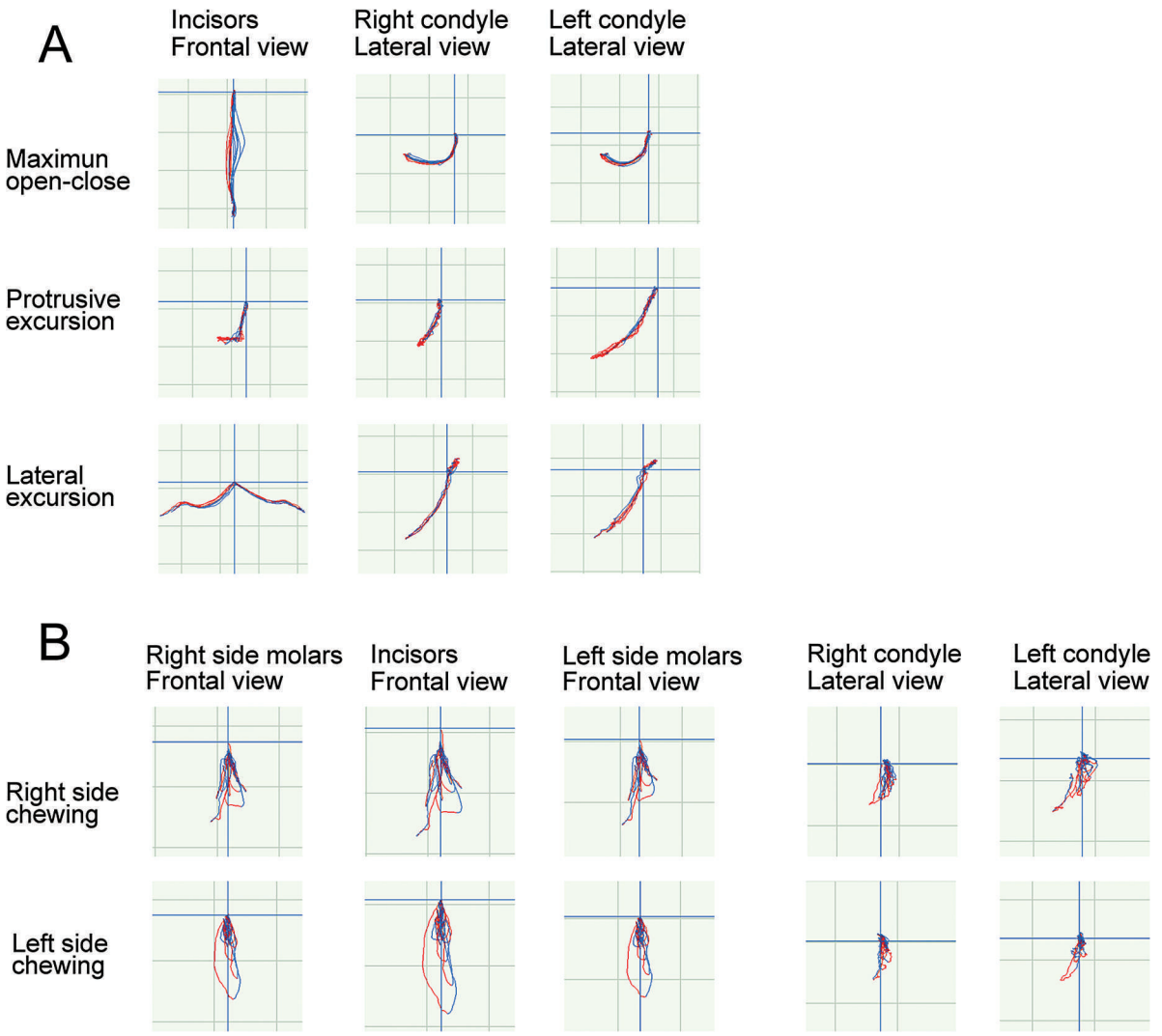

Figure 4. Pretreatment condylar movement and incisal paths as detected using a six-degrees-of-freedom jaw-movement recording system. The red line shows the opening phase, and the blue line indicates the closing phase. (A) Opening and closing, protrusive, and lateral excursive movements. (B) Chewing movements.

4.0 mm was found in the mandibular dentition. Moreover, the maxillary right first molar, right lateral incisor, right medial incisor, and left lateral incisor were nonvital and discolored. An optoelectronic jaw-tracking system (Gnathohexagraph system, version 1.31, Ono Sokki Ltd, Kanagawa, Japan) was used to record jaw movements with 6 degrees of freedom.[12] The incisal path was not stable during maximum opening and closing, protrusive excursion, and lateral excursion jaw movement. Asymmetrical movements of the bilateral condyles were also observed during protrusive excursion jaw movement (Figure 4A). Irregular patterns of movement were observed in a chewing test using a hard gummy jelly (Figure 4B).

Cephalometric analysis showed the patient to have a skeletal Class II jaw relationship (ANB: 8.0°), a high mandibular plane angle (Mp-SN: 45.0°), and a normal gonial angle (126°) (Table 1).[13] Although the SNA angle was normal, the SNB angle was 70.0°, reflecting a retruded position of the mandible to the cranial base with regard to the anteroposterior relationship, and a short mandibular ramus height (Ar-Go) of 41.0 mm was observed with regard to the vertical relationship. The maxillary anterior teeth significantly protruded (U1 to A-Po: 12.0 mm), and the mandibular incisors were labially inclined (L1-Mp: 103°). The mandibular dental midline closely coincided with the facial midline, but the maxillary midline was observed to have shifted 2.0 mm toward the right. Patient consent was received for this study.

Treatment Objective

Based on these findings, the patient was diagnosed with Angle Class II malocclusion, a skeletal Class II

Table 1. Cephalometric summary

Variables	Japanese norms (Adult female)	S.D.	Pretreatment	Post-treatment	Post-retention
Angular (°)					
ANB	2.8	2.44	8.0	8.5	8.5
SNA	80.8	3.61	78.0	77.5	77.5
SNB	77.9	4.54	70.0	69.0	69.0
FMA	30.5	3.60	34.0	35.0	35.0
Mp-SN	37.1	4.64	45.0	46.0	46.0
U1-SN	105.9	8.79	99.0	92.0	94.0
L1-Mp	93.4	6.77	103.0	100.5	99.5
Inter incisal angle	123.6	10.64	114.5	120.0	121.0
Occ. Plane to SN	18.0	3.50	26.0	27.5	27.5
Gonial angle	122.2	5.29	126.0	126.0	126.0
Linear (mm)					
S-N	67.9	3.65	70.0	70.0	70.0
N-Me	125.8	5.04	125.5	126.0	126.0
Me/PP	68.6	3.71	66.5	67.0	67.0
Overjet	3.1	1.07	8.5	2.5	3.0
Overbite	3.3	1.89	2.0	1.5	2.0
U1/PP	31.0	2.34	30.5	30.0	30.0
U6/PP	24.6	2.00	23.0	23.5	23.5
L1/Mp	44.2	2.68	44.0	44.0	44.0
L6/Mp	32.9	2.50	32.0	32.0	32.0
E-line to Upper lip	–2.5	1.90	3.5	0.0	0.0
E-line to Lower lip	0.9	1.90	3.5	0.0	0.0

jaw-base relationship with mandibular retrusion and a large overjet. The treatment objectives were to create more ideal overbite and overjet relationships, to reduce the anteroposterior skeletal discrepancy to improve her facial profile, to correct her excessive curve of Spee, and to obtain Class I canine and Class II molar relationships. We planned to use miniscrews for absolute anchorage. In this case, the upper lateral incisors were extracted in response to the patient's strong request, followed by orthodontic treatment using edgewise appliances. A J-hook headgear was used concomitantly to prevent further labial inclination of the lower incisors.

Treatment Progress

After extraction of the upper lateral incisors and the lower left third molar, a 0.018-in preadjusted edgewise appliance was placed in the upper arch. Initial alignment was achieved with 0.016-in nickel-titanium archwire (Figure 5A). Three months after the leveling and alignment of the upper arch, a 0.016 × 0.022 in stainless steel wire was installed to retract the anterior teeth and to induce space closure of the extraction sites simultaneously by using an elastic chain and closing-loop mechanics (Figures 5B through 5D). A temporary crown was also placed at the extraction space to improve the esthetics. Three months after the retraction of the upper anterior teeth, a 0.018-in preadjusted edgewise appliance was placed in the lower arch. Initial alignment was achieved with a 0.016-in nickel-titanium archwire. Four months after the leveling and alignment of the mandibular arch, 0.016 × 0.022 in stainless steel archwires were installed for 3 months to use as part of a high-pull J-hook headgear on the lower arch (Figure 6). Then, 0.017 × 0.025 in stainless steel archwires were installed for detailing. Miniscrews were also implanted between the roots of the maxillary second premolar and first molar to achieve en masse retraction of the upper arch. The total active treatment period was 37 months. After removing the appliance, the maxillary and mandibular teeth were stabilized with a six-unit lingual bonded retainer and a Begg-type retainer.

Treatment Results

Treatment produced improvement of the patient's facial profile and acceptable occlusion. The posttreatment facial photographs showed a notable change in the lip posture and balance from retraction of the upper and lower lips (Figure 7). The posttreatment casts illustrated well-aligned arches and good interdigitation of the teeth. A normal overjet and overbite were established, and Class I canine and Class II molar relationships were also achieved (Figure 8). A posttreatment cephalometric evaluation and superimposed cephalometric tracing showed no marked skeletal changes. The upper incisors were lingually inclined (U1-SN: 92.0°) due to a camouflage skeletal Class II cranial relationship and had been intruded by 0.5 mm. An acceptable interincisal angle was also obtained

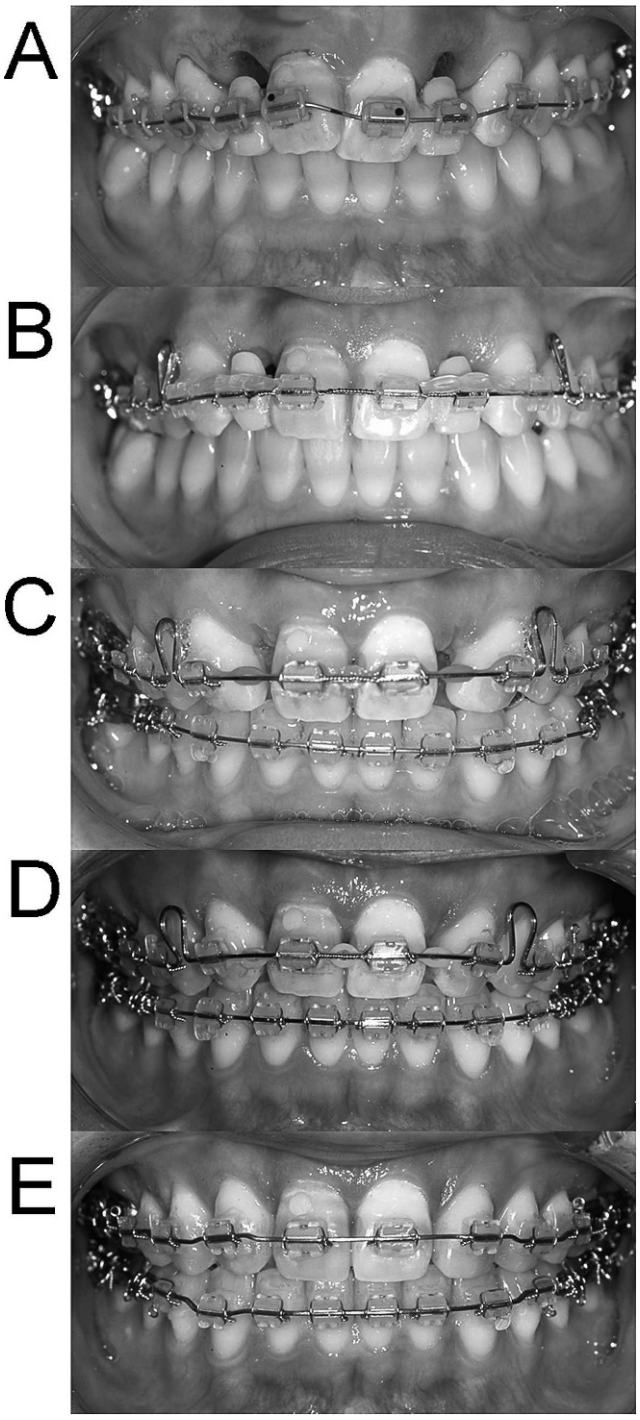

Figure 5. Treatment progress during retraction of the maxillary incisors: (A) At the start of leveling. (B) At the start of retraction. (C) Four months after the start of retraction. (D) Ten months after the start of retraction. (E) One year after the start of retraction.

(Table 1). The dental midlines were almost coincidental with the facial midline. The excessive curve of Spee had been leveled without flaring of the incisors by distal tipping of the lower molars. The lower incisors were lingually inclined by 2.5°. The mandibular plane angle showed very little variation. Acceptable root parallelism was achieved, and neither marked root resorption nor marginal bone loss in the periodontal tissue was observed (Figure 9). In an evaluation of the jaw movement after treatment, a smooth and stable incisal path was demonstrated during maximal open-close movement, protrusive excursion, and lateral excursion (Figure 10A). In a chewing test using a hard gummy jelly after treatment, increases in the range of motion of both condyles and a stabilized pattern of movement during chewing on both sides were observed (Figure 10B). At the 4-year retention follow-up, the patient's occlusion and the facial esthetics were stable (Figures 12–14). A cephalometric analysis showed a slight lingual inclination of the mandibular incisors (Figure 11). Overall, the patient was satisfied with the treatment results.

DISCUSSION

Premolar extraction has been widely accepted by orthodontists for the treatment of a nongrowing maxillary protrusion because of its esthetic and methodological advantages. In the present case, dental compensation by the extraction of the upper first premolars and lower second premolars could be planned to obtain a Class I molar relationship. According to the "wedge effect" concept, it has been hypothesized that second premolar extraction permits molar mesialization in comparison to first premolar extraction, thus resulting in a greater decrease of the mandibular plane angle.[14–17] However, this continues to be a source of controversy among researchers. Kim et al[18] compared the changes in facial vertical dimension between first and second premolar extraction cases. They concluded that extraction of the second premolar in hyperdivergent facial types would not contribute to mesial molar movement or decrease the mandibular plane angle. Although the present patient showed some understanding of the necessity of tooth extraction, she wanted to avoid extraction as much as possible, asking to keep her teeth intact. In consideration of her request, we decided to extract her upper lateral incisors, as they were pulpless teeth.

After extraction of the lateral incisors, retraction of the central incisors and closure of extraction sites were required. These procedures were simultaneously conducted by closing-loop mechanics with elastomeric chains, in addition to trimming of temporary crowns that were installed at the extraction spaces (Figure 5). As a result, each procedure was carried out without spoiling the patient's facial esthetics throughout the treatment. To improve esthetic considerations, a crown labial torque was applied to the

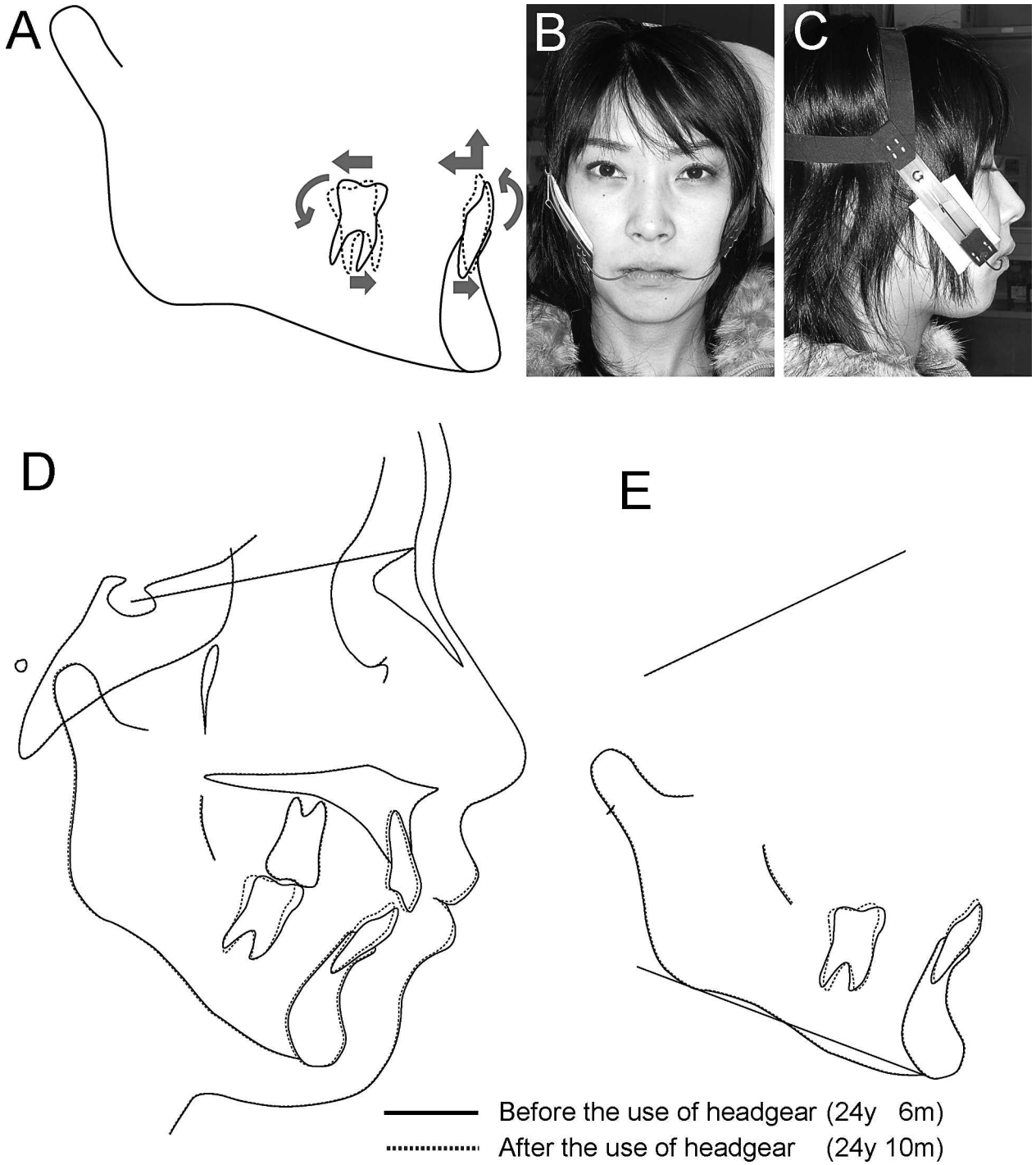

Figure 6. (A) Schematic illustrations of the effect of the high-pull J-hook headgear on the lower arch. (B) Frontal view and (C) lateral view facial photographs taken of the patient wearing the high-pull J-hook headgear on the lower arch. (D, E) Superimposed cephalometric tracings showing the changes from the pretreatment to posttreatment stages using the high-pull J-hook headgear on the lower arch. (D) The sella-nasion plane at the sella. (E) The mandibular plane at the menton.

maxillary canines, which needed to be aligned in the position of the lateral incisors. The canines were extruded to obtain optimum marginal gingival contours for the anterior teeth, and their cusps were ground.

The applicability of orthodontic space closure for lateral incisors is sometimes debatable. Concerns can be related to treatment complexity, esthetic outcomes and functional quality. To optimize the esthetics, we recommended bleaching and porcelain laminate veneer

Figure 7. Posttreatment facial and intraoral photographs.

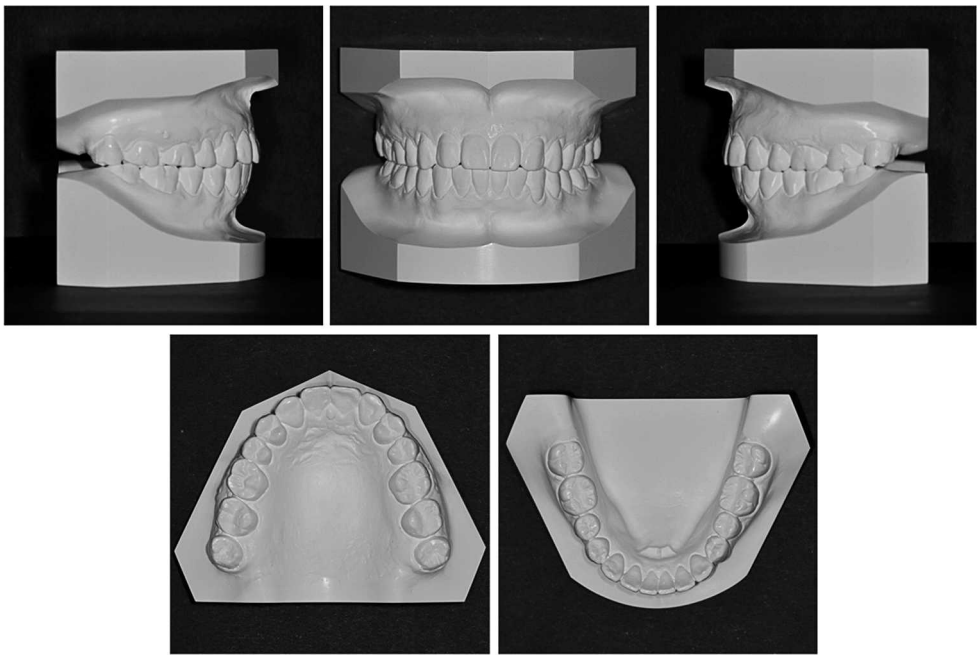

Figure 8. Posttreatment dental casts.

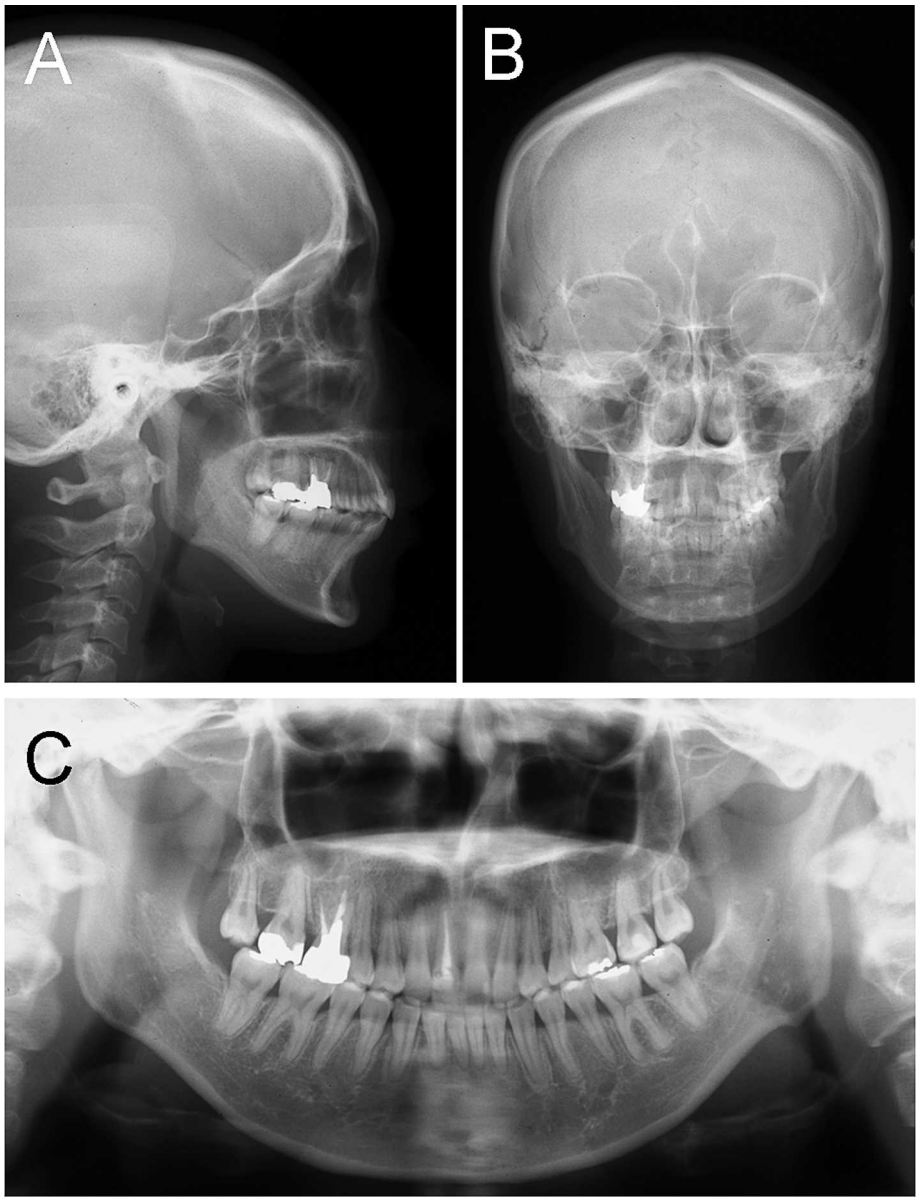

Figure 9. Posttreatment cephalograms and a panoramic radiograph. (A) Lateral cephalogram. (B) Posteroanterior cephalogram. (C) Panoramic radiograph.

restorations on the maxillary central incisors and canines in the present patient. However, the patient was satisfied with the treatment outcomes and did not wish to pursue esthetic treatments. Such approaches will be examined in the near future.

Most clinicians agree that permanent canines are essential for functional occlusion. Individualized extrusion and crown lingual torque of the upper first premolars were performed to obtain guidance between the mandibular canines during lateral jaw movements. In the stomatologic evaluation, we found that the condylar movement and incisal paths were not affected during maximum mouth opening and closing, lateral excursion, or protrusive excursion after treatment (Figure 10).

To the best of our knowledge, this is the first report of a quantitative evaluation of a functional assessment obtained after the treatment of a patient with extraction of the upper lateral incisors. The short-term measurements for functional issues were satisfactory, but long-term measurements have not yet been investigated, and there may be issues because the premolar roots are shorter than the canine roots. Nevertheless, we are expecting long-term satisfactory convalescence with the guidance provided by the two premolars (Figure 10C).

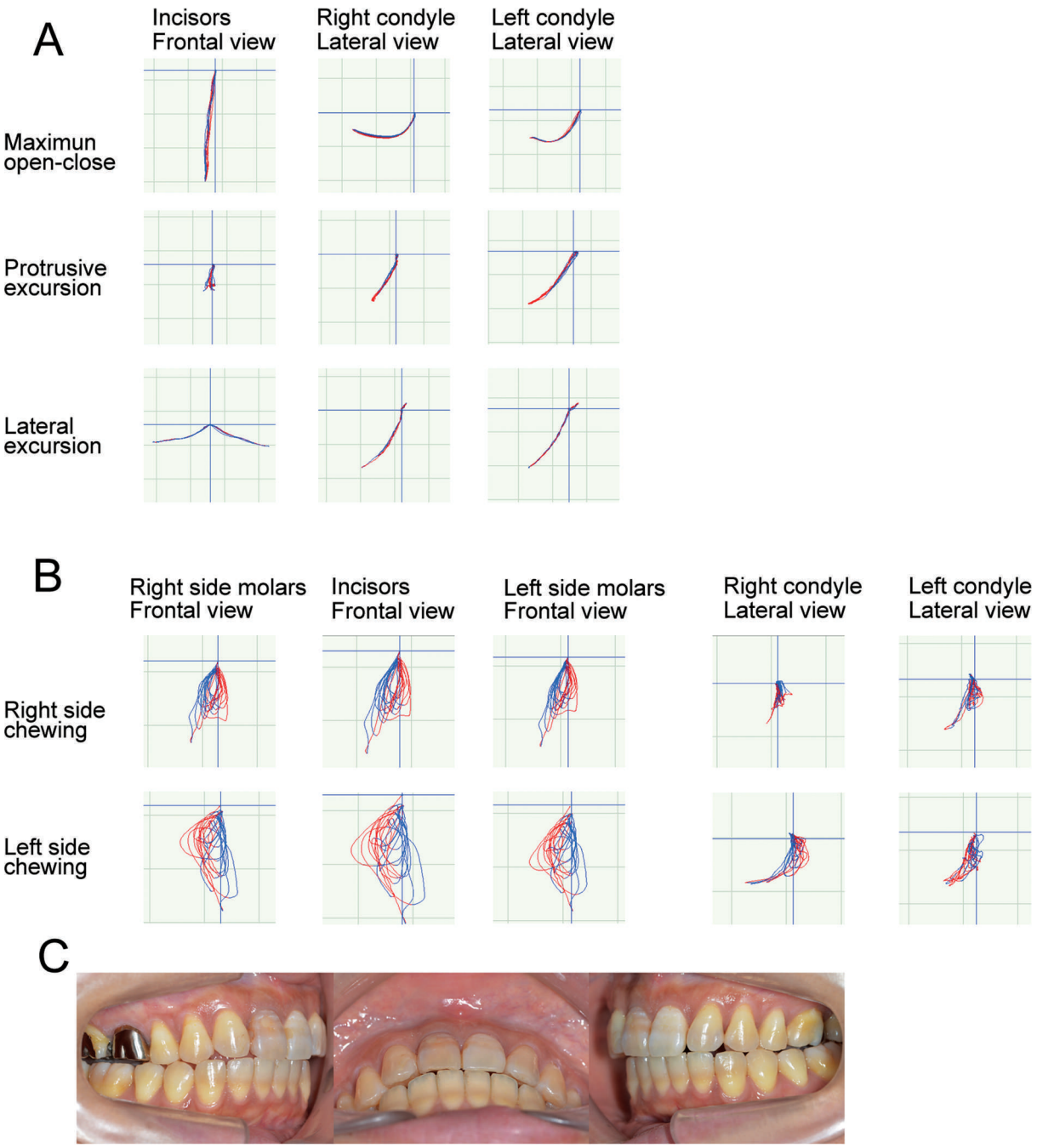

Figure 10. Posttreatment condylar movement and incisal paths as detected using a six-degrees-of-freedom jaw-movement recording system. The red line shows the opening phase, and the blue line indicates the closing phase. (A) Opening and closing, protrusive, and lateral excursive movements. (B) Chewing movements. (C) Intraoral photographs of protrusive and lateral excursive movements.

Concerning the aforementioned problems, the 3-month use of a high-pull J-hook headgear on the lower arch resulted in lingual tipping and elongation of the lower incisors and distal tipping of the molars. As a result of these changes, proper interincisal relationships were achieved without clockwise rotation of the mandible and labial inclination of the lower incisors. A similar effect can be expected by using Class III elastics, including tipping back of all the lower teeth and elongation of the upper molars.[19] However, the treatment outcome would worsen the Class II jaw relationship and result in a steep mandibular plane angle due to a clockwise rotation of the mandible.

The usefulness of the J-hook headgear applied to the lower arch for distal tooth movement was reported previously.[20] In this system, a J-hook headgear attached to the lower arch is used to produce sequential forces on the terminal molars, second

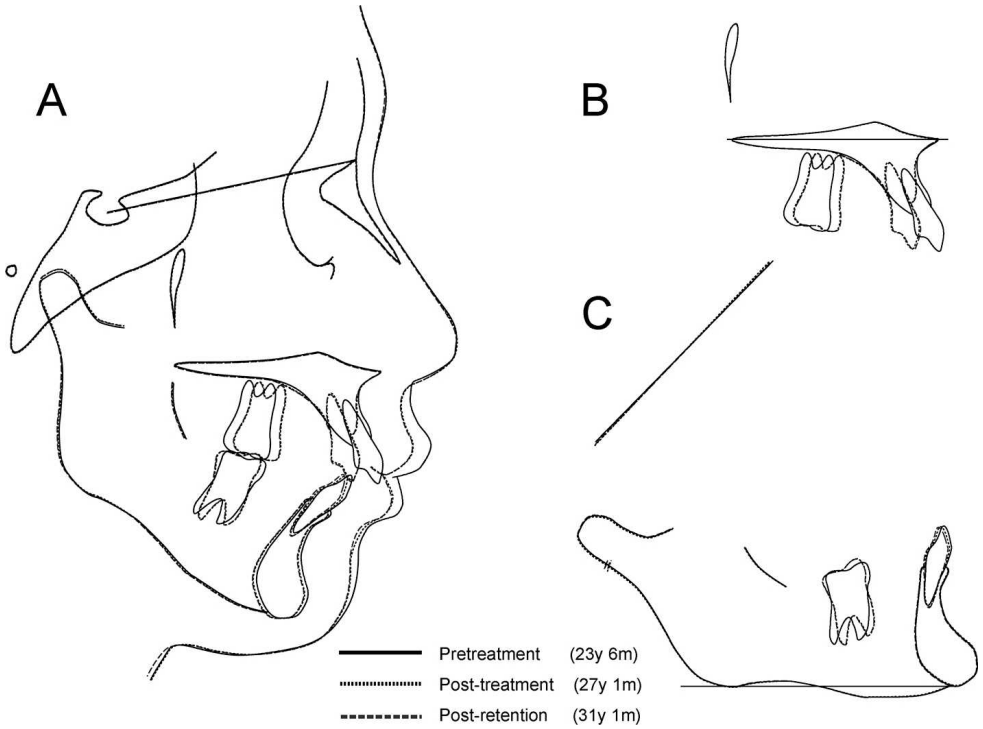

Figure 11. Superimposed cephalometric tracings showing changes from the pretreatment phase to the 4-year retention stage. (A) The sella-nasion plane at the sella. (B) The palatal plane at the ANS. (C) The mandibular plane at the menton.

premolars, and canines. Consequently, this system contributes to the achievement of lingual movement of the lower incisor and helps eliminate intrusive forces on the lower incisors.[19] Although a few case reports have demonstrated how to bring the lower molars upright with a J-hook headgear in patients with a Class III relationship,[21,22] there have been few previous reports of the effects of high-pull J-hook headgear on the lower dental arch in patients with a Class II relationship with regard to preventing further labial inclination of the mandibular incisors. Therefore, to the best of our knowledge, this is the latest report to demonstrate the effects of using a J-hook headgear on the lower arch in a patient with a Class II relationship.

Recently, implant-anchored orthodontics has become a new orthodontic treatment strategy that provides sufficient anchorage for various tooth movements and even makes it possible to move a tooth in more than one direction, which is impossible with traditional orthodontic methods. This method also provides sufficient anchorage to tip back the lower dentition even in patients who are uncooperative in regard to wearing orthodontic appliances. However, some orthodontic patients hesitate to undergo invasive procedures, such as placing screws or plates into their jaw through the gingival.[23,24] Moreover, it might not be a universal system applicable to all patients, as reported previously, as well as in this patient, where the miniscrews in the mandibular bone were harder to install than those in the maxillary bone.[23,25] In these patients, bringing the molar upright with a J-hook headgear is suitable, and is still considered to be an effective alternative approach.

Treatment results were fairly stable during the 4-year retention period. However, further observation is required because of the lingual cusp of the first premolar. Should there be functional problems in the future, prosthetic treatment with crown restoration would need to be considered.

CONCLUSION

- An adult patient with a Class II division 1 malocclusion was treated with extraction of the upper lateral incisors and orthodontic space closure. This can be an effective treatment of choice when the upper lateral incisors are dwarfed, nonvital, or demonstrate severe malposition.
- The use of a high-pull J-hook headgear on the lower arch is an efficient and valid alternative to distally move and bring the entire lower dentition upright.

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Figure 12. The 4-year retention facial and intraoral photographs.

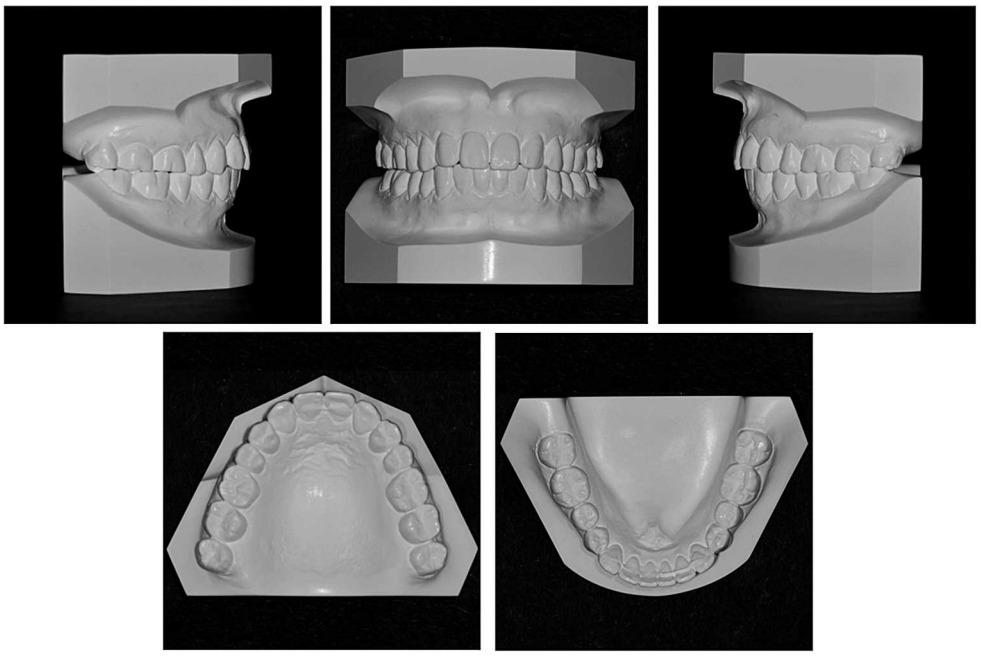

Figure 13. The 4-year retention dental casts.

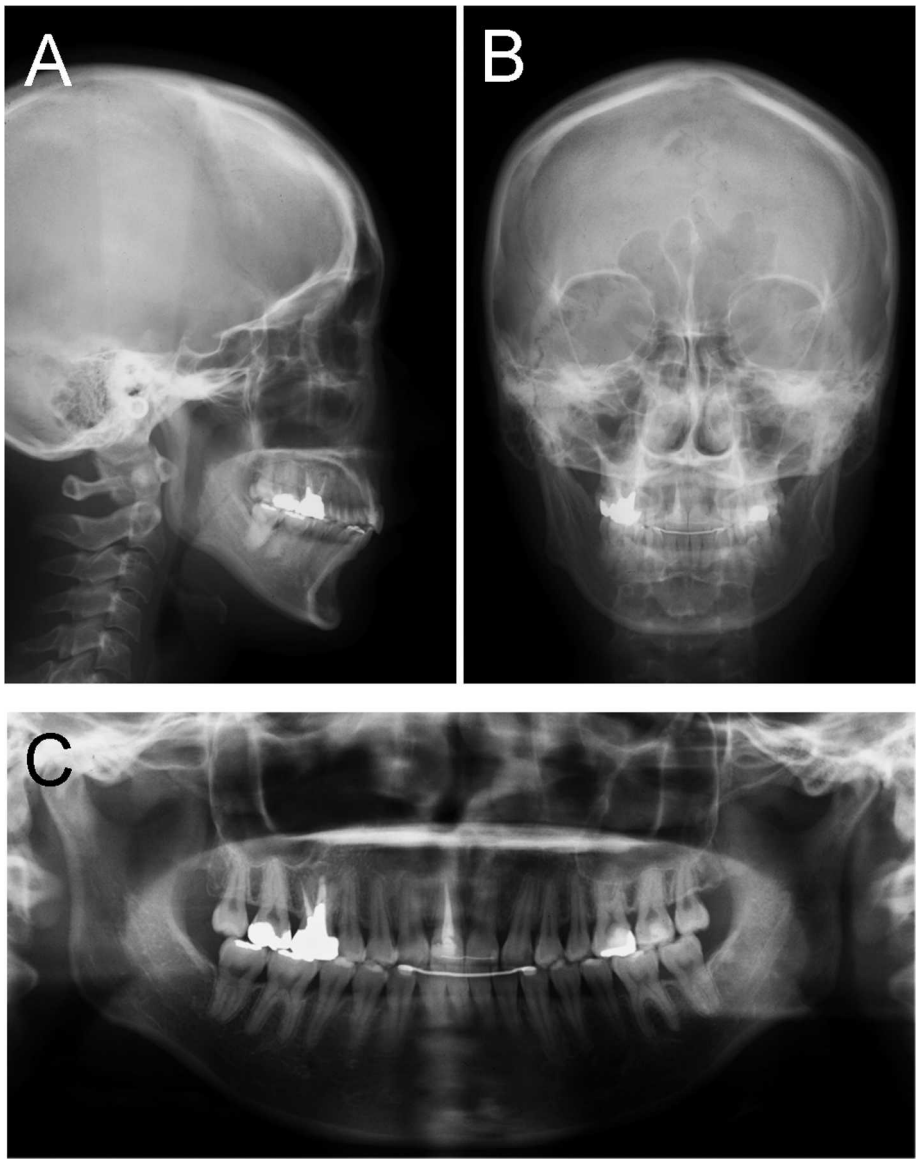

Figure 14. The 4-year retention cephalograms and a panoramic radiograph. (A) Lateral cephalogram. (B) Posteroanterior cephalogram. (C) Panoramic radiograph.

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