*Case Report*

# An Adult Bimaxillary Protrusion Treated with Corticotomy-Facilitated Orthodontics and Titanium Miniplates

**Shoichiro Iino[a]; Sumio Sakoda[b]; Shouichi Miyawaki[c]**

**Abstract:** We performed an orthodontic treatment combined with corticotomy and the placement of titanium miniplates in an adult patient who desired a shortened treatment period. The patient had an Angle Class I malocclusion with flaring of the maxillary and mandibular incisors. First, titanium miniplates were placed into the buccal alveolar bone of the maxilla for absolute orthodontic anchorage. Second, an edgewise appliance was applied to the maxillary and mandibular teeth. Then, the maxillary first premolars and mandibular second premolars were extracted. At the same time, a corticotomy was performed on the cortical bone of the lingual and buccal sides in the maxillary anterior as well as the mandibular anterior and posterior regions. Leveling was initiated immediately after the corticotomy. The extraction spaces were closed with conventional orthodontic force (approximately 1 N per side). The edgewise appliance was adjusted once every 2 weeks. The total treatment time was 1 year. Cephalometric superimpositions showed no anchorage loss, and panoramic radiographs showed neither significant reduction in the crest bone height nor marked apical root resorption. A corticotomy-facilitated orthodontic treatment with titanium miniplates might shorten an orthodontic treatment period without any anchorage loss or adverse effects.

**Key Words:** Corticotomy; Temporary anchorage devices; Rapid tooth movement



## INTRODUCTION

Adult patients who seek orthodontic treatment often desire that their treatment be completed in as short a period as possible.[1] At present, however, adult patients with bimaxillary protrusion requiring maximum anchorage usually require at least 2 years of active treatment.[2] One possible method for completing treatment in a shorter period is through an orthodontic treatment combined with corticotomy.[3–10]

It is known that corticotomy is a surgical method used to move teeth faster than usual, leading to a shorter orthodontic treatment period[3–9] because the teeth are moved together with the bone block.[5–7] Therefore, a heavier orthodontic force is needed to move teeth after the corticotomy.[3–9] However, the heavier orthodontic forces may induce various adverse effects, such as necrosis of periodontal ligament or root resorption.[11–13] On the other hand, Wilcko et al[10] have noted that orthodontic tooth movement is accelerated by the increase of bone turnover and decrease of bone density because osteoclasts and osteoblasts are increased by a regional acceleratory phenomenon (RAP)[14] after the corticotomy. Therefore, orthodontic tooth movement after the corticotomy may be accelerated even without using heavier orthodontic forces.

Anchorage loss often produces insufficient treatment results, particularly in patients who require maximum anchorage, and such a treatment further produces the extension of orthodontic treatment period. The recent introduction of temporary anchorage devices (TADs) such as titanium screws and miniplates provides clinicians with an alternative anchorage system instead of the conventional extraoral appliances that

[a] Assistant Professor, Department of Orthodontics, Center of Developmental Dentistry, Medical and Dental Hospital, Kagoshima University, Kagoshima, Japan.

[b] Professor and Department Chair, Department of Oral and Maxillofacial Surgery, Miyazaki Medical College, University of Miyazaki, Miyazaki, Japan.

[c] Professor and Department Chair, Department of Orthodontics, Field of Developmental Medicine, Health Research Course, Graduate School of Medical and Dental Sciences, Kagoshima University, Kagoshima, Japan.

Corresponding author: Dr Shouichi Miyawaki, Department of Orthodontics, Field of Developmental Medicine, Health Research Course, Graduate School of Medical and Dental Sciences, Kagoshima University, 8-35-1 Sakuragaoka, Kagoshima 890-8544, Japan
(e-mail: miyawaki@denta.hal.kagoshima-u.ac.jp).

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**Figure 1.** Pretreatment facial photographs.

depend on patients' cooperation.[15–21] The TAD system has been shown to provide an effective anchorage to obtain en masse retraction of anterior teeth without anchorage loss.[17,19] Therefore, an orthodontic treatment combined with corticotomy and placement of a TAD system may provide the advantage of shortening the orthodontic treatment period in maximum anchorage cases. However, there have been few case reports in which such a therapy was performed. This article demonstrates the successful treatment of a 24-year-old Japanese woman with bimaxillary protrusion treated by corticotomy-facilitated orthodontic treatment with titanium miniplates as TADs.

## CASE REPORT

### Case Summary

A 24-year-old Japanese woman presented with a chief complaint of both protruding and irregularly aligned maxillary anterior teeth. Her medical history showed no allergies or medical problems. No signs or symptoms of temporomandibular dysfunction were noted.

Pretreatment facial photographs showed marked protrusive lips, hypermentalis activity, and facial symmetry with competent lips (Figure 1). The patient had an Angle Class I malocclusion with a 5.5-mm overjet and a 0.5-mm overbite. Both the maxillary and mandibular arches were irregularly aligned, with 3.5-mm maxillary and 3.0-mm mandibular arch length discrepancy (Figure 2). The pretreatment dental casts indicated 11 points of Peer Assessment Rating (PAR) index[22] and 22 points of Discrepancy Index (DI) score[23,24] of the American Board of Orthodontics (ABO).

The lateral cephalometric analysis indicated a normal skeletal relationship with an ANB angle of 4.3°, a slight low mandibular plane angle (FMA) of 21°, and a flaring of the bimaxillary incisors with a maxillary central incisor to Frankfort plane angle of 122.9° and a mandibular central incisor to Frankfort plane angle (FMIA) of 54° (Table 1).

### Diagnosis

This patient was diagnosed as having an Angle Class I malocclusion with bimaxillary protrusion with a slightly low mandibular plane angle.

### Treatment Objective

The main objective in treating this malocclusion was to retract the maxillary anterior teeth to reduce upper- and lower-lip protrusion. Maximum anchorage of the maxillary molars was needed for the maintenance of the Class I molar relationships.

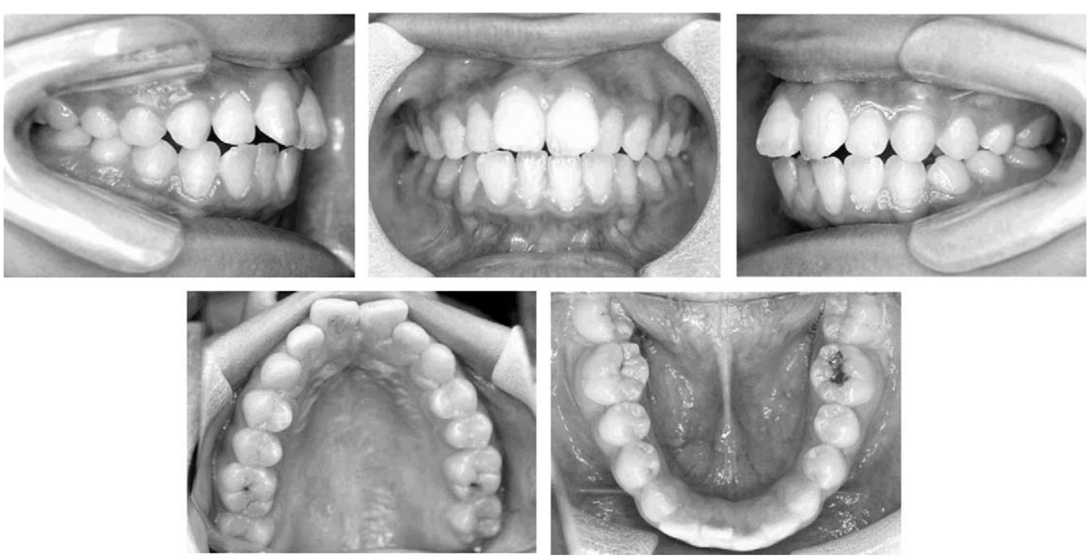

**Figure 2.** Pretreatment intraoral photographs.

**Table 1.** Cephalometric Analysis*

| Measurement | Pretreatment Value | *Z*-score | Posttreatment Value | *Z*-score |
|---|---|---|---|---|
| SNA (°) | 82.8 | 0.1 | 82.8 | 0.1 |
| SNB (°) | 78.5 | −0.1 | 78.5 | −0.1 |
| ANB (°) | 4.3 | 0.5 | 4.3 | 0.5 |
| FMA (°) | 21.0 | −1.5 | 21.0 | −1.5 |
| FMIA (°) | 54.0 | −0.5 | 62.0 | 0.8 |
| IMPA (°) | 104.0 | 1.3 | 95.5 | −0.1 |
| FH-U1 (°) | 122.9 | 2.6 | 107.0 | −0.6 |
| PTV to U6 (mm) | 15.2 | −1.2 | 15.4 | −1.3 |
| Occlusal plane angle (°) | 8.5 | −0.8 | 8.5 | −0.8 |

* *Z*-score was calculated as (value − norm)/1 SD using norms and SDs of mean Japanese women with good occlusion.[24]

## Treatment Alternatives

Facial and occlusal corrections of this malocclusion could be solved orthodontically without facilitated orthodontic treatment. However, the patient desired a shortened treatment period. Therefore, we used a corticotomy of the maxillary anterior teeth, mandibular anterior teeth, and molars to shorten the active treatment period.

Titanium miniplates[15,20,21] or screws[16–19] have been introduced as TADs. Although patients who receive flap surgery for the placement of titanium miniplates more frequently complain of both swelling and pain than those patients with titanium screws, the titanium miniplates have advantages such as a strong resistance to force and a nearly 100% success rate.[17,21] Therefore, in this case, titanium miniplates were used as TADs because a strong force may be needed when retracting anterior teeth after the corticotomy.

## Treatment Progress

All the surgical procedures were performed after obtaining the consent of the patient regarding this therapy. Under local anesthesia, the gingival mucoperiosteal flap was detached from the attached gingiva of the maxillary molar region to expose the infrazygomatic crest. Then, a titanium miniplate (Dentsply-Sankin, Japan) was fixed into the infrazygomatic crest of maxilla on the right side with three titanium screws (length 5 mm, diameter 2 mm) (Figure 3). The mucoperiosteal flaps were sutured after placing the miniplate. Another titanium miniplate was placed into the infrazygomatic crest of maxilla on the other side with the aforementioned procedure 1 week after the first surgery.

One month after the placement of second titanium miniplate, the maxillary first premolars and mandibular second premolars were extracted and a corticotomy was performed on the buccal side. The gingival mucoperiosteal flap was detached from the alveolar crest to the apical region to expose the cortical bone on the

**Figure 3.** Titanium miniplates fixed with three titanium screws at the maxillary molar region. Black arrows indicate the arm of titanium miniplate.

buccal side of the maxillary anterior, mandibular anterior, and molar regions. The surgical procedure was performed so as not to damage any of the neurovascular bundles exiting the bone and not to disturb the genioglossus attachment. Vertical corticotomy cuts stopping just short of the alveolar crest were made between the roots of teeth and were connected beyond the apices of teeth with scalloped horizontal corticotomy cuts. The corticotomy was performed with a fissure bar under water cooling, and the depth of the corticotomy cuts was adjusted to reach the bone marrow by confirming bleeding through cut lines (Figure 4). The mucoperiosteal flaps were sutured after the

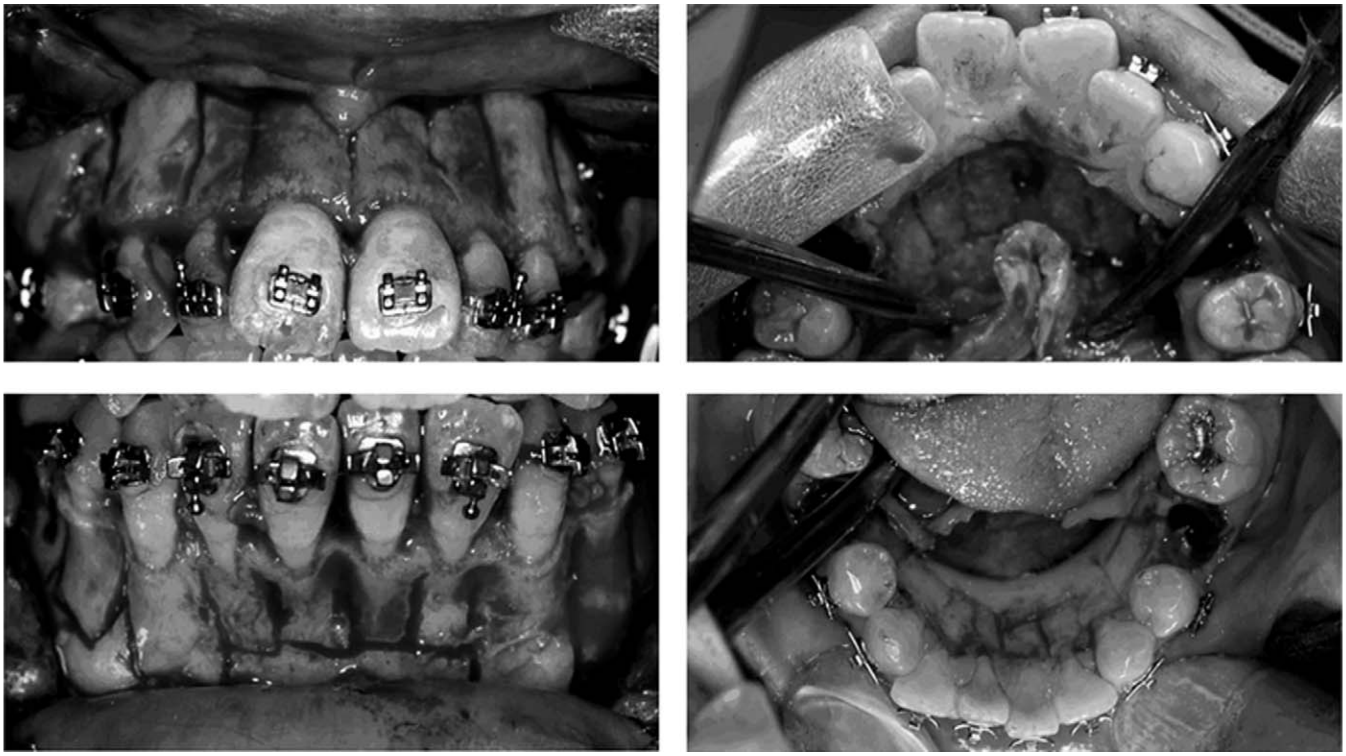

**Figure 4.** Maxillary and mandibular corticotomy of the buccal and lingual sides of alveolar bone.

corticotomy. The corticotomy on the lingual side was performed with the aforementioned procedure 3 days after the first corticotomy.

Immediately after the second corticotomy, leveling and alignment of teeth were initiated with a preadjusted edgewise appliance (0.018 $\times$ 0.025 inch). This appliance was adjusted approximately every 2 weeks. Two months later, en masse retraction of the maxillary anterior teeth was initiated with the titanium miniplates, and the space closing of the mandibular arch was also initiated (Figure 5B). Power chains were used to close the extraction spaces from the titanium plate to the hook on the arch wire with an initial force of approximately 1 N per side. The extraction spaces were almost closed after 7 months of active treatment in the mandibular arch (Figure 5C). The total active treatment period was only 1 year (Figure 5D). The preadjusted edgewise appliance and titanium miniplates were removed. A Hawley retainer and a bonded retainer were applied full time to the maxillary and mandibular arch, respectively. The sequence of treatment events is shown in Table 2.

## RESULTS ACHIEVED

The posttreatment dental casts indicated 2 points of PAR index, 1 point of DI score, and 24 points of Objective Grading System (OGS)[25] score of the ABO. The patient showed an acceptable occlusion and good facial profile (ie, balanced lip line), owing to the successful retraction of the upper anterior teeth (Figure 6). The dental arches were aligned and leveled and ideal overjet and overbite were achieved (Figure 7), with upright maxillary and mandibular central incisors (Table 1). Cephalometric superimpositions before and after treatment showed no mesial movement of the maxillary molars. Owing to no anchorage loss, the Class I molar relationship was maintained (Figure 8).

During the active treatment, no significant periodontal problems, such as gingival recession or loss of tooth vitality, and no looseness or deformation of the titanium miniplates were observed. Panoramic radiographs before and after treatment showed no significant reduction in the crest bone height and no marked apical root resorption (Figure 9).

## DISCUSSION

It is well known that orthodontic therapy with corticotomy shortens the period of conventional orthodontic treatment.[3–10] According to a previous report,[8] the total treatment time was only one-third to one-forth that of routine nonextraction and extraction orthodontic therapies. In another study,[2] it was reported that the mean active treatment time for conventional orthodontic treatment without corticotomy was 29 months in extraction cases. In the current case, in which a conventional orthodontic force of 1 N was used, the total ac-

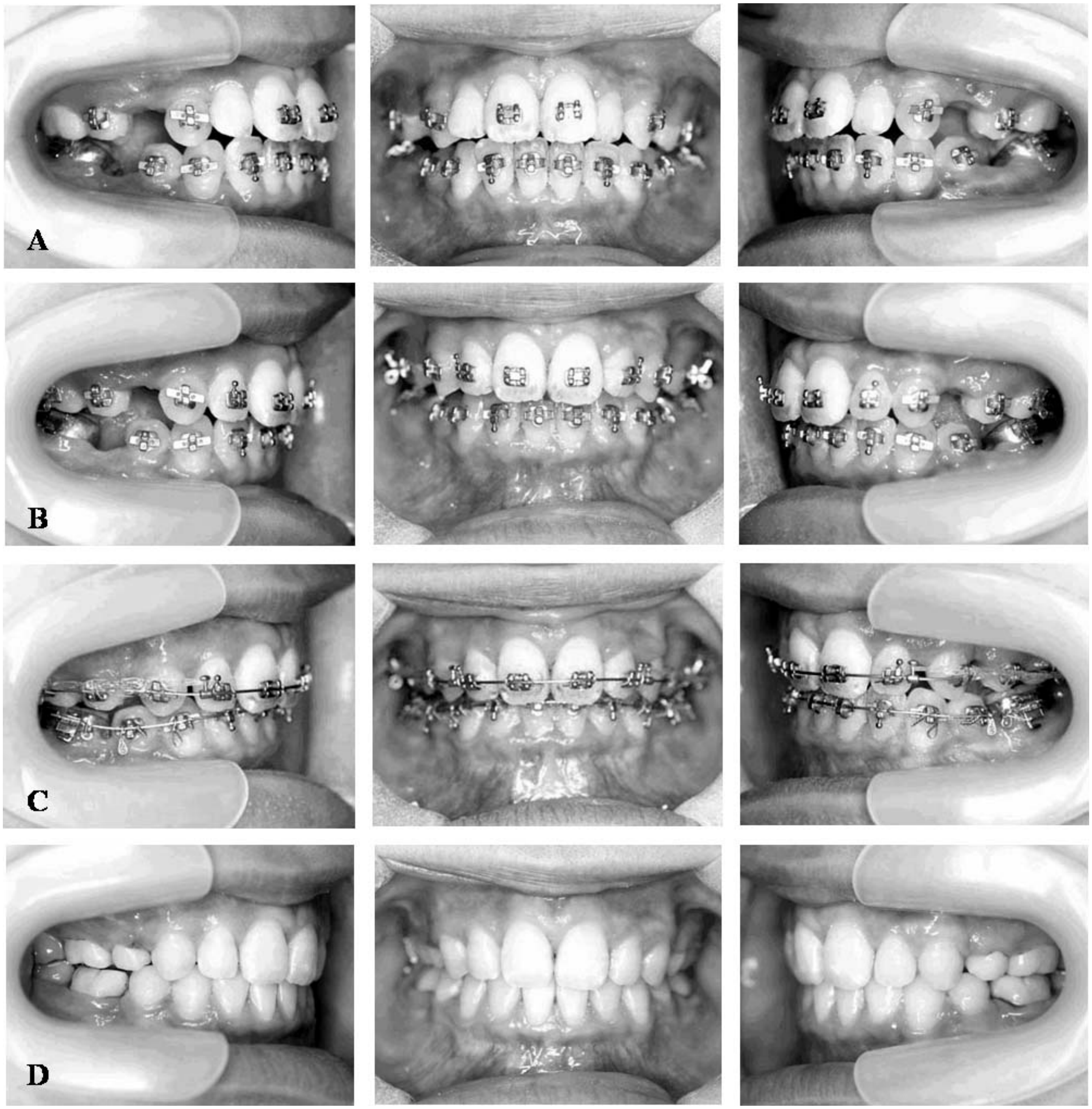


**Figure 5.** Intraoral photographs at 2 weeks (A), 2 months (B), 7 months (C), and 12 months (D) after corticotomy.

tive treatment period was only 1 year. It is well known that a heavier orthodontic force (eg, 4.5 N) is needed in a corticotomy-facilitated orthodontic treatment for the movement of the bone block with tooth.[3–7,9] Orthodontic tooth movement as well as segmental bone movement after the corticotomy has been histologically observed in an animal experiment.[6]

However, rapid tooth movement might have been achieved even with conventional orthodontic force in the current case. The rate of orthodontic tooth movement is related to the metabolism of bone[26,27] and bone density.[28] Tooth movement in juveniles is faster than in adults at the initial phase[29] because mediator levels in juveniles are more responsive than those in adults in early tooth movement.[30]

Osteoclasts and osteoblasts are increased by RAP after fractures and surgery such as osteotomies or bone grafting, and bone healing is accelerated.[14]

**Table 2.** Sequence of Treatment Events

| Time | Treatment Event |
|---|---|
| Before 1 mo | Placement of titanium miniplates |
| TO | Corticotomies and initiation of active treatment |
| 2 mo | Leveling achieved and initiation of en mass retraction |
| 7 mo | Retraction of the mandibular arch complete |
| 12 mo | Active treatment complete |

**Figure 6.** Posttreatment facial photographs.

When a surgical incision was made into the head of the tibia in rabbits, new bone formed even in the trabecular bone around the incision area by increasing bone turnover.[31,32] Furthermore, it has been confirmed that many osteoclasts were observed along the bone surface and around the bone marrow spaces at the pressure side in orthodontic tooth movements after corticotomy compared with those without corticotomy.[5] Therefore, tooth movement after corticotomy might be accelerated by the increase in the metabolism of the bone even if using conventional orthodontic force.

There have been several reports regarding the adverse effects to the periodontium after corticotomy.[10,33–36] These reports range from no problems[10,33,36] to slightly interdental bone loss and decrease of attached gingiva[35] and periodontal defects observed in some cases with short interdental distance.[34] In the current case, no significant reduction in the crest bone height, decrease of attached gingiva, marked apical root resorption, or devitalization were observed after the orthodontic treatment. Heavier orthodontic force may induce various adverse effects.[11–13] If the marginal bone is not incised by corticotomy, the pulps and the periodontal membrane are not damaged.[33] No significant adverse effects were observed in the current case because a weak conventional orthodontic force of 1 N was used and because the alveolar crest was not incised by corticotomy.

Titanium miniplates are often used to establish absolute anchorage.[15,20,21] They were necessary to retract the maxillary anterior teeth with the absolute anchorage of maxillary molars in order to improve severe upper- and lower-lip protrusion and to maintain Class I relationships in the current case. The extraction spaces were closed with power chains from the titanium plate to the hook on the arch wire, and the superimposition of pre- and posttreatment cephalometric radiographs showed no mesial movement of the maxillary molars. Because no retraction force in the mesial direction was loaded on the maxillary posterior teeth, no mesial movement of the maxillary molars occurred.

In the current case, titanium miniplates were placed on the infrazygomatic crest of the maxilla because the bone of that region was thick[21] and distant from the roots. Although an orthodontic force could be applied to the titanium miniplates immediately after implanta-

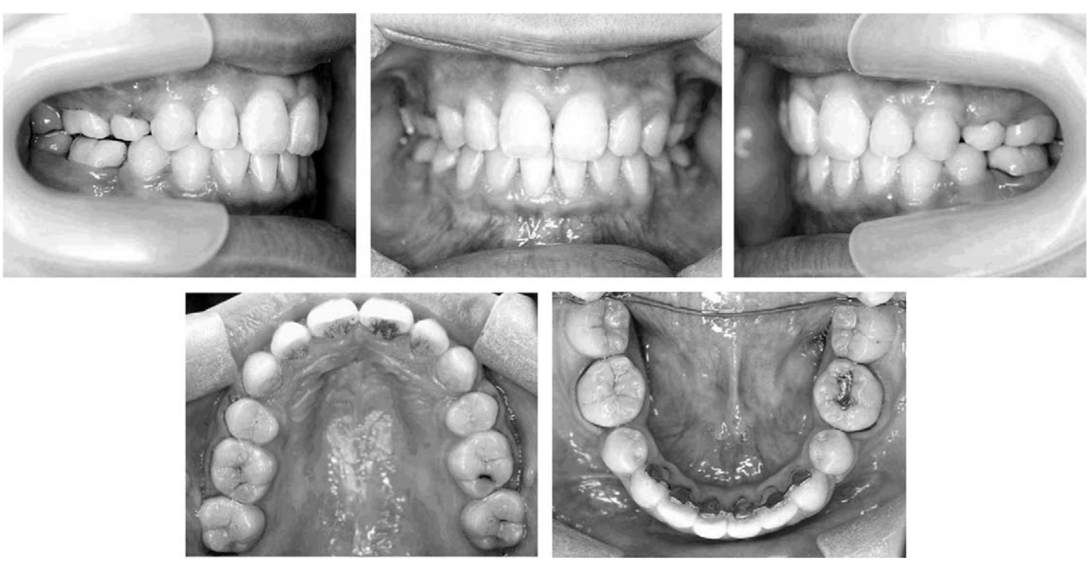

**Figure 7.** Posttreatment intraoral photographs.

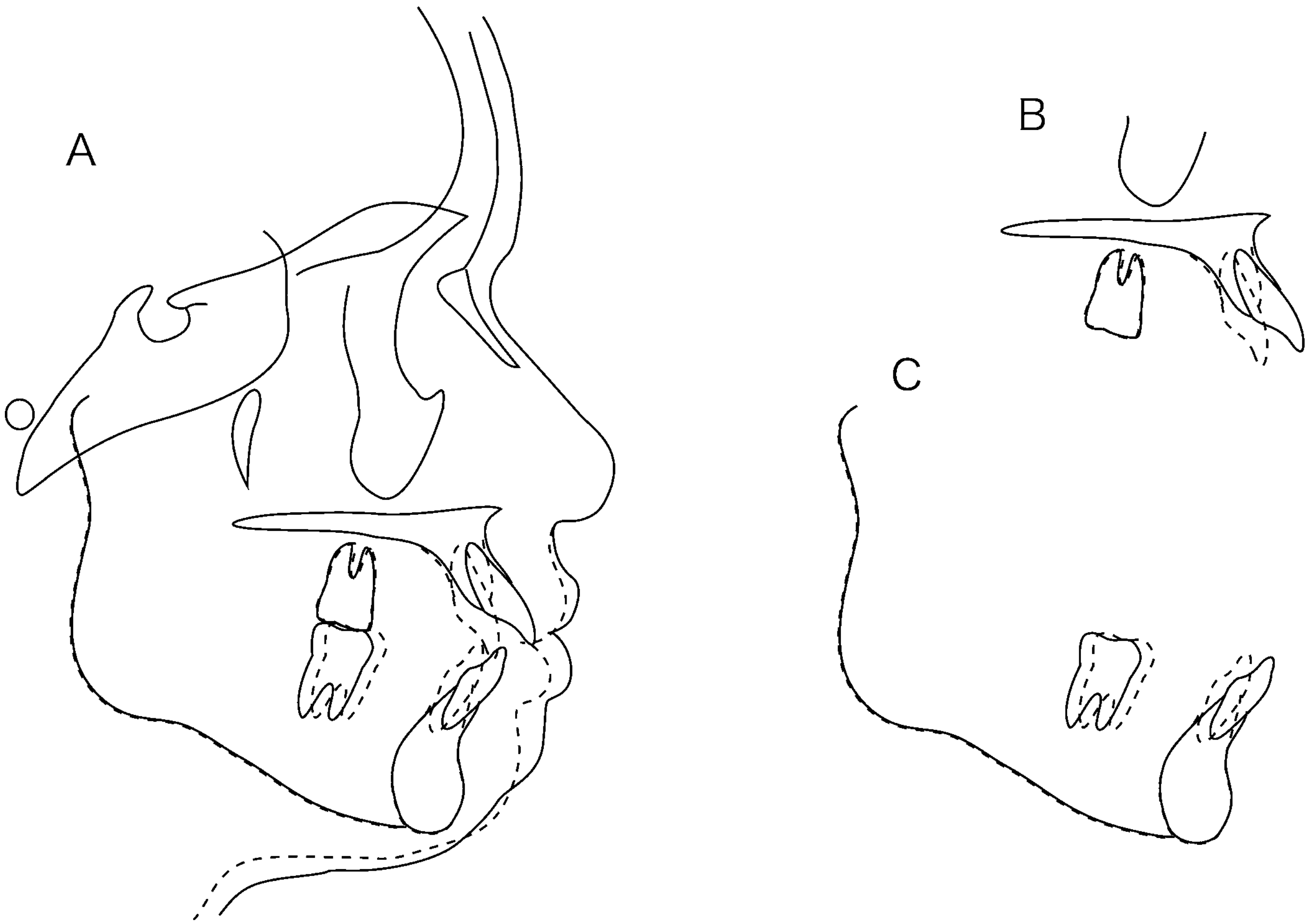


**Figure 8.** Superimposition of cephalometric tracings before (solid line) and after (dotted line) treatment. (A) A best fit on the anterior wall of sella turcica, the greater wings of the sphenoid, the cribriform plate, the orbital roofs, and the surface of frontal bone. (B) A best fit on the zygomatic process of the maxilla (key ridge) and the curvature of the palate. (C) A best fit on the symphysis and the mandibular plane.

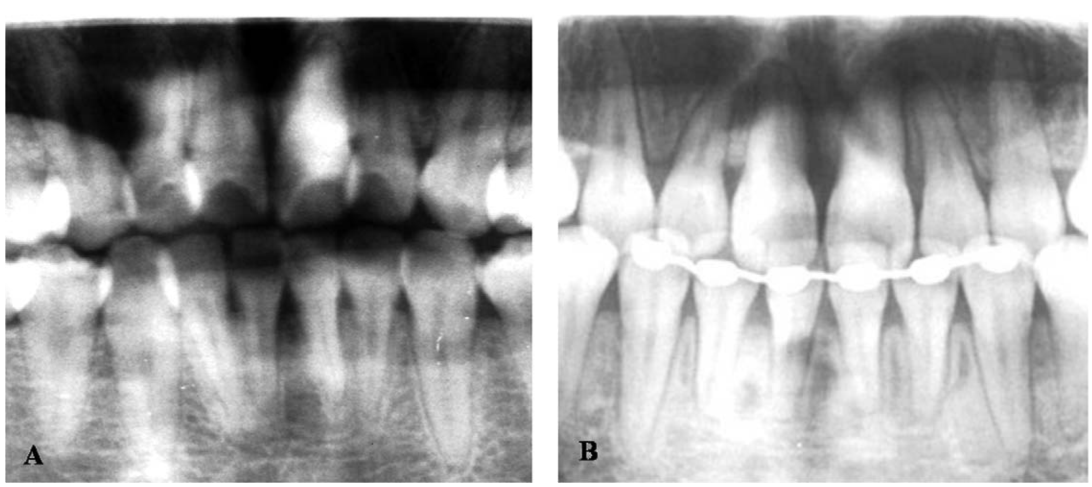


**Figure 9.** Panoramic radiograph at the pretreatment (A) and posttreatment (B) stages.

tion, it is advisable to wait for healing of the wound and for the patient to learn how to clean the peripheral region of the miniplates.[15] Therefore, the patient had 1 month of healing time after placement of the titanium miniplates in the current case.

During the active treatment, anchorage loss, significant periodontal problems such as gingival recession or inflammation in the peri-implant soft tissue conditions, or looseness or deformation of the titanium miniplates were not observed. Segmental bone movement would be needed with heavier orthodontic force if the tooth movement had not been accelerated with conventional orthodontic force. Therefore, titanium miniplates were chosen as TADs for using the heavier orthodontic force.

In the current case, heavier orthodontic forces over 1 N were not needed for closing space. Using titanium screws as TADs is possible if the applied force is less than 2 N and the postoperative pain and discomfort symptoms are almost negligible.[17,19] Therefore, it is suggested that titanium screws are used as TADs with corticotomy-facilitated orthodontic treatment.

## CONCLUSIONS

A corticotomy-facilitated orthodontic treatment with titanium miniplates may be an effective method for maximum anchorage cases in adult patients who desire a shortened orthodontic treatment period.

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