Case Report

A Mini-Implant for Orthodontic Anchorage in a Deep Overbite Case

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Abstract: This article describes the orthodontic treatment of a 19-year-old female patient with anterior crowding. There was a moderate arch length discrepancy in the lower dental arch, a significant deep overbite, and a ''gummy smile.'' We inserted an orthodontic mini-implant as anchorage for the intrusion of the upper incisor segment, followed by alignment of the upper and lower dental arches with an edgewise appliance without tooth extraction. The overbite was corrected from +7.2 mm to +1.7 mm by upper incisor intrusion, and the gummy smile was improved. Good occlusion and facial esthetics were achieved, and these results have been maintained for two years after completion of the active treatment. (*Angle Orthod* 2005;75:444–452.)

Key Words: Orthodontic; Orthodontic mini-implant; Deep bite; Gummy smile; Intrusion

INTRODUCTION

Anchorage control is fundamental to successful orthodontic treatment. Orthodontic tooth movement has always been limited to action-reaction reciprocal force mechanics in anchorage control. Although extraoral anchorage can be used to supplement toothborne anchorage and deliver force in directions not possible with intraoral anchorage, extraoral anchorage has such limitations that it requires excellent patient cooperation.[1]

The use of osseointegrated titanium implants[2] has been reported. Implants have been used to extrude impacted teeth,[3] to retract anterior teeth,[4] and to correct tooth position in preprosthetic treatment. These osseointegrated implants are usually used as an anchorage to assist orthodontic tooth movement and as support for prostheses because these devices provide maximal anchorage and do not depend on patient cooperation.[5–9] For these reasons, numerous different orthodontic skeletal anchorage systems (OSAS) have been developed. These implants are designed to be removed after completion of orthodontic treatment; consequently, they are functional for only a relatively short time compared with endosseous implants used for dental rehabilitation.

Prosthetic implants have also been applied as OSAS in orthognathic surgery.[1] These implants, used for intermaxillary fixation, are placed below the anterior nasal spine. A light elastic thread was tied from the head of the implant to the archwire and renewed throughout treatment. During one year, the maxillary central incisors are elevated about six mm.

Recently, a skeletal anchorage system was introduced using a titanium miniplate as the OSAS.[10] The report showed that the lower molars were intruded using a miniplate designed for rigid internal fixation in orthognathic surgery instead of prosthetic implants for intermaxillary fixation. The miniplate was designed for immediate use after implantation. However, it was often troublesome for patients because of the severity of surgical invasion, discomfort during the initial healing, and difficulty of oral hygiene control.[11]

OSAS was developed using an orthodontic mini-implant for skeletal anchorage and placement on the mandibular incisors. With this system, it was reported that the mandibular incisors could be intruded about six mm during four months, improving the deep bite. In this case, the surgical procedures for insertion and removal of the mini-implant were simple and relatively less traumatic.[11]

This article presents a deep bite case treated with such a mini-implant (Orthoanchor K1 System®; Dentsply Sankin Corporation, Tokyo, Japan) (Figure 1).

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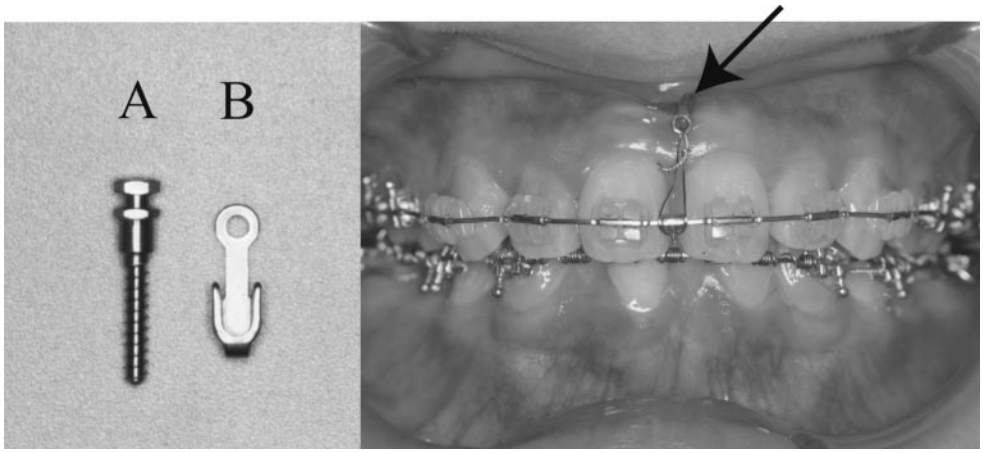

FIGURE 1. Orthoanchor K1 System® and intraoral view of the setting. (A) Anchor screw (ϕ, 1.2 × 6 mm). (B) Abutment sagittal view shows Orthoanchor K1 System and how to use it.

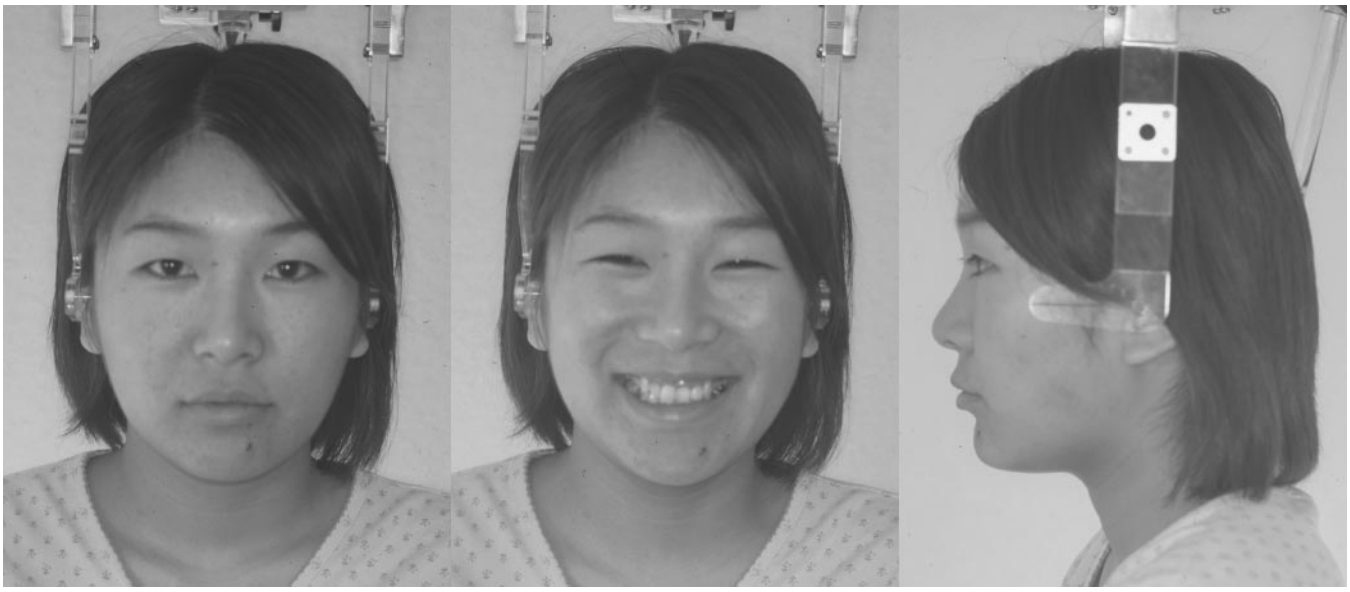

FIGURE 2. Pretreatment facial photographs. Patient showed a gummy smile.

CASE REPORT

A 19-year-old Japanese female patient came to our clinic for orthodontic evaluation. Her chief complaint was anterior crowding in the upper and lower dental arches, and an excessive overbite was also present. There was no remarkable medical history.

Findings

The patient exhibited a straight-type facial profile. Maxillary gingival exposure in the smile or a ''gummy smile''[12] was noted (Figure 2). The overbite was 7.2 mm, and the overjet was 4.8 mm. The patient showed Class I molar and Class II canine relationships on both sides. Both of the dental arches were saddle shaped. The arch length discrepancy was estimated at −1.2 mm for the upper dental arch and −6.3 mm for the lower dental arch. The lower second premolars, 35 and 45, were lingually inclined (Figure 3).

Panoramic radiographs revealed no missing teeth except the upper third molars and no sign of root resorption. The lower third molars were tipped mesially and were horizontally impacted (Figure 4).

Lateral cephalometric analysis (Figure 5; Tables 1 and 2) showed a skeletal Class I relationship (ANB angle, 3.7°). The mandibular plane angle was slightly small (Mp-SN, 34.4°), whereas the lower anterior facial height was 72.7 mm, more than one SD greater than the Japanese normative mean.[13]

The upper incisors were at a 92.2° angle relative to the SN plane, and the lower incisors were at an 85.5° angle relative to the mandibular plane (L1-Mp) and a 65.7° angle relative to the Frankfurt plane (L1-FH). The positions of

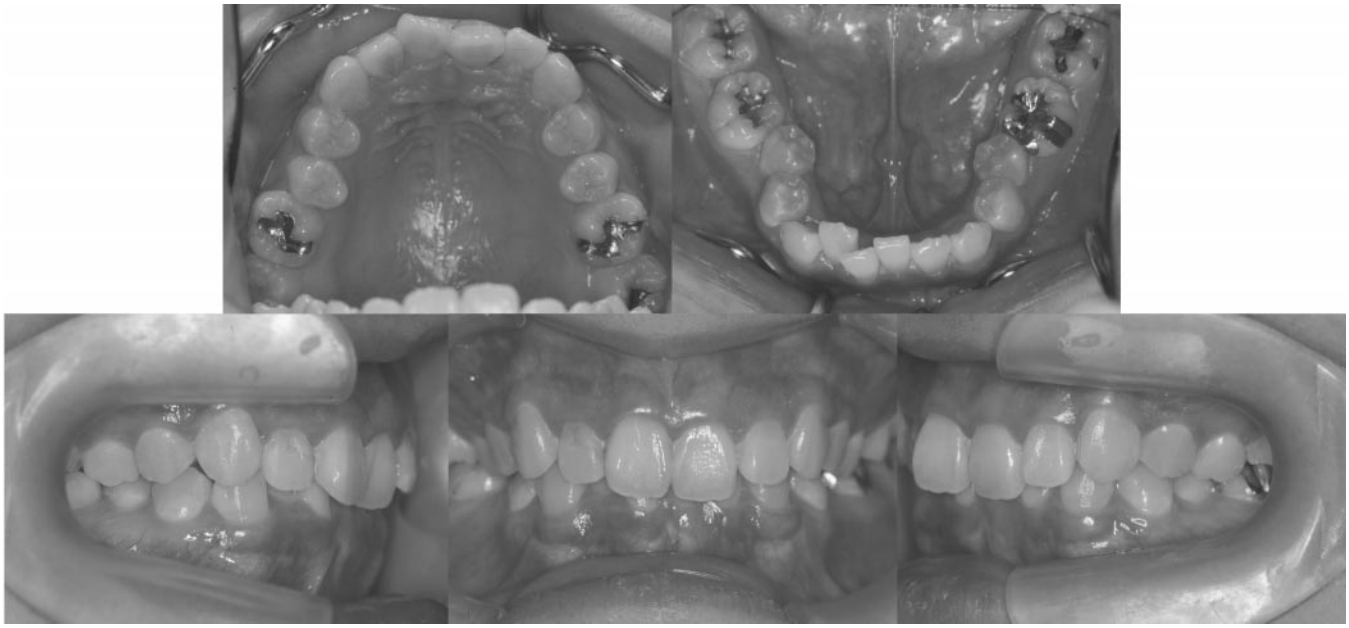

FIGURE 3. Pretreatment intraoral photographs.

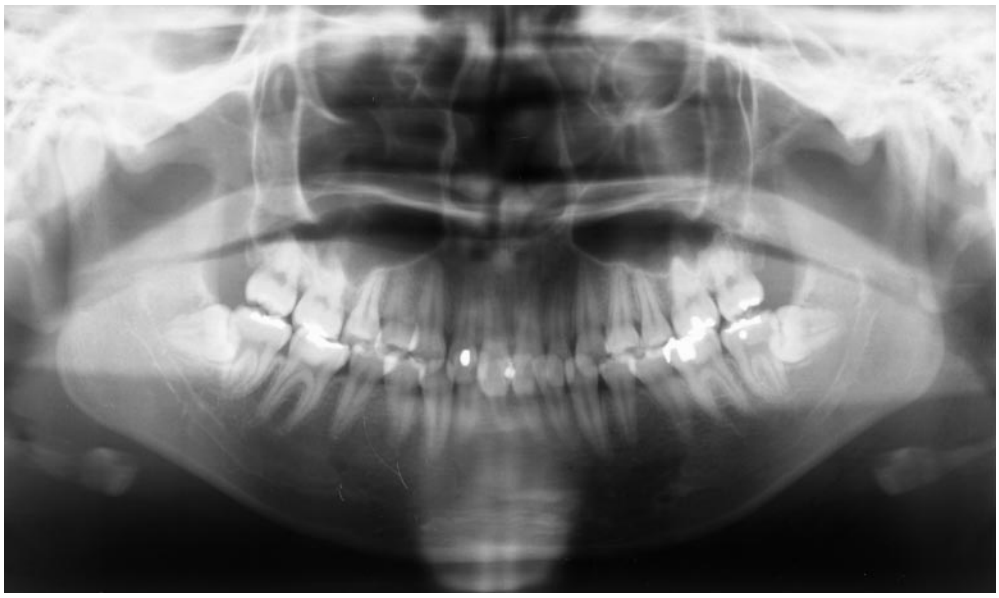

FIGURE 4. Pretreatment panoramic radiograph.

the upper incisors were extruded more than one SD beyond the normative mean (U1/PP, 33.5 mm). The upper and lower lips protruded 0.0 and 1.0 mm relative to the E-line,[14] respectively. The measurement of the H-line[15] to NB and Pog to NB demonstrated a range within ±1 SD of the Japanese normative mean. However, L1 to NB was 4.5 mm, which was less than one SD,[16] and the Holdaway ratio[17] was 2:1. The dental midline discrepancy consisted of a mandibular midline deviation of 1.0 mm toward the right side and the maxillary midline coincided with the facial midline.

A temporomandibular joint evaluation showed no signs of clicks or crepitation, and the facial and masticatory muscles were asymptomatic.

Diagnosis and treatment objectives

We diagnosed the patient as having an Angle Class I malocclusion and a skeletal Class I jaw base relationship with a deep bite and a gummy smile. The treatment objectives included achieving (1) intrusion of the upper incisors with a mini-implant as the orthodontic anchorage and (2)

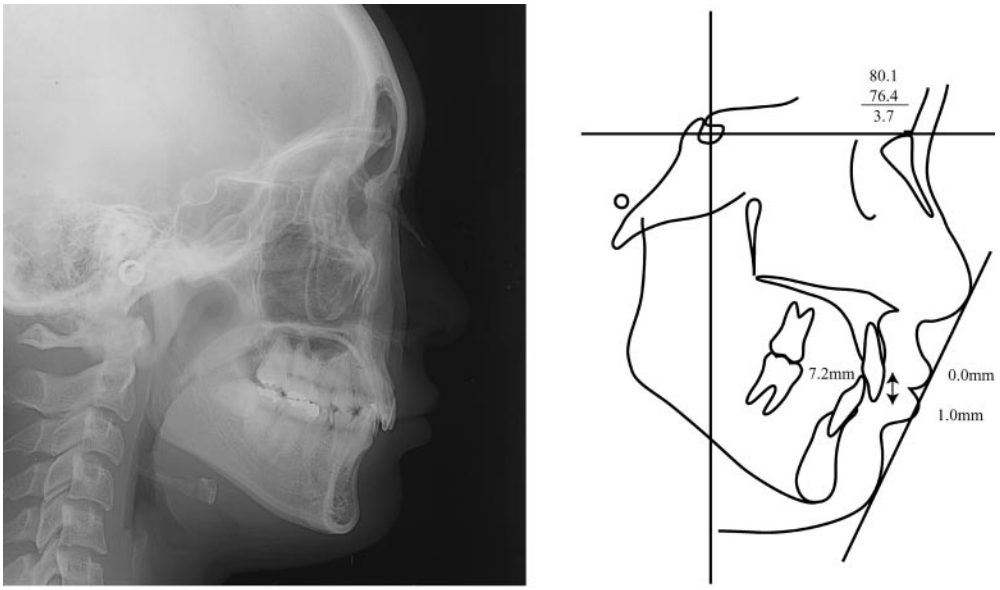

FIGURE 5. Pretreatment. (A) Lateral cephalometric radiograph. (B) Its tracing.

adequate overbite and overjet for a satisfactory maxillary gingival exposure in the smile.

Treatment plan and progress

There were three treatment alternatives for this case: (1) extraction of the first premolars; (2) nonextraction and intrusion of the upper incisors; and (3) surgical treatment for correction of the gummy smile. The patient and her family chose the nonextraction alternative, and the intrusion of the upper incisors was planned. First, the horizontally impacted lower third molars were extracted. At the age of 19 years and seven months, the mini-implant was implanted in the alveolar bone between the root apices of the maxillary central incisors under local anesthesia (Figure 1). The mini-implant was positioned approximately three mm above the root apex.

The orthodontic appliances were placed on the maxillary teeth for leveling. A lower initial archwire was inserted at 19 years and 11 months. After a healing period of six months, the second operation for the implantation procedure was performed and an abutment was placed and fixed. Two months after the second operation, an orthodontic ligature wire was tied from the head of the abutment to the upper archwire. A light force (20 g) was maintained until the mini-implant was removed 15 months later. The maxillary central incisors were elevated approximately four mm and given a 5° lingual root torque. After 21 months, all the appliances were removed and removable wraparound-type retainers were set.

RESULTS

In this case, the implant remained functional until completion of the active treatment. The posttreatment facial photographs showed an improvement of the gummy smile in a posed smile (Figure 6). The posttreatment oral photographs showed that Class I molar and canine relationships were obtained with excellent tooth alignment (Figure 7). The overbite and overjet were improved to 1.7 and 2.6 mm, respectively, as a result of the active treatment.

The posttreatment panoramic radiograph confirmed that no additional root resorption occurred in the intruded upper incisor region, and the root paralleling was achieved (Figure 8).

The posttreatment lateral cephalometric radiograph and its tracing illustrated the changes that were achieved (Figures 9 and 10; Tables 1 and 2). The maxillary incisor angle to the palatal plane increased until reaching the normative range. The mandibular incisor angle to the mandibular plane also increased. The length between U1 and PP decreased. The patient's facial midline corresponded with her dental midline in the posttreatment facial photographs (Figure 6).

The protrusive upper and lower lips decreased to −0.4 and 0.9 mm relative to the E-line, respectively. The H-line to NB was 11.0°. Pog to NB hardly changed, but L1 to NB increased to 7.0 mm. The Holdaway ratio was 2.8:1.

Begg-type retainers were placed on both sides. Although the overbite has relapsed to 0.5 mm in total throughout the retention period, the treatment is considered successful because occlusion has remained and a normal overbite maintained.

TABLE 1. Cephalometric Measurements

Measurement	Pretreatment (19 y 3 mo)	Posttreatment (21 y 4 mo)	Retention Phase (23 y 4 mo)	Normative Value (Japanese Female Adults) (Mean ± SD)
Angular (°)				
SNA	80.1	80.2	80.1	80.8 ± 3.6
SNB	76.4	77.4	77.0	77.9 ± 4.5
ANB	3.7	2.8	3.1	2.8 ± 2.4
Mp-SN	34.4	33.6	33.4	37.1 ± 4.6
Mp-FH	28.9	28.1	28.4	30.5 ± 3.6
U1-SN	92.2	102.2	102.9	105.9 ± 8.8
U1-PP	105.5	115.0	116.0	115.0 ± 7.0
L1-Mp	85.5	99.6	99.5	93.4 ± 6.8
L1-FH	65.6	52.3	52.1	56.0 ± 8.1
IIA	148.0	124.6	124.2	123.6 ± 10.6
Occ P	20.4	19.6	18.5	16.9 ± 4.4
Linear (mm)				
S-N	69.8	69.8	69.8	67.9 ± 3.7
N-Me	133.1	133.6	133.6	125.8 ± 5.0
Me/PP	72.0	72.8	72.6	68.6 ± 3.7
U6/PP	24.5	24.7	25.0	5.3 ± 4.4
U1/PP	32.6	29.1	29.2	31.0 ± 2.3
L1/Mp	45.7	45.1	45.8	44.2 ± 2.7
Overjet	4.8	2.6	3.3	3.1 ± 1.1
Overbite	7.2	1.7	2.5	3.3 ± 1.9

TABLE 2. Cephalometric Soft-Tissue Measurements

Measurement	Pretreatment (19 y 3 mo)	Posttreatment (21 y 4 mo)	Retention Phase (23 y 4 mo)	Normative Value (Japanese Female Adults) (Mean ± SD)
Upper lip to E-line[a] (mm)	0.0	−0.4	0.0	−0.3
Lower lip to E-line[a] (mm)	1.0	0.9	1.1	2.0
H-line to NB[b] (°)	8.5	9.0	12.0	12.4 ± 2.5
L1 to NB[b] (mm)	4.5	7.0	6.1	7.3 ± 1.1
Pog to NB[b] (mm)	2.3	2.5	2.3	1.8 ± 1.2

[a] Asai.[31]
[b] Namura and Muneta.[16]

DISCUSSION

Conventional prosthetic implants have a limited range of application because of their relatively large size. The mini-implant that we used is only 1.2 mm in diameter and six mm long. Accordingly, it was easy to maintain oral hygiene, and it could be inserted between the two central incisor roots. As a result, the implant could bear the load of the continuous intrusion force without inflammation.

Before treating a deep bite case, it is necessary to determine its cause. The problem may be due to a reduced lower face height and lack of eruption of the posterior teeth or to overeruption of the anterior teeth.[18] In this case, the mandibular plane angle (Mp-SN) and L1 to Mp length were within the normal ranges; however, the U1 to PP length and Me to PP length were greater than the Japanese normative mean. Accordingly, it was considered that this deep bite was caused by a dental problem.

It is widely accepted that correction of deep bite by extrusion of posterior teeth is both more difficult to accomplish and less stable when it is performed on nongrowing patients than when it is attempted on those with appreciable growth remaining.[19–21] Furthermore, Proffit and Fields[18] and Houston et al[22] reported that if elongating the incisors will create an unesthetic gummy smile, it would be better to intrude incisors to obtain proper gingival exposure. In this case, our evaluation led us to the conclusion that the deep bite and gummy smile would be improved by maxillary incisor intrusion.

Intrusion archwire systems such as a utility arch[23] or an intrusion base arch[24] are frequently used for incisor intrusion. This system creates a force to elongate the molars.[18,25] In actively growing patients with a good facial pattern, this is not a major problem. However, in nongrowing patients or those with a poor facial pattern, molar extrusion should be avoided. As a result, the lack of posterior anchorage compromises the ability to intrude incisors. Furthermore,

FIGURE 6. Posttreatment facial photographs.

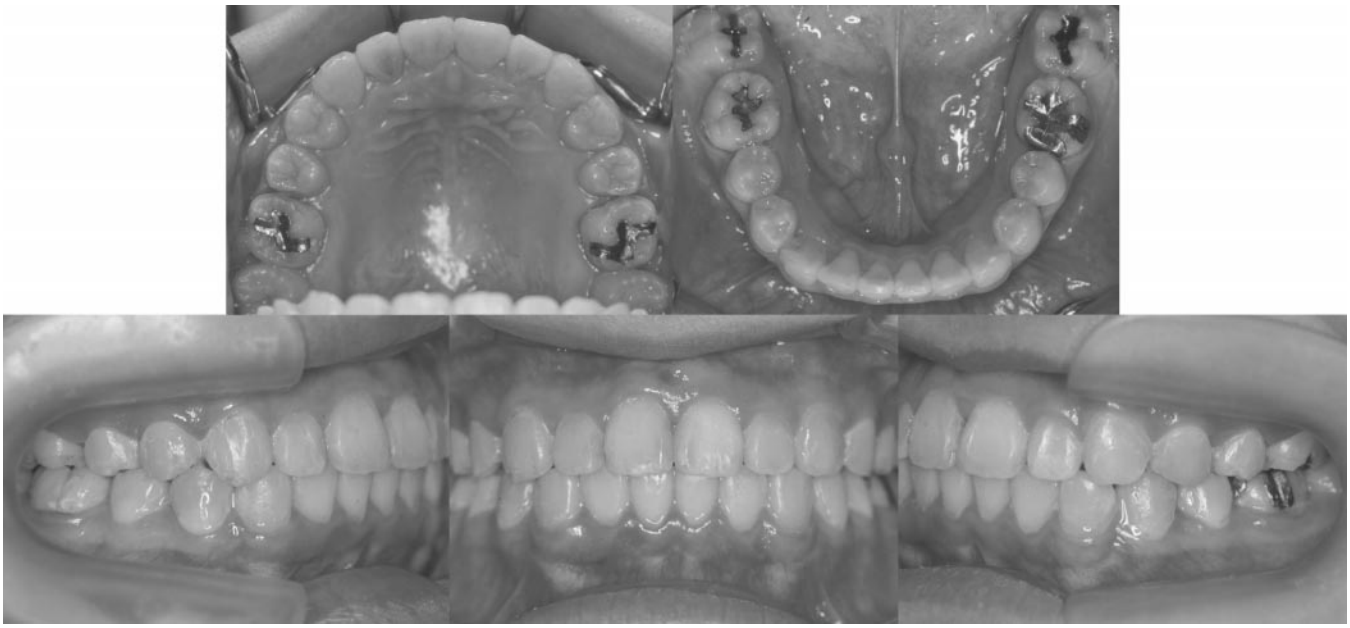

FIGURE 7. Posttreatment intraoral photographs.

molar elongation may invite a downward and backward rotation of the mandible.[18] The J-hook headgear depends on anchorage on the head and is also used for incisor intrusion, but it requires excellent patient cooperation.[26]

In this case, the maxillary incisors were elevated by 3.5 mm, and there was no vertical molar effect giving clockwise rotation of the mandible. Therefore, the implant anchorage demonstrates that maxillary intrusion does not have an effect on vertical molar position and is not influenced by patient cooperation. In addition, it causes almost no relapse in the retention phase, so it may be important for maintaining stability during the retention phase of treatment.

Previous studies suggest that external apical root resorption (EARR) occurs during treatment when forces at the apex exceed the resistance and reparative ability of the periapical tissues.[27,28] Excessive force during treatment increases the risk of EARR, particularly if heavy continuous forces are used. Accordingly, extremely light forces (15–25 gm) should be used to produce appropriate pressure within the periodontal ligament.[18,28] In the current patient, an elastic thread and a metal ligature could introduce this optimal

FIGURE 8. Posttreatment panoramic radiograph.

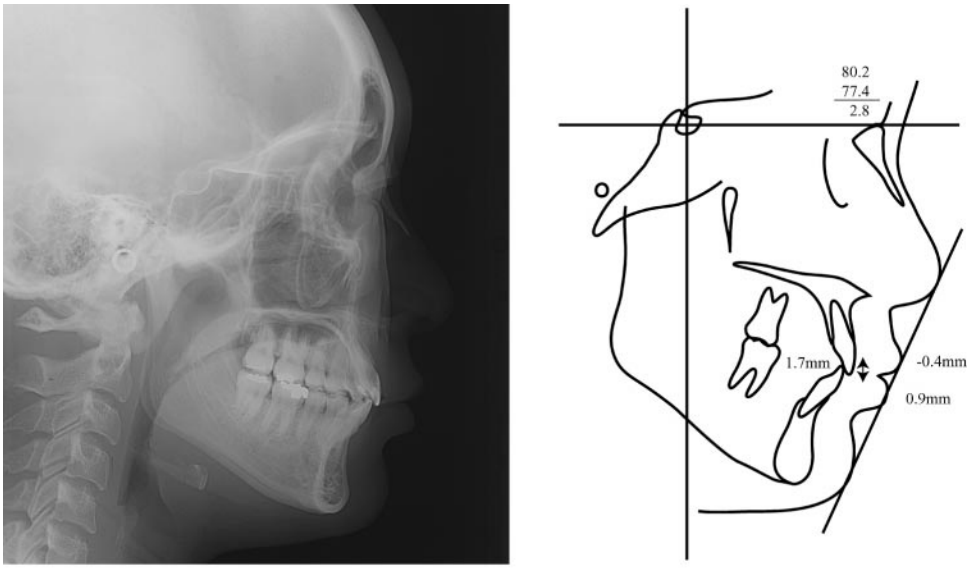

FIGURE 9. Posttreatment. (A) Lateral cephalometric radiograph. (B) Its tracing.

light force from mini-implant anchorage. As a result, optimal intrusion could be acquired without EARR during the active treatment period.

In a crowded case, the decision of whether to perform extraction or nonextraction must be made with consideration given to the arch length discrepancy and the harmony of the soft-tissue profile.[29] Proffit and Fields[18] recommended nonextraction for cases with an arch length discrepancy less than four mm and extraction for those with discrepancy greater than 10 mm. Cases demonstrating a five- to nine-mm arch length discrepancy are considered borderline. The decision would depend on soft-tissue features and incisor position.

In this case, the upper arch length discrepancy was 1.2 mm and the lower arch length discrepancy was a moderate 6.2 mm. However, the value of the protrusive lip was within the normative range. The upper and lower incisors were inclined lingually by more than one SD. If extraction were selected, the patient was concerned that excessive lingual tipping would cause a so-called dished-in facial appearance. Moreover, the risk of overbite relapse is larger than that in nonextraction cases.[30] Thus, we selected a nonextraction treatment.

The posttreatment profile maintained a straight appearance, and the protrusion of the lips was improved. Relative to the E-line, the upper lip decreased to −0.4 mm and the

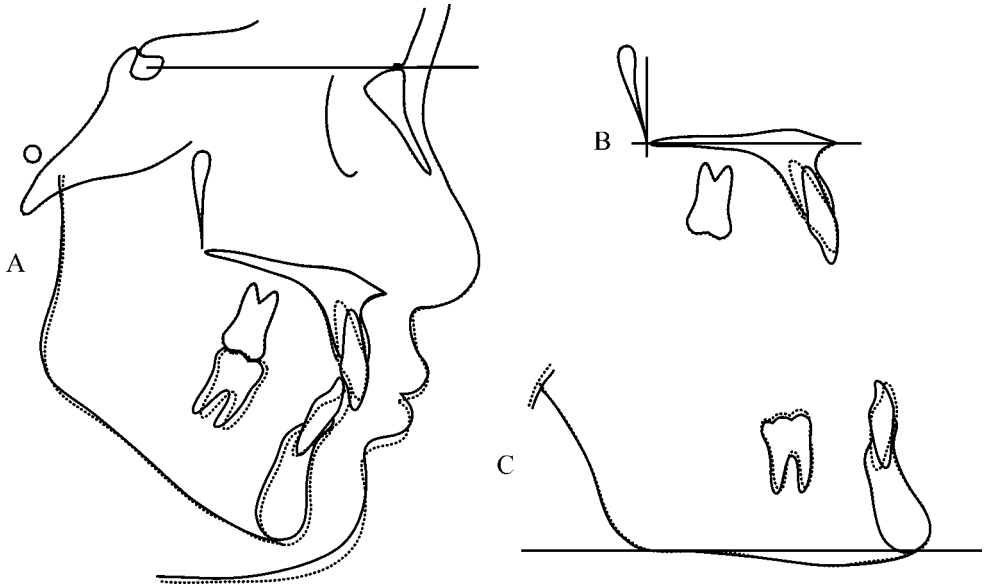

FIGURE 10. Cephalometric superimposition (A) on the S-N plane at S; (B) on the palatal plane at Ptm′; (C) and on the mandibular plane at Me at the pretreatment (solid line) and retention phases (dotted line).

lower lip decreased to 0.9 mm. The anteroposterior relationship of the upper and lower lips approximately coincided with the Japanese normative mean.[31] The labial tipping of the lower incisors caused an increase in the L1 to NB length to 7.0 mm. The Holdaway ratio changed to 2.8:1, and the patient's lateral profile illustrated the balance and harmony of a Japanese facial profile.[13]

CONCLUSIONS

The maxillary incisors achieved remarkable intrusion and alignment with the mini-implant without relying on patient cooperation. There were no side effects and no problem with patient cooperation. Moreover, there was no remarkable root resorption. This demonstrated that the mini-implant anchorage method was useful for achieving an excellent improvement of a dental deep bite and gummy smile in this patient.

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