Case Report

**Adult gummy smile correction with temporary skeletal anchorage devices**

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**A R T I C L E   I N F O**

**Article history:**
Received 14 January 2018
Accepted 28 January 2018

**Keywords:**
Temporary skeletal anchorage devices
gummy smile
vertical maxillary excess
maxillary intrusion

**A B S T R A C T**

Temporary skeletal anchorage devices were used to correct the gummy smile of a 27-year-old woman. She was also missing her maxillary left second molar and mandibular right central incisor. Her mandibular anterior missing space was closed with orthodontic treatment. Her occlusion, smile esthetics, dental midline, and soft tissue profile were significantly improved after her orthodontic treatment. A 2-year follow-up showed that the patient had a stable occlusion and the results of the orthodontic treatment were maintained.

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1. Introduction

An excessive gingival display on smiling, referred to as “gummy smile,” “high lip line,” or “high smile line,” is often esthetically unpleasant and is undesirable [1,2]. Less than 2 mm of gingival display is acceptable and is considered youthful, as the amount of exposure of the maxillary central incisors both at rest and smiling gradually decreases with age [3]. A gummy smile can be defined as 2.0 mm or more of maxillary gingival exposure in full smiling. The sexual dimorphism in smile types indicates that women are twice as likely as men to have gummy smiles. Although the incidence of excessive gingival display has not been established, it is common [4,5].

The etiologies of gummy smile include abnormal lip length/activity, diminished clinical crown length because of gingival hyperplasia or altered passive eruption, dentoalveolar extrusion, and vertical maxillary excess (VME) [6]. It is necessary to diagnose the etiologies associated with each individual gummy smile to prescribe the appropriate treatment modalities. Traditionally, dentoalveolar extrusion and VME could be effectively corrected only with invasive orthognathic surgery [7,8], but the upsurge of temporary skeletal anchorage devices (TSADs) in orthodontic therapy offers an alternative to surgery in some cases. TSADs have been successfully used for maxillary intrusion, improving gummy smiles resulting from dentoalveolar extrusion and VME [9–13].

For cases with a multifactorial etiology, a combination of treatment methods should be prescribed to improve each problem. If possible, overcorrection of one etiological factor can camouflage another etiological factor that is indirectly or incompletely corrected. This case report details successful correction of a gummy smile because of VME using TSAD-assisted maxillary intrusion. Further a 2-year follow-up record of the patient is provided to establish the stability of the treatment result.

2. Diagnosis and treatment planning

A 27-year-old woman presented with concerns of spacing in her upper and lower arches at the Division of Orthodontics, The Nippon Dental University Hospital in Japan. A review of her medical history, as well as temporomandibular joint evaluation, showed nothing remarkable. She had a convex profile with
posterior divergence and her smile revealed excessive gingival show (Fig. 1). Intraoral clinical examination revealed her missing maxillary left second molar and one mandibular incisor. She had Class I molar relationship on her right side and Class III molar relationship on her left side, with bilateral Class I canine relationships. She had an approximately 1 mm overjet and a 50% overbite. Because of her missing mandibular incisor, her dental midline was not coincident with her facial midline, and her maxillary dental midline was deviated by approximately 1 mm to the right (Figs. 1 and 2).

A panoramic radiograph confirmed that she was missing her maxillary left second molar and mandibular right central incisor, and her mandibular left lateral incisor showed short root. It also showed that her left mandibular third molar was horizontally impacted along with a difference in the shape of her left and right condyle. Lateral cephalometric analysis revealed a skeletal Class II (A point, nasion, B point: 7.8°) relationship with hyperdivergent growth pattern (sella nasion to mandibular plane: 42.0°). Her maxillary incisors were retroclined (upper central incisor to sella nasion line: 87.0°), her mandibular incisors were proclined (incisor mandibular plane angle: 97.9°), and her lower lip was protrusive such that it was ahead of the E-line (Fig. 3 and Table 1).

3. Treatment objectives

The following treatment objectives were established: (1) correct VME; (2) correct jaw deformities of the maxilla and the mandible; (2) coordinate the skeletal and dental midlines; (3) correct and coordinate the maxillary and mandibular arch forms; (4) obtain normal overjet and overbite; (5) maintain Class I canine and establish Class I molar relationships; (6) close the spaces between her teeth; and (7) improve her gummy smile and facial esthetics.

4. Treatment alternatives

To improve her gummy smile and facial profile, and to close her spaces in the dental arches and to attain ideal inclination of maxillary and mandibular incisors, we recommended orthognathic surgery, including genioplasty and dental implants to restore her missing teeth, but she declined the surgical and restorative treatment options. She wanted to close all the missing spaces without dental restorations and improve her gummy smile without surgery. Because of the complexity of the case, TSADs were chosen to improve her gummy smile and close her missing teeth.
spaces, but it would be a challenge to close all her missing areas and correct her dental midline, so a diagnostic setup model was fabricated (Fig. 4).

5. Treatment progress

Before the start of orthodontic treatment, the patient was referred to a general dentist to ensure that she had no active dental issues that might interfere with treatment. After her dental clearance, full-fixed 0.022 × 0.028-inch preadjusted orthodontic brackets (Clarity ceramic brackets; 3M Unitek, Monrovia, CA) were placed and bonded on both arches. The wire sizes in both the upper and lower dental arches were gradually increased from 0.012-inch nickel-titanium (NiTi), 0.016-inch NiTi, to 0.019 × 0.025-inch NiTi arch wires over 6 months for leveling and alignment.

After leveling and alignment, two TSADs (6.0 mm length, 1.6 mm diameter; Dual Top Auto Screw; Jeil Medical Corp, Seoul, Korea) were placed in the mesial area of her maxillary lateral incisors along with a DISCOpender (BioMaterials Korea, Inc., Seoul, South Korea) and power elastics to provide maxillary anterior intrusion. For maxillary incisor intrusion, 80 g was used per side [14]. One palatal TSAD (6.0 mm length, 2.0 mm diameter; BioMaterials Korea, Inc.) was placed in the para-median area, posteriorly parallel to the

Fig. 2. Pretreatment dental casts.
palatal roots of her maxillary first molars [15]. For molar intrusion, 150 g per side was used [16]. On her posterior teeth, the maxillary first molars developed slight edge-to-edge bite due to the intrusive force from the palatal TSAD and transpalatal arch. To correct these side effects while space closing, 0.019\textperthousand \times 0.025-inch stainless steel wire was used to deliver buccal crown torque during anterior retraction. It was hoped that this would reduce anterior overjet and increase overbite. On the posterior sides, wire was also slightly expanded to correct the edge-to-edge bite. Additional torque was not added in the anterior and posterior portions of the wire to reduce friction during space closing. In the mandibular arch, to correct the dental midline as much as possible and to protract the left second molar, one TSAD was placed (6.0 mm length, 1.6 mm diameter; Dual Top Auto Screw; Jeil Medical Corp) between her right second premolar and first molar and 0.017\textperthousand \times 0.025-inch stainless steel wire was used (Figs. 5 and 6).

Because the palatal TSAD became lose during treatment, the maxillary left first molar lost anchorage and tilted mesially. To correct this, a palatal TSAD was reinstalled to upright the tooth with modified transpalatal arch and power elastics. To prevent canting of the transpalatal arms, a stainless steel ligature was also passively.

### Table 1

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Normal</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
<th>2-y retention</th>
</tr>
</thead>
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<tr>
<td>SNA (°)</td>
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<td>78.9</td>
<td>78.5</td>
<td>78.5</td>
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<tr>
<td>SNB (°)</td>
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<td>71.1</td>
<td>72.0</td>
<td>71.8</td>
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<tr>
<td>ANB (°)</td>
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<td>7.8</td>
<td>6.5</td>
<td>6.7</td>
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<tr>
<td>Wits (mm)</td>
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<td>–3.7</td>
<td>–3.3</td>
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<tr>
<td>SN-MP (°)</td>
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<td>42.0</td>
<td>41.3</td>
<td>41.5</td>
</tr>
<tr>
<td>FH-MP (°)</td>
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<td>29.9</td>
<td>30.1</td>
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<td>LPH (ANS-Me/ N-Me) (%)</td>
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<td>61.0</td>
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<td>60.7</td>
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<tr>
<td>U1-SN (°)</td>
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<td>87.0</td>
<td>86.4</td>
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<td>U1-NA (°)</td>
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<td>7.9</td>
<td>8.1</td>
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<td>IMPA (°)</td>
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<td>87.4</td>
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<td>Lowerlip (mm)</td>
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<td>–2.1</td>
<td>–0.1</td>
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</table>

ANB, A point, nasion, B point; ANS, anterior nasal spine; FH-MP, Frankfort horizontal plane—mandibular plane; IMPA, incisor to mandibular plane angle; LPH, lower facial height; L1, lower central incisor; L6, lower first molar; Me, menton; N, nasion; NA, nasion point A; NB, nasion point B; NF, nasal floor; SN-MP, sella nasion—mandibular plane; SNA, sella nasion point A; SNB, sella nasion point B; U1, upper central incisor; U6, upper first molar.
engaged on the maxillary right first molar (Fig. 7). In the finishing stage, the mandibular second molars were bonded for final adjustment. The patient also was advised to wear Class II elastics (1/4", 3.5 oz) from her maxillary left canine to her mandibular second molar, and triangular elastics (3/16", 4 oz) from her maxillary right canine to her mandibular canine and first premolar, along with the midline elastics (5/16", 4 oz) from her maxillary right canine to her mandibular left canine. A fixed first premolar–to–first premolar retainer was placed on the maxillary and mandibular arches. Essix retainers were also delivered to secure the stability of both arches. Because of the difficulty of the case, her total treatment time was longer than expected: 3 years and 6 months, aggravated by several missed appointments. (Figs. 8 and 9).

6. Treatment results

Posttreatment records revealed that the goal of improving her gummy smile and closing the missing space without dental prosthesis were achieved. Facial photographs showed improved smile esthetics. Class I molar relationship on the patient’s right side and Class III molar relationship on her left side have been maintained. An acceptable overbite and overjet were also achieved (Figs. 8 and 9).
Fig. 5. Intrusion of maxillary anterior teeth and retraction of mandibular anterior to the right-side teeth with TSADs. The TSAD on the anterior right segment was reinstalled from between upper right (UR)1 and UR2 to between UR2 and UR3 due to mobility.

Fig. 6. Illustration of total intrusion of maxillary anterior and posterior dentition with TSADs. (A) Buccal crown torque and expansion on the maxillary posterior teeth to prevent side effect as palatal tipping of the maxillary posterior teeth. (B) Maxillary anterior TSADs were used for intrusion and torque control of maxillary anterior teeth.
Fig. 7. A TSAD and transpalatal arms were used for uprighting of the maxillary left first molar.

Fig. 8. Posttreatment facial and intraoral photographs.
The posttreatment panoramic radiograph showed proper space closure and acceptable root parallelism. There were no significant signs of bone resorption, although anterior teeth demonstrated signs of apical root resorption. She was referred to her oral surgeon for the evaluation of the extraction of her horizontally impacted mandibular third molar. She was also referred to a plastic surgeon to determine whether botulinum toxin (Botox) therapy would reduce her excessive gingival display, but she declined Botox therapy (Figs. 8 and 10).

Posttreatment lateral cephalometric analysis and superimposition revealed slight skeletal changes (A point, nasion, B point: 6.5°, sella nasion to mandibular plane: 41.3°). The maxillary and mandibular incisors showed retroclination (upper central incisor to sella nasion line: 86.4°, incisor mandibular plane angle: 86.2°) (Figs. 10 and 11, and Table 1). Facial aesthetic harmony was achieved by retracting the maxillary and mandibular anterior teeth and closing the mandibular plane following intrusion of the maxillary posterior teeth and forward movement of the mandible. The lower anterior facial height was slightly decreased, and mentalis muscle strain was reduced. These overall changes improved facial balance [17]. Because a significant amount of overbite relapse and more than 80% of the total relapse of the maxillary molars occurs during the first-year retention period [18], the patient was asked to wear her retainers all the time. At

![Fig. 9. Posttreatment dental casts.](image-url)
the 2-year follow-up, the patient had a stable occlusion and the results of the orthodontic treatment were maintained (Figs. 12–14).

7. Discussion

The patient presented in this report was having a gummy smile with deep overbite due to extrusion of maxillary anterior teeth. Even though her upper lip showed normal position, her lower lip was protrusive compared with the E-line. Her protrusive appearance was due to backward and downward positioning/rotation of mandible along with proclined mandibular incisors. Therefore, closing of the spaces in the mandibular dentition will retrocline the anterior dentition, and intrusion of the maxillary posterior dentition will lead to a counterclockwise rotation of the mandible to improve her profile. It was very difficult to control the torque of maxillary anterior teeth during retraction because her maxillary anterior teeth were initially upright to start with. A maxillary palatal TSAD was used for intrusion of maxillary posterior teeth to autorotate the mandible. A mandibular posterior unilateral TSAD was used for retracting the mandibular anterior teeth toward the right side to substitute the canine for the missing incisor and closing all spaces.

Orthognathic surgery is an effective and predictable treatment alternative to TSAD intrusion for correction of gummy smiles resulting from dentoalveolar extrusion and VME [7,8]. However, some patients are reluctant to undergo elective orthognathic surgery due to its high cost and risk. Likewise, because our patient did not want to have orthognathic surgery, camouflage treatment options were limited. We intruded the maxillary anterior and posterior teeth with TSADs to reduce VME as much as possible. As a result, approximately 5 mm at the maxillary incisor and approximately 1.5 mm at the maxillary molar intrusion were observed in the lateral cephalometric measurements, and her gummy smile was significantly reduced. Moreover, to improve her dental midline, it was possible to move the mandibular dental arch approximately 6 mm to the right side with the help of a miniscrew. This case report, along with other successful TSAD-assisted intrusion cases [9–13], offers orthodontists and patients a more cost-effective, lower-risk alternative to orthognathic surgery.

Although the risk associated with TSAD-assisted maxillary intrusion is lower than the risk associated with orthognathic
surgery, risk and limitations do still exist. TSADs are contra-indicated in patients with bone metabolic disorders and in heavy smokers [19]. As is the case with all orthodontic movement, root resorption is an associated risk with TSAD-assisted maxillary intrusion [20]. However, TSAD-assisted maxillary intrusion has not been shown to cause more root resorption than other methods of intrusion [16,21,22]. As is true with all orthodontic cases, serial panoramic radiographs along with periapical radiographs should be captured throughout active treatment to look for changes in root length. Multiple studies show that root movement into the maxillary sinus does not cause bone loss or root damage [23–25]. Sinus perforations smaller than 2 mm will
heal by themselves without complications [26,27]. Because most TSADs are smaller than 2 mm in diameter, most asymptomatic sinus perforations are not a concern and should heal without intervention [16]. Kuroda and Tanaka [28] conclude that tooth intrusion is a safe procedure, and limitations on movement have not been identified.

Retention following maxillary intrusion should be considered for long-term stability. Hsu and Liou [29] reported 30% relapse rate 14 months after miniscrew intrusion. Other studies [18,30] indicated that most relapses following molar intrusion with TSADs occur within the first year after treatment. To provide better retention in the first year postintrusion, it is suggested to retain the TSADs that were used for intrusion to anchor a clear retainer [12,18]. Scheffler et al. [30] suggested that maxillary molar intrusion with TSADs was effective to decrease long anterior facial height and showed that maxillary first molars relapse 0.5–1.5 mm following TSAD intrusion. On the other hand, intrusion of upper incisors with TSADs was very effective compared with intrusion arch or J-hook headgear, although further studies are needed for posttreatment stability [14,22,31,32].

Surgical impaction of the maxilla as has the potential to relapse. A study by Proffit et al. [33] reports that patients receiving superior positioning of the maxilla experienced a 5-year relapse rate of 20%. Although neither TSAD-assisted maxillary intrusion nor surgical-assisted maxillary impaction can guarantee long-term stability, both treatment modalities offer long-term success in 70% to 90% of

Fig. 13. Two-year retention dental casts.
patients [29,33]. Proper diagnosis and treatment planning are critical for successful impaction and retention [34].

Lip line can be excessively elevated due to a short upper lip length or hyperactive lip elevator muscles. Measured from subnasale to the most inferior portion of the upper lip at the midline, the average lip length at rest is approximately 23 mm in men and 20 mm in women [3]. Excess gingiva displayed because of short upper lip length can be corrected through lip reposition surgery [35–37]. Hyperactivity of elevator muscles of the lip can be reduced through surgery or botulinum toxin (Botox) therapy [35,38–42].

The average height of the maxillary central incisors is 10.6 mm in men and 9.8 mm in women [3]. Small clinical crowns, because of hyperplastic gingiva or altered passive eruption, create a smile with excess gingival display. Diagnosis of altered passive eruption is done by determining the location of the cemento-enamel junction (CEJ) in relation to the gingival margin. The CEJ should be just apical to the gingival margin. If the CEJ is found to be excessively apical to the gingival margin, altered passive eruption should be considered. Altered passive eruption does not autocorrect; a gingivectomy is necessary to remove the excess gingival tissue. To obtain a healthy and stable result when performing a gingivectomy, it is important to respect biologic width [43].

8. Conclusions

Gummy smiles can be a result of abnormal lip length/activity, short clinical crowns, dentoalveolar extrusion, and VME. Each of these factors requires a different treatment modality for correction. Gummy smiles with a multifactorial etiology require a combination of treatment modalities for correction. Both surgical-assisted maxillary impaction and TSAD-assisted maxillary intrusion can improve gummy smiles in cases of dentoalveolar extrusion and VME. In appropriately selected cases, TSAD-assisted maxillary intrusion can effectively reduce a gummy smile without orthognathic surgery and result in an esthetic outcome.

Acknowledgments

We thank Brent Jorgensen for his help with the preparation of the manuscript. The authors have no other financial relationships to disclose.