A 23-year-old Mongolian woman came for a consultation with chief complaints of protrusive lips and a gummy smile. The clinical examination showed a convex profile, a protrusive maxilla, excessively proclined and extruded maxillary incisors, and a Class II Division 1 malocclusion. Temporary anchorage devices (TADs) in the posterior dental region were used as anchorage for the retraction and intrusion of her maxillary anterior teeth. Those appliances, combined with a compensatory curved maxillary archwire, eliminated the severe gummy smile and the protrusive profile, and corrected the molar relationship from Class II to Class I. With no extra temporary anchorage devices in the anterior region for intrusion, the treatment was workable and simple. The patient received a satisfactory occlusion and an attractive smile. (Am J Orthod Dentofacial Orthop 2011;140:97-105)

Temporary anchorage devices (TADs) have changed the conventional conception of anchorage control and biomechanics in orthodontics. They have replaced many traditional types of mechanics and simplified orthodontic treatment. In 1983, Creekmore and Eklund reported a patient with a deep overbite corrected with a Vitallium bone screw; it was the first report of the clinical use of TADs. Based upon the extensive applications of TADs, many appliances have been invented to solve orthodontic problems, such as a protrusive alveolus and a significant gummy smile. Gummy smile refers to excessive gingival display during full smile. The current opinion is that less than 2 mm of gingival exposure is more esthetic and youthful. Kim et al and Kim and Freitas introduced a Class II Division 2 patient treated with a segmental arch appliance with TADs, which corrected the excessive vertical growth of the maxillary dentoalveolar complex and alleviated the gummy smile. Lin et al reported on 4 patients with gummy smiles treated by a combination of TADs and periodontal surgery without orthognathic surgery. But there has been no case report of TADs used in the treatment of a Class II Division 1 patient with a significant gummy smile.

In this case report, we aimed to introduce the treatment of a woman with a Class II Division 1 malocclusion. TADs with compensatory curved archwires corrected the patient’s protrusive profile and significant gummy smile.

DIAGNOSIS AND ETIOLOGY

The patient, a 23-year-old Mongolian woman, had a convex profile and a Class II malocclusion. Her chief complaints were protrusive lips and a gummy smile. The photographs taken before treatment showed protrusive upper and lower lips, both of which exceeded the E-line and were strained on closure (Fig 1). No anomaly was seen in the frontal facial photos, except that the patient was overly cautious about smiling naturally. When the patient relaxed, we took another smiling image (Fig 2), which showed a significant gummy smile with more than 4 mm of gingival exposure in the incisor region. The photographs and pretreatment study casts (Fig 3) exhibited excessively proclined and extruded maxillary incisors, and cusp-to-cusp canine and molar relationships with a deep overbite and overjet and no apparent crowding. The clinical examination suggested
incisal and canine guidance without prematurity and shift. The patient had no temporomandibular joint symptoms. No deviation and pain during the border movement of the mandible were discovered. No short or hyperactive upper lip or vertical maxillary excess was found in our clinical examination that could be the etiology of the gummy smile.8-10

A cephalogram (Fig 4, A) and a panoramic radiograph (Fig 4, C) were taken before treatment. The cephalometric analysis (Table) and the tracing (Fig 4, B) demonstrated a Class II skeletal relationship (ANB, 6°) as a result of the retruded mandible. The A-point was in the normal range (SNA, 80°), and B-point was retruded (SNB, 74°). The angle between the maxillary incisors and the S-N plane was 112°, and the IMPA was 101°, which indicated that the protrusive profile was mainly caused by the proclined maxillary anterior teeth.

**TREATMENT OBJECTIVES**

The treatment objectives were to create a satisfactory occlusion with a Class I molar relationship and normalize overjet and overbite. Retraction and intrusion of the maxillary anterior teeth were indicated to reduce the exposure of the gingiva and the protrusive profile. Simultaneously, extrusion of the posterior teeth would be limited to prevent a clockwise rotation of the mandible and an increase in lower facial height.

**TREATMENT ALTERNATIVES**

Three alternatives were presented to the patient.

1. Combined surgical and orthodontic treatment to harmonize the molar relationship with extraction of premolars in both the maxilla and the mandible. Orthognathic surgery could be used to elevate and retract the anterior maxillary dentoalveolar part to eliminate the gummy smile and improve the profile. Advancement genioplasty could be used to camouflage the retruded mandible and improve the profile.
2. Harmonize the molar relationship and retract the anterior teeth by extracting the maxillary first premolars and the mandibular second premolars. Use TADs to provide absolute anchorage for maximum retraction of the proclined maxillary teeth and maxillary incisor intrusion to eliminate the gummy smile. The disadvantage was that the retruded mandible would not be corrected.

3. Extract the maxillary first premolars and the mandibular second premolars, and use J-hook headgear as anchorage for retraction and intrusion. The disadvantage was that the effect of this treatment depended on the patient’s cooperation.

After we discussed these alternatives with the patient, she chose the second option. She considered the improvement from orthognathic surgery not worth the additional cost and risk, and the headgear was unacceptable.

**TREATMENT PROGRESS**

Orthodontic treatment began on February 28, 2006, and lasted for 38 months. Before bracket bonding, the maxillary first premolars and mandibular second premolars were extracted. Two mini-implants (1.6 × 9 mm, Aarhus, Medicon, Tuttlingen, Germany) were placed between the roots of the maxillary second premolars and first molars, 3 mm occlusally to the buccal frenum.11 Preadjusted 0.022-in brackets (Shiye, Hangzhou, China) were bonded to all teeth. With sequential nickel-titanium archwires, alignment and leveling were achieved in 9 months. Then, 0.018 × 0.025-in stainless steel wires were placed in both dental arches. The maxillary wire had a 5-mm compensating curve of Spee. Nickel-titanium closed-coil springs and Class II elastics were used for space closure and mesial mandibular molar movement (Fig 5, A). In the 20th month of treatment, the mandibular space was closed, and the first molars were in a Class I relationship. Further maxillary retraction was achieved by nickel-titanium closed coil springs on the TADs (Fig 5, B). After 4 months of retraction of the maxilla, both overbite and overjet were reduced. No Class II elastics were used during the final maxillary retraction. At the third stage, the second molars were bonded, and intermaxillary elastics were applied with 0.018-in stainless steel wires in the brackets for better interdigitation of the occlusion (Fig 5, C).

The total treatment time was 3 years 4 months. It took approximately 9 months to close the mandibular space and over 20 months to retract and intrude the maxillary anterior teeth.
TREATMENT RESULTS

The posttreatment photographs (Fig 6) showed a remarkable improvement in lip profile from the significant retraction of the anterior teeth. Meanwhile, there was no gummy smile at the posttreatment clinical examination. The posttreatment photographs (Fig 6) and dental casts (Fig 7) demonstrated Class I canine and molar relationships with normal overbite and overjet. The posttreatment cephalogram and panoramic radiograph are shown in Figure 8. The cephalometric analysis (Table) and superimposition (Fig 8, B) showed no change in the position of the maxillary molars. The incisal edge of the maxillary incisors was retracted by 7 mm and intruded by 2.5 mm, and the mandibular first molars moved 3.5 mm mesially. Normal overbite and overjet were achieved. The maxillary anterior alveolar bone and gingiva moved lingually and upward with the tooth movement. However, the final cephalometric analysis (Table) showed that the skeletal discrepancy between the maxilla and the mandible remained unchanged. The comparison between the pretreatment and posttreatment panoramic radiographs showed no apparent root shortening.

Table. Cephalometric data

<table>
<thead>
<tr>
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<th>Pretreatment</th>
<th>Posttreatment</th>
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<tr>
<td>SNA (°)</td>
<td>83.13 ± 3.6</td>
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<td>79</td>
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<tr>
<td>SNB (°)</td>
<td>79.65 ± 3.2</td>
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<td>ANB (°)</td>
<td>3.48 ± 1.69</td>
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<tr>
<td>FMA (°)</td>
<td>29 ± 5</td>
<td>34</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>U1 to SN (°)</td>
<td>102 ± 5.4</td>
<td>112</td>
<td>99</td>
<td>-13</td>
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<td>IMPA (°)</td>
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<td>101</td>
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<td>Interincisal angle (°)</td>
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<td>105</td>
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</table>

DISCUSSION

Gummy smiles can be classified by etiology into soft-tissue, \(^3\) dentoalveolar, and skeletal types.\(^6\)\(^,\)\(^8\)\(^,\)\(^10\) The skeletal type is caused by excessive vertical maxillary growth and is found in patients with long-face syndrome. Orthognathic surgery is generally required to treat this problem.\(^8\)\(^,\)\(^12\) However, in some dentoalveolar cases, orthognathic surgery could produce an unfavorable result. For the patient whose gummy smile is derived from protrusion and extrusion of the maxillary anterior dentoalveolar complex, decreased anterior dentoalveolar height after surgery might result
These considerations, plus the favorable outcome of the selected treatment, suggested that orthognathic surgery was inappropriate for eliminating the gummy smile in our patient. In addition, the patient thought that improvement of her profile was not worth the additional cost and risk. As a result, orthognathic surgery was abandoned after careful consideration.

Two mandibular second premolars were extracted instead of 2 mandibular first premolars, because mandibular first premolar extractions might increase the difficulty of mesial movement of the mandibular molars. The selected alternative, extraction of the maxillary first premolars and mandibular second premolars, which ameliorated the profile and molar relationship, is a classic treatment modality for a Class II Division 1 patient.

For this patient, the convex profile and gummy smile were both caused by excessive protrusion of the maxillary anterior dentoalveolar complex. Thus, maximum retraction of the maxillary anterior teeth was needed. To meet this purpose, anchorage control was emphasized throughout the treatment.

Before the development and application of TADs, orthodontists’ choices were limited to appliances such as transpalatal arches, Nance arches, and headgears. These appliances have disadvantages, such as their esthetic appearance, undesirable intermittent forces, and dependence on patient cooperation. Also, mesial movement of the molars was inevitable even with these appliances. Correction of gummy smiles with continuous light intrusion forces on the maxillary anterior dental arch could be accomplished by extraoral intrusion appliances such as headgear and J-hook. Traditional intrusion techniques, such as utility arches and 1-piece intrusion arches, were not optimal for this patient, because they require anchorage on the molars and produce undesirable moments on the anterior teeth.

The first clinical case report about TADS was published in 1983. Creekmore and Eklund used a Vitallium bone screw in treating a patient with a deep overbite. But TADs were not accepted immediately. TADs have gradually become more acceptable and are now used in solving orthodontic problems. Currently, several cases
Fig 6. Posttreatment photographs.

Fig 7. Posttreatment study casts.
have been reported in the literature with TADs for en-masse retraction. With time, TADs are gradually replacing the aforementioned appliances and have become the preferred anchorage option for orthodontists.

The development of TADs has triggered various novel techniques for treating gummy smiles. Kim et al. introduced a segmental archwire assisted by placing TADs between the roots of the maxillary central incisors to correct a gummy smile that was caused by vertical growth of the maxillary anterior dentoalveolar complex. Lin et al. reported on 4 patients with skeletal gummy smiles treated with a combination of TADs and periodontal surgery. But there have been no reports of a Class II Division 1 patient with a gummy smile treated with TADs.

For Class II Division 2 patients, TADs in the anterior alveolus could provide an intrusion force and proclining moments on the maxillary incisors; this is ideal for extruded and retruded teeth. But in our Class II Division 1 patient, the gummy smile was caused by protrusion and excessive vertical growth of the anterior dentoalveolar complex. Therefore the mechanical system for Class II Division 1 patients should be different. TADs in the anterior alveolus were not appropriate. We adopted TADs between the maxillary second premolars and first molars combined with nickel-titanium closed-coil springs that could provide a continuous total force passing near the center of resistance of the 6 anterior teeth. The force could be divided into 2 parts: a greater horizontal force for retraction of the protrusive anterior dentoalveolar complex and a smaller vertical force for intrusion of the anterior teeth (Fig 9, A).

The smaller vertical force was suitable and enough to meet the need for anterior tooth intrusion. This appliance is simple and workable in the treatment of patients with gummy smiles and Class II Division 1 malocclusion. On the other hand, this mechanical system is also suggested for the Class II Division 1 patient who has a low or average smile. However, the intrusion force produced by TADs during en-masse retraction will reduce the exposure of the maxillary teeth, and this would aggravate an unesthetic smile.

However, orthodontists have found that the TADs technique could not completely eliminate anchorage loss. One reason is that the force on the traction hook
will cause deformation even with stainless steel archwires; it also creates couples, inducing mesial tipping of the molars and lingual tipping of the anterior teeth (Fig 9, A). A finite element analysis of TADs used for en-masse retraction also showed that the inclination of the incisor would be reduced without torque control even when the total force passed through the center of resistance of the 6 anterior teeth. To ensure maximal retraction and prevent excessive lingual tipping of the anterior teeth, we placed a compensatory curve in the maxillary archwire, which could counteract the deformation of archwire, provide torque control on the anterior teeth, and assist in correcting the deep overbite. Torque control of the anterior teeth also prevented the roots from approximating the cortical plate, which, when combined with continuous light retraction forces, effectively reduced root resorption. The posttreatment radiographs might have underestimated root resorption but did not show any apparent root shortening.

**CONCLUSIONS**

TADs and a curved archwire were adopted for the treatment of a 23-year-old woman with protrusive lips and a gummy smile, and a desirable result was achieved.

1. The protrusive anterior dentoalveolar complex and excessively erupted anterior teeth were corrected by retraction and intrusion of the anterior dental alveolus; this eliminated the gummy smile and the protrusive profile.
2. For intrusion of the maxillary anterior teeth in Class II Division 1 patients, posterior TADs provide more optimal force than TADs placed in the anterior part.

![Fig 9. Mechanical analysis. A, Force system involved: F, total force; V, vertical force; H, horizontal force (H was much greater than V); CR, center of resistance. B, Couples induced by deformation of the archwire.](image)
3. When TADs are used for en-masse retraction in a Class II Division 1 patient with a low smile, aggravation of the unesthetic smile is caused by an intrusion force from the TADs and should be avoided.

4. The appropriate application of TADs to correct a gummy smile must be based on the correct analysis of the etiology.

5. The compensatory curve played an important role in anchorage control of the molars, torque control of the anterior teeth, and correction of the deep overbite.

6. This appliance was simple and workable for the treatment of a Class II Division 1 patient with a gummy smile, and she was satisfied with the result.

REFERENCES


