

BRIEF CLINICAL STUDIES

Gummy Smile Correction Using Lingual Orthodontics and Augmented Corticotomy in Extremely Thin Alveolar Housing

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Background: Tooth movement out of anatomic limitations was assisted by augmented corticotomy using deproteinized bovine bone mineral.

Methods: Lip protrusion can be reduced by premolar extraction followed by retraction of the anterior teeth. Surgical intervention is appropriate when the alveolar bone housing of the anterior region is insufficient for the tooth movement. In this patient, corticotomy in upper palatal area and anterior segmented osteotomy in the mandible were performed. Anatomic limitation to the retraction was expanded by xenograft. An antero-posterior lingual appliance was used to bodily retract the upper anterior teeth. The gummy smile was resolved by intrusion of upper entire arch using 2 mid-palatal temporary skeletal anchorage devices.

Results: New bone formation was observed on palatal side of upper anterior teeth. The teeth were moved into augmented area without fenestration or vitality loss. Lip protrusion was resolved, and the gummy smile was effectively improved.

Conclusions: Orthodontic tooth movement beyond the limitation of the alveolar bone housing can be achieved with surgical assistance, which can be performed under local anesthesia. Without orthognathic surgery, the gummy smile can be reduced using an antero-posterior lingual retractor with mid-palatal skeletal anchorage.

Key Words: Antero-posterior lingual appliance, augmented corticotomy, gummy smile, lingual orthodontics, thin alveolus

Sufficient amount of trabecular bone in the alveolus in the direction of tooth movement is a prerequisite of orthodontic tooth movement. If the orthodontic force is applied without consideration of this anatomic limit, the teeth may perforate the alveolar cortical plate, leading to fenestration, and gingival recession.¹ The alveolar bone thickness has commonly been evaluated using lateral cephalometric radiographs. More accurate assessment is possible using computed tomography (Fig. 1). The palatal and

lingual cortical bone of the housing is the posterior limit of retraction of the anterior teeth, and should be considered when orthodontic movement is planned. Retraction of upper and lower anterior teeth without adverse effects in adults has heightened concern, because bone becomes more brittle and less able to perform its mechanical functions with aging.² It has been noted that after retraction of the upper anteriors, alveolar bone volume and the crest level decreases.³

Bialveolar protrusion is one of the most common chief concerns of orthodontic patients. Typical orthodontic approaches can include 2 types: orthodontic treatment only and surgery-assisted orthodontic treatment. Orthodontic treatment including premolar extraction without any surgical procedure is the most common approach. If the teeth have enough cancellous bone to be moved, this approach is appropriate. Torque control of anterior teeth in lingual orthodontics is challenging but quite possible. The antero-posterior lingual retractor appliance described here provides good torque/intrusion control with lingual orthodontics (Fig. 2). Figure 3 shows a patient with total upper arch intrusion. Anterior teeth were intruded about 6 mm with negligible root resorption. The lingual cortical bone plate was intact post-treatment nevertheless large amount of intrusion (Fig. 4). Counter-clockwise rotation of mandible was observed, and the profile was improved.

In bi-alveolar protrusion patients with insufficient alveolar bone thickness for tooth retraction, orthognathic surgery including anterior segmented osteotomy (ASO) under general anesthesia is an option. But in borderline patients, surgery under general anesthesia requires nonignorable financial cost, surgical risk, and psychological stress.

Wilcko et al⁴ presented periodontal accelerated osteogenic orthodontics. The technique accelerates tooth movement, and can allow tooth movement beyond the original anatomic limit. Osteotomy can be used for single tooth movement.⁵ Ahn et al presented labial augmented corticotomy for proclination of anterior mandibular roots in Class III patients. The technique reduced the risk of periodontal damage during dental compensation.⁶ In our study, augmented corticotomy on the palate was beneficial for bodily movement in a bialveolar patient with an extremely thin alveolar bone housing.

Gummy smile is generally treated by skeletal anchorage and intrusion of the upper incisors or the whole upper arch.⁷ Application of an antero-posterior lingual retractor with mid-palatal temporary anchorage is a suitable appliance to achieve intrusion and retraction with full control.

MATERIALS AND METHODS

In the mandible, an ASO was performed under local anesthesia.⁸ A chin-plate with bendable C-tube was used to fix the fragment. This mini-plate could be used as a skeletal anchorage subsequently.⁹ The lower profile was improved by surgery immediately.

Two weeks later, author SYS performed a full thickness gap and an augmented corticotomy on the palate (Fig. 5). Inter-radicular corticotomy was conducted by high-speed fissure bur and piezoelectric kit.¹⁰ Deproteinized bovine bone mineral (Bio-oss, Geistlich Biomaterials, Wolhusen, Switzerland) was applied for bone augmentation.¹¹ Figure 6 shows the preoperative alveolar bone thickness of upper 4 incisors.

En-masse retraction of upper anteriors was initiated using the antero-posterior lingual retractor 3 weeks after the augmented corticotomy (Fig. 7).¹² Static and torque-controlled retraction force can be applied using the antero-posterior lingual retractor known as Biocreative KILBON (Kinematics of Lingual Bar on Non-Parallel-ing Technique). The KILBON appliance was made with a 3-dimensional CAD-CAM and casting technique. It is made of a 0.036-inch casted wire and lingual mesh pads that splints the

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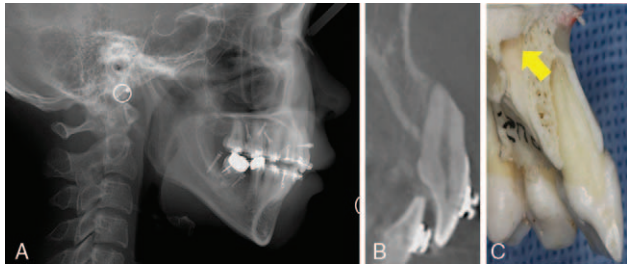


FIGURE 1. (A) Cephalometrics undergoing orthodontic treatment. Anterior teeth movement out of bony wall due to uncontrolled tipping. (B) Severe root resorption during retraction. (C) Orthodontic tooth movement is possible because there is a sufficient amount of bone on the lingual side with careful torque control of anterior teeth.

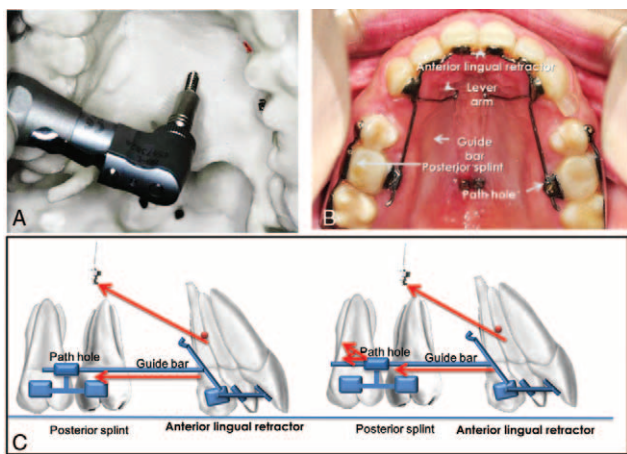


FIGURE 2. Antero-Posterior Lingual Retractor Appliance called Biocreative KILBON (Kinematics of Lingual Bar on Non-Paralleling Technique) appliance for gummy smile correction. (A) The retraction forces are applied from mid-palatal temporary anchorage devices (Jin-E screw). (B) Components of KILBON system. (C) By controlling the direction of the retraction with secured guide wire, the anterior segment can easily achieve bodily translation movement, meaningful reduction in anterior and canine angulation changes.

anterior segment into 1 unit. The sliding guide wires connect the anterior to the posterior segment. The posterior compartment controls the antero-posterior movement of anterior segments with minimum friction between the base wire and tube. By controlling the direction of the retraction with secured guide wire, the anterior segment can easily achieve bodily translation movement and meaningful reduction in the angulations of the upper incisors and canines. Intrusive retraction of upper anterior teeth for space closure can be achieved. The KILBON appliance is an effective tool to reduce gummy smile when used with mid-palatal temporary anchorage devices. The retraction forces were applied from 2 Jin-E screws a length of 6 mm and a diameter of 1.6 mm (Shinheung, Seoul, Korea), which were placed at the median palatal suture (Figs. 8 and 9).

CLINICAL REPORT

A 23-year-old female patient had lip protrusion and gummy smile. Three years ago she already had orthodontic treatment with extraction of the second molars. The skeletal relationship was diagnosed as a skeletal Class II because of retruded mandible, but the molars had a Class I relationship. She had hyperdivergent facial type, with the FMA of 40.2°. Overbite was a negative 0.5 mm, with an upper mild arch length deficiency (Fig. 6). Premolar extraction and retraction of anterior teeth was recommended to improve her

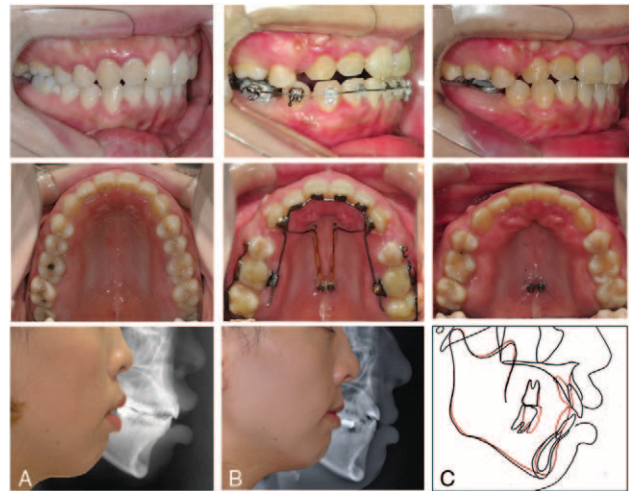


FIGURE 3. Target teeth/bone movement using Biocreative Kinematics of Lingual Bar on Non-Paralleling Technique appliances (Maxilla). Anterior and canine teeth axes were maintained during retraction periods. (A) Initial, (B), 15 months, and (C) 30 months.

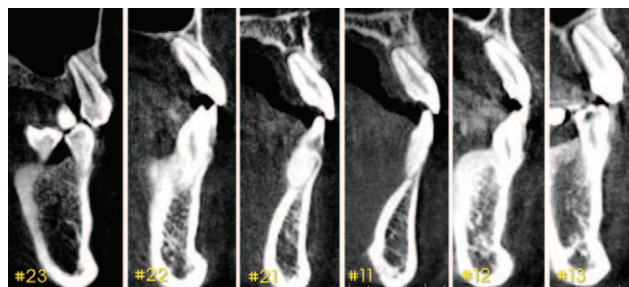


FIGURE 4. Cone beam computed tomography images of post-treatment anterior teeth and alveolus.

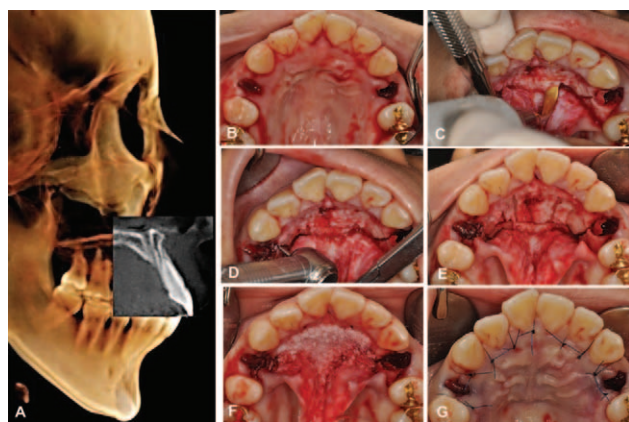


FIGURE 5. Surgical procedure of augmented corticotomy. (A) Cone beam computed tomography image of the patient with thin alveolar bone thickness. (B) Full thickness flap elevation and detachment of naso-palatine nerve using periosteal elevator. (C-E) Inter-radicular corticotomy and horizontal corticotomy using Piezo surgery and high-speed burs. (F) Application of Bio-Oss (0.5 g). (G) Suture with 5-0 nylon.

profile. The alveolar housing for upper and lower anterior teeth was extremely thin; therefore, surgical intervention was considered necessary to avoid adverse effects. Orthodontic antero-posterior movement of incisors has high risk of root resorption or root

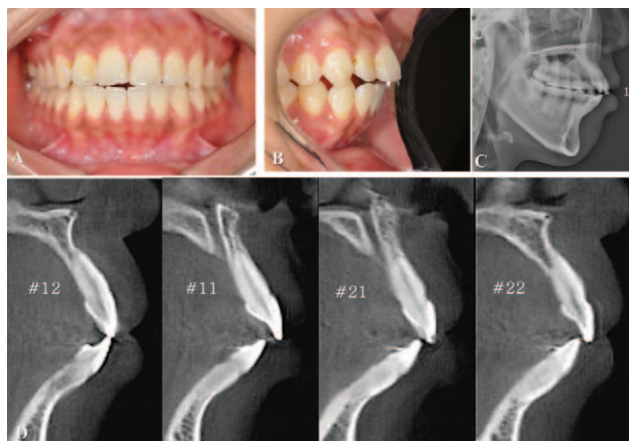


FIGURE 6. Pretreatment intraoral photographs (A, B) and radiographic images. (D) Cone beam computed tomography images show extremely thin alveolar housing of upper incisors.



FIGURE 7. Intraoral photographs and panoramic radiographs of augmented corticotomy and lingual orthodontic treatment. (A-C) Immediately after augmented corticotomy, (D-F) after Kinematics of Lingual Bar on Non-Parallel Technique appliance and palatal TADs application, (G-I) 12 months after lingual retraction, (J-L) post-treatment.

fenestration if trabecular bone for orthodontic movement is not sufficient.¹

Orthognathic surgery including maxillary and mandibular ASO under general anesthesia can be considered as a treatment option. However, the patient strongly refused surgery under general anesthesia. Mandibular ASO under local anesthesia was adopted to retract lower anteriors. This is the appropriate treatment to overcome a posterior anatomic limit in the mandible. To retract upper incisors, corticotomy with bone graft was planned. After augmented corticotomy, the KILBON appliance was used to bodily retract upper anteriors for 12 months.

Counter-clockwise autorotation of mandible due to posterior intrusion can be observed in the superimposition (Fig. 10). The upper incisors showed a large amount of retraction with proper torque control.

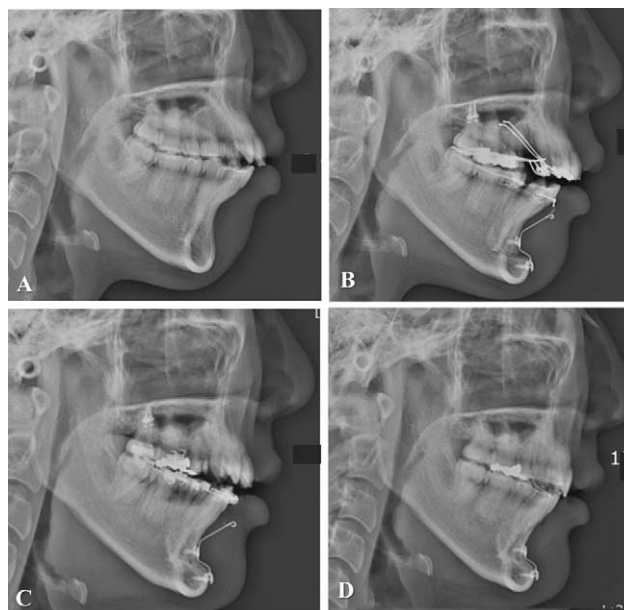


FIGURE 8. Lateral cephalometric radiographs of augmented corticotomy and lingual orthodontic treatment. (A) Pretreatment, (B) 7 weeks after retraction, (C) 12 months after retraction, (D) post-treatment.

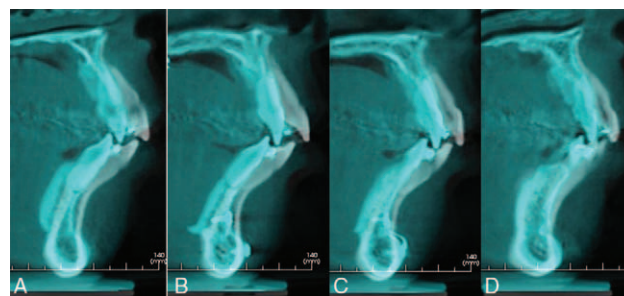


FIGURE 9. Superimpositions of pre- and post-treatment 3-dimensional Cone beam computed tomography images. (A) Upper right lateral incisor. (B) Upper right central incisor. (C) Upper left central incisor. (D) Upper left lateral incisor.

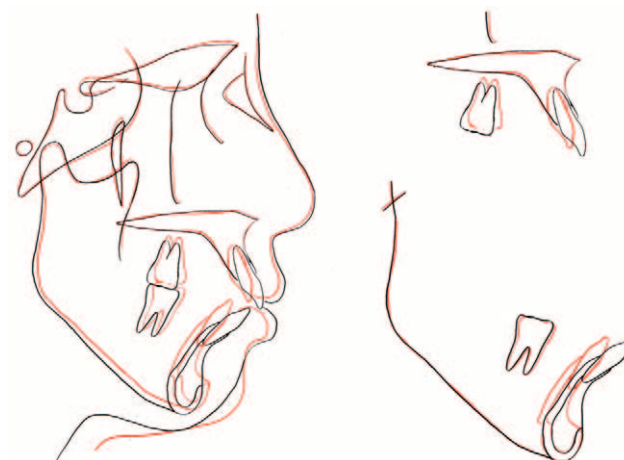


FIGURE 10. Superimpositions of pre- and post-treatment lateral cephalometric radiographs.



FIGURE 11. Intraoral photographs of 1-year retention period.

DISCUSSION

In pretreatment lateral cephalographic radiograph, the upper incisors were uprighted. Because U1 to FH plane was 111° , careful root torque control was important. The KILBON appliance is composed of a lingual retractor with a lever arm and a guide bar that passes through a tube on the posterior assembly (Fig. 7). Apart from the patient benefit of no visible appliances, this lingual system has the advantages of vertical and torque correction. Variation of the lever-arm length and position allows the clinician to titrate the moments applied to the teeth. In this patient, retraction force was originated from mid-palatal TSADs, which were vertically superior to the lever arm. The resulting moment provided retraction of the anterior teeth and intrusion of the whole maxillary arch.

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New bone formation on the palatal side of lateral incisor housing can be observed clearly in the superimposition of pre- and post-treatment cone beam computed tomography (Fig. 9). Alveolar bone augmentation on central incisors was not maintained compared with the lateral incisors, but there was no significant loss of original alveolar bone level or gingival recession. The stable occlusion and periodontal health was maintained at the 1-year follow up (Fig. 11).

External root resorption occurred on the incisors, more on the central incisors. The causes of root resorption may be the resistance of palatal cortical bone and jiggling. The last period of orthodontic treatment, light nickel–titanium arch wires were applied for a few months for leveling, which involved some jiggling movements.

Whether the risk of root resorption increases when the teeth move into the bone grafted area is not clear. However, orthodontic tooth movement and eruption through grafted bone material are certainly possible and provide good results.¹³ In a beagle dog study, tooth movement was initiated 3 months after bone graft. After 12 months of bone grafting, the graft material was absorbed, bone formation occurred around the bone graft. Bone augmentation for tooth orthodontic or prosthodontic treatment is broadly used.^{14–16} These approaches could broaden the orthodontic boundaries. Clinicians must evaluate anatomic limitations carefully, and computed tomography is a useful tool, since the skeletal limit is not clear on lateral cephalometric radiographs.

CONCLUSION

Anatomic limitations of orthodontic movement can be altered by augmented corticotomy and ASO under local anesthesia. Tooth movement toward the augmented bone was possible, and new bone was formed at the augmented site. Intrusive retraction of anterior

teeth was successfully accomplished with the KILBON appliance. Mid-palatal temporary skeletal anchorage devices provided the biomechanics to reduce the gummy smile reduced without orthognathic surgery.

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