

A case of severe maxillary gingival exposure treated with combined compression osteogenesis of the anterior alveolar bone and conventional Le Fort I osteotomy

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ABSTRACT

Excessive gingival exposure at the maxillary anterior region during not only smiling (a gummy face) but also at rest creates both functional and aesthetic problems for patients. We herein introduce a unique treatment procedure for mandibular retrognathia with a gummy face. This procedure combines conventional Le Fort I osteotomy and following corticotomy at the anterior region of the maxilla. Subsequently, the anterior segment is continuously compressed (compression osteogenesis) in a posterior-superior direction until it reaches an ideal position. This procedure appears to safely and adequately resolve both the aesthetic and functional complaints associated with patients with a gummy face.

Keywords: compression osteogenesis, corticotomy, gummy face

INTRODUCTION

An aesthetic smile has three important components: teeth, lips and gingiva¹. Therefore, gingival overexposure around the maxillary anterior region (a gummy face) often creates not only functional but also aesthetic problems for patients. In order to satisfy the aesthetic desires of patients with a gummy face, several treatment modalities have been reported, including gingivectomy^{1,2}, miniscrew anchorage³, injection of botulinum toxin^{4,5}, orthodontic treatment^{1,2} and orthognathic surgery⁶. If a skeletal abnormality is a main cause of the gummy face, a combination of orthodontics and orthognathic treatment may be the first-line treatment procedure⁶.

Le Fort I (L-1) osteotomy is a popular technique for treating the maxilla as an orthognathic surgical treatment in facially deformed patients and induces a great outcome^{7,8}. This technique can treat a patient with a long face by moving the bone segment upward after osteotomy. However the migration pattern of the bone segment is limited because the bone segment along with the dental arch is moved *en bloc* after osteotomy. In order to resolve this limitation, bipartite and tripartite osteotomies of the maxilla have been devised with improved results⁹. On the other hand, these surgical methods are complicated and it may sometimes be difficult to fix the bone segment at the ideal position during surgery because of interference among bone segments after osteotomy. Moreover, most of the patients who complain of facial deformity with a gummy face regard aesthetic improvement as an important factor, something that is entirely subjective. Therefore, determining the position and fixing of the bone segment by clinicians after osteotomy does not always gratify the aesthetic desire of patients with facial deformity, especially a gummy face.

We performed a new treatment procedure using compression osteogenesis that could overcome the disadvantages accompanying treatment of a patient with a gummy face, and the outcome satisfied the patient's aesthetic desire. We herein report the case with this unique treatment strategy.

CASE REPORT

An 18-year-old Japanese female was referred to the Department of Orthodontics, Nagasaki University Hospital for correction of excessive gingival exposure of the maxillary anterior region. Her facial and intraoral appearances are shown as figure 1. She failed bilateral upper first and lower second premolars, left upper and lower right lateral incisors and left upper and right lower third molars were impacted. The occlusal relationship of the first molar was class I and II at the left and right side, respectively as determined by angle classification. She had no remarkable family medical history. She

had undergone tumorectomies for pilocytic astrocytoma five and seven years prior to the first visit to our clinic. She had been followed up by periodic MRI examinations. The brain tumors did not impair her treatment by orthognathic surgery according to her brain surgeon.

Diagnosis

Routine examinations such as cast models and cephalometric analyses detected several issues. In orthopantomography (OPG) (Fig. 2), bilateral upper first and lower second premolars, left upper and right lower lateral incisors were missed and left upper and right lower third molars were impacted. In cephalometric analysis at the pre-treatment point (T1) (Table 1), the mandibular plane, occlusal plane and interincisal angles were bigger than two standard deviations (S.D.) compared with the average value of Japanese woman. On the other hand, the facial angle, U-1 to SN plane (the angle between the long axis of the upper central incisor and the SN plane) and L-1 to mandibular plane (the angle between the long axis of the lower central incisor and the mandibular plane), were smaller than 2 S.D. SNA (the angle between the SN line and NA line) was within 1 S.D. and SNB (the angle between the SN line and NB line) was at the lower limit of 1 S.D. ANB (the angle between NA line and NB line) was at the higher limit of 1 S.D. According to these data, the patient was diagnosed with skeletal mandibular retrognathia with clockwise rotation and linguoclination of the upper incisor and labioclination of the lower incisor as a dental compensation.

Treatment Objectives

The treatment goal was set to resolve the problems detected by pre-treatment analyses as follows:

- 1) To reduce the value of excessive gingival exposure in the maxillary anterior region.
- 2) To decrease the occlusal plane and mandibular plane angles.
- 3) To improve mandibular retrognathia.
- 4) To labioclinate the upper and lower incisors.
- 5) To create an ideal dental arch.

A dummy tooth for missed left upper lateral incisor was temporary fixed with adjacent teeth. The final occlusal relationship of the first molar was planned to be class I at left side and class III at right side because of discrepancy of teeth number between upper and lower dental arches.

To decrease the value of the occlusal plane angle, a bone segment was counter clock-wise rotated centering on the posterior nasal spine (PNS) as a fulcrum point, and

the maxillary anterior region was moved upwards 5 mm after LeFort I osteotomy. Simultaneously, sagittal split ramus osteotomy (SSRO) was performed and the distal segment was moved by counter clock-wise rotation synchronized with the movement of the maxillary segment. This bimaxillary osteotomy could decrease the occlusal plane and mandibular plane angles. Movement of the maxillary anterior region upwards was planned to be insufficient at this point. However, if the bone segment could be moved further upwards, it might change the shape of the nasal wing or nasal aperture. Therefore, linguoclination of the upper incisors was planned as the second step of improvement after bone healing. Since the patient's demand for aesthetic improvement was high, the bone segment was compressed by persisting traction force after corticotomy on the anterior region to set the bone segment in an ideal position with an ideal declination of the upper incisors, so as not fix it in any positions during the operation.

Treatment Progress

Orthodontic treatment before L-1 osteotomy and SSRO

Teeth leveling and alignment were initiated with 0.017 x 0.025 inch stainless steel archwires three months before L-1 osteotomy and SSRO.

Surgical procedure for L-1 osteotomy and SSRO

The surgical treatment was performed at the Department of Oral and Maxillofacial Surgery, Nagasaki University Hospital. Conventional L-1 osteotomy and SSRO were performed under general anesthesia. The segment was rotated counter clock-wise centering on PNS as a fulcrum point. The maxillary anterior region moved 5 mm upwards after L-1 osteotomy and was fixed with titanium mini plates and screws (Modus[®]: MEDARTIS, Basel, Switzerland). Four plates and four screws in each plate were placed at the bilateral side of the anterior nasal aperture and root of the zygoma. The distal segment of the mandible was moved forward 5 and 7 mm at the right and left side, respectively, with counter clock-wise rotation after SSRO. There were no remarkable events during surgery.

Treatment procedure before corticotomy

The postsurgical orthodontic treatment was initiated with 0.018 x 0.025 inch nickel-titanium archwires, followed by 0.017 and 0.018 x 0.025 inch stainless steel archwires on both jaws. The facial appearances before corticotomy are shown as figure 3. The tension of orbicularis oris muscle is remained slightly when mouth is closed.

Although the exposure of upper gingiva is less than that at first visit, her smile still induces excessive upper gingival exposure.

Surgical procedure of corticotomy

Corticotomy was performed first on the palatal side of the anterior alveolar bone between upper canine using an ultrasonic cutting device, PiezoSurgery[®] (Mectron Medical Technology, via Loreto, Italy), five months after bimaxillary orthognathic surgery (Fig. 4a). The other corticotomy, on the labial side, was performed 2 weeks after the palatal side corticotomy when blood supply to the bone fragment was considered to have restored from the palatal mucosa (Fig. 4b). Both corticotomies were performed under general anesthesia. In addition to the second corticotomy, the plates and screws of the previous L-1 osteotomy were removed from the side wall of the nasal aperture. For the posterior plates at the root of the zygoma, two screws on the bone segment were removed but not the other two screws at the superior site. The plates were bent about sixty degrees to bulge from the mucosa after closing the wound (Fig. 4c) for use as an anchor when the anterior bone segment had formed by persisting traction force after healing of the mucosa.

Treatment procedure after corticotomy

Traction of the maxillary segment was initiated with power chains on the 7th day after corticotomy. Free spaces, which were produced by the corticotomy and extraction of the bilateral first premolars, were gradually closed and concurrent postsurgical orthodontic treatment proceeded steadily. Finally, a retainer was set almost one year after corticotomy (Fig. 5), less than two years since treatment had been initiated. The assessment of skeletal and dental changing was performed by cephalometric analysis at various time points, between bimaxillary surgery and corticotomy (T2), setting a retainer (T3) and 18 months post treatment (T4) (Table 1).

RESULTS

Up to 18 months since the retainer was set relapse had not been observed (Table 1). The superimposed findings of the maxilla during treatment are shown as figure 7. It was clearly observed that the anterior region moved towards the posterior-superior direction. Minimum gingival exposure of the maxillary anterior region has been maintained. No gingival exposure was observed during rest and final occlusal relationship of the first molar was class I and III at left and right side, respectively (Fig. 5 and 6). According to Bell, Proffit and White¹⁰, the skeletal vertical distance between soft tissue glabella

(SGLB) and subnasale (SN) should be equal to that between SN and soft tissue menton (Me'), and the ratio of the distance from SN to stomion (Stm) and from Stm and Me' should be 1: 2 for ideal esthetic proportion. The ratio of SGLB-SN and SN-Me' was changed ideally from 1:0.86 (T1) to 1:1.02 (T3) and the ratio of SN-Stm and Stm-Me' was also changed ideally from 1:1.53 (T1) to 1:214 (T3) (Fig. 8).

DISCUSSION

Most patients who undergo orthognathic treatment and whose chief complaint is a gummy face usually have high aesthetic demands. For them the treatment procedure must be carefully planned. Since aesthetic appreciation is based on individual subjectivity, a dissonance between the actual outcome and the patient's prediction may happen if the surgeon decides the position of the bone segment after osteotomy based on their own objectives during surgery, even if the surgeon and patient have discussed the matter at length prior to surgery. To avoid this, corticotomy was performed after L-1 osteotomy in the present case and the dentalveolar segment was moved continuously to achieve an ideal position for the patient. Finally, the patient could acquire the desired aesthetic features.

Movement of the dentoalveolar segment is sometimes applied for adjusting the dental arch. This technique is considered of value in shortening the treatment term and avoiding root exposure from the alveolar bone by changing the tooth axis. Wassmund and Wundere first demonstrated the anterior maxillary subapical osteotomy method¹¹. This technique easily corrects the maxillary protrusion by compression or rotation of the dentoalveolar segment, and the bone segments are fixed as determined by the surgeon during surgery. On the other hand, Kanno et al.¹² treated a severe open bite case by compression after corticotomy. The bone segments of the maxillary posterior region were compressed using anchor plates and elastic, and the segments were induced into an ideal position during one month. They used the unique term "compression osteogenesis" to describe this technique. We adapted this technique to the anterior region of the maxillae.

Compression osteogenesis is the obverse concept to distraction osteogenesis (DO). DO is a method whereby the bone segment is moved to the ideal position by gradually enlarging the gap between the bone segments after osteotomy^{11, 13}. We previously reported¹⁴ a case in which an ideal dental arch was obtained by lateral DO after osteotomy of the unilateral alveolar bone in an asymmetrical dental arch. Our technique in the present case represents an alternative of this method. Reducing the gap between the bone segments allowed movement of the dentoalveolar segment of the maxillary

anterior region gradually into the ideal position by observing the maxilla-mandible relationship. The most advantageous feature of this technique is that it allows the dentalveolar segment to be continually compressed after corticotomy and to achieve an ideal position according to the patient's desire. In this case, she satisfied the outcome and finally acquired an ideal aesthetic vertical proportion according to Bell and White¹⁰. Furthermore, there are few risks of ischemia of the bone segments and a failure of bone healing because bone marrow is continually linked between the bone segments. On the other hand, one disadvantage of this technique is a requirement for longer treatment terms and more operations than conventional osteotomies. Moreover, it is possible that the bone segment will not move into the ideal position if the decorticating area is not wide enough. Therefore, detailed treatment planning is required for this technique to work, as is the case for conventional methods. We show here a method whereby the bone segment is continuously retracted to an ideal position after L-1 osteotomy. It is an outstanding treatment modality for cases of severe gummy face, producing both ideal occlusion and aesthetic appreciation.

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FIGURE LEGENDS

Figure 1. The facial and intraoral appearances when the orthodontic treatment was initiated. The orbicularis oris muscle is under tension when mouth is closed. Excessive exposure of upper gingiva is observed during smiling. The relationship of the first molar is class I at left and class II at right with a deep bite.

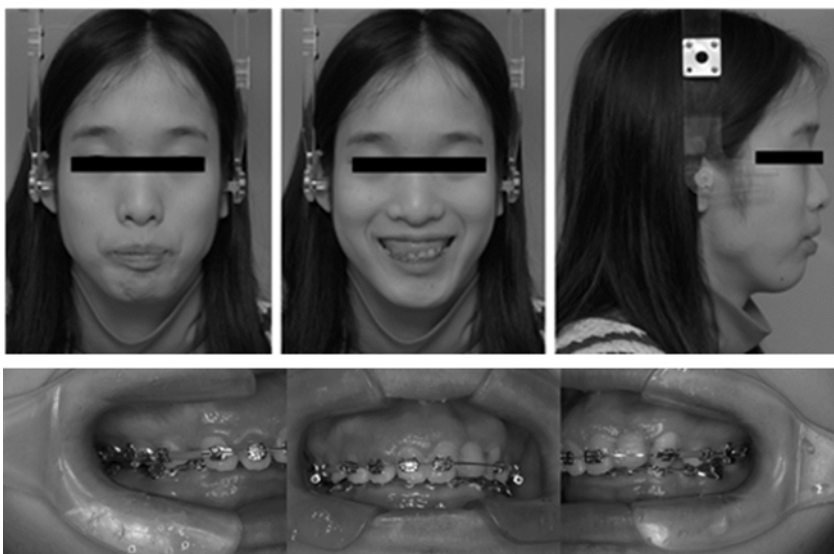


Figure 2. Orthopantomographic finding at initiating the treatment. Bilateral upper first and lower second premolars and upper left and lower right lateral incisors were missed and left upper and right lower third molars were impacted.



Figure 3. The facial appearance between bimaxillary surgery and corticotomy. The tension of orbicularis oris muscle still remains when mouth is closed. The exposure of upper gingiva is still observed during smiling.



Figure 4. Intraoperative findings at corticotomy. Corticotomy was performed on the palatal side at first (a), and subsequently on the labial side (b) 2 weeks later. The plates, which were fixed to the bone segment after LeFort I osteotomy at the zygoma, were bent to bulge from the mucosa (arrows) (c).

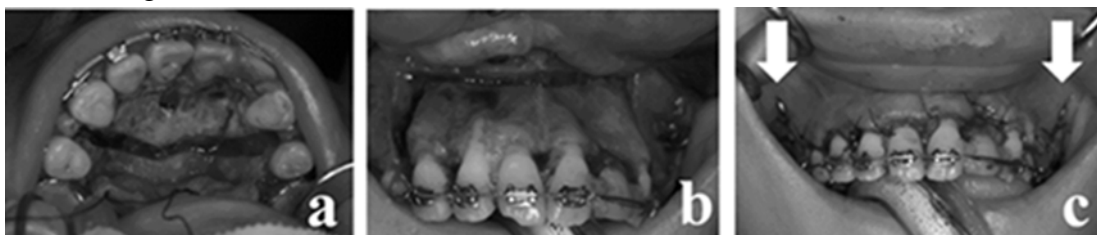


Figure 5. The facial and intraoral appearances when the retainer was set. Slight tension of the orbicularis oris muscle is observed when mouth is closed. Ideal teeth and gingival exposure is observed during smiling. The occlusal relationship of the first molar is finally class I at left side and class II at right side.



Figure 6. Orthopantomographic finding at setting a retainer. The space of upper lateral incisor was maintained for dummy tooth. The midlines of upper and lower dental arches are fit.



Figure 7. Superimposed cephalometric and maxillary illustrations. The alveolar bone segment was moved in a posterior-superior direction by continuous compression force. T1: Pre-treatment, T2: between bimaxillary surgery and corticotomy, T3: Retainer (post-compression osteogenesis).

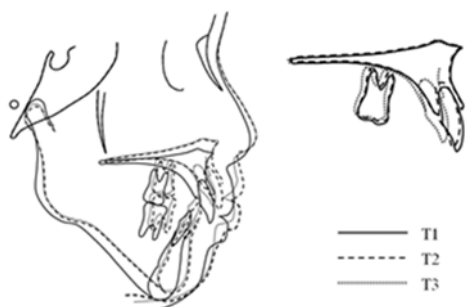
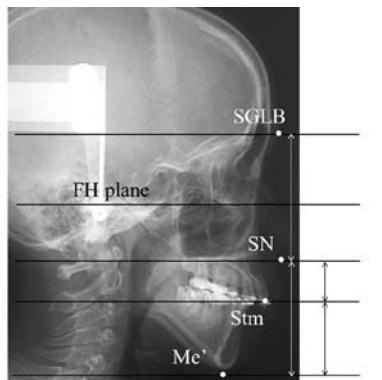


Figure 8. The reference lines were paralleled with FH plane. T1; pre-treatment, T3; setting a retainer.

Me'; soft tissue menton, SGLB; soft tissue glabella, SN; subnasale, Stm; stomion.



Ratio	Ideal ratio	T1	T3
SGLB-SN : SN-Me'	1:1	1:0.86	1:1.02
SN-Stm : Stm-Me'	1:2	1:1.53	1:2.14