Corticotomy-Assisted Le Fort I Osteotomy: An Alternative to Segmentation of the Maxilla in Orthognathic Surgery

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Purpose: The aim of this study was to describe a surgical technique that can be used to solve dentofacial deformities associated with narrow interradicular spaces of the anterior teeth of the maxilla and inadequate overbite/overjet seen in hand-articulated models. This is presented here as an alternative to segmentation of the maxilla in Le Fort I osteotomy.

Methods: Six patients with dentofacial deformities (classes II and III malocclusions) had Le Fort I osteotomy accompanied by buccal alveolar corticotomies of the maxilla. During the immediate postoperative period, elastic forces were applied to mobilize the anterior dentoalveolar segments until the planned overjet/overbite was observed.

Results: All patients reached the desired occlusion approximately 1 month after the surgical procedure. Pulp vitality of the teeth adjacent to the corticotomies was not compromised.

Conclusions: The clinical results obtained confirm the technique as a safe and reliable alternative to segmentation of the maxilla in orthognathic surgery.

Key Words: Dentofacial deformities, orthognathic surgery, Le Fort I osteotomy, corticotomy, maxillary segmentation

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In orthognathic surgery, Le Fort I osteotomies plus maxillary segmentations are not exempt from complications. These can occur during the procedure itself or in the postoperative period.[1] Complications described in the literature include exacerbation of periodontal disease with tooth loss, pulp necrosis, oronasal communications and fistulas, tooth damage, and bone-healing abnormalities.[1] It is important to point out that there is a higher possibility of damaging adjacent structures when there is a narrow interradicular distance between the teeth.[1]

Corticotomy was first described by Köle.[2] In 2001, Wilcko et al[3] published a variation of the technique. They combined corticotomies and lyophilized bone graft with the objective of accelerating orthodontic treatment, diminishing its length by 50% or more.

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We propose the use of maxillary selective alveolar decortication (SAD) technique to assist orthognathic surgery in cases where the segmentation may imply high risks to the adjacent structures.[1] The goal of that procedure is positioning the skeletal bases with a Le Fort I osteotomy and postoperatively mobilize the dentoalveolar anterior segment in an accelerated manner.

The objective of this study was to evaluate corticotomy-assisted Le Fort I osteotomy for the vertical management of the anterior maxillary segment when there is narrow interradicular space.

This study was approved by the Hospital del Salvador ethics board.

MATERIALS AND METHODS

Six subjects, systemically healthy, ranging in age between 17 and 31 years with dentofacial deformities were included in this study. Participants were selected from the main author's private practice between the years 2012 and 2013 (Table 1). To be included in the study, patients had to have a dentofacial deformity that required surgical management by means of Le Fort I osteotomy. The analysis of the hand-articulated models had to indicate the need for maxillary segmentation between lateral incisors or canines without arch expansion to overcome the inadequate overjet/overbite observed, and the panoramic radiographs had to show narrow interradicular spaces at the anterior dentoalveolar segment, which impeded the needed maxillary segmentation.

Patients signed a written consent form prior to their enrolment in the study. A medical history and oral soft and hard tissue examinations were performed. Pulp vitality tests were applied, and the results obtained documented on the clinical record. Upper and lower jaw casts were obtained.

The maxillary cast was mounted on a semiadjustable articulator via face-bow transfer; the mandibular cast was mounted according to centric relation bite registration. Lateral cephalograms and Delaire's cephalometric tracing enabled the design of the virtual treatment objective (VTO). The maxillary cast was repositioned in compliance with the VTO considering the vertical discrepancy of the upper incisor with the lower incisor and the upper lip. This was calculated as follows: (1) The patient tooth-lip relation was measured clinically during the physical examination and considered for VTO planning; (2) the vertical distance between 2 anterior points in hand-articulated models was measured; (3) the same analysis was made in the casts after doing the segmentation between lateral incisors or canines, which set the anterior maxilla in the desired final position; and (4) the difference between the vertical distance measured in (2) and (3) was calculated.

This measurement was considered for VTO and during surgery in order to locate the maxilla in an upper position. After surgery, elastic forces were applied to the anterior maxillary dentoalveolar segment allowing the accomplishment of the planned occlusion. This relevant consideration warrants the achievement of the desired anterior overjet/overbite and lip-tooth relationship.

TABLE 1. Operated Patients Using Corticotomy-Assisted Le Fort I Osteotomy

Patient	Age, y	Sex	Skeletal Class	Procedure
1	31	Male	Class III	Le Fort I osteotomy Maxillary corticotomy Rhinoplasty
2	18	Male	Class III	Le Fort I osteotomy Maxillary corticotomy genioplasty Rhinoplasty
3	31	Female	Class II	Le Fort I osteotomy Maxillary corticotomy BSSRO Genioplasty Rhinoplasty
4	17	Male	Class III—unilateral Cleft lip and palate	Le Fort I osteotomy Maxillary corticotomy Genioplasty
5	24	Male	Class III	Le Fort I osteotomy Maxillary corticotomy BSSRO Genioplasty
6	20	Male	Class III	Le Fort I osteotomy Maxillary corticotomy Genioplasty

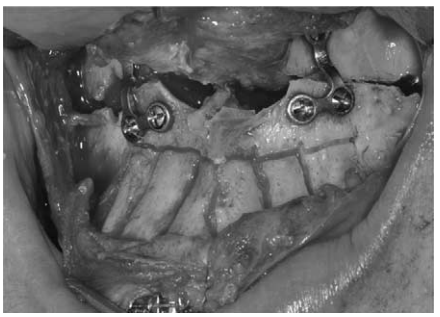

FIGURE 1. Vestibular corticotomies.

Surgical Procedure

Le Fort I osteotomy was carried out on all 6 patients. Acrylic splints were applied to reposition the maxilla and removed after fixation. Two L-shaped (2.0 system) miniplates and screws were used for osteosynthesis. Afterward, the prominences of the roots of the anterior maxillary teeth were identified and marked using a pencil to guide the sites for corticotomies according to needs. Vestibular interradicular corticotomies were done using a cylindrical 701 burr mounted on a handpiece, 3 to 4 mm below the alveolar crest and extending 4 to 5 mm above the apex of the anterior teeth. Once bleeding from the trabecular bone was identified, the sites decorticated were grafted with Puros allograft (Zimmer, Carlsbad, CA) (Figs. 1 and 2).

Three days after surgery, the maxilla orthodontic archwire was sectioned behind lateral incisors or canines bilaterally. During all postoperative period, a rigid mandibular orthodontic archwire was kept to avoid mandibular dentoalveolar extrusion. Then, elastic forces were applied to mobilize the maxillary dentoalveolar segments using heavy elastics (14 inch, 4 oz) applied to lower teeth brace hook. They were changed every fifth day. During this postoperative period, no tooth discoloration was observed. It was possible to close the inadequate overbite/overjet after approximately a month, and an appropriate occlusion was achieved (Figs. 3–5). An adapted and adequately bent rigid orthodontic archwire was applied to the maxilla maintaining the anterior dentoalveolar segment in the new position and preventing relapse. The rigidity of the mandibular orthodontic archwire did not allow any lower teeth extrusion.

Patients were followed up for 1 year after the surgery; none of the patients had compromised tooth vitality in the teeth adjacent to

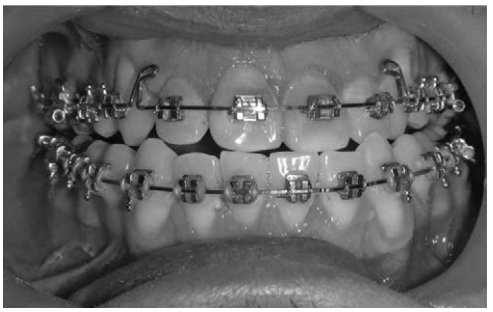

FIGURE 3. Patient 1: occlusion before surgery.

FIGURE 4. Patient 1: occlusion intraoperatory.

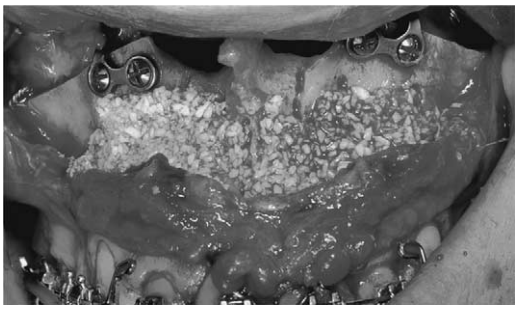

FIGURE 2. Allograft.

FIGURE 5. Patient 1: occlusion 2 weeks after surgery.

FIGURE 6. Patient 2: profile view before surgery.

FIGURE 8. Patient 2: profile view 1 year after surgery.

the corticotomies according to pulp vitality tests applied. Frontal, profile, and intraoral photographs obtained before and after treatment demonstrate the changes obtained with this technique (Figs. 6–13 and Table 2).

DISCUSSION

Nowadays, there are several therapeutic strategies for the management of open-bite deformities. In pediatric patients, the treatment plan is based on the child's growth potential combining orthopedic and orthodontic therapy.[4] In adult patients, the orthodontic treatment plan focuses on 3 areas, namely, the extrusion of superior and inferior anterior teeth, the intrusion of molars, and the expansion of the maxillary arch.[4] The surgical orthodontic approach is based on the maxillary and/ or mandibular reposition using Le Fort I osteotomy, with or without segmentation depending on the occlusion noticed, in conjunction with bilateral sagittal split ramus osteotomy (BSSRO) or only with BSSRO.[4]

The conventional treatment for the cases presented here would have been segmental Le Fort I osteotomy. Despite the fact that maxillary segmentation is a widely accepted complement to the Le Fort I osteotomy, it is not exempt from complications. Some are as severe as partial necrosis of a maxillary segment and oronasal communications and fistulas.[5] Ho et al[1] describe others less severe such as periodontal defects, damage to adjacent teeth, unfavorable segmentation, and bone-healing abnormalities.

One of the limitations of segmental osteotomies is the presence of a presurgical narrow interradicular distance. There must be a distance of at least 2 mm at the cementum enamel junction and of 4 mm at the apical third of the roots in order to avoid vascular compromise or damage to neighboring teeth at the interdental osteotomy sites.[1] Sawada et al[6] measured the interradicular distance between teeth in the maxilla in 40 skulls. They reported a mean distance between the lateral incisor and the canine of 1.99 mm at the subcrestal portion and 3.89 at the apical region. These findings confirm the need for an alternative technique for patients who do not meet the criteria for maxillary segmentation. To our knowledge, there are no reports in the literature on how to overcome this anatomic limitation in order to perform the maxillary segmentation. This is why the authors pose a combination of surgical techniques that avoid the complications associated with segmentation and achieve similar results.

The proposed technique can be controversial when seen from a surgical morbidity point of view. Recently, in the literature, cases have been described of an alternative solution to orthognathic surgery in which SAD is used in conjunction with orthodontic therapy.[7] The argument in favor is that it can be used to treat certain malocclusions, except for severe class III deformities. The advantage of this is that there is less morbidity, and similar results are obtained.[7] We believe that what is proposed by Wilcko et al.[7] has its indications, and it is also a technique that can correct certain malocclusions. However, it does not provide a solution for functional or aesthetic problems. In his publications, the patients treated are never classified in a skeletal class. Indeed, there are no records of the cephalometric radiographs either frontal or profile photographs to analyze if the initial indication was indeed orthognathic surgery.[7,8] Nevertheless, because their indications are different, we believe the techniques are not mutually exclusive and could therefore be used in the same patients.

The technique presented and named by Wilcko et al[3,7,8] as "periodontally accelerated osteogenic orthodontics" (PAOO) is performed on both the buccal and the palatal surface. In fact, the procedures are sometimes conducted in a 2-phase manner. The technique proposed here was limited to the buccal surface for 2 reasons. First, there is an elevated risk of avascular necrosis of the maxilla if the Le Fort I osteotomy is accompanied by a full-thickness palatal flap. The works of Bell et al[9] have shown that the vascular supply to the maxilla is kept by the palatal periostium.

FIGURE 7. Patient 2: occlusion before surgery.

FIGURE 9. Patient 2: occlusion 1 year after surgery.

FIGURE 10. Patient 3: profile view before surgery.

FIGURE 12. Patient 3: profile view 1 year after surgery.

Second, it is possible to apply the "modified corticotomy" technique described in Germeç et al.[10] It consists of only elevating a buccal flap without the need to reflect a palatal flap, this being sufficient to achieve the accelerated orthodontic movements.[10]

In order to reach the treatment goal, it is necessary to apply orthodontic forces to the dentoalveolar segments involved in the SAD. The authors propose the use of intermaxillary elastics in a rectangular configuration in the anterior segment and segmentation of the orthodontic arch. The objective of that is extruding the dentoalveolar segment, thus achieving the desired overjet/overbite without the loss of alveolar bone height.[11] Surgical planning plays a vital role in the aesthetic outcome of these patients. The anterior dentoalveolar final position after elastic traction must be considered before surgery to avoid an incisor overexposure, an inadequate tooth-lip relationship, and a high smile.

The main advantage of this technique is the avoidance of maxillary segmentation. As described above, the latter has many associated complications, which are prevented by the proposed procedure. In addition, just as reported by Wilcko et al,[3,7,8] the length of orthodontic treatment is shortened. This is because the SAD produces an increase in bone metabolism, known as rapid acceleratory phenomenon,[3,8] and decreases the local bone density, which allows the accelerated movement of the involved teeth.[3,7,8,10] For example, in Germeç et al,[10] the treatment objectives are accomplished in 6 weeks. Moreover, in those cases, the length of the orthodontic treatment was shortened from 31 to 16 months, approximately half the duration of a conventional orthodontic treatment. Other authors mention the shortening of the total treatment time by a third or a quarter.[3,7] Furthermore, the reduction of the treatment time could avoid the radicular resorption that presents when orthodontic treatments lengthen and therefore decrease periodontal damage.[7] Moreover, this shortens bacterial action time, decreasing enamel demineralization, decay, and infection.[7] We believe that this last statement is not quite compatible in exposed cases, as these patients before orthognathic surgery were exposed to lengthy presurgical orthodontic therapy. Nonetheless, the postsurgical orthodontic time will decrease, and that can be beneficial.

Just like in the studies of Wilcko et al,[3,7,8] and Germeç et al,[10] these patients received buccal bone grafts. Grafting has the objective of gaining bone transversely and correcting fenestrations and dehiscences prior to treatment.[3,7,8] Another advantage of grafting is that it allows tooth movement 2 or 3 times beyond the reference range, decreasing the limitations of conventional orthodontic treatments and thus avoiding the extraction of teeth because of lack of space.[3,7,8]

Another unwanted reported effect of orthodontic treatments that can be corrected with grafting is the relapse. As was stated by Ferguson,[12] when the treatment stability after conventional orthodontic therapy is analyzed in patients treated without tooth extraction and with or without PAOO, there are no statistical differences. However, during the retention phase, the clinical result for the PAOO patients is better, without the presence of relapse.[7,12]

In summary, we believe that the main advantage of this technique is the avoidance of maxillary segmentation, making this a safe and reliable technique. Furthermore, the decrease in postsurgical orthodontic treatment time, single step corticotomy, and the adequate aesthetic and functional balance given by the orthognathic surgery assisted by corticotomies make this technique a relevant innovation worth researching more.

FIGURE 11. Patient 3: occlusion before surgery.

FIGURE 13. Patient 3: occlusion 1 year after surgery.

TABLE 2. Overbite, Measured From the Incisal Edge of the Central Upper and Lower Incisors

Patient	Intraoperative Overbite, mm	Overbite 2 mo After Surgery, mm	Difference, mm	Overbite 12 mo After Surgery, mm
1	0	+3	+3	+3
2	−2	+2	+4	+2.5
3	−2	+3	+5	+2
4	−3	+2	+5	+2
5	−2	+3	+5	+2.5
6	−3	+2	+5	+2

A limitation of this study that must be considered is the small number of participants. However, the exceptionally positive response to the combined techniques makes this initial report relevant.

CONCLUSIONS

The clinical results obtained confirm that the corticotomy-assisted Le Fort I osteotomy is a safe and reliable alternative to segmentation of the maxilla.

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