Case Report

Sliding Malar Bone Augmentation Technique with a High Le Fort I Surgically Assisted Rapid Maxillary Expansion

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Abstract

The purpose of this report is to evaluate the effectiveness of a high Le Fort I osteotomy design, including the malar bones, which allows segment sliding over the zygoma and forces the osteotomized segment to move forward with distraction. Two patients (male, 23- and 30-year-old) with malar deficiency underwent high Le Fort I osteotomy and surgically assisted rapid maxillary expansion procedure was followed. Records were taken before and 6 months after surgery for comparison, including intra and extra oral photographs and three-dimensional cone-beam computed tomography (CBCT) images. The bone malar width and bone malar depth changings in malar region were evaluated. Preoperative and postoperative CBCT images and clinical views of the patients showed forward movement of the malar region.

Keywords: *Cone-beam computed tomography, malar deficiency, malar depth, malar width, surgically assisted rapid maxillary expansion*

Introduction

A transverse maxillary discrepancy that results in esthetic and functional impairment is one of the most common dentoskeletal problems encountered in clinical orthodontics.[1] A transverse maxillary deficiency often presents with a midfacial deficiency. Such a midfacial deficiency is usually characterized by paranasal hollowing and a flat malar eminence.[2]

Upon clinical evaluation of the frontal view, maxillary hypoplasia is often associated with a deep paranasal triangle.[2] The oblique view is most important for assessing the contour and projection of the malar complex.[3] The malar eminence is defined as the point below the lateral canthus, which gives the impression of being the most prominent point of the malar mound in any view. The malar line of eminence of the malar mound has been suggested to be in a posterosuperior to anteroinferior orientation.[4]

Many studies have shown that a surgically assisted rapid maxillary expansion (SARME) causes forward movement of the maxilla due to the buttress effect.[5,6] Given this background, in the present study, we evaluated the effectiveness of a high Le Fort I osteotomy design, including the malar bones, which allows segment sliding over the zygoma and forces the osteotomized segment to move forward with distraction. We examined whether this surgical technique is beneficial for maxillary retrognathia and malar deficiency cases.

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Case Report

Patients and methods

Two patients (both males, 23- and 30-year-old) were recruited from Marmara University, Department of Orthodontics, Istanbul. The subjects were Caucasians from the same geographic area. The patients signed informed surgery consent forms.

Patients were selected to participate in this procedure based on the following criteria:

- Skeletally mature/adult
- Transverse maxillary deficiency with unilateral/bilateral posterior crossbite
- Midfacial hypoplasia (malar deficiency)
- No underlying systemic disease
- No craniofacial deformity
- No previous orthodontic treatment

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- SARME included as part of the initial orthodontic treatment plan.

The patient's skeletal maturity was determined after evaluating hand-wrist radiographs. Malar deficiency was detected using a Prendergast and Schoenrock analysis.[4] Cone-beam computed tomography (CBCT) images were obtained before the SARME and 6 months after completion of the expansion. A modified Le Fort I osteotomy at a more superior level without a down fracture was performed under general anesthesia. The SARME appliance of choice was the acrylic cap splint. Hyrax screws (G and H Wire Company, Hanover, Germany) were positioned as high and deep as possible into the palatal vault. All of buccal, lingual, occlusal/incisal edge surfaces, from the upper second molars to the upper central incisors, were covered with acrylic resin. For the cementation of the appliance, light-cured glass ionomer cement (Unitek Multi-Cure Glass Ionomer Orthodontic Band Cement, 3M Unitek Orthodontic Products, CA, USA) was used.

Surgical technique

Midfacial skeleton exposure was accomplished through an intraoral labiobuccal incision above the attached gingiva, from first molar to first molar. The anterior maxillary wall and inferior orbital foramen were exposed with a subperiosteal dissection superiorly, and the dissection was continued to the lateral zygomaticomaxillary buttress and the anterior portion of the zygomatic arch. The whole surgical region was identified with a superior-posterior subperiosteal elevation. After the nasomaxillary buttress, the pyriform aperture, and the anterior nasal spine were exposed anteriorly, and the pterygoid plates were exposed with a subperiosteal dissection posteriorly. Lateral nasal walls below the inferior turbinate and septum were exposed with an intranasal dissection. Before the modified high Le Fort I maxillary osteotomy was performed, the osteotomy line was marked with a number 14 round bur. Horizontal osteotomies, proceeding from the anterior portion of zygomatic bone through the posterior-lateral maxillary wall, 5 mm below the infraorbital foramen, to the lateral nasal wall, across the anterior maxillary wall, were accomplished with a reciprocating saw, directed posterior to anteriorly, following the previously marked osteotomy line [Figure 1]. Vertical cuts down to most distal part of horizontal osteotomy on the zygomatic bone were performed with an oscillating saw [Figure 2] and [Figure 3], angled at 45° anteroposteriorly in the coronal plane, to allow segment sliding over the zygoma in distraction. Sliding of the distal portion of bone segment on the zygoma pushes or bends the distal portions of the distracted bone forward, augmenting the malar deficiency while correcting the transverse insufficiency. To separate the nasal septum and vomer from the maxillary crest, a septal osteotome was used to prevent nasal septum deviation after distraction. A curved osteotome was used to separate the pterygoid plate from the maxillary tuberosity. Finally, a midpalatal split, from the anterior to the posterior nasal spine, was performed with an osteotome [Figure 4] and [Figure 5]. After the osteotomies were completed, the hyrax appliance was activated to check that it worked properly, and this was followed by immediate regression, leaving a 1 mm gap, instead of the osteotome. The patients received postoperative prophylactic antibiotics (cefazolin sodium 1 g IM BID, Sefazol, Mustafa Nevzat) and analgesics (tenoxicam 20 mg BID, Oksamen, Mustafa Nevzat) for 7 days, postoperatively.

At 3 days after the surgery, the patients' parents/guardians were taught how to turn the screw and activate the expansion appliance. They were instructed to activate it twice a day; per activation, a ¼ - turn of the hyrax screw expanded the cap splint by 0.25 mm. Thus, 0.5 mm of

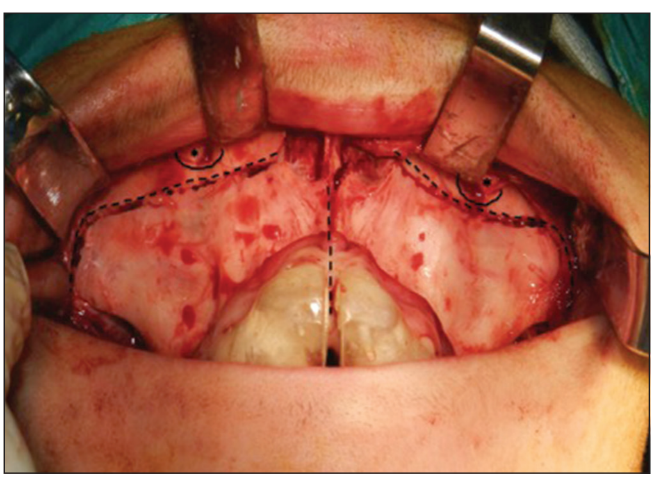

Figure 1: Osteotomy line

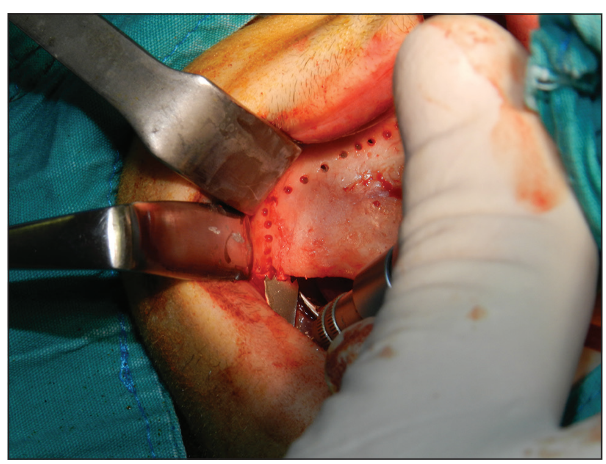

Figure 2: Positioning of the oscillating saw angled at 45° anteroposteriorly in the coronal plane

expansion daily was expected. The expansion was ended when the palatal cusps of the maxillary molars coincided with the buccal cusps of the antagonist mandibular molars. Then, the patients were examined monthly for the 6-month retention period.

Three-dimensional analysis

Records were taken before and 6 months after surgery for comparison, including intra and extra oral photographs and three-dimensional (3D) CBCT images. The CBCT images were captured using an Iluma CBCT scanner (Iluma, Imtec Imaging, 3M Company, Belgium), with 0.4 mm voxel, 0.290 mm pixel, and 0.299 mm slice sizes. The images obtained in DICOM data format were transferred to a computer using the MIMICS 15.0 software (Materialize, Leuven, Belgium) to further analyze the changes that occurred after SARME. Superimposition of the before and after SARME images were done, and the 3D images were matched and superimposed using bony landmarks of the cranial base. Preoperatively, most prominence points of the left and right malar bone in osteotomy lines were compared. Malar advancement in the two patients was recorded.

- Bone malar width (BMW) change, preoperative, and postoperative transverse change between left and right bone malar prominence
- Right bone malar depth (R-BMD), sagittal change in right bone malar region
- Left bone malar depth (L-BMD), sagittal change in the left bone malar region.

Results

Preoperative and postoperative differences in BMW (mm) and L-BMD and R-BMD (mm) measurements are shown in Table 1.

Preoperative and postoperative CBCT images and clinical views of the patients showed the forward movement of the malar region [Figure 6,Figure 7,Figure 8].

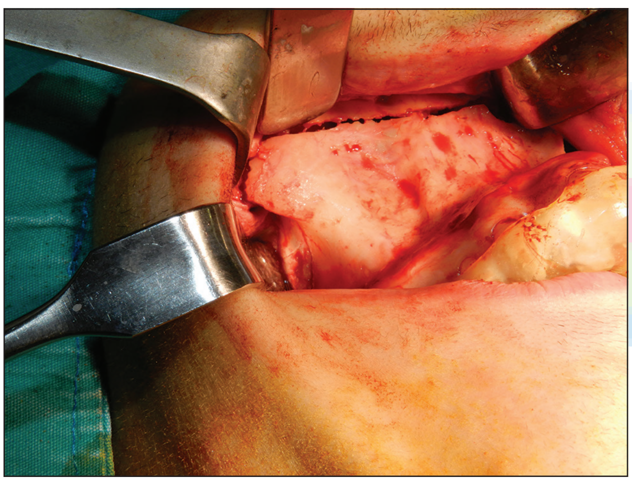

Figure 3: Vertical-oblique cut down from most distal part of horizontal osteotomy on the zygomatic bone to the pterygoid plate

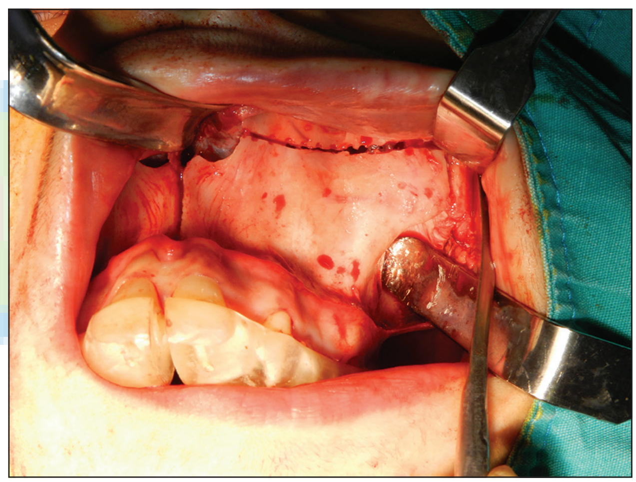

Figure 4: Final intraoperative left aspect

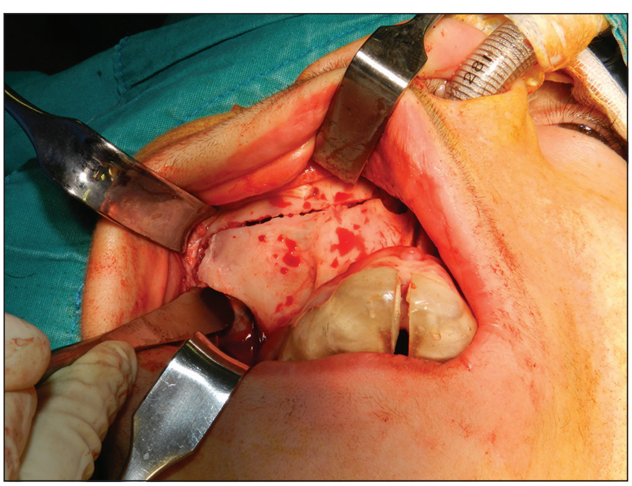

Figure 5: Final intraoperative right aspect

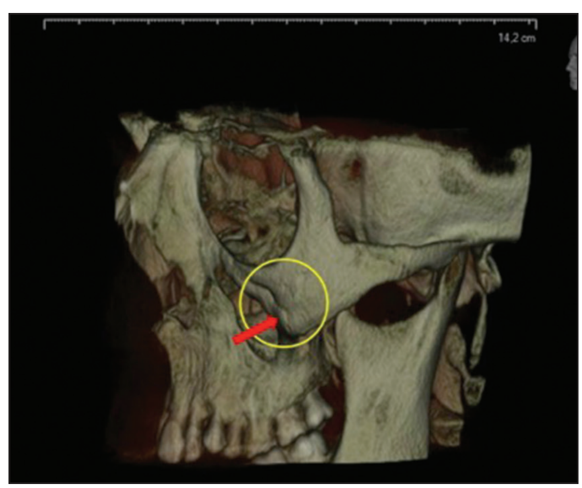

Figure 6: Preoperative three-dimensional cone-beam computed tomography image

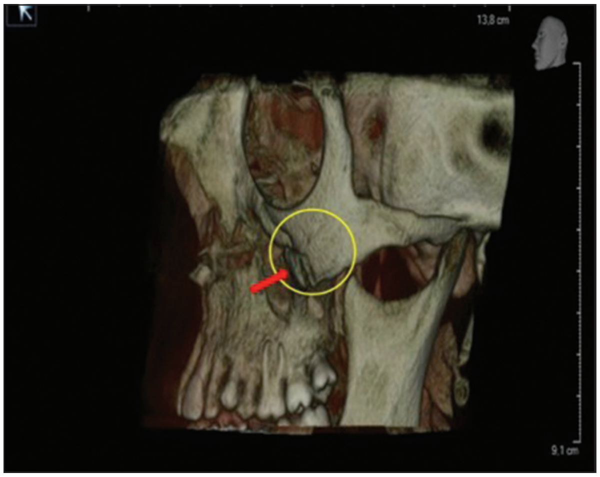

Figure 7: Postoperative three-dimensional cone-beam computed tomography image

Figure 8: Preoperative and postoperative coronal, oblique, and lateral extra-oral aspects

Table 1: Differences among malar bones

	Patient 1	Patient 2
BMW (mm)		
Preoperative	115.71	107.5
Postoperative	117.54	109.36
Difference	1.83	1.86
Right-BMD (mm)		
Preoperative	11.58	5.31
Postoperative	9.92	6.72
Difference	1.66	1.41
Left-BMD (mm)		
Preoperative	7.82	11.16
Postoperative	9.72	14.16
Difference	1.9	3.0

BMW=Bone malar width; BMD=Bone malar depth

Discussion

Patients with midface deficiency with a low malar prominence tend to have a gaunt or hollow midface, leading to a perpetually tired, worn out, older, and sad appearance.[5] The malar mound is known to define the contour of the lateral middle face between the inferior orbital rim and the mandible; hence, hypoplasia or asymmetry of this region is readily noticeable. With the advent of malar augmentation in the early 1970's, various literatures had discussed the exact location of the malar complex to understand its morphology for guidance during the placement of malar implants. The malar eminence was defined as the point below the lateral canthus, which gave the impression of being the most prominent point of the malar mound in any view. The malar line of eminence of the malar mound is suggested to be in a posterosuperior to anteroinferior fashion.[4]

Nkenke *et al*. observed maxillary advancement lead to a more pronounced shifting of the soft tissues in the malar midfacial area than the upper lip.[7] This finding is further supported by McCance *et al*. who reported similar changes in their study of bone changes following orthognathic surgery.[8] In relation to previous findings, past studies have shown that SARME causes forward movement of the maxilla due to the buttress effect.[6,9-12] Based on this evidence, a high Le Fort I SARME can be considered beneficial for maxillary retrognathia patients, especially since it has the potential of improving malar deficiency.

Although a high Le Fort I osteotomy and anteroposterior distraction procedure has been used for maxillary advancement in the past,[13,14] transverse distraction with a high Le Fort I osteotomy design including the malar bones has not been used before for the treatment of maxillary and malar bone deficiencies. Malar bone deficiencies are often reconstructed with facial onlay augmentation techniques to improve facial appearance,[15,16] since autogenous bone grafts demonstrate significant resorption over time.[17] High Le Fort I osteotomies mostly combined with other surgery protocols and performed for the correction of midfacial deficiencies such as midface hypoplasia,[13] cleft palates,[18] or Crouzon syndrome.[19] Kim *et al*.'s study investigating midfacial soft tissue changes after advancement of the maxilla with high Le Fort I osteotomy and mandibular setback surgery showed soft tissue changes concentrated just below the infra orbital foramen. The distribution of the affected soft tissue after the high Le Fort I osteotomy was within the rectangular malar region between two infraorbital foramens and the upper lip.[14] As Kim[14] claims that Le Fort I and high Le Fort I osteotomies induced an overall hard to soft tissue response in the midfacial area, Ryckman *et al*.[20] notes facial soft tissues appear to respond more to anterior movement of the jaws than to an increase in transverse dimensions after maxillomandibular advancements. Ren *et al*. suggest that high Le Fort I level osteotomy could make not only maxillary advance but also regions of lateral and floor of the nose and partial infraorbital advance.[18] A previous study in which changes in 3D soft tissue in transverse palatal distraction patients were examined referred to 1–3 mm of progress in the paranasal region, but not in the malar bones; the authors also claimed that this progress decreased, medial to laterally.[21] Baik and Kim[22] studied maxillary advancement in Class III orthognathic surgery patients and performed 3D soft tissue analyzes. They reported more progress in the midfacial region of the face versus the lateral region. In the present cases, we found that both the width and depth of malar bones were higher postoperatively than preoperatively. The use of minor modifications of routine surgical procedures in conventional orthognathic surgery can improve esthetic results in patients with midfacial hypoplasia.[13] An SARME with a high Le Fort I osteotomy design, including the malar bones, can be beneficial for malar deficiency treatment while correcting transverse maxillary problems. Further clinical studies with more patients are needed to evaluate the clinical outcomes of this technique.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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