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Bone grafting with granular biomaterial in segmental maxillary osteotomy: A case report



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ABSTRACT

INTRODUCTION: Segmental maxillary osteotomy enables correction of anterior open bites. However, the outcome can be somewhat unstable, particularly if pseudarthrosis occurs. Bone grafts can be used to prevent this complication. Among the many biomaterials available for grafting, Bio-oss® has been used successfully in a range of modalities, with studies to support several indications. This report describes a case of segmental maxillary osteotomy in which Bio-oss® granules were used as bone grafts in the surgical gap.

PRESENTATION OF CASE: A 24-year-old female presented with anterior open bite, Angle class III posterior occlusion, and Angle class II anterior occlusion. Virtual surgical planning of the procedure predicted a gap of approximately 5 mm in the region of the osteotomy, which was bridged with Bio-oss® granules.

DISCUSSION: Although autogenous bone grafting is the gold standard due to its osteoconductive, osteoinductive, and osteogenic properties, it involves increased morbidity for the patient, unpredictable resorption rates, increased operative time, and risk of infection at the donor site. Use of the Bio-oss® material can provide good bone stability, osteoconduction, and biocompatibility, while reducing operative time and surgical morbidity.

CONCLUSION: This is the first report of bone grafting with a granular biomaterial in segmental maxillary osteotomy. Successful formation of new bone with density greater than that of the surrounding tissue was achieved, preventing pseudarthrosis and postoperative instability.

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1. Introduction

Le Fort I segmented osteotomy is indicated for management of transverse and vertical jaw discrepancies, correction of projecting upper incisors, and closure of anterior open bites when there is a difference between the occlusal plane of the upper incisors and the back teeth. This is hampered by the orthodontic technique used [1,2].

The main complications associated with Le Fort I segmented osteotomy techniques are oronasal communication, unfavorable segmentation (unwanted fracture), tooth damage, periodontal complications, and pseudarthrosis (nonunion) [1,2]. These surgical complications can be prevented through virtual planning, which allows preoperative visualization of the effect of osteotomies on postoperative bone anatomy, thereby helping the surgeon prepare and optimize operative technique [3,4].

When bone augmentation is required, autogenous grafting is the gold standard, as the only material that exhibits osteoconductive, osteoinductive, and osteogenic properties. However, high morbidity at the donor site, unpredictable resorption rates, and the limited amount of bone tissue available have prompted the development of several substitutes [5,6].

Among these, Bio-oss® has proven to be an excellent alternative for a range of indications, given its naturally porous architecture (75–80%), which enables better vascularization, provides a framework for osteoconductivity, and improves blood clot stabilization and natural blood absorption between micro- and macropores [7].

Within this context, this report describes a case of anterior open bite treated with segmental maxillary osteotomy and bone grafting of the surgical gap with Bio-oss® granules.

2. Case report

The patient was a healthy 24-year-old woman with an anterior open bite (3 mm overbite, 4 mm overjet, 2 mm Angle class II anterior occlusion, and 2 mm Angle class III posterior occlusion) who had been undergoing orthodontic treatment for 2 years

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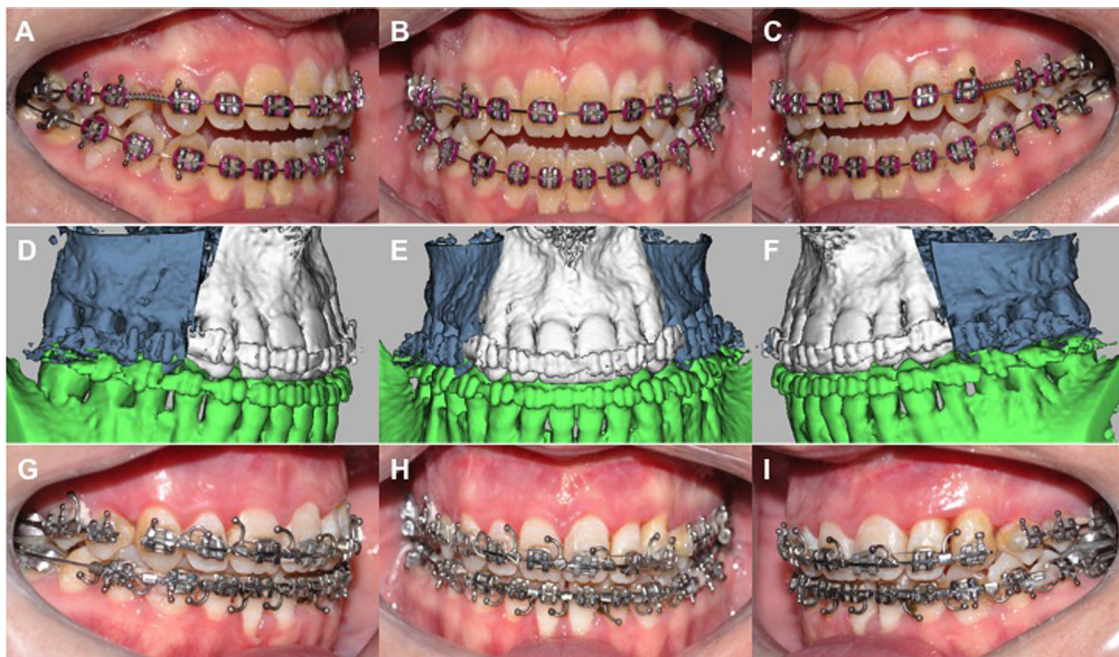


Fig. 1. A,B,C—Preoperative Occlusion. D,E,F—Occlusion in 3D virtual planning. G,H,I—Postoperative occlusion after 30 days.

(Fig. 1A–C). She presented to the Oral and Maxillofacial Surgery Center of Pontifícia Universidade Católica do Rio Grande do Sul for treatment of her dentofacial deformity, with a chief complaint of difficulty chewing with the front teeth. Written informed consent was obtained from the patient for publication of this case report, including accompanying images, and the manuscript was written in accordance with the CARE criteria [8].

2.1. Virtual planning

A cone-beam computed tomography (CBCT) scan was performed using an i-CAT system (Image Sciences International, Hatfield, PA, USA). Three-dimensional (3D) images were constructed using Dolphin Software (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). Surgical planning was based on the patient's chief complaint, facial analysis, and 3D cephalometric analysis. Based on these factors, monomaxillary surgery with Le Fort I osteotomy was chosen for 2 mm advancement of the posterior maxilla and a V-shaped segmental maxillary osteotomy between teeth UR3/4 and UL3/4 for 8° clockwise rotation and 5-mm down repositioning of the premaxilla, thereby modifying occlusion to Angle class I and closing the anterior open bite (Fig. 1D–F). Reconstructions of the segmented osteotomies showed a gap of approximately 4.1 mm in the area between teeth UR3/4 and UL3/4 and approximately 4.8 mm on the floor of the nasal fossa (Fig. 2). As such, the decision was made to place a bone graft.

2.2. Surgical procedure

The patient was placed under hypotensive general anesthesia. The maxillary vestibular approach was used for surgical access and detachment of the nasal fossa mucosa. Next, a Le Fort I osteotomy was performed and, after down fracture, a V-shaped segmental maxillary osteotomy was made between teeth UR3/4 and UL3/4 and behind the incisive foramen to correct the anterior open bite and over-projection of the anterior teeth. Osteotomies were performed using NSK VarioSurg piezoelectric instruments (NSK America Latina Ltda, Joinville, Santa Catarina, Brazil).

The splint was attached to the orthodontic appliance with a steel wire. Once the maxilla and mandible were stabilized in occlusion, the surgery was considered to be in accordance with the virtual plan. Then, as previously established, bone grafting was performed by placing 2 g of small Bio-oss® granules (Geistlich Pharma AG, Wolhusen, Switzerland) into the surgical gaps. These areas were then covered with a Bio-Gide® collagen membrane (Geistlich Pharma AG, Wolhusen, Switzerland).

The maxilla was positioned for rigid internal fixation with bilateral L-shaped miniplates in the zygomatic buttress and bilateral L-shaped microplates around the piriform aperture, to ensure stability of the collagen membranes for bone graft protection (Fig. 3).

2.3. Postoperative period

The surgical splint remained in place for 30 days with maxillo-mandibular fixation, after which time the patient was instructed to follow a liquid/semisolid diet and avoid chewing. The overbite improved from –3 mm to 2 mm and overjet from 4 mm to 2 mm, ensuring closure of the anterior open bite and maintaining coordination between the posterior and anterior segments of dental occlusion at Angle class I (Fig. 1G–I). Repeat CBCT performed 6 months after surgery revealed bone formation with density greater than that of the tissue surrounding the segmental maxillary osteotomy, providing stable occlusion (Fig. 4).

3. Discussion

Closing anterior open bites is one of the greatest challenges in orthognathic surgery, particularly when segmental maxillary osteotomy is used. As such, a series of precautions must be taken at diagnosis to mitigate the effects of instability and prevent relapse. This allows adjuvant therapies such as glossectomy [9] and bone grafting [2,10] to be planned beforehand when necessary. In the case reported herein, the patient did not exhibit true macroglossia or tongue interposition between the anterior teeth; accordingly, one of the main causes of open bite relapse was not a concern. However, 3D surgical planning of the segmental maxillary procedure showed a gap of approximately 4–5 mm between bone segments.

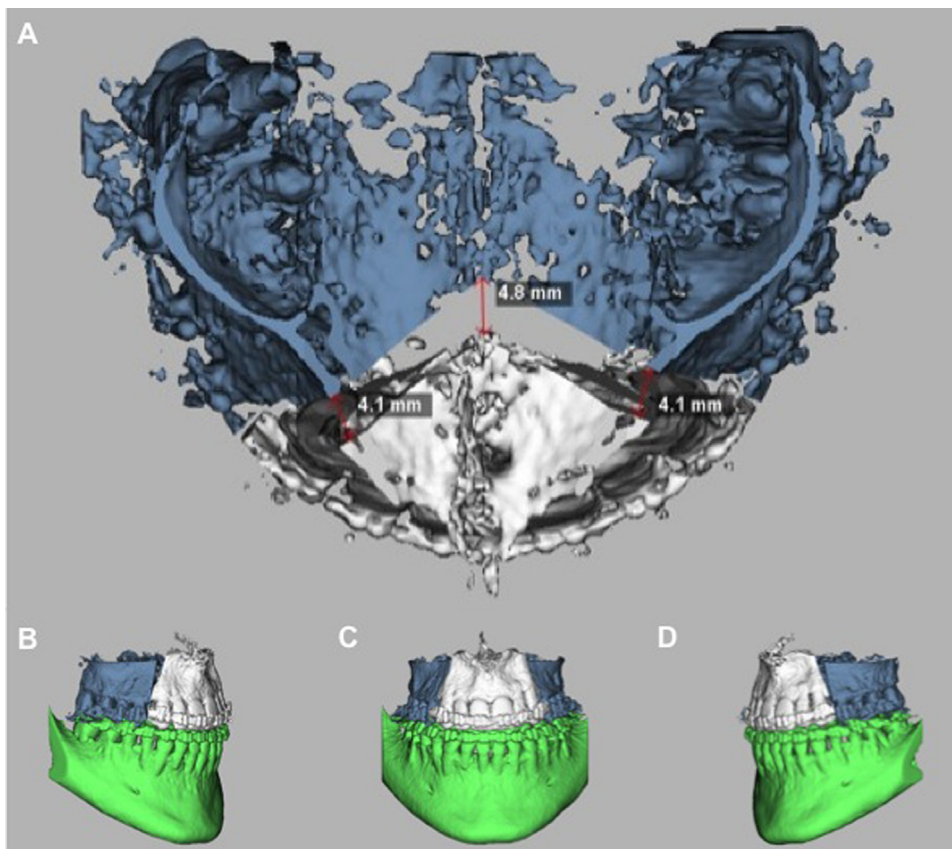


Fig. 2. Virtual planning. A—Axial view – V-shaped segmental maxillary osteotomy showing a 4.1 mm surgical gap between UR3/4 and UL3/4, and a 4.8 mm surgical gap on the floor of the nasal fossa (red arrows). B,C,D—Lateral and frontal view.

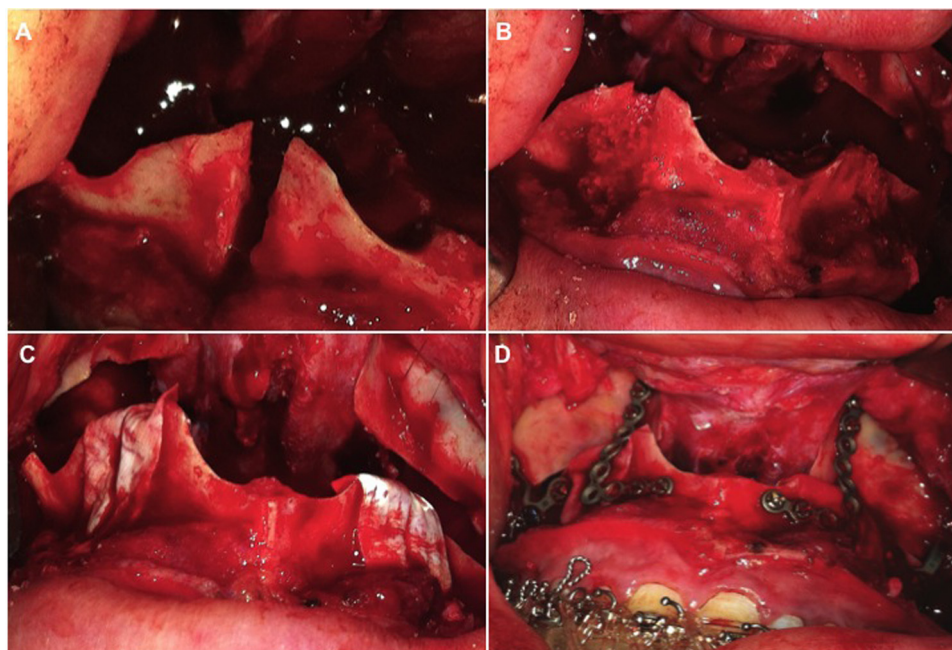


Fig. 3. Surgical procedure A—Gap between the sections of the maxilla. B—Framework filled with Bio-oss® granules. C—Collagen membrane placed over the grafted area. D—Rigid internal fixation with L-shaped microplates stabilizing the collagen membranes.

Moreover, considering loss of bone structure during osteotomy, a gap of at least 5–6 mm would be expected, which could result in nonunion of the bone segments and increase postoperative instability. In order to provide a better surgical prognosis and prevent

pseudarthrosis, the decision was made to place bone grafts in the gaps between the sectioned areas of the maxilla.

Bone grafting is necessary in around 25% of cases and both autogenous bone [2,10] and bone substitutes [2,5] have been reported

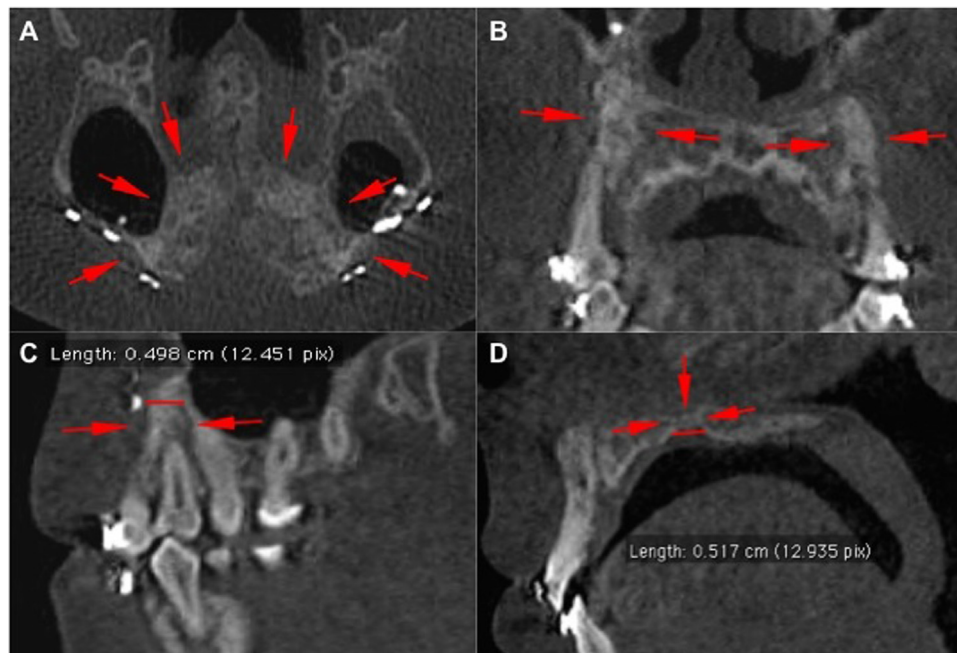


Fig. 4. Cone-beam CT Images 6 months after orthognathic surgery showing newly formed bone in the surgical gap with density greater than that of the surrounding tissues (red arrows). A—Axial view – Area on the floor of the nasal fossa. B—Coronal view – Area between UR3/4 and UL3/4. C—Saggital view – Area between UL3/4 up to 4.98 mm long with newly formed bone tissue (red line). C—Saggital view – Area on the floor of the nasal fossa of up to 5.17 mm long with newly formed bone tissue (red line).

as options in the literature. Although autogenous bone is the gold standard due to its osteoconductive, osteoinductive, and osteogenic properties, it also involves higher morbidity for the patient, unpredictable resorption rates, increased operative times, and risk of infection at the donor site. Considering these aspects, the decision was made to use a biomaterial, Bio-oss[®] granules, that has been tested in longitudinal studies and shown to provide good bone stability, osteoconduction, and biocompatibility while reducing operative time and surgical morbidity. In addition, the porous structure and interconnected macropores of this material facilitate angiogenesis [11]. Bone substitutes such as calcium triphosphate were disregarded because of their tendency for loss of volume and unpredictable resorption rates as compared to Bio-oss[®] [12]. Although the use of Bio-oss[®] granules in orthognathic surgery for maxillary segmental osteotomy had not been described previously, there is scientific evidence to support the stability of Bio-oss Collagen[®] in Le Fort I osteotomy [13] and bilateral sagittal split osteotomy of the mandibular ramus [14]. However, the main reason for using this biomaterial were the results obtained for grafting in maxillary sinus lift procedures, where long-term follow-up showed close contact between the bone graft and new bone marrow, angiogenesis, and low substitution rates [7], all of which are necessary to prevent pseudarthrosis and maintain maxillary osteotomy stability. CBCT images obtained 6 months after surgery confirmed the biomaterial characteristics cited above, showing close contact between the grafted area with greater bone density and the surrounding bone, providing the desired occlusal stability.

However, the question emerges as to how a granular bone graft could be used in segmental maxillary osteotomy. By transferring scientific knowledge found in the literature regarding use of this biomaterial in maxillary sinus lifts [7,15,16] and analyzing 3D virtual planning, that indicated a 4–5 mm three-dimensional framework between the osteotomies, easy placement and stability of granular bone grafts were expected. Additional precautions were also taken, including keeping the mucosa of the nasal fossa intact, placing collagen membranes over the grafted area as a mechanical barrier, and stabilizing the membrane under the fixation plates.

In addition to the use of Bio-oss[®] granules, two other tools played a major role in the successful outcome of this case.

The first was virtual planning, which enabled mobilization of the osteotomized bone, combining rotation and translation, in three dimensions. This closely mimics the reality of surgery, minimizing potential risks and complications [3,4], and, as such, was vital in detecting the need for bone grafting. The second essential tool was piezoelectric instrumentation, which does not injure soft tissue during osteotomy [16].

This is the first case reported in the literature to use Bio-oss[®] granules as bone grafts in segmental maxillary osteotomy for orthognathic purposes. The granular nature of the material facilitated its application between the bone segments, and we subsequently observed stabilization of the biomaterial and newly formed bone, preventing pseudarthrosis and occlusal instability. In addition, the properties exhibited make Bio-oss[®] a valid alternative to autogenous grafting, preventing the added morbidity of a donor surgical site.

Conflicts of interest

No conflicts interest.

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Ethical approval

CEP 05/02890 - Pontifical Catholic University of Rio Grande do Sul – PUC/RS.

Consent

Written informed consent was obtained from the patient for publication of this case report, including accompanying images.

Author contributions

Orion Luiz Haas Junior: Conception and design of case report, Acquisition of data: laboratory and clinical/literature search, Analysis and interpretation of postoperative CT cone-beam, Drafting of article and/or critical revision, Final approval and guarantor of manuscript.

Lucas da Silva Meirelles: Conception and design of case report, Acquisition of data: laboratory and clinical/literature search, Analysis and interpretation of postoperative CT cone-beam, Drafting of article and/or critical revision, Final approval and guarantor of manuscript.

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Rogério Belle de Oliveira: Conception and design of case report, Acquisition of data: laboratory and clinical/literature search, Analysis and interpretation of postoperative CT cone-beam, Drafting of article and/or critical revision, Final approval and guarantor of manuscript.

Guarantor

Yes.

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