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Effects of lateral osteotomy on surgically assisted rapid maxillary expansion

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Abstract. This study aimed to assess the potential effects of two different osteotomy designs of the maxillary lateral wall on dental and skeletal changes after surgically assisted rapid maxillary expansion (SARME). Thirty adult patients were divided into two groups according to the lateral osteotomy design: group 1 ($n = 16$) underwent lateral osteotomy performed in a horizontal straight fashion, and group 2 ($n = 14$) underwent lateral osteotomy performed in parallel to the occlusal plane with a step at the zygomatic buttress. Cone beam computed tomography scans were obtained preoperatively (T1), immediately after expansion (T2), and 6 months after expansion (T3). Mixed analysis of variance (ANOVA) was used for the statistical analysis. The results showed no significant interaction effect between groups and time points. Therefore, maxillary expansion was effective in both groups. Statistically significant increases in all dental and skeletal measurements were observed immediately after expansion ($P < 0.001$). Relapse of the nasal floor width, tipping of the supporting teeth, and an increase in root distance in molars occurred at T3 ($P < 0.05$). In summary, the maxillary lateral osteotomy design did not influence the results of SARME, which occurred mainly through the inclination of maxillary segments.

Key words: palatal expansion technique; maxillary osteotomy; cone beam computed tomography.

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Maxillary transverse deficiency commonly affects orthodontic patients. Clinical features of this deficiency include a narrow palate, unilateral or bilateral posterior crossbite, dental crowding, and difficulty in nasal breathing.[1] Treatment depends on the degree of maxillary transverse deficiency, as well as on the patient's skeletal maturation stage.[2] Orthopaedic rapid maxillary expansion is indicated for the treatment of maxillary transverse deficiency in children and young patients.[3] Surgically assisted rapid maxillary expansion (SARME) is recommended for adult patients because it lowers suture strength during expansion.[3–6]

Achieving uniform maxillary expansion without inclination of the teeth and maxillary segments constitutes one of the main challenges of SARME therapy.[3,6] Since the early 20th century, SARME techniques have been developed in which different osteotomies are performed.[7–13] Osteotomies of the zygomatic buttress, separation of the pterygomaxillary suture, opening of the midpalatal suture, or a combination of these procedures represent the most common techniques, as they involve structures that strongly resist expansion.[4,7]

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Despite the effectiveness of SARME as a treatment for maxillary transverse deficiency, the literature provides no consensus regarding the minimum amount of osteotomies required for effective expansion.[5,14,15] Nevertheless, most authors agree about the need for a zygomatic buttress osteotomy to reduce resistance to expansion.[7,8,10–13] Even this osteotomy, however, may involve different techniques with potentially distinct outcomes.[7,8,12,13,16] The most common lateral osteotomy is performed in a horizontal straight fashion, from the piriform aperture to the pterygomaxillary suture.[8] In a variation proposed by Betts et al., this procedure is performed in parallel to the occlusal plane with a vertical osteotomy (step) at the zygomatic buttress to avoid buttress interference and resistance during expansion.[12]

Several authors have evaluated the dental and skeletal changes that may occur after SARME using different approaches, such as lateral and postero-anterior radiographs,[17–19] study casts,[5,18] finite element analysis,[16,20] computed tomography,[3,15] and cone beam computed tomography (CBCT).[21,22] Three-dimensional images including CBCT allow for the evaluation of facial structures with minimal distortion and low radiation doses.[23]

This study used CBCT to assess the effects of two different maxillary lateral osteotomy designs on dental and skeletal transverse changes in patients who underwent SARME.

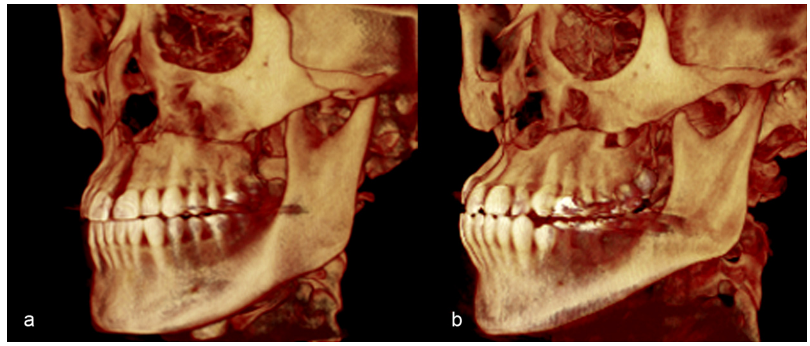

Fig. 1. Volumetric rendering from CBCT scans of patients who underwent SARME. (a) Straight osteotomy from piriform rim to pterygomaxillary suture; (b) osteotomy performed in parallel to the occlusal plane with a step at the zygomatic buttress.

Materials and methods

This retrospective study assessed the CBCT records of 30 adult patients (19 females and 11 males) who underwent SARME. The inclusion criteria were patients with a maxillary transverse deficiency of 5 mm or greater, the presence of a posterior crossbite, and SARME performed with osteotomies of the maxillary lateral walls, midpalatal suture, and separation of the pterygomaxillary suture. The exclusion criteria comprised patients with previous orthodontic treatment, cleft lip and palate, or congenital craniofacial syndromes. Surgeries were performed by two surgeons (group 1 by V.A.P.-F. and group 2 by E.S.G.) in a hospital environment under general anaesthesia, between the years of 2010 and 2012. This study was performed with ethics committee approval.

The sample was divided into two groups according to the lateral osteotomy design: group 1 included 16 patients with a mean age of 30.4 years (range 18.7–39.7 years), who underwent SARME with pterygomaxillary disjunction, midpalatal suture osteotomy, and lateral osteotomy performed in a horizontal straight fashion (Fig. 1a). Patients in this group were treated with a Hyrax type appliance and at an activation rate of one-quarter turn (0.2 mm) three times a day until the crossbite was corrected. Group 2 included 14 patients with mean age of 24.2 years (range 19.3–33.2 years), who underwent SARME with pterygomaxillary disjunction, midpalatal suture osteotomy, and lateral osteotomy performed in parallel to the occlusal plane with a step at the zygomatic buttress (Fig. 1b). In this group, patients were treated with Hyrax ($n = 8$) or Hass ($n = 6$) appliances. An initial activation of 1 mm was carried out, followed by a one-quarter turn twice a day for the first week, and after this, a one-quarter turn every day until the crossbite was corrected. In both groups, appliance activation was initiated 7 days postoperatively. After expansion, appliances were blocked and left in place for 4 months. After this period, appliances were replaced with a transpalatal arch.

CBCT scans were acquired before surgery (T1), immediately after expansion (T2), and at 6 months after expansion (T3) for each patient, using an i-CAT scanner (Imaging Sciences International, Hatfield, PA, USA) with settings of 120 kVp, 36 mA, 0.3-mm voxels, and a field of view (FOV) of 17 cm × 23 cm. CBCT images were evaluated randomly by a calibrated examiner using Dolphin 3D software (Dolphin Imaging, Chatsworth, CA, USA). The orientation of each dataset was standardized according to three reference planes using volume rendering and multiplanar views (Fig. 2). Linear and angular measurements were performed on the coronal slices at the level of the upper first molars and upper premolars to determine nasal floor width, maxillary width, distance between the

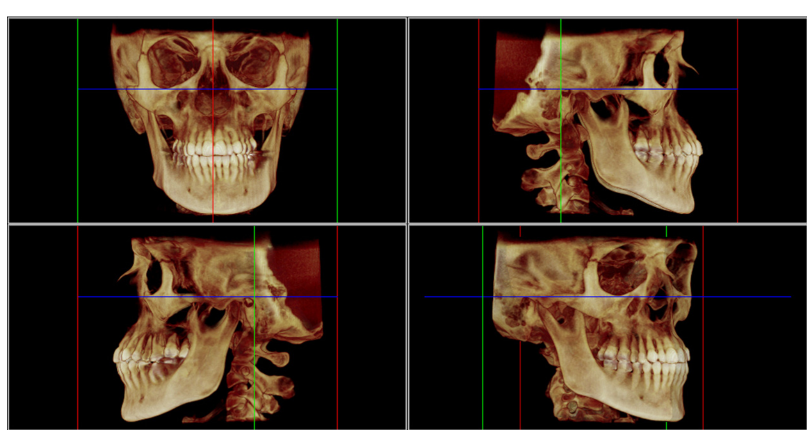

Fig. 2. Orientation and reference planes: axial plane (blue) defined by right and left orbitale and right porion landmarks; coronal plane (green) defined by right and left porions, perpendicular to the axial plane; sagittal plane (red) defined as the plane orthogonal to axial and coronal planes passing through the nasion landmark. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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