Int. J. Oral Maxillofac. Surg. 2017; 46: 1088–1093
http://dx.doi.org/10.1016/j.ijom.2017.04.011, available online at http://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Clinical Paper
Orthognathic Surgery

# Nasolabial changes after two different approaches for surgically assisted rapid maxillary expansion

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*N. Alves, T. F. M. Oliveira, V. A. Pereira-Filho, E. S. Gonçales, M. A. C. Gabrielli, L. A. Passeri: Nasolabial changes after two different approaches for surgically assisted rapid maxillary expansion. Int. J. Oral Maxillofac. Surg. 2017; 46: 1088–1093.* 

*Abstract.* This retrospective study evaluated the nasolabial changes in patients who underwent surgically assisted rapid maxillary expansion (SARME) using two different approaches. Nineteen patients were included in the study, divided into two groups according to the kind of surgical approach performed: group 1 (n = 9), SARME performed through the standard Le Fort I circumvestibular approach followed by the alar base cinch, and group 2 (n = 10), SARME performed through a subtotal vestibular approach associated to a V-shaped incision at the maxillary midline in the labial frenulum region, without alar base cinch. Measurements of width, length, and nasal projection as well as upper lip length were taken from cone beam tomographic images obtained before surgery (T1) and 6 months postoperatively (T2). Both groups presented an increase in the alar base width postoperatively ($P < 0.05$). The approach used in group 2 resulted in smaller changes in the alar base width as measured at the superior alar curvature ($P < 0.05$). Nasal length and projection and upper lip length were not altered by SARME. The type of surgical approach influenced nasolabial changes, but did not eliminate increase in width of the alar base.

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

Accepted for publication
Available online 9 May 2017

Surgically assisted rapid maxillary expansion (SARME) is the standard procedure for correction of transverse maxillary deficiency in adult patients. It can be performed as an isolated procedure or associated with maxillary repositioning for correction of anteroposterior and vertical anomalies[1]. Sagittal separation of the maxilla widens the piriform aperture and nasal floor[2]. Facial soft tissues, such as the alar base and upper lip, have insertions around the piriform aperture. Thus, changes can be expected in the morphology and position of those structures after SARME[3–5].

Soft tissue changes result not only from the increase in the transverse dimension of the maxilla, but also from the mucosal incision and muscle detachment necessary for performing the corticotomies[6–9]. Other factors, such as the direction and amount of maxillary change, skeletal pattern, tonus, and thickness of the soft tissues, may also influence postoperative changes in the alar base and upper lip[3,10].

The standard circumvestibular incision for the Le Fort I osteotomy extends from the first molar to its correspondent on the other side. The mucoperiosteum is elevated from the anterior maxilla, including the area around the piriform apertures[4,9]. Postoperatively, muscle reinsertion tends to occur with reduction in the length of the related muscles because of tissue retraction, resulting in changes at the alar base[7]. Several methods have been employed to exert control upon such changes[10–15].

The alar base cinch suture, described by Collins and Epker[11], has been widely used to minimize the increase in the width of the alar base produced by the Le Fort I osteotomy. However, the effectiveness of the method has been contested[4,5]. Enlargement of the pirirform aperture also promotes widening of the nose and overcorrection of the soft tissues become necessary in patients where such increase is not desirable[5].

The subtotal segmented approach for SARME involves bilateral incisions which run from the first molar to the canine bilaterally, associated with a V-shaped incision at the midline. This is done to preserve muscle insertions around the piriform aperture. The aim is to minimize the widening of the alar base and eliminate the need for cinch sutures[9].

Several techniques have been proposed to increase the effectiveness of SARME. The literature is scarce in relation to the influence of the surgical approach over the soft tissues after maxillary expansion. This study used the cone beam computed tomography (CBCT) to compare nasolabial soft tissue alterations in patients who received SARME by means of two different surgical approaches.

## Materials and methods

This retrospective study evaluated the CBCT records from 19 patients (14 women and 5 men) who underwent SARME. Inclusion criteria were adult patients with transverse maxillary deficiency greater than 5 mm, the presence of posterior crossbite, SARME performed with subtotal Le Fort I osteotomy involving the lateral maxillary wall, median palatine suture, and separation of the pterygoid plates. Patients presenting with craniofacial syndromes, cleft lip and palate, or who had previous orthodontic treatment were excluded from the study. Approval was obtained from the Ethics Committee of the Araraquara Dental School, Unesp (Protocol 44820615.0.1001.5416).

The patients were divided into two groups, according to the kind of surgical approach that was employed: group 1 (n = 9), SARME performed through the standard Le Fort I circumvestibular approach followed by alar base cinch (Fig. 1) and group 2 (n = 10), SARME performed through a subtotal vestibular approach associated to a V-shaped incision at the maxillary midline in the labial frenulum region, without alar base cinch (Fig. 2).

Group 1 was composed of nine patients with a mean age of 23.1 years (range 19.5–29.4 years); there were 10 patients in group 2 with a mean age of 30.3 years (range 18.7–39.7 years). Surgical procedures were performed under general anaesthesia by two of the authors. All patients were treated with Hyrax devices with activation of a $^1/_4$ turn (0.25 mm) twice per day, initiated 7 days after the procedure, until the posterior crossbite was corrected. After expansion, the devices were locked and kept in position for four months and then replaced by a transpalatal arch.

CBCT images were obtained for each patient before surgery (T1) and 6 months after expansion (T2), using an i-CAT tomograph (Imaging Sciences International, Hatfield, PA, USA) with 0.25 mm voxel. The images were randomly evaluated in the Dolphin 3D software (Dolphin Imaging, Chatsworth, CA, USA) by a single previously calibrated examiner. Tomographic reconstructions were positioned according to intracranial reference plans as described by Cevidanes et al.[16]. The amount of expansion in each individual patient was determined by measuring the opening of the Hyrax as evaluated in T2. Ten anatomical landmarks were determined (Table 1). Using those landmarks as references, superior alar width, alar base width, nasal width, alar angle, nasal length, nasal projection, and upper lip length were measured (Fig. 3).

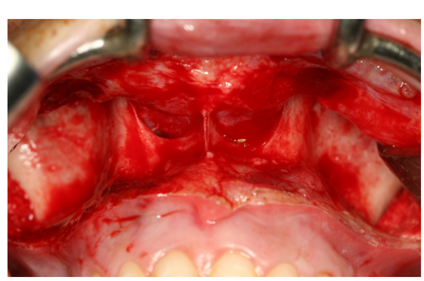

*Fig. 1.* Standard Le Fort I approach.

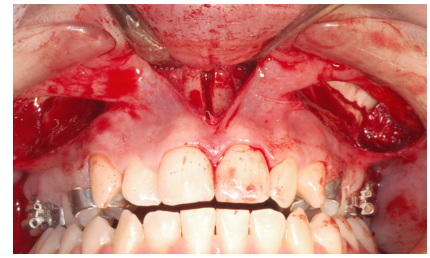

*Fig. 2.* Segmented approach.

Tomographies were evaluated twice by the same examiner with an interval of 30 days. Intra-examiner reproducibility and reliability were evaluated with Bland–Altman analysis and the intra-class correlation coefficient, which ranged from 0.829 to 0.994. The Shapiro–Wilk test and analysis of asymmetry and kurtosis were used to investigate assumptions of normality of the data. Differences between measurements after expansion (T2 − T1) were examined using the paired *t*-test and the Wilcoxon test for data with non-parametric distribution. Inter-group differences were determined using the Student's *t*-test and the Mann–Whitney test for non-parametric variables. Statistical analysis was performed with SPSS 16.0 software (SPSS, Chicago, IL, USA), considering the 5% ($\alpha = 0.05$) significance level.

## Results

The mean maxillary expansion was 8.3 ± 0.9 mm for group 1 and 8.0 ± 1.8 mm for group 2, without any significant difference between groups ($P = 0.64$). In group 1 patients, a significant increase in nasal width after maxillary expansion was observed ($P < 0.001$), as determined by the variables superior alar width (rSAC–lSAC 2.1 ± 0.4 mm), alar base width (rAB–lAB 1.6 ± 0.3 mm), and nose width (rLAC–lLAC 2.2 ± 0.3 mm). Nasal length and projection had no significant changes (Table 2). Similar changes were observed in group 2, even without disinsertion of the muscles related to the alar base, with increases in superior alar width (rSAC–lSAC 0.9 ± 0.3 mm), alar base width (rAB–lAB 1.9 ± 0.5 mm), and nose width (rLAC–lLAC 1.6 ± 0.4 mm) (Table 3). Alar angle (AB^PrN) was significantly different in group 2 ($P = 0.013$).

Although both groups presented an increase in nasal width as a result of maxillary expansion (T2–T1), no statistically significant difference was found between groups, except for the variable upper

*Table 1.* Anatomical landmarks.

| Landmark | Definition |
|---|---|
| Nasion (N) | Greatest concavity in the origin of the nose |
| Pronasale (PrN) | Most anterior nasal point |
| Subnasale (SN) | Transition between columela and upper lip |
| Labrale superius (LS) | Upper lip vermillion border |
| Right alar base (rAB) | Right point of facial insertion of the alar base |
| Left alar base (lAB) | Left point of facial insertion of the alar base |
| Right superior alar curvature (rSAC) | Right point of facial insertion of the upper portion of the alar base |
| Left superior alar curvature (lSAC) | Left point of facial insertion of the upper portion of the alar base |
| Right lateral alar curvature (rLAC) | Right most lateral point of the alar curvature |
| Left lateral alar curvature (lLAC) | Left most lateral point of the alar curvature |

alar width. Group 1 presented a larger increase for that measurement (Table 4).

## Discussion

SARME is an effective treatment for the correction of maxillary transverse deficiency in adult patients. However, aesthetic facial changes may occur after the procedure[2]. Besides profile cephalometric radiographs, several methods have been employed for evaluation of facial soft tissues, such as direct measurements[4,8], photographs[17], three-dimensional photo-

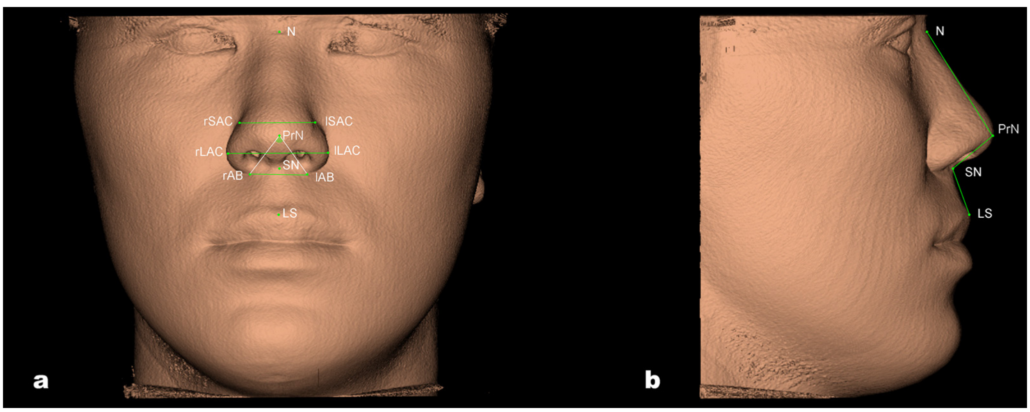


*Fig. 3.* Soft tissue anatomical landmarks and measurements marked on the three-dimensional reconstruction in the frontal (A) and lateral views (B). Superior alar width (rSAC–lSAC); alar base width (rAB–lAB); nose width (rLAC–lLAC); alar angle (AB^PrN); nasal length (N–PrN); nasal projection (PrN–SN); upper lip length (SN–LS).

*Table 2.* Group 1: nasolabial measurements after SARME.

| Measurement | T1 Mean ± SD | T2 Mean ± SD | ΔT2 − T1 Mean ± SD | 95% CI Minimum value | 95% CI Maximum value | P |
|---|---|---|---|---|---|---|
| Superior alar width (mm) | 24.8 ± 2.7 | 26.9 ± 2.2 | 2.1 ± 0.4 | 1.1 | 3.0 | 0.001 |
| Alar base width (mm) | 20.9 ± 2.3 | 22.5 ± 2.5 | 1.6 ± 0.3 | 1.0 | 2.3 | <0.001 |
| Nose width (mm) | 33.8 ± 2.6 | 35.9 ± 1.9 | 2.2 ± 0.3 | 1.5 | 2.8 | <0.001 |
| Alar angle (°) | 82.1 ± 6.7 | 87.9 ± 11.1 | 5.7 ± 2.7 | −0.9 | 12.3 | 0.080 |
| Nasal length (mm) | 42.1 ± 3.1 | 41.9 ± 2.8 | 0.3 ± 0.4 | −0.7 | 1.3 | 0.449 |
| Nasal projection (mm) | 18.1 ± 1.2 | 17.2 ± 1.6 | −0.7 ± 0.5 | −2.0 | 0.6 | 0.220 |
| Upper lip length (mm) | 12.9 ± 2.7 | 12.2 ± 1.9 | −0.6 ± 0.5 | −1.7 | 0.4 | 0.204 |

T1, before SARME; T2, after SARME; ΔT2 − T1, difference between T2 and T1; SD, standard deviation; 95% CI, confidence interval. Bold values are significant at $p < 0.05$.

*Table 3.* Group 2: nasolabial measurements after SARME.

| Measurement | T1 Mean ± SD | T2 Mean ± SD | ΔT2 − T1 Mean ± SD | 95% CI Minimum value | 95% CI Maximum value | P |
|---|---|---|---|---|---|---|
| Superior alar width (mm) | 26.9 ± 4.4 | 27.8 ± 4.2 | 0.9 ± 0.3 | 0.2 | 1.5 | 0.013 |
| Alar base width (mm) | 21.8 ± 4.3 | 23.8 ± 3.1 | 1.9 ± 0.5 | 0.7 | 3.2 | 0.007 |
| Nose width (mm)[a] | 36,0 (30.5–44.9) | 37.9 (33.1–45.8) | 1.25 (0.7–4.8) | 0.9 | 1.9 | 0.005[b] |
| Alar angle (°) | 79.3 ± 4.9 | 87.4 ± 5.9 | 7.7 ± 2.3 | 2.2 | 13.2 | 0.013 |
| Nasal length (mm) | 40.8 ± 4.0 | 40.3 ± 3.6 | 0.3 ± 0.4 | −0.7 | 1.2 | 0.506 |
| Nasal projection (mm) [a] | 17.6 (14.8–20.3) | 18.7 (13.9–20.4) | 1.0 (−6.1 to 2.4) | −3.1 | 1.3 | 0.674[b] |
| Upper lip length (mm) | 13.1 ± 2.2 | 12.5 ± 1.9 | −0.6 ± 0.4 | −1.6 | 0.4 | 0.198 |

T1, before SARME; T2, after SARME; ΔT2 − T1, difference between T2 and T1; SD, standard deviation; 95% CI, confidence interval. Bold values are significant at $p < 0.05$.

[a] For these variables median, minimum, and maximum values; 25th percentile and 75th percentile are represented.

[b] Wilcoxon's non-parametric test.

*Table 4*. Mean, standard error and confidence interval for differences between groups.

| Measurement | Difference: group 1–group 2 | 95% CI | | *P* |
|---|---|---|---|---|
| | Mean ± SE | Maximum value | Minimum value | |
| Superior alar width (mm) | 1.2 ± 0.5 | 0.18 | 2.2 | 0.024 |
| Alar base width (mm) | −0.3 ± 0.6 | −1.6 | 1.1 | 0.654 |
| Nose width (mm) | 0.5 ± 0.5 | −0.5 | 1.5 | 0.095[a] |
| Alar angle (°) | −2.0 ± 3.5 | −9.7 | 5.7 | 0.582 |
| Nasal length (mm) | 0.0 ± 0.6 | −1.2 | 1.3 | 0.935 |
| Nasal projection (mm) | −0.3 ± 1.2 | −3.0 | 2.4 | 0.336[a] |
| Upper lip length (mm) | 0.0 ± 0.6 | −1.4 | 1.3 | 0.965 |

SE, standard error; 95% CI, confidence interval.
Bold values are significant at $p < 0.05$.
[a] Non-parametric Mann–Whitney test.

graphs[5,13], laser scanning[1,10], and tomography[3,18]. The last one has the advantage of allowing evaluation of skeletal and related soft tissue changes. CBCT is recognized as a reliable method for evaluation of facial soft tissue changes[19]. Thus, this study used CBCT to assess nasolabial changes. Images were obtained 6 months postoperatively in order to eliminate the influence of post-surgical oedema[10].

As observed from the results, a significant increase in the nasal width was observed irrespective of the type of surgical approach. Several authors have described widening of the nose after SARME. Berger et al.[17] observed an increase of up to 2.0 mm in nasal width; Magnusson et al.[3] found an increase of 2.9 mm. Metzler et al.[5] encountered an increase of 1.4 mm and de Assis et al.[4] observed 1.7 mm after 6 months. All of them used

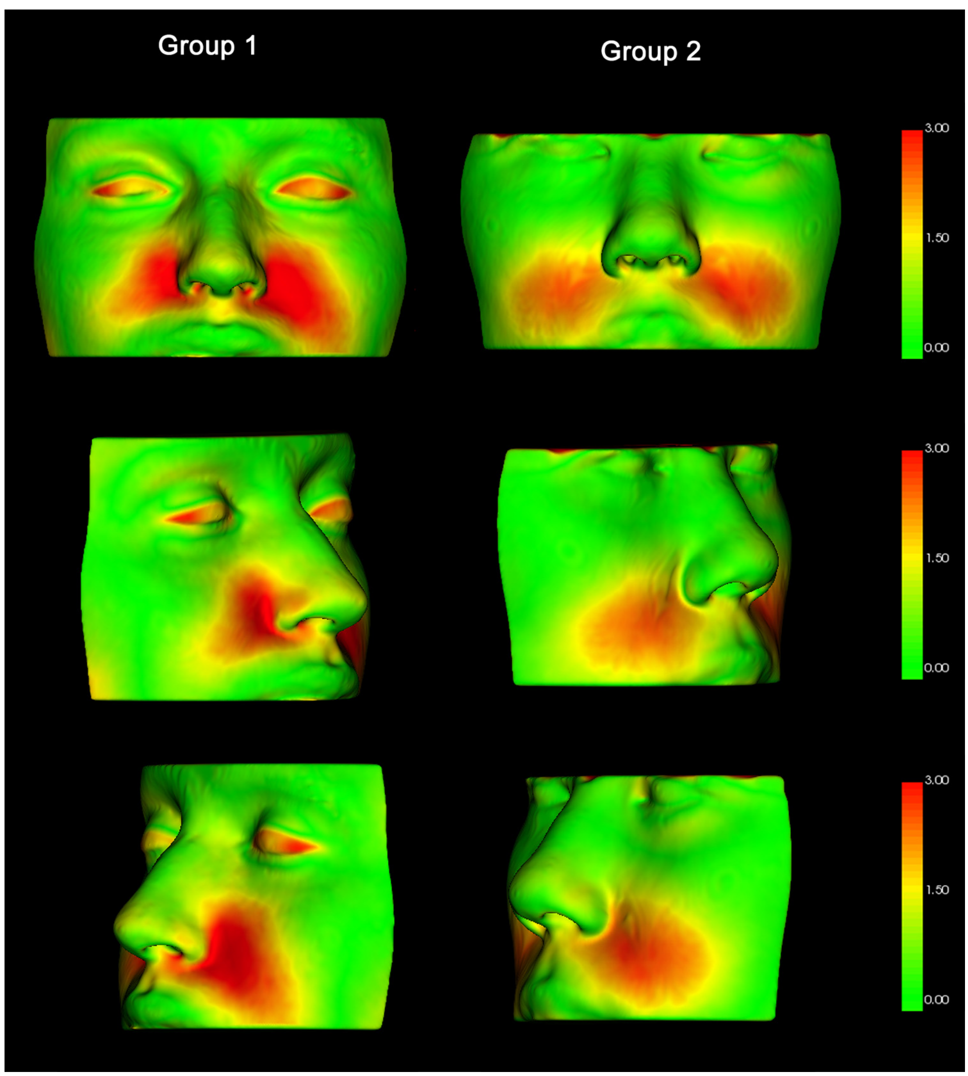


*Fig. 4*. Superimposition of pre and post-surgery for a representative subject of group 1 and group 2. The changes are represented with colour maps that indicate outward (red) displacement after SARME. An absence of change is indicated by green.

the traditional Le Fort I circumvestibular incision in those studies. Ramieri et al.[1] observed an increase in width of 1.4 mm using a segmented incision and soft tissue elevation. The differences described in the literature are related to the technique employed, amount of expansion, and study methods.

The increase in width of the alar base presented no significant differences between groups. It occurred in group 2, even with preservation of muscle attachments, possibly because the attached soft tissues follow the expansion of the piriform rim. In group 1, the alar base cinch reduced the width increase but was not able to eliminate it. When the soft tissues are detached they tend to readapt to the piriform rim during the latency period after the procedure and their final position is influenced by the expansion of the maxilla[5]. The alar base sutures were performed in this group aiming to maintain the alar width as it was before surgery. Thus, an overcorrection is necessary in cases where widening of the alar base is not desirable.

Detachment of the soft tissues in group 1 led to a larger increase in the higher portion of the alar base, affecting the upper alar width compared with when they were not disinserted, as occurred in group 2. The alar base cinch did not compensate for that effect. Tissue retraction and reinsertion position postoperatively are probably responsible for the increase in width. On the other hand, the alar curvature was less affected in group 2, where soft tissues were not detached (Fig. 4).

On the whole, there was a net widening of the nose in all patients after SARME. This is to be expected because of the widening of the piriform aperture, where the soft tissues are inserted. In patients in whom soft tissues remained attached, that change occurred mainly in the inferior region of the nose. In those who experienced detachment of the soft tissues a more homogeneous widening was noted, which was smaller at the alar base. This is mainly because of the alar base cinch.

The lateral positional changes in different parts of the nose have a critical effect in the perception of its size and shape[3]. The alar base suture technique control the width of the nostrils and alar base without considering the changes in the lateral portion of the alar base, because the sutures are positioned inferiorly. The alar base cinch should be judiciously performed to avoid undesirable morphologic changes of the nose[3].

Nasal length was not affected by SARME. Although values for nasal projection were reduced, no significant changes were noted, as previously described by Metzler et al.[5] and Magnussen et al.[3]. There were no significant changes in upper lip length with the two techniques studied, as previously noted[1,5,6,17]. However, Antonini et al.[20] observed a shortening of the upper lip after SARME, even when V–Y closures were used. Surgical expansion of the maxilla does not promote osseous vertical changes; thus, labial suturing techniques will have little effect on the vertical position of the upper lip[6]. Labial alterations that can occur after SARME are mainly because of scar contraction and muscle shortening after incision and soft muscle detachment and elevation[20].

Only transverse soft tissue changes occurred in this sample as expected. The type of surgical approach or performing alar base cinch sutures were not sufficient to prevent widening of the nose.

Nasal widening after SARME was observed for both studied techniques. The technique of segmented incision and tissue elevation was more effective in preventing nasal widening at the higher portion of the alar base. Alar base sutures partially compensated for the effects of muscle detachment and reattachment in maintaining width the inferior portion of the alar base. No differences between techniques were found in relation to the upper lip.

## Funding

None.

## Competing interests

None.

## Ethical approval

Approved by the Ethics Committee of Araraquara Dental School, under protocol number - CAAE: 44820615.0.1001.5416.

## Patient consent

Not required.

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