Surgically Assisted Maxillary Expansion Imparts Three-Dimensional Nasal Change

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Purpose: The impact of surgically assisted maxillary expansion (SAME) on facial soft tissue structures has not been adequately studied using 3-dimensional (3D) objective analysis. The purpose of this study was to analyze nasolabial soft tissue after SAME using 3D photographic technology.

Materials and Methods: This was a retrospective cohort study of patients undergoing SAME in which pre- and postexpansion 3D photographs (3D VECTRA Photosystem, Canfield, Fairfield, NJ) were analyzed. Nasolabial anthropometric measurements were performed using the 3D postprocessing software (Mirror). A follow-up period of at least 6 months was required for final evaluation. Two observers verified the landmarks on each dataset before measuring. Statistical analysis involved the paired *t* test, the Simes correction for multiple comparisons, and repeated measures analysis of covariance (ANCOVA) to control for age, gender, and the time lag between pre- and postoperative assessments.

Results: Twelve patients (24 photogrammetric datasets) were included. The male-to-female ratio was 0.5 (mean age, 17.3 yr). Nasal changes after SAME showed significant increases ($P < .05$) in alar width (from 33.1 to 34.5 mm), sill width (from 9.2 to 9.7 mm), and columella projection (from 94.1 to 95.1 mm) after the Simes correction. ANCOVA showed a significant increase in alar base width. Distinct changes in nostril shape and dimension were found, but lacked statistical significance.

Conclusion: Three-dimensional analysis shows widening of the alar width and alar base width after SAME. The magnitude of nasal change parallels that of expansion at the piriform aperture.

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Maxillary surgery, especially Le Fort I advancement, affects the overlying lip soft tissue and nasal morphology. However, the relation between transverse maxillary widening, or surgically assisted maxillary expansion (SAME), and subsequent soft tissue alteration has not been adequately examined. Most previous studies have relied on 2-dimensional (2D) soft tissue radiologic superimposition to surmise post-treatment changes.[1-3] Beyond the inability to assess frontal changes, because the soft tissue shadow of the nose and lip is lost on the posteroanterior (PA) cephalogram, such 2D techniques are inherently inaccurate. Early attempts at 3-dimensional (3D) assessment also have been attempted, including direct anthropometry, photographic cephalometry, stereophotogrammetry, moiré, and laser, each with its own limitations. Also, none of these have focused on SAME.[4-7] The 3D photometric capture has been shown, using validity studies, to exhibit excellent reliability and reproducibility in facial anthropometric measurements.[7-12] There is a paucity of data examining the nasolabial soft tissue changes after SAME. As mentioned earlier, the few existing studies have used direct measurements or lateral cephalographs, without accurate 3D assessment. The specific aim of this study was to 3-dimensionally analyze and describe the nasolabial morphologic changes created after transverse maxillary expansion (SAME). The authors hypothesized a significant increase of the

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Table 1. DEMOGRAPHICS

Patients, n	Age (yr)	Male/ Female	Expansion (mm)	Follow-Up (mo)
12	17.3 (range, 16-34)	6/6	8 (range, 6-12)	8.2 (range, 6-14)

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alar base and decrease of the nasal tip projection and prominence after SAME.

Materials and Methods

PATIENTS AND STUDY DESIGN

This is a retrospective analysis performed in concordance with the Yale University institutional review board (protocol number HIC 1101007932). Patients who underwent a SAME from November 2012 to July 2013 were included (Table 1). Patients who underwent previous or concurrent procedures to the nose, lip, or midface were excluded.

SUBTOTAL LE FORT I OSTEOTOMY AND DISTRACTION PROCEDURE

The procedure was carried out under general anesthesia and orotracheal intubation. The mucoperiosteal incision in the maxillary vestibule extended from the right to the left first molars. The tuberosity, pterygomaxillary articulation, infraorbital nerve, and piriform rim were identified. The nasal lining along the floor and lateral walls was reflected bilaterally and the nasal septum was freed with a double ball guarded osteotome. A standard Le Fort I osteotomy, including pterygomaxillary disjunction, was performed with a reciprocating saw and osteotomes. Further, a vertical osteotomy within the midsagittal maxillary plane through the anterior nasal spine, maxillary suture, and interdental space between the 2 central incisors was carried out to symmetrically separate the maxillary halves. In all patients, an alar base suture and a V-Y closure were used for soft tissue repositioning and closure.

DISTRACTION DEVICE

A tooth-borne Haas-type expander, preoperatively placed by the orthodontist, was used in all patients. Bands of the device were bonded on the first premolars and molars. Five days postoperatively, the distractor was activated twice a day (total, 1 mm/day). Distraction was performed until an overexpansion of 3 mm was achieved. The retention phase was at least 12 weeks.

IMAGING AND DATA PROCESSING

The 3D photogrammetric data were acquired under clinical lighting using the photosystem 3D VECTRA (Canfield, Fairfield, NJ). System calibration was performed before every capture process. The patient's natural head position was chosen for data acquisition. The dataset was saved and calculated into a 3D model. Further data processing was performed on a standard desktop computer using the corresponding imaging

Table 2. MORPHOMETRIC LANDMARKS USED FOR THREE-DIMENSIONAL NASOLABIAL SOFT TISSUE ASSESSMENT

Landmark	Abbreviation	Definition
Glabella	G	most anterior projected point of forehead within midsagittal plane
Nasion	N	most depressed midline point superior to nasal bridge
Alare	Al	most lateral point of nasal ala
Subalare	SA	lowest point of alar base where the ala meets the nose
Pronasale	Prn	most anterior point of nose
Columella peak	CP	most superior point of columella
Subnasale	Sn	midpoint of nasolabial angle
Medial nostril base	mN	point on inner nostril where the columella meets the columellar crest
Lateral nostril base	lN	point on inner nostril where the alar meets the naseneingangschwelle
Lateral alar	LA	most inferolateral point of nostril
Soft triangle	ST	most superomedial point of nostril
Midcolumella	MC	medial nostril point at midcolumella height level
Lateral crus	LC	perpendicular to columella, through midcolumella on lateral crus
Crista philtri superior	Cphs	top of philtral crest at level of subnasale
Labiale superius	Ls	midpoint of upper vermillion border
Crista philtri inferior	Cphi	point of maximum vertical height of upper vermillion border (cupid's bow)
Chelion	Che	most lateral point of labial commissure
Tragus	Tr	most anterior point of tragus

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