Preliminary Report

The Influence of Paranasal Augmentation on the Measurement of the Nose for the Treatment of Midfacial Concavity

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Cheng-I Yen, MD; Ruei-Fong Chen, MD; Jonathan Zelken, MD; Chun-Shin Chang, MD; Shih-Yi Yang, MD; Hung-Chang Chen, MD; Shu-Yin Chang, MD; Jui-Yung Yang, MD; Shiow-Shuh Chuang, MD; and Yen-Chang Hsiao, MD

Abstract

Background: A concave midface with its associated deep nasolabial folds is more aesthetically displeasing than a convex midface. Midfacial concavity may be addressed with autologous tissue and implants.

Objectives: The aim of this study was to determine the effect of paranasal augmentation on photogrammetric parameters.

Methods: Between July 2013 and August 2016, 12 patients underwent paranasal augmentation to address midface concavity. Augmentation was performed with autologous rib cartilage, autologous mandibular bone, or preshaped porous polyethylene (PPE). All operations were performed through the upper gingivobuccal approach. Twelve patients who underwent malar reduction using the same approach acted as a control group to account for the influence of the approach on soft tissue change. Preoperative and postoperative measurements were made photogrammetrically.

Results: The average follow-up period was 12.8 months (range, 5-30 months) for both groups. The mean thickness of augmentation grafts was 5.18 mm (range, 3-7 mm). Alar width and alar base width increased 4.84% ($P = 0.01$) and 7.66% ($P = 0.01$), respectively. The nasolabial angle increased from 97.2°to 103.6° and the columellar inclination increased from 116.0° to 119.1° but neither were statistically significant. Photogrammetric parameters did not change significantly in the control group. Partial wound dehiscence occurred in one case. There was greater postoperative increase in alar width ($P = 0.020$), alar base width ($P = 0.024$), and nasolabial angle ($P = 0.033$) in the experimental group compared to the control group.

Conclusions: Paranasal augmentation using PPE or autologous material generates measurable soft tissue changes designed to enhance paranasal aesthetics.

Level of Evidence: 3

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Drs Yen, H-C Chen, and S-Y Chang are Instructors, Drs C-S Chang and Hsaio are Associate Professors, Dr S-Y Yang is an Attending, Dr J-Y Yang is a Professor, and Dr Chuang is an Assistant Professor, Department of Plastic and Reconstructive Surgery, Aesthetic Medical Center of Chang Gung Memorial Hospital, College of Medicine, Chang Gung University, Taipei, Taiwan. Dr R-F Chen is in private practice in Taipei, Taiwan. Dr Zelken is in private practice in Newport Beach, CA, USA.

Corresponding Author:
Dr Yen-Chang, Hsiao, Department of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital, Linkuo, 5, Fu-Hsin Street, Kwei-Shan, Taoyuan 333, Taiwan.
E-mail: b8301063@gmail.com

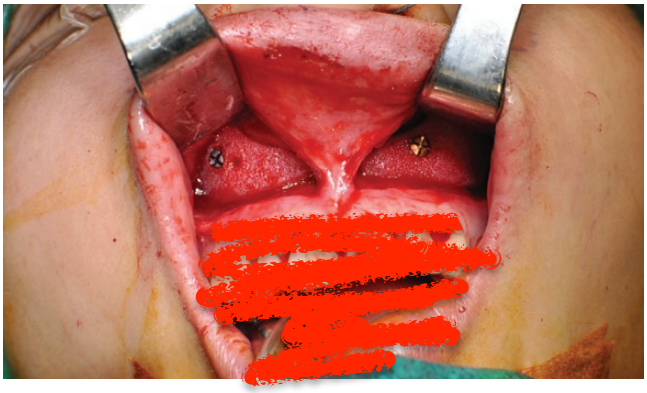
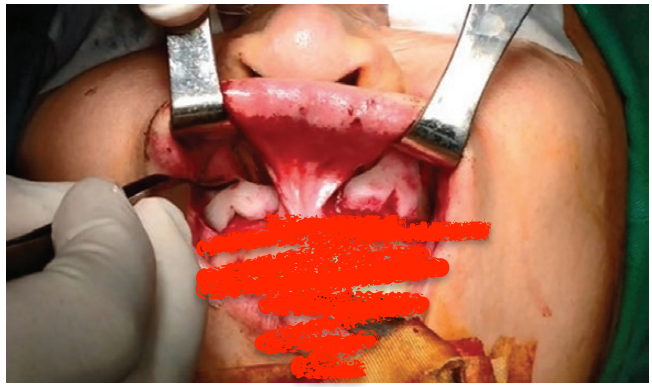


Figure 1. A 36-year-old woman with intraoperative view of paranasal PPE implants fixed with miniscrews.



Video 1. Watch now at https://academic.oup.com/asj/article-lookup/doi/10.1093/asj/sjx166

Midface concavity may be aesthetically displeasing and accelerate the appearance of facial aging.[1,2] Patients with paranasal volume deficiency and localized concavity present with a flattened facial profile, compressed nasolabial angle, and deepening of furrows around the nose and mouth.[2,3] Improvement of paranasal deficiency can be achieved by malar osteotomy, Le Fort I osteotomy, or both.[3] When there is paranasal deficiency and a normally positioned maxilla,[2] augmentation of the depressed area can camouflage the paranasal deficiency. This is accomplished with autogenous bone graft or alloplastic materials.[2]

The influence of paranasal augmentation on the surrounding soft tissue envelope remains unclear. Factors like incision placement, plane of dissection, wound closure technique, and scar formation are expected to influence the aesthetic outcome. The aim of this study was to determine the effect of paranasal augmentation on photogrammetric measurements. By comparing these changes with a control group, we controlled for the impact of the surgical approach on the outcome. To our knowledge, this is the first series about paranasal augmentation that compares an experimental group and a control group.

METHODS

This retrospective study was performed at Chang Gung Memorial Hospital after obtaining approval from the Institutional Review Board. Between July 2013 and August 2016, twenty-one patients with midface convexity and paranasal volume deficiency underwent paranasal augmentation for correction of midface concavity. Patients were included if they presented with acceptable occlusion and did not warrant orthognathic surgery, and did not have fat graft or filler injection. Informed consent was obtained for all patients. Nine patients who underwent simultaneous rhinoplasty were excluded. In the twelve remaining patients, paranasal augmentation was achieved using autologous rib cartilage (n = 1), autologous bone from the mandibular angle (n = 1), and preshaped porous polyethylene (PPE, Medpor, Stryker, Kalamazoo, MI, n = 10).

All operations were performed under general anesthesia. Bilateral upper gingivobuccal sulcus incisions were used, lateral to the pyriform aperture, above the root of the central incisor to the canine eminence and 1 cm above the sulcus to provide an adequate cuff of mucosa for wound closure.[4] The incisions did not connect at the midline and subperiosteal dissection was conservative. Autogenous and alloplastic grafts were contoured to adapt to the depressed recipient site[5] and trimmed along the margin of the canine root to avoid iatrogenic injury during fixation. The graft edges were contoured to the recipient bone for a more natural contour.

PPE was soaked in an antibiotic solution with negative pressure.[2] Using a syringe, an air-tight seal was created with a gloved finger, and the plunger was withdrawn to create a near vacuum.[2] After the shape and position of the autogenous graft or PPE was confirmed, grafts and implants were secured with an 8-mm or 10-mm miniscrew centrally. Special attention was taken to avoid injury to the tooth root (Figure 1). A 3-0 nylon alar cinch suture was placed between transverse nasalis muscles at the alar-facial junction and the overlying mucosa was closed with absorbable sutures. Drains were not placed. The surgical procedure is demonstrated in the video (available online as Supplementary Material at www.aestheticsurgeryjournal.com).

Twelve consecutive patients who underwent malar reduction through the same approach, using an alar cinch suture and identical wound closure technique, acted as a control group. This was intended to control for the effect of the gingivobuccal incision, subperiosteal dissection plane, and wound closure technique on soft tissue change.

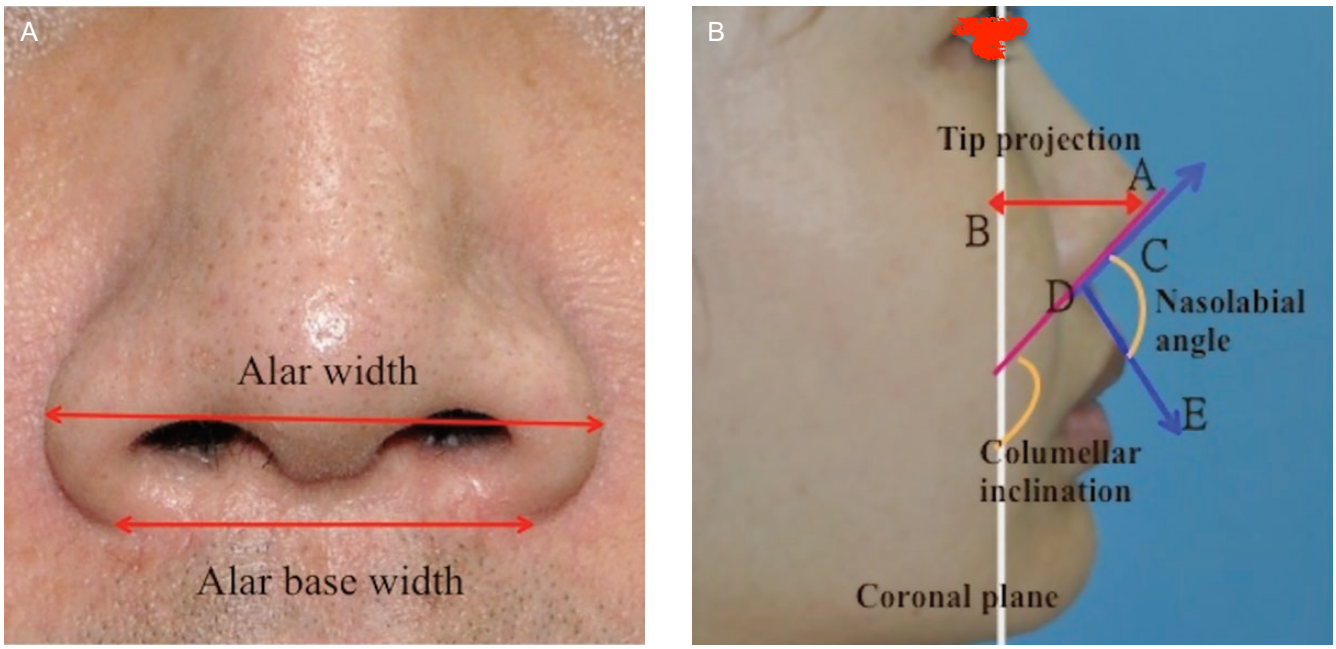


Figure 2. A 36-year-old woman with (A) Linear measurement in this study: alar width, alar base width. (B) tip projection (A-B distance). Angular measurements in this study: nasolabial angle (angle of C-D-E, collumellar-subnasale-labrale superius), columellar inclination (angle of C-D (columellar-subnasale) to coronal plane).

Table 1. Definitions of Linear and Angular Parameters

Parameter	Definition
Alar width	Distance between the most lateral part of bilateral alar wings
Alar base width	Distance between bilateral alar base
Tip projection	Distance between tip to coronal plane
Nasolabial angle	Angle of columellar-subnasale-labrale superius
Columellar inclination	Angle of coronal plane to columellar-subnasale
Coronal plane	The plane perpendicular to Frankfort horizontal plane and passed the most-protruding part of pupil

We used standardized photogrammetric methodology and efforts were made to ensure true profile views were obtained by the use of paper tape at 0°, 45°, 90°, 135°, and 180°, with the camera lens at 90° from a rotating stool. Patients were asked to look straight ahead with eyes in neutral position.[5] In both groups, alar width, alar base width, tip projection, nasolabial angle, and columellar inclination were measured pre- and postoperatively with previously described photogrammetric methodology using the Adobe Photoshop CS6 measure tool (Adobe Systems, Inc., San Jose, CA).[4,5] All measurements were performed by the same investigator (C.I.Y.). The definitions of the parameters are given in Table 1 and Figure 2. The augmentation and control group were compared.

For subjective outcome assessment, we utilized a simple questionnaire (Appendix A, available online as Supplementary Material at www.aestheticsurgeryjournal.com). composed of three questions that measured the degree of satisfaction of the aesthetic outcome and soft tissue change. We performed the questionnaire by telephone interview by the same investigator (a research assistant). For each question, the patient assigned a score from 1 to 5, where higher scores indicated greater satisfaction. Average scores for each question were calculated.

Statistical Analysis

Statistical analyses were performed using SPSS package version 20.0 for Windows. Statistical differences were evaluated by the analysis of variance test with Mann-Whiney test and paired *t*test. *P* values of less than 0.05 were considered statistically significant.

RESULTS

Table 2 summarizes the demographics of the paranasal augmentation group. There were 2 men and 10 women with a mean age of 32.5 years (range, 18-50 years). In the control group, there were 2 men and 10 women with a mean age of 32.8 years (range, 25-48 years). There was no significant change with all the parameters ($P > 0.05$) after upper gingivobuccal incision for malar reduction.

Table 2. Demographics and Characteristics of Augmentation Group

No.	Sex	Age (years)	Material	Thickness (mm)	Follow up (months)	Complication
1	F	37	Medpor	6	6	—
2	M	28	Medpor	7	16	—
3	F	18	Medpor	4.5	17	—
4	F	36	Medpor	3	10	—
5	F	50	Medpor	6	13	—
6	F	23	Medpor	4.5	5	Wound dehiscence
7	F	39	Medpor	7	6	—
8	M	31	Medpor	4.5	8	—
9	F	32	Rib	5	27	—
10	F	30	Medpor	4.5	7	—
11	F	32	Mandible angle	4	30	—
12	F	33	Medpor	6	8	—

Table 3. Measurements of Midface Soft Tissue Change Between Augmentation Group and Control Group (statistically significant at $*P < 0.05$, data presented as mean ± standard deviation)

	Control group, N = 12			Augmentation group, N = 12			
	Preoperative	Postoperative	*P* value	Preoperative	Postoperative	*P* value	*P* value
Age (years)	32.45 ± 8.5	—	—	32.83 ± 7.2	—	—	0.644
Alar width	172.2 ± 39.0	173.64 ± 39.7	0.218	209.6 ± 41.0	216.8 ± 42.7	0.010*	0.020 *
Alar base width	111.6 ± 21.2	112.5 ± 21.3	0.054	116.3 ± 34.3	126.1 ± 36.7	0.010 *	0.024 *
Tip projection	55.2 ± 13.6	54.6 ± 13.0	0.543	109.0 ± 46.4	113.8 ± 36.3	0.462	0.309
Nasolabial angle (°)	98.6 ± 10.4	97.3 ± 8.5	0.788	97.2 ± 16.0	103.6 ± 15.3	0.068	0.033 *
Columellar inclination (°)	110.2 ± 6.9	108.5 ± 8.4	0.834	116.0 ± 16.1	119.1 ± 13.8	0.243	0.156

The average thickness of Medpor, rib, and bone used for augmentation was 5.18 mm (range, 3 mm to 7 mm). The alar width and alar base width increased 4.84% ($P = 0.010$) and 7.66% ($P = 0.010$) postoperatively. Tip projection increased 7.77% ($P = 0.462$) after paranasal augmentation. The nasolabial angle increased from 97.2° to 103.6°. The average increase was 6.4° (range, 1°-20°) but the change was not significant ($P = 0.068$). Columellar inclination increased from 116.0° to 119.1°. The average increase was 3.08° (range, 2°-17°) but the difference was not significant. The postoperative increase in alar width ($P = 0.020$), alar base width ($P = 0.024$), and nasolabial angle ($P = 0.033$) was greater in the augmentation group compared to the control group (Table 3).

There were no complications including hematoma, infection, implant extrusion, or implant migration during the follow-up period of 12.8 months (range, 5 months to 30 months). Only one patient had partial intraoral wound dehiscence and recovered after aggressive oral hygiene and limited debridement with wound repair two weeks later. During the follow-up period, no patient complained about foreign body sensations over the paranasal region, nasal floor, lateral nasal linings, or gingival area. Nor did any patient suffer from airway obstruction. There were no visible or palpable stepoffs. All patients were all satisfied with the aesthetic outcome and improved soft tissue change in paranasal and nasal area, with average satisfaction scores of 4.5 (range, 4-5), 4.6 (range, 4-5), and 4.5 (range, 3-5) out of 5, respectively. Figures 3 and 4 compare these changes in the control group and augmentation group.

DISCUSSION

Paranasal augmentation is useful for correcting midfacial concavity without malocclusion.[1,6,7] It can simulate the visual effects of skeletal osteotomies without affecting

has been studied;[2,6] the average increase in soft tissue outline in the peri-alar region is 68% to 80.7% of implant thickness.[2,6] The focus of this study was not projection of the implant. Instead, the authors evaluated the photogrammetric changes of the paranasal region after augmentation. In this study, photogrammetry demonstrated that there is significant increase in alar width and alar base width and a trend toward nasolabial angle widening after augmentation. The effect was most profound along the upper lip subunit.

Correction of midface hypoplasia was achieved by adding paranasal fullness, effacing prominent nasolabial grooves, and blunting the nasolabial angle. These changes are thought to contribute to a more youthful appearance and more attractive facial profile. The results from this series corroborated those from a similar study by Kwon et al.[6] In that study, however, there was significant increase of columellar inclination whereas our results demonstrated no significant change. It is possible that variations in measurement methods or case numbers contributed to this distinction.

The biggest difference between this series and other series in the literature is the study design. The authors compared soft tissue change in a paranasal augmentation group and a control group using the same incision, plane of dissection, and closure technique. This was designed to control for the possibility that disruption of the paranasal periosteum would influence the muscles near the alar base.[6]

Widening of the alar base is a known adverse outcome after Le Fort I advancement, even when V-Y closure is performed or alar base cinch suture is placed.[6,16-19] Furthermore, it is reported that there is no significant correlation between soft tissue changes and maxillary advancement.[20] Kim et al suggested that paranasal soft tissue changes could result from muscle and soft tissue tension.[3,20,21] Clearly, there is no consensus on whether a vestibular incision with or without cinch suture influences the shape of the nose and paranasal soft tissue envelope. The effect of the surgical approach and wound closure on the soft tissue envelope warrants further study.[2,3,6] To our knowledge, this study is the first to control for these changes, and to objectively quantify them in a control group.

Indeed, the authors found that there is no significant change in alar width, alar base width, tip projection, nasolabial angle, and columellar inclination in the control group. Controlling for potential confounders allowed the authors to attribute changes in alar width, alar base width and nasolabial angle to paranasal augmentation alone.

In patients with a normal profile, postsurgical alar and alar base widening are considered adverse outcomes. However, in patients with paranasal volume deficiency and midface concavity, said changes may contribute to a more youthful and attractive appearance.[8] Changes in the upper lip and nose improves overall facial balance. In patients with midfacial concavity and excessive alar width, these relationships must be taken into consideration. In some cases, it may even be necessary to augment the paranasal region in addition to alar reduction. Alternatively, patients with preexisting alar narrowing such as overreduction of alar base, may benefit from additional alar widening. For these reasons, every patient must be evaluated individually. Thoughtful preoperative evaluation, guidance, and treatment planning is paramount to successful augmentation.

The PPE implants used in this study are preshaped. They are crescentic and available in two sizes: 27 mm × 25 mm × 4.5 mm of projection, and 30 mm × 28 mm × 7 mm of projection.[1,7] For unilateral cases, the contralateral side is used a reference to determine the thickness of augmentation grafts and tailored intraoperatively for symmetry. When there is bilateral concavity, the thickness is determined by the severity of concavity. The goal is to achieve a balance between midface volume correction, alar widening, and improved facial profile harmony. In the future, 3D simulation may guide surgical decision making to achieve more predictable outcomes.

The soft tissue envelope and facial skeleton contribute to midface contour and convexity.[8] Thus, soft tissue and skeletal augmentation may correct midfacial deficiency, but the influence of each component may vary from patient to patient. For example, fat grafting and injection of fillers may address soft tissue volume loss associated with aging where there is no need to augment skeletal projection.[8] In such a patient, augmentation of the facial skeleton may project the midface, but augmentation of the soft tissue envelope will more effectively blunt the contours of the skeleton.[6] When analyzing the face, clinicians should consider bony and soft tissue deficiencies independently.[3]

The patients presented in this series were young, and their paranasal volume deficiencies resulted more from skeletal deficiency than changes associated with aging. Midfacial concavity resulting from maxillary hypoplasia is more common in certain ethnic groups, including Asians and Blacks.[1] The PPE is a dependable substitute for bone and cartilage in facial skeletal augmentation. Paranasal augmentation with PPE is straightforward and the result is long-lasting.

In other series, the complication rate of PPE augmentation was 0.9% to 17.5%.[6,11] In our series, the long-term complication rate was 0 and there were no explanted implants. One patient had partial wound dehiscence but recovered with aggressive oral hygiene and limited debridement and repair. There were no other early or late complications and all patients were satisfied with the aesthetic outcome.