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Quantitative analysis of aesthetic outcomes of morphofunctional septorhinoplasty for secondary cleft lip nasal deformity

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Abstract

The main aim of this study was to assess nasal symmetry after morphofunctional septorhinoplasty, more specifically, symmetry of the alar base and nostrils, and nasal projection, in patients with unilateral and bilateral cleft nasal deformities. Secondary cleft rhinoplasty was performed using morphofunctional septorhinoplasty techniques in 150 patients with unilateral and bilateral cleft lip and nose deformities. Nasal changes were analysed by measuring nasal tip projection, nostril height, nostril width, alar base width, and nasal gap area preoperatively and postoperatively on standard submentovertex view 2-dimensional photographs. In the unilateral cleft group there were statistically significant improvements ($p<0.001$) in ratios of nasal height and width ($p=0.024$) and nasal gap area, and in nasal tip projection and alar base width. In the bilateral cleft group there were statistically significant improvements in nasal gap area ratio ($p=0.009$), nasal tip projection, and alar base width. The morphofunctional septorhinoplasty technique improved aesthetic outcomes.

Keywords: Morphofunctional septorhinoplasty; Cleft lip nasal deformity; Secondary cleft rhinoplasty; Nasal symmetry

Introduction

The nose is the most conspicuous feature on the face so the minutest change in form (loss, deformity, or exaggeration) tends to draw undesired attention and sometimes disparaging remarks, which can be disquieting and make the subject self-conscious. The range of aesthetically acceptable variations of the nose regarding dimensions and form is huge compared with any other visible part of the body.[1]

A deformed nose secondary to cleft lip and palate poses multiple morphological and functional issues such as septal deviation, shortening of the columella, disproportionate nostril size, reduced nasal patency leading to difficulty in breathing, and many more, all of which may affect the physical and psychological well-being of the individual. In patients with bilateral clefts the short columella, and undefined and under-projected tip with a wide alar base, are troublesome areas. Thus, cleft rhinoplasty aims to restore the structure of the nose and its surroundings to improve aesthetics and function.[2]

Despite the availability of various surgical approaches for correction and multiple treatment philosophies, the cleft lip nasal deformity remains an arduous challenge to manage due to longstanding disruption and distortion of the basic architecture, and hence to the nature of the tissues making

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up the nose and its supporting structures.[3] Morphofunctional septorhinoplasty is a comprehensive surgical technique that provides a conceptualised surgical method to target all the areas of secondary cleft nose deformities in adults.[4]

With the help of quantitative analysis in several dimensions on 2-dimensional photographs, this study aimed to evaluate objective aesthetic outcomes of patients undergoing secondary cleft rhinoplasty using our morphofunctional septorhinoplasty technique.

Patients and methods

Non-syndromic patients who underwent secondary cleft rhinoplasty as a final surgical correction procedure at the GSR Institute in Hyderabad, Telangana, India, between June 2013 and June 2018, were included in this retrospective study. All procedures were performed under general anaesthesia with a standard protocol by the principal investigator. Patients who had previously had nasal corrections, those with other craniofacial malformations or syndromic clefts, and those who needed other medical assistance or were unwilling to provide written informed consent, were excluded from the study.

Surgical technique

The morphofunctional septorhinoplasty technique was used in both groups.[4] It is an open rhinoplasty procedure wherein a Tajima inverted 'U' flap (Fig. 1) is raised over the alar cartilage on the cleft side to correct the nasal web and the overhanging skin of the nasal soft triangle. A columellar-philtral skin advancement is done using a modified V-Y plasty to increase columellar length and to revise contracture of the cleft lip scar. The rule of 5 'R' (relieve, resect, reposition, restructure, and restrengthen) is implemented to correct the deviated septum along with the displaced and deformed lower lateral cartilages, which are reduced and sutured together to narrow the dome. An extended septal graft is used in the unilateral cleft group to act as a spreader graft on the cleft side as well as a columellar strut. This graft is obtained from posterior nasal septal cartilage, as it is the most preferred site. In the bilateral cleft group, another spreader graft is needed on the contralateral side of the extended septal graft to counterbalance it. The extended septal graft is stabilised anterocaudally by anchoring it to a hole in the bone on the cleft side. Flaring of the nostrils is controlled with bilateral alar nasalis sling sutures through the anterocaudal part of the nasal septum. Depending on the deformity, further shield and cap grafting for the nasal tip, or alar battening or dorsal grafts may be needed, utilising parts of the nasal septal, tragal, or auricular cartilages.

Photographic analysis

Standardised submentovertex view photographs were shot with a Nikon D100 digital camera (Nikon Corp) and used for measurements and analysis to evaluate the surgical outcomes.[5,6] Facial photographs were standardised by maintaining the camera at a preset distance of 50 cm from the subjects for the submentovertex view, and by a natural position of the head (self-balanced position while looking at a point on the horizon). The head positions were also standardised using the parallelism method, which compares the interpupillary line with a reference horizontal line drawn on the background.

Indirect anthropometric measurements (Fig. 2) were made on digital photographs (non-compressed TIFF files) processed by Photoshop 9.0 (Adobe Inc) using Scion Image software (Scion Corp) (Fig. 3). Linear measurements were made with the help of the line tool (width 3 pixels). Area measurements were made using the magic wand tool after selecting the shape of the nostril in the separately saved files.

The following outcome variables were measured:

Vertical measurements (Fig. 4)

- Nasal tip projection (NTP): distance between the constructed pronasale and the line connecting the alar base points on the right and left sides of the nose (perpendicular to the alar base line) (black line)
- Nostril height (NH): distance from nostril tip to nostril base (perpendicular to the interpupillary line) (red line).

Fig. 1. Tajima's inverted 'U' on soft triangle and 'V-Y' plasty incision marking for open cleft rhinoplasty.

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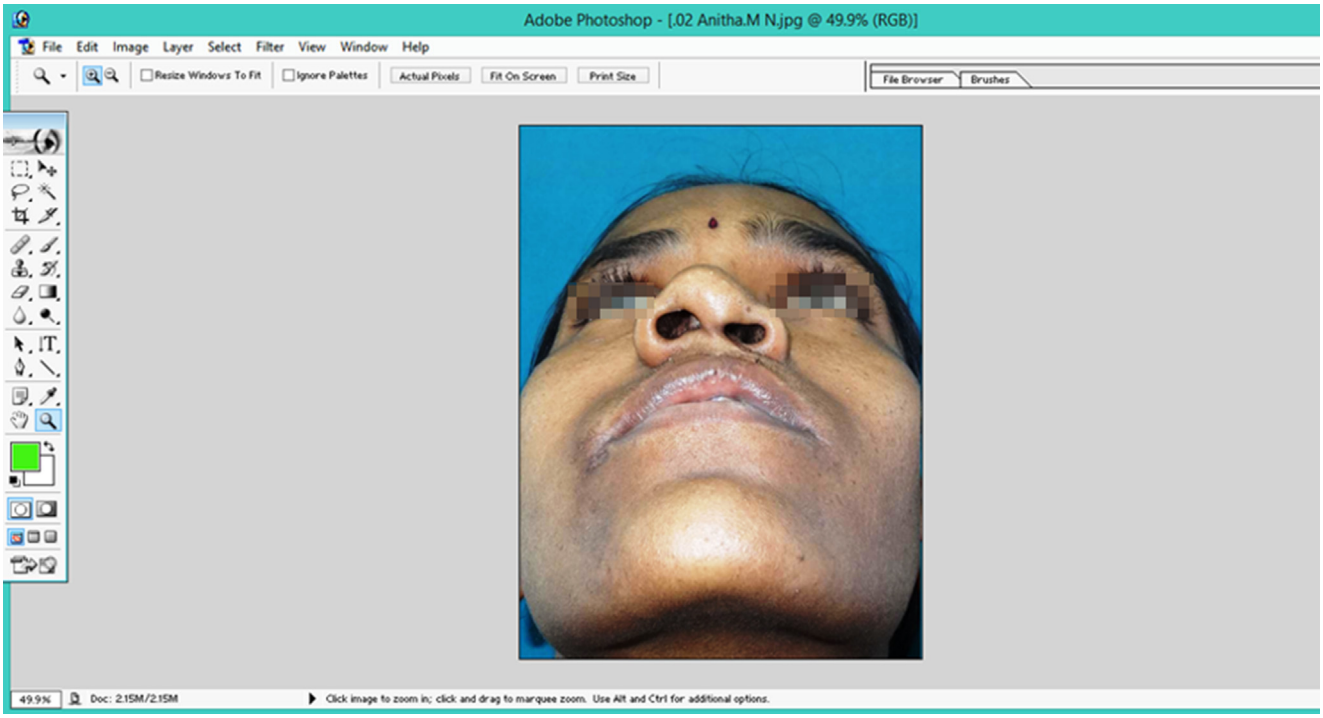

Fig. 2. Indirect anthropometric measurements performed on the digital photographs processed by Adobe Photoshop 9.0.

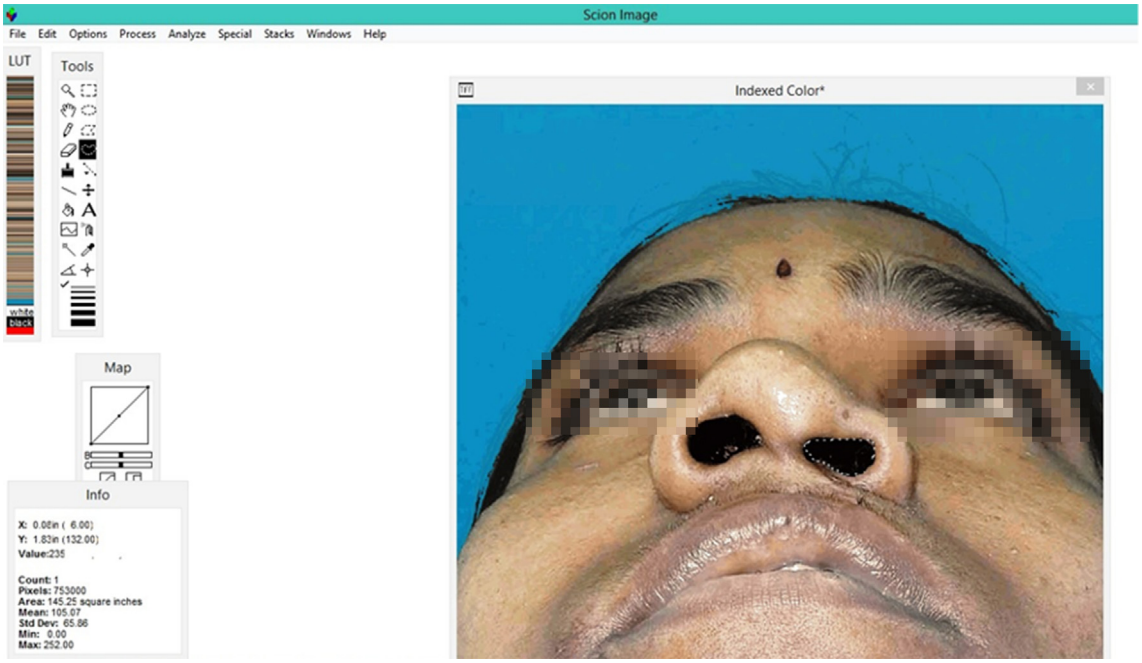

Fig. 3. Files opened in the Scion Image software (Scion Corp).

Horizontal measurements (Fig. 4)

- Nostril width (NW): distance between nostril mediale and nostril laterale (parallel to the interpupillary line) (yellow line)
- Alar base width (ABW): distance of points of alar insertion on the right and left sides of the nose (parallel to the interpupillary line) (blue line).

Nasal gap area (NGA): area of the nostril (Fig. 5).

The outcome variables were quantified on photographs acquired before and after surgery.

Statistical analysis

All statistical analysis was performed using IBM SPSS Statistics for Windows version 22.0 (IBM Corp). A p value of less than 0.05 was considered statistically significant. Two-dimensional landmark measurements were used to anal-

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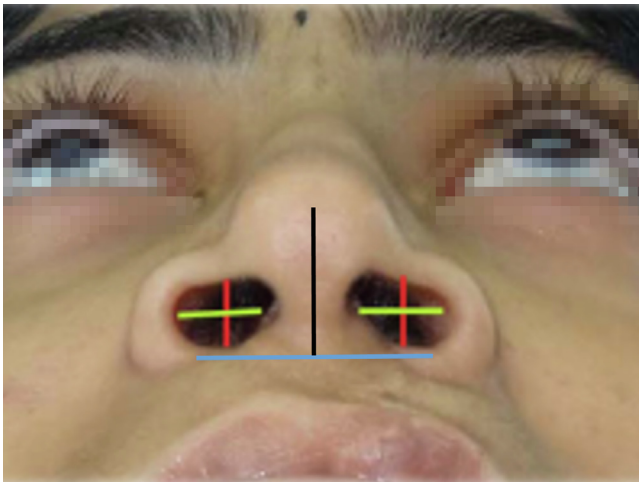

Fig. 4. Nasal tip projection (black), alar base width (blue) nostril height (red), and nostril width (green), on photograph of submentovertex view.

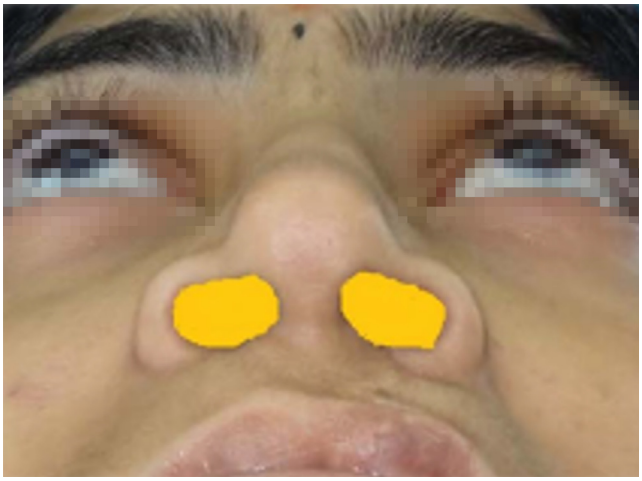

Fig. 5. Nostril gap area on the cleft and non-cleft sides.

yse the cleft (CL) and non-cleft (NCL) sides. In unilateral cases the values on the CL side were divided by the value on the NCL side. In bilateral cases, measurements on the right side (RS) and left side (LS) were compared and calculated as ratios before and after surgery, targeting the numerical aim of 1. A ratio of 1 indicated perfect symmetry, and any deviation from 1 was a measure of asymmetry. Data were subjected to the paired *t* test to identify statistically significant differences between preoperative and postoperative values.

Interclass correlation coefficients (ICC) were calculated to evaluate interobserver and intraobserver reliability. For intraobserver reliability, the measurements were repeated at an interval of five weeks. Post-hoc analysis with G* Power software 3.1 was performed to calculate the power of our study based on sample size.[7,8]

Results

This retrospective study involved secondary cleft rhinoplasty in patients with cleft lip and palate (100 unilateral and 50 bilateral).

Powers of the study for both groups were larger than 0.9, which showed a low chance of committing a type II error. Preoperative and postoperative observations were repeated between two observers, and the ICC ranged from 0.4 - 0.9 in unilateral and bilateral parameters (Tables 1 and 2).

The age of the subjects ranged from 15-29 years with a mean of 17.8 years. The male:female ratio (M:F) for unilateral and bilateral groups was 39:61 and 30:20, respectively. Postoperative follow up ranged from a minimum of six months to a maximum of 30 months with a mean of 13.7 and 12.5 for unilateral and bilateral cleft groups, respectively.

NH ratio (NHR) (Tables 3 and 4)

The mean preoperative NHR for the cleft:non-cleft side was 0.7, but it improved to over 0.9 postoperatively ($p<0.001$). In the bilateral group, there was a significant improvement in nostril height postoperatively.

NW ratio (NWR)

The NWR for unilateral cases decreased from 1.12 to 1.05. In the bilateral group, nasal symmetry in relation to NW improved, but the preoperative SD of 0.25 increased to 0.43 postoperatively, indicating slightly more variability in outcomes.

NGA ratio (NGAR)

Postoperatively, the nostril gap area improved by 63% on the cleft side in the unilateral group, and by 46% - 52% in the bilateral group.

ABW and NTP

There was a significant improvement ($p< 0.001$) in ABW in both groups. The NTP increased significantly by 35% in the unilateral group and by 63% in the bilateral group.

Discussion

Cleft nasal deformity is a 3-dimensional abnormality that involves all the layers of the nose, beginning with the skeletal

Table 1
Interobserver reliability for the measurements made by the first and second observer in the unilateral and bilateral cleft rhinoplasty group.

Parameter	ICC	p value
Unilateral cleft rhinoplasty:		
NWR postoperatively	0.587	<0.001
NHR preoperatively	0.957	<0.001
NGAR preoperatively	0.386	<0.001
Bilateral cleft rhinoplasty:		
NHR preoperatively	0.992	<0.001
NGAR postoperatively	0.991	<0.001

ICC: interclass correlation coefficient; NGA: nasal gap area; NHR: nostril height ratio; NWR: nostril width ratio; NGAR: nasal gap area ratio

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base, and extending into the vestibular lining, cartilaginous infrastructure, and external nasal skin.[9] Open rhinoplasty was performed, which is key to nasal plastic surgery.[10]

Aesthetic assessment needs to be more nuanced due to many factors including areas of concern around the nose, which are affected a great deal by the cultural, ethnoracial, and socioeconomic background of the patient, and the surgeon. Various techniques can be used to evaluate surgical outcomes - for example, anthropometric measurement on facial casts, 2D and 3D photographic scaling, cephalometric

Table 2
Intraobserver reliability of the measurement made by the first and second observer in the unilateral and bilateral cleft rhinoplasty group.

Parameter	ICC		p value	
	Observer1	Observer 2	Observer1	Observer 2
Unilateral cleft rhinoplasty:				
NWR postoperatively	0.894	0.663	<0.001	<0.001
NHR preoperatively	0.999	0.995	<0.001	<0.001
NGAR postoperatively	0.780	0.389	<0.001	0.008
Bilateral cleft rhinoplasty:				
NHR preoperatively	1	0.971	<0.001	<0.001
NGAR postoperatively	0.995	0.997	<0.001	<0.001

NHR: nostril height ratio; NWR: nostril width ratio; NGAR: nasal gap area ratio.

Table 3
Measurement and ratios of the nostril, nasal tip projection (NTP), and width of alar base (ABW) in unilateral cleft rhinoplasty group.

	Mean (SD)		p value	Change (%)
	Preoperatively	Postoperatively		
NH NCL (cm)	1.29 (0.55)	1.71 (0.74)	<0.001	30.23
NH CL (cm)	0.91 (0.53)	1.55 (0.70)	<0.001	56.04
NW NCL (cm)	1.67 (0.71)	1.53 (0.68)	<0.001	−23.35
NW CL (cm)	1.81 (0.79)	1.55 (0.67)	<0.001	−26.52
NGA NCL (mm^2)	172.46 (106.29)	226.20 (137.45)	<0.001	47.29
NGA CL (mm^2)	139.01 (96.92)	218.03 (137.56)	<0.001	63.51
NTP (cm)	2.76 (1.25)	3.97 (1.55)	<0.001	35.87
ABW (cm)	4.44 (1.63)	4.02 (1.52)	<0.001	−11.04
NHR	0.70 (0.26)	0.91 (0.14)	<0.001	-
NWR	1.12 (0.37)	1.05 (0.26)	0.024	-
NGAR	0.82 (0.35)	0.98 (0.26)	<0.001	-

NH: nostril height; NCL: non-cleft; CL: cleft; NW: nostril width; NGA: nasal gap area; NHR: nostril height ratio; NWR: nostril width ratio; NGAR: nasal gap area ratio.

Table 4
Measurement and ratios of the nostril, nasal tip projection (NTP), and width of alar base (ABW) in bilateral cleft rhinoplasty group.

	Mean (SD)		p value	Change (%)
	Preoperatively	Postoperatively		
NH RS (cm)	1.25 (0.49)	1.74 (0.70)	<0.001	44
NH LS (cm)	1.29 (0.50)	1.78 (0.62)	<0.001	39.54
NW RS (cm)	2.42 (0.76)	2.01 (0.68)	<0.001	−29.75
NW LS (cm)	2.57 (0.76)	1.94 (0.65)	<0.001	−28.79
NGA RS (mm^2)	244.38 (127.2)	329.68 (153.71)	<0.001	46.30
NGA LS (mm^2)	266.82 (136.99)	331.14 (156.74)	0.002	51.74
NTP (cm)	2.28 (1.17)	4.73 (1.57)	<0.001	63.60
ABW(cm)	5.39 (1.31)	4.99 (1.33)	<0.001	−13.54
NHR	1.07 (0.29)	1.65 (0.10)	0.203	-
NWR	1.09 (0.25)	1.05 (0.43)	0.547	-
NGAR	1.01 (0.26)	1.11 (0.20)	0.009	-

RS: right side; LS: left side; NH: nostril height; NW: nostril width; NGA: nasal gap area; NHR: nostril height ratio; NWR: nostril width ratio; NGAR: nasal gap area ratio.

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radiographs, rhinomanometry, and psychological and panel evaluations between centres.[11–14] All these have been devised to enable clinicians to analyse outcomes objectively, but as with all clinical investigations, it is almost impossible to eliminate bias due to aesthetic subjectivity.[5,6]

The method we have used to analyse nasal symmetry, indirect anthropometry using standardised 2-dimensional photographs with basal views,[5,15–18] makes it possible for us to analyse our surgical results as objectively as possible.[12] Furthermore, sharp facial profile contours on the photographs could eliminate the differences between direct and indirect measurements. Difficulties with accurate measurements of distances and angles on photographs arise from the absence of 3-dimensional curvatures and contours of the face, and are further complicated by variations in times, places, personnel, camera equipment, and photography techniques. This observation bias can be eliminated by constructing ratios from the primary measurements, and by the use of intraobserver and interobserver reliability tests, as asymmetry in the shape of the nostrils is the most sensitive index of nasal deformity.[1] The accuracy of anthropometric measurements on 2-dimensional photographs taken in frontal, lateral, and basal views has been compared with direct measurements and has proved to be reliable.[5,6,19]

Preoperatively in both our groups, the nostrils were asymmetrical with significantly distorted shapes in terms of width, height, and nostril gap area. Postoperative NH on the cleft side in the unilateral group showed predictable improvement of 5-6 mm (Table 3). These improvements were achieved by suturing the lower lateral cartilages to the septal graft and by superior positioning of the domes, along with a columellar-philtral skin advancement flap. Lindsay and Farkas found close to 5 mm shortening of the columella on the cleft side, which also improved as the increased nostril height presented as an overall increment in columella length.[20]

In the unilateral group, a significant reduction of 3-4 mm in NW on the cleft side remained stable on long-term follow up (Table 3). In the bilateral group, the change in the NWR was not significant (Table 4). This showed that the preoperative NWR had been maintained because the height of the nasal columella in this group was reduced more that it was in the unilateral group, and preoperatively the bilateral nasal width was normal. This can be affected by the severity of the cleft deformity as well as the type of primary nasal repair.

Flores and Sailon conducted a retrospective review of secondary cleft rhinoplasty using a combination of the Dibbell and Tajima techniques, and photogrammetric analysis of preoperative and postoperative photographs showed a statistically significant reduction in ABW of about 8% (19.9 mm versus 18.2 mm; $p<0.01$) on the affected side, along with a significant increase in the height of the columella and apex of the nostril.[21] Compared with this, our technique achieved a significant improvement in ABW in both groups, with a reduction of 11% (4-5 mm) in the unilateral group and 13% (5-6 mm) in the bilateral group (Tables 3 and 4). These observations suggest that our technique has achieved good

Fig. 6. Unilateral cleft rhinoplasty preoperatively and postoperatively (12 months' follow up).

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Fig. 7. Bilateral cleft rhinoplasty preoperatively and 18 months postoperatively.

symmetry of the alar base with the help of two sling sutures of bilateral alar nasalis muscles.

The improvement in NGA was statistically significant in both groups (Tables 3 and 4), and the overall quantitative improvements of this resulted from the cumulative effects of improvements in NH, NTP, and the removal of skin hooding of the nasal soft triangle. The Tajima technique, which was used on the cleft side, repositioned the alar cartilage and recontoured the overhanging soft-tissue envelope of the nose. Conversion of external skin of the alar web to nasal lining to correct the alar-columellar web also helped to correct the deficiency in nasal vestibular skin associated with the cleft lip nasal deformity. This surgical technique in both primary and secondary cleft rhinoplasty showed the most improvement in symmetry.[22,23]

Another important factor for the assessment of nasal form is the NTP, which increased in both groups (Tables 3 and 4). These improvements can be attributed to the long columellar strut graft that was fixed securely to the bone, and the columellar-philtral skin advancement flap. Byrd et al stated that the projecting columellar strut can be used in conjunction with domal mattress sutures for over-projection of the domal segment by approximately 7 - 8 mm above the plane of the dorsum to compensate for a tighter soft-tissue envelope.[24] In patients with thick skins, the domal projection needs to be increased further to 10-12 mm above the plane of the dorsum.

Interobserver reliability showed moderate to excellent agreement except for NGA in the unilateral group (Tables 1 and 2). In the unilateral group the ICC for NGA showed poor agreement in marking of the outline, and this might have been because of the soft triangle hood and displaced alar base on the cleft side.

As with any surgery, suboptimal results presented in six participants in the form of a drooping alar rim, while two others showed internal collapse of the nasal valve, which could not be predicted based on the nature of the surgical procedure. These sequelae resulted from wound dehiscence and excessive scarring, and were promptly and adequately managed using appropriate techniques.

Conclusion

The technique described here has achieved significant changes in the cleft lip nasal deformity from the aesthetic point of view (Figs. 6 and 7). The method of linear measurement on 2-dimensional photographs is highly precise and useful. However, long-term aesthetic evaluations using multiple modalities including 3-dimensional photography and functional volumetric evaluation are recommended for further evidence-based support.

Conflict of interest

We have no conflicts of interest.

Ethics statement/confirmation of patients permission

Ethics approval not required. Patients' permission obtained.

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