ORIGINAL ARTICLE

The Study of Facial and Nasal Symmetry in Patients with Unilateral Cleft Lip Achieved by Primary Cleft Lip Repair with Rhinoplasty Plus Postoperative Nasal Appliance "Nasoform"

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Objective: To evaluate nose, lip, and face symmetry in patients with unilateral cleft lip who used "Nasoform" as a postoperative nasal appliance.

Materials and Methods: The present cross-sectional study included twenty-two patients with unilateral cleft lip aged four to nine years. Their facial defects were surgically addressed in childhood, and Nasoform was used to preserve the surgical results for at least six months. Each volunteer's face was photographed with a DSLR camera and macro lens. Five photographs were taken in frontal view during rest, social smile, big smile, lip purse, and cheek puff, and one was taken in submental view. The images were processed using Keynote software, and specific facial landmarks were identified and measured. The measurements on the cleft sides were divided by those on the non-cleft sides. A result of one indicated perfect symmetry. The conformity to the neoclassical canons of facial proportions was also considered.

Results: In the frontal view, the calculated results of alar width, philtrum height, and vermillion height were close to one. In the submental view, the calculated results of columella length and nostril width were close to one. However, in some postures, the results deviated statistically from the ideal ratio. The inter-alar line and inter-commissure line were harmonized with the interpupillary line. The ratio of interocular width to alar width conforms to the neoclassical canons proportion.

Conclusion: The protocol of using Nasoform after primary cleft lip repair with rhinoplasty for at least six months could provide balance and symmetry to the face.

Keywords: Unilateral cleft lip; Cleft lip repair; Rhinoplasty; Symmetry; Nasoform; Nasal stent

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The human face is the most complex and recognizable part of the body, as it expresses identity and emotion. Since esthetic concerns are as important as functional demands, facial appearance is considered a consequential step in the long-term treatment of facial abnormality. For decades, the concepts of symmetry and proportion have been widely used and positively correlated with facial attractiveness[1]. Facial symmetry also profoundly impacts mate selection since it can be instantly recognized by visual cognition. More symmetrical faces are appealing in both still and moving images[2].

Prior to reconstructive surgery, the following considerations must be considered, psychological status, severity of deformity, postoperative scarring, growth and development, and overall facial aesthetics. Nowadays, surgeons are advised to incorporate four primary instruments, symmetry, sexual dimorphism, averageness, and youth, into the neoclassical canons for facial esthetic evaluation and to gain a better comprehension of each distinguishing characteristic among individuals and various tribes[1,3,4].

Cleft lip is a common congenital anomaly that affects facial appearance. Despite undergoing surgical repair for the cleft, patients frequently endure childhood and young adulthood challenges such as dissatisfaction with their facial appearance and persecution in the form of taunting and bullying[5].

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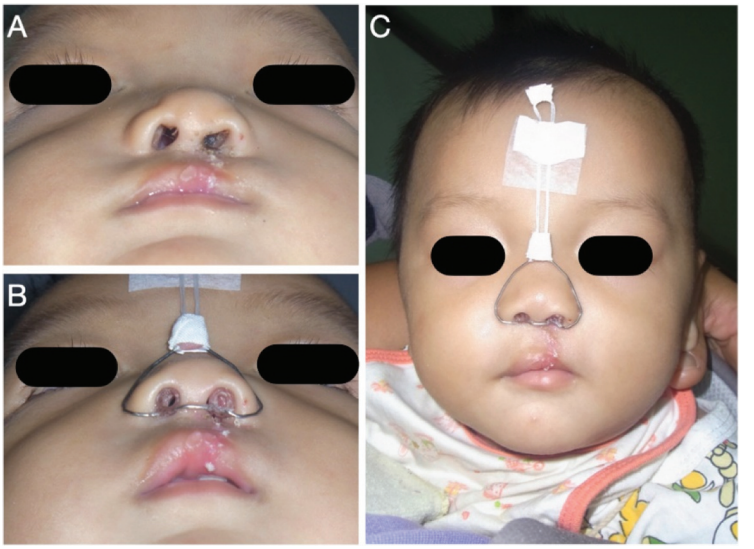

Figure 1. Nasoform was used after the operation of primary cleft lip repair with rhinoplasty. (A) The collapse of nose after surgery, (B) The shape of nose was reformed by Nasoform, (C) The position of nose was maintained by Nasoform.

Even though none of the patients reported any dissatisfaction with the overall appearance of their faces, 54% of respondents reported that they were dissatisfied with some individual facial features. The dissatisfaction was ranked in descending order as follows: their nose, their lip, their profile, their smile, their teeth, and the shape of their face. These features were directly affected by the cleft. Twenty-five percent of respondents reported that they had been teased because of their cleft. Names referring to their nose, face, and lips were used "Squashed noses" and "Bent nose" were the most used[6].

The key to the success of the cleft care team in terms of function and satisfaction is early treatment and proper planning. Primary cleft lip repair with rhinoplasty was performed on infants a few months old. The goal is to reposition the alar base and the lower lateral cartilage, close the nasal floor, provide better symmetry, and create the nasal sill[7,8].

Hence, primary cleft lip repair with rhinoplasty has a direct impact on reducing psychological trauma, balancing nasal growth, reducing residual deformities, and producing a consistent outcome into adulthood[8-10]. However, surgical correction of nasal asymmetry alone may not yield a noticeable outcome and remains a challenging task for any surgeon. Various types of postoperative nasal stents demonstrate a propensity to enhance esthetics outcome, nasal symmetry, and reduce the deterioration effects from scar contraction and the relapsing nature of lower lateral cartilage[11-13].

Nasoform, a nasal appliance, was developed in 2013 to satisfy the user's needs. It is comprised of a stainless-steel frame that holds two acrylic supporting tubes and one acrylic button. The stainless-steel frame can be adjusted to control the action of force, the alignment of the nasal base, and the alar position. Two acrylic supporting tubes were inserted into the nostrils to mold the shape of the corrected nose. The holding strap attached to the acrylic button functions as an extension for taping to the forehead[14,15].

The objective of the present study was to analyze the symmetry of the nose, lip, and face in patients with unilateral cleft lip using the "Nasoform" as a postoperative nasal appliance. The emphasis on symmetry encompassed both static and dynamic postures.

Materials and Methods

Samples preparation

The present study was a cross-sectional study that included twenty-two Thai patients and comprised 14 males and eight females with unilateral cleft lip, aged four to nine years, who underwent primary cleft lip repair with rhinoplasty via rotational advancement technique. The postoperative nasal appliance "Nasoform" form a cleft care team of Chiang Mai University was applied after surgery for a minimum of six months to preserve the surgical outcome (Figure 1). Their parents consented to their participation in the present study. The study was carried out at the Faculty of Dentistry, Chiang Mai

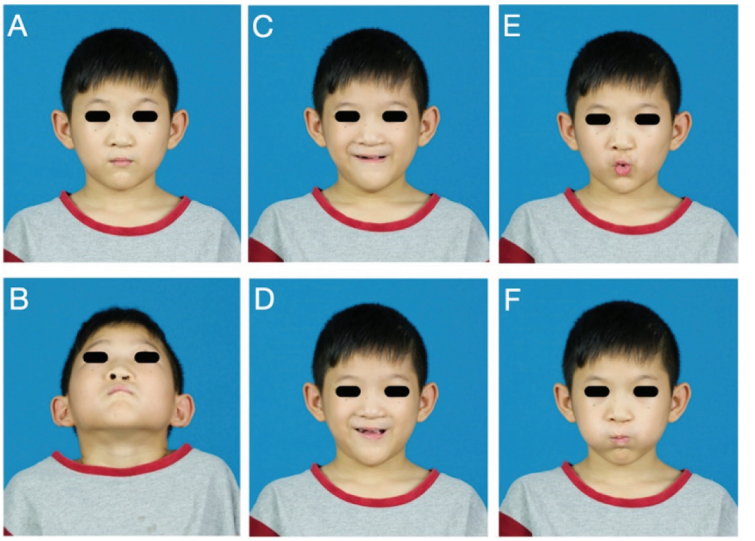

Figure 2. The photographs used for measurement. (A) Frontal view during rest, (B) Submental view, (C) Frontal view during a social smile, (D) Frontal view during a big smile, (E) Frontal view during lip purse, (F) Frontal view during cheek puff.

University, Thailand, with ethical approval No. 34.1/2021.

Photography setup

The photographs of volunteers were taken by using a digital single-lens reflex camera (Canon EOS 80D) mounted with a 100 mm f/2.8L macro IS USM lens supported on a tripod. The modified quarter-light system was used to control the environment of the photography[16]. The two identical studio flashes were positioned in front of the samples and at a 45-degree angle from the middle line. The distance between volunteers and the blue background was two meters. The volunteers were positioned on a chair three meters away from the camera.

For frontal view photography, the volunteers were instructed to sit comfortably and look straight at the lens. The interpupillary line was set parallel to the floor. In this view, five photographs of face were taken during rest, social smile, big smile, lip purse, and cheek puff postures. For submental view photography, the volunteers were instructed to tilt the head backward until the inter-commissure line was at the same level as the upper borders of the ears and focus the eyes on the ceiling. In this view, one photograph close-up of the nose was taken. The photographs used for measurement are shown in Figure 2.

All frontal and submental view photographs were captured by a single photographer following the guidelines established by the Council of the European Association for Cranio-Maxillo-Facial Surgery, approved in November 2005[17].

Analysis of photographing

Each photograph was imported to the Keynote software (version 12.2, macOS Ventura). A grid was used to maintain every picture of each sample before plotting and measuring. Reference lines and soft tissue landmarks were plotted, and the description provided by previous studies were used to define the landmarks of the nose and lip[1,18-20], as presented in Figure 3.

Soft tissue landmarks were chosen based on the following principles, 1) they had to be visible and distinct in every photograph, 2) they had to be reliable, 3) they could not move or change due to clothing or hairstyle, and 4) they had to provide evidence in the scientific community.

The facial midline and the interpupillary line were used as vertical and horizontal reference lines, respectively. The subnasale line was drawn through the subnasale point and parallel to the interpupillary line. Based on the two-dimensional photogrammetry technique, the linear distances were measured in millimeters.

As present in Figure 4 and 5, the measurements were categorized and interpreted into three groups, the nasal component symmetry index, the perioral component symmetry index, and the overall facial symmetry index. The linear measurements of the cleft side were divided by the non-cleft side. The result of one means absolute symmetry. The closer the ratio was to one, the greater symmetry was observed.

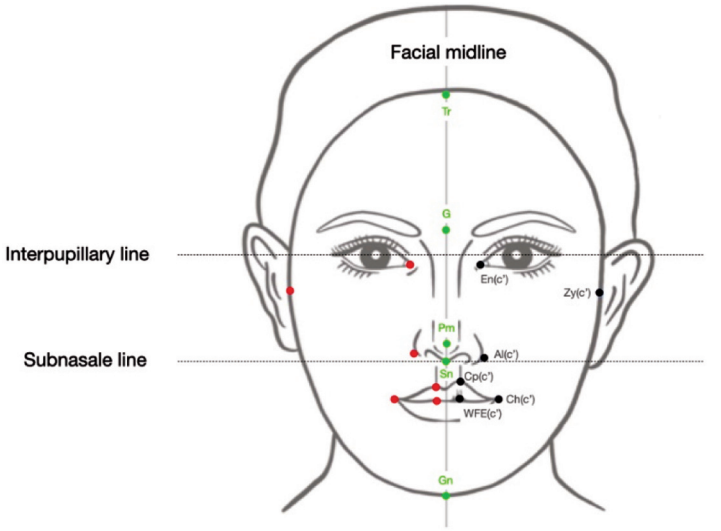

Figure 3. The reference lines and soft tissue landmarks.

En=endocanthion, Zy=zygoma, Sn=subnasale, Al=alar, CP=Cupid's peak, Ch=cheilion, WFE=vermillion free edge
Green dots=soft tissue landmarks that lie on the facial midline, Red dots=soft tissue landmarks that lie on the non-cleft side (n'), Black dots=pairing landmarks of red dots that lie on the cleft-side (c')

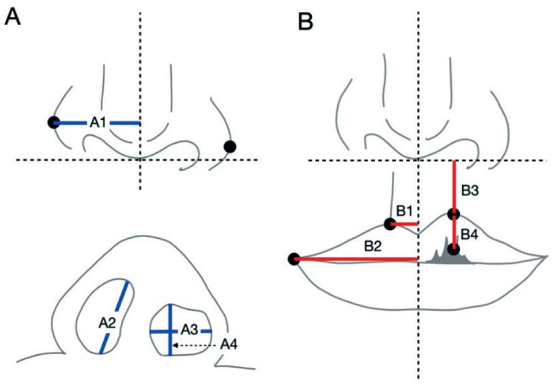

Figure 4. (A) Nasal component symmetry index - Alar width ratio: A1(c')/A1(n'), Columella length ratio: A2(c')/A2(n'), Nostril width ratio: A3(c')/A3(n'), Nostril height ratio: A4(c')/A4(n'). (B) Perioral component symmetry index - Cupid's bow width ratio: B1(c')/B1(n'), Cheilion width ratio: B2(c')/B2(n'), Philtrum height ratio: B3(c')/B3(n'), Vermillion height ratio: B4(c')/B4(n').

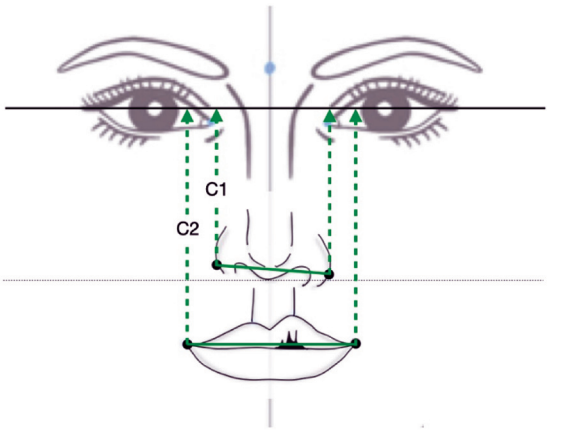

Figure 5. Overall facial symmetry index (horizontal plane) - Alar to interpupillary line ratio: C1(c')/C1(n'), Cheilion to interpupillary line ratio: C2(c')/C2(n').

The proportions of the neoclassical canons were calculated. A ratio closer to the neoclassical canons indicates their conformity to the population.

Study error and statistical analysis

The data similarity between the individual and the second examiner were verified by relocating the landmarks and measuring the distances within a two-week period. Both examiners had a background in the dental field and could identify soft tissue landmarks and linear measurements.

The value of the intraclass correlation coefficient (ICC) was 0.97 at 95% confidence interval, which showed significant consistency between the main and repeated records. The value of the interclass ICC was 0.95 at 95% confidence interval, which showed significant consistency between the main and the second examiners.

The ratio between the cleft side and non-cleft side distances and the neoclassical canons proportion was calculated. IBM SPSS Statistics, version 25.0 (IBM Corp., Armonk, NY, USA) was used to assess

Table 1. The result of nasal component symmetry index

Nasal component symmetry index	Ideal ratio	Cleft side/non cleft side; mean±SD				
		Rest posture	Social smile	Big smile	Lip purse	Cheek puff
A1 alar width	1	0.972±0.064	0.959±0.088	0.959±0.075	0.946±0.084	0.927±0.1008
p-value		0.058	0.038[a]	0.018[a]	0.008[a]	0.006[a]
A2 columella length	1	0.900±0.226	N/A	N/A	N/A	N/A
p-value		<0.001[a]				
A3 nostril width	1	1.002±0.276	N/A	N/A	N/A	N/A
p-value		<0.001[a]				
A4 nostril height	1	0.868±0.212	N/A	N/A	N/A	N/A
p-value		<0.001[a]				

SD=standard deviation; N/A=not applicable
[a] Difference is significant at p<0.05

Table 2. The result of perioral component symmetry index

Perioral component symmetry index	Ideal ratio	Cleft side/non cleft side; mean±SD				
		Rest posture	Social smile	Big smile	Lip purse	Cheek puff
B1 Cupid's bow width	1	1.659±0.655	1.581±0.535	1.544±0.580	1.557±0.602	1.237±0.660
p-value		<0.001[a]	<0.001[a]	<0.001[a]	<0.001[a]	0.116
B2 cheilion width	1	1.059±0.140	0.949±0.239	0.995±0.076	1.255±0.281	1.137±0.288
p-value		0.065	0.326	0.754	<0.001[a]	0.041[a]
B3 philtrum height	1	0.928±0.142	0.931±0.150	0.936±0.154	0.850±0.343	0.956±0.178
p-value		0.032	0.047	0.073	0.059	0.265
B4 vermillion height	1	0.989±0.206	1.138±0.318	1.120±0.304	1.030±0.263	1.11±0.359
p-value		0.808	0.060	0.086	0.606	0.187

SD=standard deviation
[a] Difference is significant at p<0.05

the mean and standard deviation of the calculated values, and the differences from ideal ratio. The descriptive analysis was used to explain the proximity to the ideal ratio. The one-sample t-test was used to determine whether the calculated ratio deviated from the ideal ratio at a 95% confidence level or an alpha level of 0.05, with a p-value of less than 0.05.

Results

The mean and standard deviation of the nasal component symmetry index, perioral component symmetry index, and overall facial symmetry index are shown in Table 1-3.

Nasal component symmetry index

The alar width ratio in frontal view was close to the ideal ratio in every posture. The significant differences from the ideal ratio were found during social smile, big smile, lip purse, and cheek puff.

When viewed from a submental in rest posture, the nostril height ratio deviated the most from the ideal ratio. The shorter nostril height on the cleft side was considered. However, all three parameters in this view, the columella length ratio, nostril width ratio, and nostril height ratio, differed significantly from the ideal ratio.

Perioral component symmetry index

The cupid's bow width ratio in frontal view deviated the most from the ideal ratio in all postures. The significant differences of this parameter were found during rest posture, social smile, big smile, and lip purse. The wider cupid's bow width on the cleft side was considered.

The cheilion width ratio was significantly different from the ideal ratio only during lip purse and cheek puff.

The philtrum height ratio and the vermillion height ratio did not show significantly different from the ideal ratio in all postures.

Overall facial symmetry index

For the horizontal plane, the alar to interpupillary line ratio and the cheilion to interpupillary line ratio were close to the ideal ratio in all postures. These represented the harmonization of the inter-alar line

Table 3. The result of overall facial symmetry index

Overall facial symmetry index	Ideal ratio	Cleft side/non cleft side; mean±SD				
		Rest posture	Social smile	Big smile	Lip purse	Cheek puff
Horizontal plane						
C1 alar to interpupillary line	1	0.996±0.049	0.996±0.039	0.992±0.056	0.977±0.030	0.975±0.076
• p-value		0.694	0.638	0.511	0.001[a]	0.139
C2 cheilion to interpupillary line	1	0.986±0.023	0.990±0.026	0.995±0.028	0.993±0.021	0.989±0.025
• p-value		0.008[a]	0.094	0.449	0.133	0.054
Neoclassical canons proportion						
Interocular width to alar width	1	0.969±0.086	N/A	N/A	N/A	N/A
• p-value		0.102				
Bizygomatic width to alar width	4	3.468±0.313	N/A	N/A	N/A	N/A
• p-value		<0.001[a]				
Inter-commissure width to alar width	1.5	1.053±0.237	N/A	N/A	N/A	N/A
• p-value		<0.001[a]				

SD=standard deviation; N/A=not applicable

[a] Difference is significant at $p<0.05$

and the inter-commissural line with the interpupillary line. However, a significant difference from the ideal ratio was found during lip purse for the alar to interpupillary line ratio and in rest posture for the cheilion to interpupillary line ratio.

For neoclassical canons proportion, the interocular width to alar width ratio was close to the ideal ratio, while the bizygomatic width to alar width ratio and the inter-commissure width to alar width ratio were significantly lower than the ideal ratio.

Discussion

Patients with unilateral cleft lip and palate frequently present notable asymmetrical features of the nose, such as the deviation of the anterior septum, malposition of the alar cartilage, inferior and lateral displacement of the lower lateral cartilage, oblique and short columella, and depression of the nasal tip[11,21]. The symmetrical appearance achieved immediately following primary surgery tends to diminish with time because of the degree of any remaining abnormality, the memory of the affected alar cartilage, and the scarring effects. It has been believed that less invasive surgical techniques, coupled with postoperative maintenance devices, may potentially reduce the complexity and frequency of rhinoplasty procedures in the future[11].

Nasal symmetry is an important consideration in patients with cleft lip due to its prominent location at the center of the face and its proximity to the cheeks and lips, which are involved in various functions and expressions. Therefore, assessing a restored nose and lip in static and dynamic postures is crucial because everyone has unique beauty and attractiveness. The present study examined the symmetry in frontal view and submental view obtained from face photography, as previously reported in the prior studies[11,13,22,23].

The alar width ratio [A1(c')/A1(n')], which is close to one in every posture, should be the optimal outcome of a stainless-steel framework that was placed adjacent to the alar contour. It serves to limit the broadening of the alar on the cleft side. An effective fixation of the alar position lessened the impact of the cheek and lip muscles on the nose shape. The significant differences found during social smile, big smile, lip purse, and cheek puff could reflect the effects of muscle function.

Even though the nostril width ratio at 1.002±0.276, the nostril height ratio at 0.868±0.212, and the columella length ratio at 0.900±0.226 were significantly different from the ideal ratio, these findings aligned with prior studies. Chang et al.[23] found that patients who used nasal stents after primary rhinoplasty had a nostril width ratio and nasal height ratio of approximately 1.235±0.345 and 0.806±0.113, respectively. Funayama et al.[11] found the benefit of using nasal stents after primary lip repair compared to the control group, which did not use an appliance. The patients who used only nasal stents after primary lip repair had a nostril width ratio, nasal height ratio, and columellar length ratio of approximately 0.87, 1.30, and 0.85, respectively. It could be assumed that Nasoform, used as a postoperative appliance, is beneficial to patients.

The symmetry of the lip was an important issue since it is a moveable organ that connects to the alar

base. An optimal philtrum height and vermillion height can be attributed to the efficacy of nasal fixation, an advantageous feature of Nasoform. The nasal component supports the nasal base against tension from lip muscles and strain from scar tissue during muscle movement, facilitating the creation of a symmetrical lip on the vertical axis.

In the present study, the cupid's bow width ratio was more than one in all postures, at 1.237 to 1.659, and the cheilion width ratio was more than one during lip purses, at 1.255±0.281 and cheek puffs at 1.137±0.288. Even though Al-Rudainy et al.[24] found that at a 4-year follow-up assessment, the residual asymmetry had changed to involve both the philtrum and the nares. Since the nostril width ratio in the present study was close to one, it could be suggested that both parameters could be improved by altering the surgical technique.

The proximity of the alar to the interpupillary line [C1(c') and C1(n')], which is close to one in every posture, could be related to a stainless-steel framework positioned underneath the alar base. The force of the lip muscle and scar contraction on the base of the nose was minimized by an effective fixation of the alar base.

The closeness of the cheilion to the interpupillary line [C2(c') and C2(n')] and the alar to the interpupillary line [C1(c') and C1(n')], reflect the concordance between the interpupillary line, the inter-alar line, and the inter-commissural line. This harmony contributes to a beautiful and balanced facial appearance[25].

In the frame of neoclassical canons facial proportion, the data showed the consistency of the proportion between the alar width and the interocular width. The result represented the successful creation of the beautiful proportions on the patient's face. The surgical correction cannot alter the ratio of the alar width to the bizygomatic width and the inter-commissural width. The Neoclassical canons can be utilized as an initial point of reference to achieve symmetry and closeness to the norm[1].

Even though postoperative nasal stents have gained popularity, they are not implemented by all cleft centers because their effectiveness is still up for debate. The study conducted by Niimi et al.[26] introduced the utilization of nasal stents for a minimum duration of six months after surgery to prevent deformities. Similarly, the study conducted by Yeow et al.[13] addressed using nasal stents to preserve the desired outcomes. The long-term efficacy of nasal stents is being questioned, and there is currently no consensus on the optimal postoperative appliance recommendation.

In the present study, the verification of symmetry was divided into three components, nasal, perioral, and facial. The attention was focused on a group of patients with cleft lip aged four to nine years who used Nasoform for at least six months following cleft lip repair with rhinoplasty. The ideal ratio was used as a standard for comparison without accounting for the fact that this ratio is not present in ordinary people. The comparison with the control group was intentional because the prior studies showed the advantage of using a postoperative nasal stent[11,22,23]. According to the results and the comparison with prior studies, Nasoform is beneficial for patients.

The present study encountered limitations, notably the absence of long-term postoperative measurements and a small sample size. To address these shortcomings, future investigations could adopt a prospective design with a larger sample size, incorporating data collection at various intervals following the initial application of Nasoform such as three, six, and nine months. Such an approach would facilitate the observation of Nasoform's evolving symmetry and efficacy over time, thereby contributing to consensus development and a comprehensive analysis of postoperative outcomes.

Two-dimensional assessment using a single camera offers advantages, including simplicity, non-invasiveness, and effectiveness in soft tissue identification. In the present study, linear measurements encompassing nostril width, nostril height, and columella length provided valuable and reproducible data, facilitating comparable observations with future studies. However, this method presents challenges, particularly in its unsuitability for young children and the necessity of allowing time for sample acclimatization before data collection. Using the ratio, the parallax effect introduced by a tilted head during photography and the refraction caused by the distance between the subject and the camera were resolved.

Three-dimensional assessment[27] utilizes innovative technologies such as facial scanners, intraoral scanners, and multiple camera captures. However, it comes with a high cost, necessitating standardized scanner systems for inter-study comparisons. For optimal research outcomes, expertise in utilizing the tools is essential, along with validating their accuracy before data collection. This ensures that the research is conducted with precision and reliability.

According to Van der Heijden et al.[28], additional research could address the limitations by implementing a randomized control trial. The population should have clear inclusion criteria because the degree of severity of cleft lip and palate has a different effect on nasal symmetry. Collecting data at different intervals, such as pre-surgery and post-surgery, can give information on the effectiveness of the appliance, the additional effect of surgery or surgery with a postoperative appliance, and the timing of relapse. The study of growth with a postoperative nostril retainer could potentially help in understanding the long-term success of symmetry from a postoperative appliance, the timing of relapse, and the need for secondary repair.

Conclusion

The protocol of using Nasoform after primary cleft lip repair with rhinoplasty for at least six months could provide balance and symmetry to the face.

What is already known on this topic?

Postoperative nasal stents aid in preserving surgical outcomes, preventing nasal collapse due to scar formation, and maintaining the desired nasal morphology. Cleft centers offer a variety of preferred treatment options.

What does this study add?

The "Nasoform" postoperative nasal appliance provides nasal symmetry to a close-to-normal morphology during both repose and function.

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Conflicts of interest

The authors declare no conflict of interest.

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