A Three-Dimensional Comparison of Nasolabial Soft Tissue between Children with Repaired Unilateral Complete Cleft Lip and Palate and Unaffected Children in Khon Kaen, Thailand

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Objectives: *The objectives were to assess the treatment outcomes of unilateral cleft lip and palate after primary surgery on nasolabial soft tissue of children ages 4-5 years old as compared with unaffected children and to establish a nasolabial soft tissue norm within Khon Kaen.* ***Study design:*** *This cross-sectional study consisted of 60 unaffected subjects living in Khon Kaen province and 20 subjects with repaired complete unilateral cleft lip and palate who were treated at Srinagarind Hosipital, Khon Kaen, Thailand. 3D images were taken by a Morpheus 3D Scanner and measured by the Morpheus 3D program. Independent t-tests and paired t- tests were used to analyze the significant differences between subjects with cleft and unaffected subjects.* ***Results:*** *There were statistically significant differences ($p<0.05$) of nasolabial measurements between affected subjects and unaffected subjects. Unilateral measurements showed decreased nostril height, columella lengths, and nose protrusion from ala base and ala length in the affected group. In addition, bilateral measurements found decreased upper lip protrusion, philtrum length, upper lip height, upper vermillion thickness, and lip angle.* ***Conclusion:*** *This study attempted to establish a norm for evaluating the treatment outcome of cleft lip and cleft palate repair at Srinagarind Hospital in relation to unaffected or noncleft individuals. The results suggest that the noncleft side in affected patients is not an optimal surgical guide for cleft repair and the surgeon should correct both sides of lip and nose features according to the norms. A surgical treatment plan should emphasize correcting nostril height, columella length, nose protrusion from ala base, ala length, and upper lip features.*

Keywords: *Nasolabial soft tissue norm, Repaired unilateral complete cleft lip and palate*

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INTRODUCTION

Cleft lip and cleft palate are the most common innate abnormalities in Thailand with incidence of the condition at 1.51 per 1000 total live births.[1] To correct abnormalities, treatment should begin from infanthood, such as cheiloplasty at 3-6 months old and palatoplasty at 10-18 months old. After patients have undergone an operation, some residual deformities usually occur until adulthood, especially in the nasolabial area. Consequences of residual deformities can include: depression of the cleft side dome; shortening of the cleft side columella, lateral, and inferior; and posterior deviation of the cleft side alar base.[2] Factors affecting the severity of deformities include severity of cleft, potential growth of the patients, primary surgery technique, and post-operative care.

Several studies have assessed important treatment outcomes to improve treatment protocol and develop treatment techniques. Americleft and Eurocleft studies have demonstrated many aspects of treatment outcomes in patients with repaired unilateral complete cleft lip and palate. Special attention has been paid to nasolabial appearance, as it impacts the patient's and parents' satisfaction.[3, 4] For Thais, Thittiwong found that lips and noses are the main features affecting patient satisfaction.[5]

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Assessment methods have been used to determine treatment outcomes and indications for lip-nose revision surgery subsequent to primary surgery. Qualitative assessment involves subjective perception of deformity without performing any measurements and by using photographs of nasolabial areas in frontal and lateral views.[6-9] Quantitative measurement of defined facial landmarks, in contrast, employs calipers and rulers to direct measurement using 2D or 3D photographs.[10-13] This method is the most precise and well-accepted by experts.[10]

Tawanchai Cleft Center, Khon Kean University, Khon Kaen, Thailand, still lacks assessment of treatment outcomes and there is no obvious consensus on assessment of the nasolabial soft tissue or criteria for lip-nose revision surgery in young children who are participating in the school environment and are likely to be bullied and teased.[14, 15] Therefore, this research was conducted to assess the treatment outcomes after primary cleft lip and palate surgery on nasolabial soft tissue using a comparison of nasolabial soft tissue measurements between 4- to 5-year-old unaffected children and children with repaired unilateral complete cleft lip and palate and also compared cleft and noncleft side in each subject. This will help surgeons and orthodontists to assess the success of treatments and to improve the surgical techniques and considerations for cleft lip-nose revision surgery.

MATERIALS AND METHOD

All subjects in the cleft group had undergone repaired unilateral complete cleft lip and palate surgery at Srinagarind Hospital, Khon Kaen University. The mean age at time of assessment was 4.5 years (4-5.5 years). They had typical growth and development, no history of facial trauma or accident, and no syndromic or underlying disease. Techniques that used in subjects were modified Millard and two-flap palatoplasty technique. There were 11 females and 9 males. The control group was of 30 females and 30 males living in Khon Kaen Province and with a mean age of 4.9 (4.1-5.5) years. All unaffected subjects were healthy children with no history of facial trauma or accident and with dental Class I occlusion according to British Standard Classification. All subjects were of Thai nationality. Demographic characteristics of the subjects are presented in Table 1.

3D photographs and measurements

Standard 3D photographic images were taken in frontal, 45° right, and 45° left positions using a Morpheus 3D Scanner. All subjects were set at a 45°upward head position with centric occlusion and lips relaxed (Figure 1). The photographs were taken at 65 cm from the frame. To standardize the measurements in this study, the anatomical landmarks were plotted (Table 2) and each parameter was measured twice by the same operator. The 27 linear measurements, 2 angular measurements, and 1 proportion related to nose and lip appearance and facial proportion were modified from Farkas (1993), Zreaqt (2012), Othman (2016), Bagante (2018), and Meng (2015).[13, 16-18] All landmarks were measured by the Morpheus 3D program in both frontal and lateral views. (Table 3)

Figure 1 3D photographs in frontal and lateral views with anatomical landmarks (Table 2)

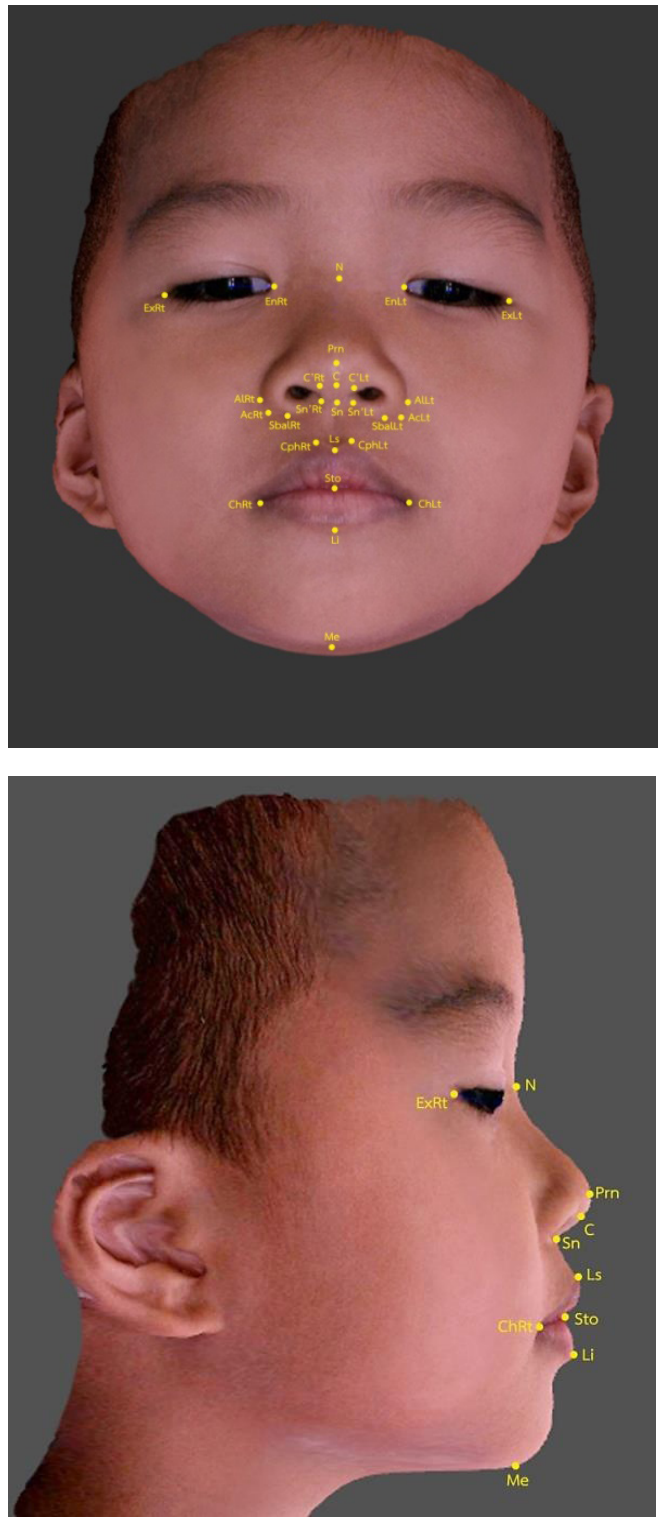

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Table 1 Demographic characteristics of affected and unaffected groups

Characteristics	Affected group	Unaffected group
Sex		
Female	11	30
Male	9	30
Age (years)	4.5 (4.0- 5.5)	4.9 (4.1-5.5)
Weight		
Female (Standard 13.0-21.7 Kg)	14.8 (12.0-17.0)	15.2 (12.0-25.0)
Male (Standard 13.6-22.6 Kg)	18.6 (11.5-39.0)	16.5 (14.0-25.3)
Height		
Female (Standard 95.0-106.9 cm)	101.8 (95.0-108.0)	103.6 (94.0-112.0)
Male (Standard 95.5-115.1 cm)	101.7 (95.0-107.0)	106.4 (97.0-115.0)
Normal growth development	90% (Thin = 2 children)	98.33% (Thin = 1 child)
Cleft side		
Right	7	
Left	13	
Technique of primary surgery		
Cheiloplasty	Modified Millard technique	
Palatoplasty	Two-flap palatoplasty technique	

Table 2 List of anatomical landmarks in this study

Abbreviation	Landmarks	Definitions
ExRt	Right exocanthion	Right outer commissure point of eye fissure
ExLt	Left exocanthion	Left outer commissure point of eye fissure
EnRt	Right endocanthion	Right inner commissure point of eye fissure
EnLt	Left endocanthion	Left inner commissure point of eye fissure
N	Soft tissue Nasion	The midpoint of the naso-frontal suture
Prn	Pronasale	The most prominent point of the tip of the nose
Sn	Subnasale	The junction between the lower border of the nasal septum, the partition that divides the nostrils, and the cutaneous portion of the upper lip in the midline
Sn'Rt	Right Subnasale'	The point at the right margin of the midportion of the columella crest
Sn'Lt	Left Subnasale'	The point at the left margin of the midportion of the columella crest
C	Top point of the columella	The midpoint of the columella crest at the level of the nostril top points
C'Rt	Right superior point of the nostril	The highest point of the right nostril or the superior terminal point of the nostril axis
C'Lt	Left superior point of the nostril	The highest point of the left nostril or the superior terminal point of the nostril axis
AlRt	Right alare	The most infero-lateral point on the nasal ala on the right side
AlLt	Left alare	The most infero-lateral point on the nasal ala on the left side
SbalRt	Right subalare	The point on the lower margin of the base of the right nasal ala where the ala disappears into the upper lip skin
SbalLt	Left subalare	The point on the lower margin of the base of the left nasal ala where the ala disappears into the upper lip skin
AcRt	Right Alar curvature point	The most lateral point on the curved base line (alar groove)
AcLt	Left Alar curvature point	The most lateral point on the curved base line (alar groove)
CphRt	Right. crista philter	The point on the crest of the philtrum on the right side, the vertical groove in the median portion of the upper lip, just above the vermilion border
CphLt	Left crista philter	The point on the crest of the philtrum on left side, the vertical groove in the median portion of the upper lip, just above the vermilion border
Ls	Labiale superius	The midpoint of the vermilion border of the upper lip
ChRt	Right.Cheilion	The most lateral point on the right side of gently closed lips
ChLt	Left cheilion	The most lateral point on the left side of gently closed lips
Sto	Stomion	The midpoint of the labial fissure when the lips are closed naturally
Li	Labiale inferius	The midpoint of the vermilion border of the lower lip
Me	Soft tissue Menton	The lowest median landmark on the lower border of the chin

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Table 3 Orofacial parameters in this study (bilateral and unilateral measurements)

	Measurement	Plane	Definition
Bilateral measurement	Alar base width	Horizontal	The most lateral point on the nasal ala from the right side to the left side (AlRt–AlLt)
	Subnasal width	Horizontal	The point on the lower margin of the base of the nasal ala where the ala disappears into the upper lip skin from the right to left side (SbalRt–SbalLt)
	Upper lip protrusion	Horizontal	Position of the upper lip to a line parallel to a true vertical line passing through the subnasale (SnV-Ls)
	Nasal tip protrusion	Vertical	The junction between the lower border of the nasal septum to the most prominent point of the tip of the nose (Sn-Prn)
	Philtrum width	Horizontal	The point on the crest of the philtrum from the right to the left side (CphRt–CphLt)
	Philtrum length	Vertical	The junction between the lower border of the nasal septum to the midpoint of the vermilion border of the upper lip (Sn–Ls)
	Upper lip height	Vertical	The junction between the lower border of the nasal septum to the midpoint of the labial fissure (Sn–Sto)
	Lower lip height	Vertical	The midpoint of the labial fissure to the lowest point of the midline on the lower border of the chin (Sto–Me)
	Mouth width	Horizontal	The most lateral point from the right side to the left side of the lips when gently closed (ChRt-ChLt)
	Upper vermillion thickness	Vertical	The junction between the midpoint of the vermilion border of the upper lip and the midpoint of the labial fissure (Ls-Sto)
	Lower vermillion thickness	Vertical	The junction between the midpoint of the vermilion border of the lower lip to the midpoint of the labial fissure (Li-Sto)
	Nasolabial angle	Angular	The angle between the lower border of the nasal septum, the midpoint of the columella crest at the level of the nostril top points, and the midpoint of the vermilion border of the upper lip (C-Sn-Ls)
	Lip angle	Angular	The angle between the midpoint of the vermilion border of the upper lip, the midpoint of the vermilion border of the lower lip, and the most lateral point on the right side of the lips when gently closed (Ls-Li-Ch)
	Biocular width	Horizontal	The distance between the right and left outer commissure point of eye fissure (ExRt–ExLt)
	Intercanthal width	Horizontal	The distance between the right and left inner commissure point of eye fissure (EnRt-EnLt)
	Upper face height	Vertical	The junction between the midpoint of the naso-frontal suture to the lower border of the nasal septum (N-Sn)
	Lower face height	Vertical	The junction between the lower border of the nasal septum to the lowest median landmark on the lower border of the chin (Sn-Me)
	Lower facial height to total face height ratio	Vertical	The proportion of lower face height to total face height (Sn-Me/N-Me)
Unilateral measurement	Nostril floor width (Rt, Lt)	Horizontal	The point on the lower margin of the base of the right and left nasal ala where the ala disappears into the upper lip skin to the junction between the lower border of the nasal septum (SbalRt–Sn, SbalLt-Sn)
	Nostril width (Rt, Lt)	Horizontal	The most medial to the most lateral nostril margin on the right side and the left side
	Nostril height (Rt, Lt)	Vertical	The highest point to the lowest point of the nostril on the right side and the left side
	Nose protrusion from ala base (Rt, Lt)	Horizontal	The distance from the right and left alare to the tip of the nose (AlRt-Prn, AlLt-Prn)
	Columella length (Rt, Lt)	Horizontal	The junction between the lower border of the nasal septum to the most protruded point of the nasal tip (C'–Sn')
	Ala length (Lt, Rt)	Vertical	The junction between the most lateral point on the curved base line to the most prominent point of the tip of the nose (AcRt-Prn, AcLt-Prn)

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RESULTS

This study used comparative analysis and all parameters were reported by mean, standard deviation, and mean difference (Tables 4, 5, 6). All statistics were analyzed in SPSS version 22 (Armonk, NY: IBM Corp.). There was normality of data distribution that analyzed by Kolmogorov-Smirnov test. Therefore the independent t-test was used to detected significant differences between the subjects with repaired cleft and unaffected subjects. The paired t- test was used to detect the differences between cleft and noncleft sides in the repaired cleft group and left and right sides in the unaffected group. Statistical significance was taken as $p<0.05$. Eight subjects (10% of all subjects) were randomized and remeasured by the same operator. The ICC between each value that was measured twice was 0.77 to 0.99.

Comparison of anthropometric unilateral measurements between cleft and noncleft sides in affected subjects

The study compared mean values between cleft and noncleft sides in the affected group for evaluation of symmetry with special focus on the nasolabial area (Table 4). Nostril floor width on cleft sides were significantly wider than on noncleft sides ($p= 0.01$). Nostril height and columella length on noncleft sides were significantly higher compared to cleft sides ($p<0.01$). However, there was insignificant broader nostril width on cleft sides ($p= 0.17$). Nose protrusion from ala base and ala length on cleft side was also insignificantly shorter than on noncleft side ($p= 0.55, 0.78$).

Comparison of anthropometric unilateral measurements between right and left sides in unaffected subjects

The study compared mean values between right and left sides in the unaffected group as well. Although slight differences between the dimensions on each side were found, they were insignificant (Table 4).

Comparison of anthropometric unilateral measurements between affected and unaffected subjects

Because right and left mean values in unaffected subjects were not significantly different (Table 4) and the majority of clefts were on the left, we compared the left side in unaffected subjects to cleft side in affected subjects (Table 5). We found that nostril height, columella length, nose protrusion from alar base, and ala length on the left sides of unaffected subjects were longer than those measured on the cleft sides of affected subjects ($p<0.01$). Nostril width on cleft sides was insignificantly wider than in the unaffected group, though the nostril floor width was narrower. However, neither of these values reduced significance.

We also compared the noncleft side in affected group to the right side in unaffected group to find out some deformities that were affected to the noncleft side.The results showed significant differences in noncleft sides (Table 5). Nasal floor width and ala length on the right sides of unaffected group were significantly longer compared to noncleft sides of affected group ($p< 0.01$). However, nostril height was significantly higher in cleft group ($p= 0.04$) with a small mean difference (0.67), while columella length on noncleft sides were longer than that found in unaffected group, though insignificantly. In addition, nostril width and nose protrusion from ala base in the affected group were insignificantly shorter than those in the unaffected group.

Comparison of anthropometric bilateral measurements between affected and unaffected subjects

Bilateral measurements were taken of nasolabial areas, transverse horizontal eye width, and facial proportions, comparing between affected and unaffected groups (Table 6). The results showed clear differences in upper lip, including upper lip protrusion, philtrum length, upper lip height, upper vermillion thickness, and lip angle, with significant discrepancies in the affected group ($p< 0.01$). In general, affected subjects' mean values were smaller than those of unaffected subjects, except philtrum width and nasolabial angle, which were insignificantly larger. In the orbit region, intercanthal widths and biocular width were narrower in the affected group, but the differences were insignificant. Affected subjects were shown to have smaller facial proportion relative to unaffected subjects, but the difference was insignificant.

DISCUSSION

In patients with cleft, the upper lip and nose were more irregular than other parts of the face.[11] The residual deformities of the nasolabial area presented as lateral, inferior, and posterior deviation of cleft side alar base and shortening of columella in cleft side.[2] Residual cleft deformities in affected children can cause self-consciousness for both the children and their parents, especially when the child is entering school.[14, 15] At present, there is no consensus guideline for lip-nose revision. Methods are used to characterize these deformities, including objective and subjective assessment. Subjective evaluation involves opinion without performing any measurements. Asher-McDade et al. developed a standardized method to evaluate nasolabial appearance of patients with unilateral cleft lip and palate using frontal and lateral photographs.[6] Although this method is simple and easy to use, there are many confounding factors, including the evaluator's amount of experience, gender which could influence the results.[6, 19, 20] Another type of assessment is the objective evaluation that we used in this study. Direct measurement is the most precise and well-accepted by experts. Although measurements can be taken from the subject directly, such a method is very difficult to reproduce in a large cohort. In addition, comparing results among centers would be impossible. Reliability of this method depends on the training of the examiner in locating the landmarks accurately.[10] To solve this problem, we utilized 3D imaging technology that was not harmful or uncomfortable for the subjects. This technology eliminated magnification problems, [21] is replicable, proved to be highly suitable for clinical facial analysis, and has been widely used in many studies.[11, 12, 17, 22] However, 3D photographs can produce some errors during 3D reconstruction of subnasal areas, especially at the nostrils. As a result, some studies have set the head position at 45° upward to collect the details of the subnasal areas. [2, 13, 23]

When we compared cleft to noncleft areas in the same subject, we found asymmetry in nasolabial areas, including significantly broader nostril floor width and shorter nostril height and columella length on cleft sides than on noncleft sides. Previous studies have had similar findings.[18, 24,25] For example, Liou *et al* followed the progressive changes of nasal symmetry for 3 years after cheiloplasty

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Table 4 Intragroup comparison of anthropometric mean values (mm) of unilateral measurements

Measurement	Affected group				Unaffected group			
	Cleft side Mean (SD)	Noncleft side Mean (SD)	Mean Difference (95% CI)	p value	Right side Mean (SD)	Left side Mean (SD)	Mean Difference (95% CI)	p value
Nostril floor width (Sbal-Sn)	11.64 (1.54)	9.98 (1.63)	1.67 (0.42, 2.91)	0.01*	11.60(1.18)	11.70 (1.12)	-0.10 (-0.22, 0.03)	0.13
Nostril width	6.85 (1.64)	6.40 (0.97)	0.45 (-0.21, 1.11)	0.17	6.72 (0.94)	6.69 (0.95)	0.03 (-0.05, 0.11)	0.46
Nostril height	4.18 (1.14)	5.88 (1.11)	-1.70 (-2.31, -1.09)	<0.01*	5.21(1.25)	5.17 (1.23)	0.03 (-0.07, 0.13)	0.50
Columella length (C'-Sn')	4.61 (1.28)	6.50 (1.05)	-1.89 (-2.51, -1.27)	<0.01*	5.93 (1.36)	5.93 (1.35)	0.00 (-0.02, 0.01)	0.64
Nose protrusion from alar base(Al-Prn)	20.72 (1.15)	20.89 (1.31)	-0.17 (-0.73, 0.40)	0.55	21.57 (1.50)	21.69 (1.22)	-0.12 (-0.35, 0.11)	0.30
Ala length (Ac-Prn)	19.60 (1.17)	19.69 (1.20)	-0.09(-0.71, 0.54)	0.78	21.21 (1.50)	21.16(1.23)	0.05 (-0.15, 0.25)	0.62

* Statistically significant at *p*-value <0.05

- Values for affected subjects were divided into cleft and noncleft sides.

- Values for unaffected subjects were divided into right and left sides.

Table 5 Intergroup comparison of anthropometric mean values (mm) of unilateral measurements

Measurement	Cleft side of affected group versus Left side of unaffected group				Noncleft side of affected group versus Right side of unaffected group			
	Cleft side Mean (SD)	Left side Mean (SD)	Mean Difference (95% CI)	p value	Noncleft side Mean (SD)	Right side Mean (SD)	Mean Difference (95% CI)	p value
Nostril floor width (Sbal-Sn)	11.64 (1.54)	11.70 (1.12)	-0.06 (-0.69, 0.58)	0.86	9.98 (1.63)	11.60 (1.18)	-1.63 (-2.30,-0.95)	<0.01*
Nostril width	6.85 (1.64)	6.69 (0.95)	0.15 (0.44, 0.75)	0.61	6.40 (0.97)	6.72 (0.94)	-0.33 (-0.82,0.16)	0.19
Nostril height	4.18 (1.14)	5.17 (1.23)	-1.00 (-1.62,-0.37)	<0.01*	5.88 (1.11)	5.21 (1.25)	0.67 (0.05, 1.29)	0.04*
Columella length (C'-Sn')	4.61 (1.28)	5.93 (1.35)	-1.33 (-2.01,-0.64)	<0.01*	6.50 (1.05)	5.93 (1.36)	0.57 (-0.09, 1.23)	0.09
Nose protrusion from alar base(Al-Prn)	20.72 (1.15)	21.69 (1.22)	-0.97 (-1.58,-0.35)	<0.01*	20.89 (1.31)	21.57 (1.50)	-0.68 (-1.43, 0.07)	0.07
Ala length (Ac-Prn)	19.60 (1.17)	21.16 (1.23)	-1.56 (-2.19,-0.94)	<0.01*	19.69 (1.20)	21.21 (1.50)	-1.53 (-2.26,-0.79)	<0.01*

in complete unilateral cleft lip and palate patients. Although nasal asymmetry was corrected immediately after surgery, significant relapse occurred in the first year. Surgery with overcorrection on areas prone to relapse should be considered, and Liou also suggested the use of a nasal conformer to maintain the treatment results.[26]

The symmetry of noses in the unaffected group was also compared. Our results showed a slight difference between the left and right sides of the nose but this difference was not significant. These findings are consistent with previous studies,[13, 27, 28] In non-growing adults, Rosati et al. found a difference between the left and right side of the nose in twenty 19- to 29-year-old normal Caucasian adults, in whom ala length in the right side differed from the left side significantly.[29]

This study also carried out a side-by-side comparison between affected and unaffected groups. First, we compared the cleft side of the affected subjects to the left side of the face in the unaffected subjects. We found most nose features in the unaffected group were significantly larger than those in the affected group. In contrast, Bagante *et al* found ala wing length (Al-Prn), nostril width at the base (Al-Sn), and nostril height were significantly larger in their affected group relative to their unaffected group.[13] Zreaqat and Ayoub also found nostril floor width of affected patients was significantly wider.[16, 24]This may be due to racial characteristics of Asian nose morphology; flared nose shape, wide alar base, and low dorsum.[30-32] Deformities after primary surgery in Asian cleft patients usually present as depressed alar dome, buckled inward ala on the cleft side.[33] Secondly, we compared the noncleft side in the affected subjects to the right side of the face unaffected subjects. Our results showed that noncleft sides had significantly narrower nostril floor width, higher nostril height, and shorter ala length when compared to the right sides of the unaffected group. Similarly, Bagante *et al* found higher nostril height on noncleft sides, yet in contrast to our study, they also found a wider nostril width at the base and longer ala wing length (Al-Prn) on noncleft sides.[13] Zreaqat *et al* found no significant difference between noncleft sides in the affected group and features in the unaffected group.[16] Our results imply that

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Table 6 Intergroup comparison of anthropometric mean values of bilateral measurements

Measurement	Affected group	Unaffected group	Mean Difference	p-value
	Mean (SD)	Mean (SD)	(95% CI)	
Alar base width (AlRt-AlLt) (mm)	32.83 (1.52)	33.44 (2.03)	-0.61 (-1.60, 0.37)	0.22
Subnasal width(SbalRt-SbalLt) (mm)	20.98 (1.78)	21.99 (2.40)	-1.01 (-2.17, 0.16)	0.08
Upper lip protrusion (SnV-Ls) (mm)	3.94 (1.13)	6.06 (1.42)	-2.12 (-2.82, -1.43)	<0.01*
Nasal tip protrusion (Sn-Pn) (mm)	10.63 (1.26)	11.26 (1.42)	-0.64 (-1.35, 0.07)	0.08
Philtrum width (CphRt-CphLt) (mm)	13.51 18.11)	8.85 (3.62)	4.66 (-0.21, 9.53)	0.06
Philtrum length (Sn-Ls) (mm)	11.84 (1.62)	13.43 (2.07)	-1.60 (-2.61, -0.58)	<0.01*
Upper lip height (Sn-Sto) (mm)	17.24 (2.14)	19.76 (1.91)	-2.52 (-3.53, -1.51)	<0.01*
Lower lip height (Sto-Me) (mm)	40.12 (2.84)	41.84 (5.35)	-1.72 (-4.22, 0.77)	0.18
Mouth width (ChRt-ChLt) (mm)	35.86 (3.02)	36.37 (3.21)	-0.51 (-2.14, 1.12)	0.54
Upper vermillion thickness (Ls-Sto) (mm)	5.91 (1.84)	8.93 (1.68)	-3.03 (-3.91, -2.14)	<0.01*
Lower vermillion thickness (Li-Sto) (mm)	7.73 (1.32)	7.83 (1.60)	-0.09 (-0.88, 0.69)	0.81
Nasolabial angle (C-Sn-Ls) (degree)	112.79 (11.58)	107.82 (11.64)	4.97 (-1.00, 10.95)	0.10
Lip angle (Ls-Li-Ch) (degree)	77.31 (4.55)	83.80 (6.95)	-6.49 (-9.80, -3.17)	<0.01*
Biocular width (ExRt-ExLt) (mm)	81.30 (6.33)	83.34 (4.18)	-2.04 (-4.50, 0.43)	0.10
Intercanthal width (EnRt-EnLt) (mm)	32.45 (2.54)	33.11 (3.43)	-0.67 (-2.33, 1.00)	0.43
Upper face height (N-Sn) (mm)	32.00 (4.97)	32.41 (3.37)	-0.41 (-2.40, 1.58)	0.68
Lower face height (Sn-Me) (mm)	48.87 (4.57)	51.34 (5.89)	-2.48 (-5.37, 0.41)	0.09
Lower face height: Total face height (Sn-Me/N-Me)	0.60 (0.03)	0.61 (0.02)	-0.01 (-0.02, 0.00)	0.19

* Statistically significant at p-value <0.05

abnormalities on the cleft side can sometimes affect the noncleft side as well. Some anatomies may deviate to the noncleft side. For example, the interrupted insertion of orbicularis oris muscle into the columella on the noncleft side can result in the premaxilla, columella, and caudal nasal septum shifting to the noncleft side.[34] This indicates that the noncleft side of the face in an affected patient may not be a valid guide for surgeons when planning surgical treatment.

Bilateral measurements demonstrated that the nasal base and upper lip were mainly affected. We found a significant reduction of upper lip protrusion from subnasale, philtrum length, and upper lip length in the affected group when compared to the unaffected group. Two other studies found similar results. Susami *et al* found low elasticity of upper lip and decreased upper lip length in patients with repaired cleft lip.[35] Duffy pointed out that various surgical techniques could have an effect on upper lip length and vermilion thickness. Some procedures result in a shorter or longer lip on the cleft side. [22, 35] Chowdri *et al* also found that the various techniques result in different lip features. They stated that Tennison repair results in a long lip, while a short lip is a common finding after Millard advancement repair.[36] Lip angle was another value that was smaller than unaffected subjects due to the retruded upper lip of affected subjects. All subjects with cleft in this study also presented with an anterior dental crossbite, another potential contributor to a retracted upper lip position. These results were in line with those of Zhu, who found that the lower lip becomes more protrusive relative to the upper lip in children with repaired cleft between 5 and 10 years old. They explained that this phenomenon was due to progressive maxillary retrusion causing a failure of upper lip support. [37] Moreover, Liao et al. found that lip repair also affected the anterior maxillary alveolar bone due to a bone bending effect; this made the maxillary incisors more upright and the bone was resorbed in the base of the anterior maxillary alveolar bone.[38] Moreover, an experimental animal study found that increased upper lip pressure after cleft lip repair in rabbits was due to scar tissue from the repair causing constriction in the anteroposterior facial skeleton. This exhibited as anterior crossbite and reduced maxillary length.[39]

The present study also focused on certain characteristics in other facial areas. We found intercanthal widths were narrower in the affected subjects relative to the unaffected subjects, but these differences were not significant. Duffy believed that such abnormities could affect growth in other areas of the face, namely the orbital region, so they compared intercanthal width distances between affected and unaffected groups.[22] They found that intercanthal distance was significantly narrower. While our study and others had consistent findings with Duffy's, ours findings did not reach clinical significance.[12, 16, 22] Meanwhile, Othman et al. found a wider intercanthal width in the cleft group but to an insignificant degree.[17] Another statistically insignificant finding in the present study was a slightly shorter lower facial height in affected subjects. Othman et al. had the same finding.[17] These findings may be due to overclosure of mandible as a consequence of the retarded growth of maxilla in all three-dimensions.[40, 41] Moreover, many cleft subjects from this study had poor oral hygiene resulting in the loss of anterior and posterior teeth. Whereas Zreaqat found longer lower facial height in 8- to 10-year-old affected subjects.[16]

The limitation of this study is that it was a cross-sectional study that focused only on subjects treated at Srinagarind Hospital from 2014 to 2016. A prospective future study should entail long-term

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follow up of treatment results after primary surgery to identify other factors that affect nasolabial appearance, and a multi-center study throughout Thailand should be conducted in order to generalize results. Regardless, the present study can be used as a guide for other cleft centers to assess their outcomes, improve their surgical techniques and treatment protocols.

CONCLUSION

This study attempted to establish a norm for evaluating the treatment outcome of cleft lip and cleft palate repair at Srinagarind Hospital in relation to unaffected or noncleft individuals. The results suggest that the noncleft side in affected patients is not an optimal surgical guide for cleft repair and the surgeon should correct both sides of lip and nose features according to the norms. A surgical treatment plan should emphasize correcting nostril height, columella length, nose protrusion from ala base, ala length, and upper lip features.

FUNDING

Funding support from Research and Academic Services Khon Kaen University and The Center of Cleft Lip-Cleft Palate and Craniofacial Deformities, Khon Kaen University under Tawanchai Royal Grant Project (Tawanchai Center) (Grant Number I62-01-08)

Conflict of interest

None declared.

Ethical approval

Ethical approval was granted by the Ethics Committee in Human Research, Khon Kaen University.

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