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Esthetic Evaluation of the Treated Unilateral Cleft Lip Using Photographs and Image Analysis Software: A Retrospective Study

S. Sabitha,¹ M. Veerabahu,² and B. Vikraman²

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Abstract

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Aim

The aim of this study was to objectively evaluate the surgical outcome of unilateral cleft lip patients treated by Dr. Adenwalla's modification of Millard's rotation advancement technique using image analysis software.

Method

Of the unilateral cleft lip cases done by a single surgeon using Dr. Adenwalla's modification of Millard's rotation advancement technique, only 11 cases satisfied the photographic standardization criteria (frontal view with both ears visible to minimize rotation and least nostril show to minimize tilt) and were included in this study. These photographs were acquired into the imageJ Software and Farkas cleft-related landmarks were marked on the lip area. The values of treated cleft side and the normal side were used to work out a Cleft Lip Component Symmetry Index. A value of 100 would indicate perfect symmetry of the lip. A value of either less or more would mean a degree of asymmetry.

Result

The horizontal lip length, vertical lip length from the top of the Cupid's bow to subnasale and nostril floor width were slightly increased on treated side of the lip and the vertical lip length from the top of the Cupid's bow to the alar base, the Cupid's bow width and vermilion length on the treated side were slightly decreased when compared to the normal side. Even though there were some differences, it was not statistically significant. The horizontal and vertical lip lengths, the Cupid's bow width, vermilion length and nostril floor width were almost symmetrical.

Conclusion

Computer assisted anthropometric analysis of photographs using imageJ software demonstrates that Dr. Adenwalla's modification of Millard's rotation and advancement technique produces esthetic lip symmetry consistently.

Keywords: Esthetic evaluation, Cleft lip- photographs, Image analysis software

Introduction

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Cleft lip is one of the most common congenital anomalies. Its surgical repair is the most challenging procedure encountered by surgeons. The goal in primary unilateral cleft lip surgery is to recreate normal lip architecture, which is esthetic and symmetrical to the normal side. The desire of every surgeon is the restoration of the Cupid's bow, the flawless continuity of the vermillion free border and the body of the upper lip.

Over the decades, in pursuit of esthetic primary correction of unilateral cleft lip, various techniques have been proposed (Le Mesurier 1949, Tennison 1952, Cronin 1966, Millard 1976, Noordhoff 1984) [1-3]. Each technique has its own theory supporting the procedure. The Millard's rotation advancement flap is the most widely used technique but has some disadvantages of residual notching and absence of muscle in the repaired region. Based on this Dr. Adenwalla proposed a technique which includes

1. Producing adequate rotation and advancement following Millard's technique.
2. De-epithelializing the vermillion flaps and leaving a filler of muscles on both the edges.
3. Dissecting the vermillion muscle from skin and mucosa for 3-4 mm using fine scissors.
4. Approximating these muscles with three 6-0-ethilon sutures.
5. Using 'Z' plasty on the inner aspect of the mucosa to reduce constriction of the free border.

Some of the methods for assessment of the repaired cleft are Direct surface assessment [4, 5], two-dimensional photographs, [6, 7] three-dimensional imaging [8-10] or a combination of these methods. Objective analysis is commonly performed using an anthropometric method. Esthetic evaluation of the repaired cleft lip has been done by considering landmarks related to the nose, the body of the lip and the vermillion.

Anthropometry and clinical examination were considered best to evaluate the morphology of the repaired cleft lip and nose. With advances in science and technology, the use of the computer and digital imaging now plays a major role in any scientific evaluation, so also in the evaluation of morphology of a repaired cleft lip. Coghlan et al. [11-13] described various studies on computer-based analysis to assess the facial symmetry of treated cleft lip and palate patients. The validity of these tools has been confirmed.

In this study, using ImageJ software (<http://rsb.info.nih.gov/nih-image>), (<http://rsb.info.nih.gov/ij/download.html>) as a quantitative assessment tool, we objectively evaluated the esthetic outcome of the unilateral cleft lip, treated by the same surgeon over a seven year period using Dr. Adenwalla's modification of Millard's rotation advancement technique.

Materials and Methods

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The photographic slides of eleven cases of treated unilateral cleft lip by Dr. Adenwalla's modification of Millard's Rotation and Advancement were retrieved from the records. The photographs were taken at least one year post operatively. Photographs that satisfied the following criteria for standardization (frontal view with both ears visible to minimize rotation and least nostril show to minimize tilt) were selected, scanned and acquired into the imageJ program with a measuring plugin. Farkas' [14, 15] cleft-related anthropometric lip landmarks were marked on the enlarged images of the lip area (Fig. 1).



Fig. 1

ac (alar curvature) The point most lateral in the curved line of each ala towards the cheek junction. *sn* (subnasale) Midline junction of the columella and lip. *cph* (crista philtri) Lateral high points of the Cupid's bow. *ls* (labiale superius) Lowest point ...

Using these points, the anthropometric measurements of the lip were made using linear measuring tool in ImageJ software (Figs. 2, 3). These linear measurements give an indication of the horizontal and vertical lip length, the vertical vermillion length as well as the width of the Cupid's bow and nostril floor.



Fig. 2

ch-cph Point at the lateral labial commissure to the lateral high points of the Cupid's bow (Horizontal lip length). *cph-ac* Point at the lateral high points of the Cupid's bow to the point most lateral point in the curved ...

Fig. 3



Measuring the parameters using imageJ software

Methodology

These parameters are used to work out a Cleft Lip Component Symmetry Index that could be used to compare objectively the various components of the lip and nose [16].

$$\text{Cleft Lip Component Symmetry Index} = \frac{\text{Cleft side component value}}{\text{Normal side component value}} \times 100$$

A value of 100 would indicate perfect symmetry of the lip. A value of either less or more would mean a degree of asymmetry [16].

Data analysis was done using t test and correlation. P value was set at 95% confidence interval and below 0.05 was considered significant. P value above 0.05 showed that there is no statistical difference between the treated and the normal side.

Results

Go to:

The sample included 8 males and 3 females with age ranging from 1 to 5 years. Nine patients had cleft on the left side and two with cleft on the right. All the parameters were measured using ImageJ software. The values of treated cleft side and the normal side were used to work out a Cleft Lip Component Symmetry Index that could be used to compare objectively of the various components of the lip and nose (Table 1).

Parameter	Mean	SD	Min	Max
ch-cph	104.64	10.74	79.00	130.00
cph-ac	94.29	11.84	65.00	125.00
cph-sn	101.96	16.26	70.00	130.00
cph-ls	96.25	10.96	70.00	120.00
cph-redline point	95.30	13.60	65.00	125.00
ac-sn	112.80	25.67	70.00	150.00

Table 1
Cleft lip component symmetry index for the parameters

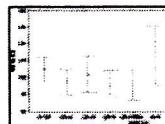
Results of the data analysis were tabulated (Tables 2, 3) (Graph 1).

Parameter	Mean	SD	Min	Max
ch-cph	104.64	10.74	79.00	130.00
cph-ac	94.29	11.84	65.00	125.00
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cph-ls	96.25	10.96	70.00	120.00
cph-redline point	95.30	13.60	65.00	125.00
ac-sn	112.80	25.67	70.00	150.00

Table 2
t-Test for the parameters

Parameter	Correlation	P value
ch-cph	0.987	0.000**
cph-ac	0.988	0.000**
cph-sn	0.988	0.000**
cph-ls	0.988	0.000**
cph-redline point	0.988	0.000**
ac-sn	0.987	0.000**

Table 3
Correlation for the parameters



Graph 1
Mean ratio with standard deviation for the parameters

The mean ratio for the horizontal lip length (ch-cph), vertical lip lengths (cph-ac) (cph-sn), the cupid's bow width (cph-ls), vermillion length (cph-redline point (□)), and nostril floor width (ac-sn) are 104.64 (SD: 10.74) (P-value: 0.183); 94.29 (SD: 11.84) (P-value: 0.466); 101.96 (SD: 16.26) (P-value: 0.697); 96.25 (SD: 10.96) (P-value: 0.283); 95.30 (SD: 13.60) (P-value: 0.279); 112.80 (SD: 25.67) (P-value: 0.129) respectively

Discussion

Go to:

Though there are many surgical techniques to repair the cleft lip, the Millard's procedure has found universal acceptance. Dr. Adenwalla of Trichur has modified or refined the Millard's technique to prevent the vermillion notching that can occur when using the standard technique. Since then Dr. Adenwalla's modified Millard's rotation advancement technique has been found to address all the aspects of lip symmetry.

Over the last two decades, there has been increasing interest in the short and long term assessment of the quality of cleft care. The surgical outcome can be analyzed subjectively or objectively. A variety of methods have been used in assessment of the repaired cleft associated deformity. These include direct surface assessment, two-dimensional photographs, three-dimensional imaging or a combination of these methods [17].

Although direct facial assessment has allowed angular and linear measurement to be established, the method is very time consuming and does not permit the clinician to revisit the data without the presence of the patient. On the other hand, most investigators have used two-dimensional photography, because it provides a simple and quick method of depicting the face. These photographic techniques, however, present the three-dimensional face in two dimensions. Standardization of the views necessary for comparison of assessment is difficult, especially in younger subjects. As a result, attempts have been made to develop three-dimensional methods that represent the human face more realistically. However, the natural facial texture of the normal face has not been factored in previous imaging systems. This deficiency has been addressed in a recent three-dimensional imaging system with the added advantage that it also captures the facial image in 50 seconds [17].

With advances in science and technology the use of the computer and digital imaging now plays a major role in any scientific evaluation. It has been used with good effect in the evaluation of the morphology of a repaired cleft lip. Coghlan et al. [11-13] have objectively analyzed symmetry of treated facial cleft patients using follow up photographs and computer analysis. Hurwitz et al. [18] compared the accuracy of NIH-Image based anthropometry with direct measurements of 22 linear distances on the lip and nose. Their study showed that there was strict linear correlation between computer aided and direct measurements.

Objective evaluation of the overall results of cleft lip repair can be difficult, because esthetic appearance is largely a subjective phenomenon. However, the symmetry of the architecture of the lip and nose can be evaluated by mathematical means [16]. In our study, frontal view photographs were retrieved from the records and reformatted using the Image analysis software to evaluate symmetry of the surgically treated unilateral cleft lip. The linear measurements of heights and widths of certain important features of the lip and nose were used to assess symmetry.

When photographs are taken from varying distances with lenses of different focal lengths the magnification of the final image is unknown. These are then considered unsuitable for absolute measurements, unless standardized procedures are followed to ensure a consistent, known magnification. When calculating proportions the magnification factor is not relevant. Even in the absence of standardized views it is possible to measure proportional ratios [6]. In this study, we objectively evaluated symmetry of treated unilateral cleft lip for esthetic outcome by taking proportions between treated side and normal side [19]. The imageJ software (<http://rsb.info.nih.gov/ij/download.html>) helped us to magnify all the images by a factor of ten and then analyzed the proportions between certain predetermined points on the lip and nose.

Lee TJ [5] studied the growth ratios of vertical, horizontal, and nostril sill dimensions by comparing the cleft side and the non cleft side of the same patient after Modified Rotation Advancement flap repair in unilateral cleft lip patients. He found that the repaired unilateral cleft retained its vertical and horizontal dimensions, determined at the time of the initial repair. Only the ratio of the nostril sill width between cleft side and non-cleft sides changed with time. In our study photographs of 11 patients, with a minimum of one-year follow up, were transferred and worked on using ImageJ software and the resultant data obtained was analyzed.

Image analysis showed that horizontal lip length, vertical lip length from the top of the Cupid's bow to subnasale and nostril floor width were slightly increased on the treated side of the lip when compared to the normal side of the lip. Similarly the vertical lip length from the top of the Cupid's bow to the alar base, the Cupid's bow width and vermilion length on the treated side were slightly decreased when compared to the normal side.

Even though there were some differences, it was not statistically significant. The horizontal and vertical lip lengths, the Cupid's bow width, vermilion length and nostril floor width were almost symmetrical. Hence it does not reject the null hypothesis.

Facial plastic surgeons have always relied on photography for preoperative and postoperative analysis. The current standards for analysis and documentation of facial structures have been determined by obtaining measurements and parameters from two-dimensional photographs or radiographs. However, the face and neck are three-dimensional structures and require manipulation in three planes within the constraints of esthetics,

stability, and function. Recent advances in technology have made three-dimensional imaging and analysis possible. The ability to capture images in three dimensions has opened up new avenues for observation and has increased the ability to analyze changes after surgery. Recently various studies have focused on descriptions of imaging techniques, validation of measurements, and the creation of normative data and its applications in surgery. So that, the availability of three-dimensional imaging and software systems presents new opportunities for the facial cosmetic surgeon to plan, execute, and assess the outcomes in patients undergoing surgery of the face and neck [20].

Conclusion

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Image analysis showed that horizontal lip length, vertical lip length from the top of the Cupid's bow to subnasale and nostril floor width were slightly increased on the treated side of the lip when compared to the normal side and the vertical lip length from the top of the Cupid's bow to the alar base, Cupid's bow width and vermilion length on the treated side were slightly decreased when compared to the normal side. Even though there were some differences, it was not statistically significant. The horizontal and vertical lip lengths, Cupid's bow width, vermilion length and nostril floor width were almost symmetrical. So this technique can be considered to provide an esthetically good outcome.

In conclusion, computer assisted anthropometric analysis of photographs using imageJ software demonstrates that Dr. Adenwalla's modification of Millard's rotation and advancement technique produces esthetic lip symmetry consistently. This technique deserves to be widely reported.

Recent Innovation

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Recently, the electromagnetic digitizer used and provides the three-dimensional coordinates of landmarks. This method therefore, could couple the benefits of conventional anthropometry and computerized systems and thus provide a simple, fast and direct computerized anthropometry [21].

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