

Quantitative assessment of healthy and reconstructed cleft lip using ultrasonography

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Abstract

Purpose: This study is conducted to investigate the feasibility of echographic imaging of tissue thickness of healthy and reconstructed cleft lip. **Design:** Prospective study. **Materials and Methods:** The study was conducted in SDM Craniofacial Unit, Dharwad and was approved by Local Institutional Review Board. A total of 30 patients, age group ranging from 4 to 25 years, of which 15 postoperative unilateral cleft lip constituted the test group. The remaining 15 with no cleft deformities, no gross facial asymmetry, constituted the control group. The thickness of the mucosa, submucosa, muscle and full thickness of the upper lip were measured with the transversal images using ultrasonography at midpoint of philtrum, right and left side philtral ridges and vermillion border, at 1, 3, 6 months interval. **Results:** There was an increase in muscle thickness at the vermillion border (mean = 6.9 mm) and philtral ridge (5.9 mm). Equal muscle thickness were found between the normal and test group at 6 months follow-up in a relaxed position, which was statistically significant ($P = 0.0404$). **Conclusion:** Quantitative assessment of thickness and echo levels of various lip tissues are done with proper echographic calibration. Diagnostic potentials of this method for noninvasive evaluation of cleft lip reconstructions were achieved by this study.

Key words: Cleft lip, echographic, philtral ridge, ultrasonography, vermillion border

INTRODUCTION

Cleft lip with or without cleft palate is the most common of these facial clefts. An important step in the treatment of children with cleft lip (with or without palate) is the reconstruction of the upper lip and the restoration of the continuity of the orbicularis oris muscle. Every surgical intervention, however, inevitably leads to scar formation. It is observed that the amount of scar tissue and its position has both functional and esthetic consequences. Although the esthetic outcome of the surgery can be judged clinically, it remains unclear to what extent the continuity and function of the muscle have been established. For this reason, it is important to investigate the tissue dimensions of the reconstructed lip.^[1-3]

Different techniques to examine the healthy or the reconstructed lip have been described in the literature.

Magnetic resonance imaging is not the method of choice because it is expensive and cannot be used if any metal plates are *in situ*. Computed tomography easily penetrates the entire depth of the orofacial tissues, but it does not allow detailed differentiation of orofacial structures.^[4-7]

Vinkka-Puhakka *et al.* (1989) mentioned that the orbicularis oris muscle is sandwiched between the facial and lingual connective tissues.^[3] By comparing the ultrasound images of the upper lip in relaxed and contracted condition in both healthy and repaired cleft lip; it is possible to relate quantitatively function to anatomy.^[1]

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This prospective study intends to assess quantitatively

- The feasibility of echographic imaging of healthy and reconstructed cleft lip
- The tissue dimensions of healthy and reconstructed cleft lip.

MATERIALS AND METHODS

The patients who reported to Cranio Maxillofacial Unit, SDM College of Dental Sciences and Hospital, Dharwad with cleft lip, at the time period of 2010–2012 were included in the study, with the approval of Local Institutional Review Board. A total of 30 patients, with age group ranging from 4 to 25 years with mean age of 15 years were included in the study. Of these 15 patients operated for unilateral cleft lip deformity constituted the test group. The remaining 15 patients, with no cleft deformities, no gross facial asymmetry, and no significant skeletal and/or dental abnormalities constituted the control group. Patients with bilateral cleft lip were not included in the study.

The thickness of the various tissues of the upper lip was measured in the transversal images using ultrasonography at four positions: Midpoint of philtrum, right and left side philtral ridges and vermillion [Figure 1]. The layers measured were the mucosa, sub mucosa, muscle, and the full thickness of the lip at these various points.

Millard's rotation advancement technique was employed for surgical correction in all patients. Ultrasound evaluation of the lip was performed with patients in supine position and neck hyper extended. All examinations were performed by a single radiologist with a medical ultrasound system SONOS 7500 (Philips Medical Systems, Andover, MA, USA) HD 11 high frequency (7–12 MHz) linear transducer. The processed ultrasound pulse bandwidth was set at

12 MHz. Axial sections were obtained by angling the transducer or moving it to different locations on the lip [Figure 2]. Measurements taken in the study were subjected to statistical analysis by using standard paired *t*-test.

RESULTS

A total of 30 patients, age group ranging from 4 to 25 years, of which 15 patients who underwent surgery for unilateral cleft lip were included in this study. The thickness of the various tissues of the upper lip was measured in the transversal images using ultrasonography at four positions: Midpoint of philtrum, right and left side philtral ridges and vermillion border. The mucosa, sub mucosa, muscle and the full thickness of the lip were measured.

In the test group, the mean value of muscle thickness of midpoint of philtrum in relaxed position was 3.9 mm at 1-month, which got increased to 4.1 mm at 3 months and further at the end of 6 months the mean value was 4.5 mm. The mean value of muscle thickness of in midpoint of philtrum in contracted position was 5.1 mm at 1-month, which got increased to 5.2 mm at 3 months and further at the end of 6 months, the mean value was 5.9 mm [Table 1].

In test group, the mean value of muscle thickness of cleft side philtral ridge in relaxed position was 5.1 mm at 1-month, which got increased to 5.4 mm at 3 months and further at the end of 6 months, the mean value was 5.7 mm. The mean value of muscle thickness of in cleft side philtral ridge in contracted position was 10.3 mm at 1-month, which got decreased to 7.1 mm at 3 months and further at the end of 6 months, the mean value was 14.2 mm [Table 2].

The mean value of muscle thickness at the vermillion border in relaxed position was 4.8 mm at 1-month,



Figure 1: Sites of imaging



Figure 2: Positioning of ultrasound transducer

which got decreased to 4.7 mm at 3 months and 6 months. The mean value of muscle thickness of in vermillion border in contracted position was 6.4 mm at 1-month, which got increased to 6.0 mm at 3 months and further at the end of 6 months, the mean value was 6.9 mm.

DISCUSSION

An important step in the treatment of children with a cleft lip is the reconstruction of the upper lip and the continuity of the orbicular oris muscle. Every surgical intervention, however, inevitably leads to scar formation. The amount of scar tissue and its position have both functional and esthetic consequences. Although the aesthetic outcome of an intervention might be judged clinically, the extent of the continuity and functionality of the muscle after surgery can be known only by investigating the anatomy of the reconstructed lip. Further, it is unknown to what

extent scar tissue has an effect on muscle function. By making detailed anatomical information available, it might be possible to evaluate better the outcome of treatment.^[2,8-11]

The anatomic features of cleft lip and palate have numerous variations with complexity in the nature of tissues involved. Thus, only unilateral complete clefts were included in this study to reduce the number of confounding variables.^[12,13]

Ultrasound imaging enables the visualization of different tissues in the healthy and reconstructed upper lip. A study was conducted on the functional assessment of the reconstructed lip. Using this method, they showed that muscle activity on the cleft side is increased, compared with the contralateral side. The authors attributed this result to the increased muscle thickness in the operated region.^[2,8]

Using ultrasound imaging, it is possible to visualize different tissues in the healthy and reconstructed upper lip. Vinkka-Puhakka *et al.* (1989) mentioned that the orbicularis oris muscle is sandwiched between the facial and lingual connective tissues.^[1-3,14] By comparing the ultrasound images of the upper lip in relaxed and contracted condition in the relaxed and contracted condition in both healthy and repaired cleft lip, it is possible to qualitatively relate function to anatomy.^[2]

In our study, the mean value of muscle thickness of midpoint of philtrum in relaxed and contracted position increased from 1-month to 6 months and the values when compared to normal patients are either same or more, which is indicative of proper reconstruction of muscle. This can be correlated with the study conducted by van Hess *et al.*, where there was an increase in muscle thickness in contracted position (mean difference = 1.5) [Figures 3 and 4].

Table 1: Muscle relaxed

	Time	Mean	SD	Mean difference
Cleft side philtral ridge (months)	1	5.1267	1.8109	-0.2867
	3	5.4133	1.3320	
	6	5.7400	1.5747	
Noncleft side philtral ridge (months)	1	5.4933	1.6060	0.2533
	3	5.2400	1.4237	
	6	5.4933	1.6060	-0.3333
Midpoint of philtrum (months)	1	3.9133	2.0560	-0.2400
	3	4.1533	1.9914	
	6	4.5933	2.1032	-0.6800
Vermillion border (months)	1	4.8667	2.3603	0.1400
	3	4.7267	2.0666	
	6	4.8667	2.3603	0.1467

SD: Standard deviation

Table 2: Muscle contracted

	Time	Mean	SD	Mean difference
Cleft side philtral ridge	1	10.3133	13.3861	3.1400
	3	7.1733	1.8900	
	6	14.2867	23.7543	-3.9733
Noncleft side philtral ridge	1	7.2600	1.9697	0.0800
	3	7.1800	1.9524	
	6	8.2267	1.4429	-0.9667
Midpoint of philtrum	1	5.1133	2.6594	-0.0667
	3	5.1800	2.6737	
	6	5.1133	2.6594	-0.7867
Vermillion border	1	6.4067	3.2055	0.3400
	3	6.0667	2.9156	
	6	6.9533	2.7414	-0.5467

SD: Standard deviation

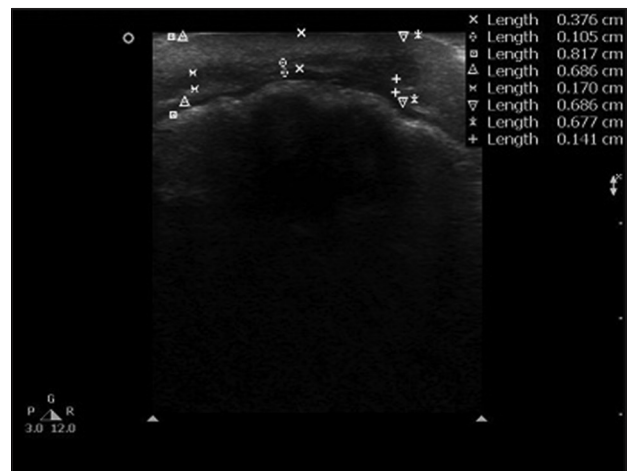


Figure 3: Upper lip philtrum relaxed

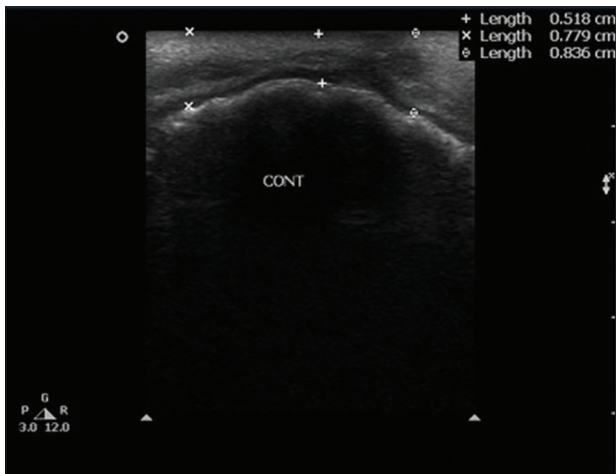


Figure 4: Upper lip philtrum contracted

The mean value of muscle thickness of cleft side philtral ridge in relaxed position increased from 1-month to 6 months. The measurement was similar when compared to normal side, which is indicative of adequate thickness at the philtral ridge on cleft side.

The mean value of muscle thickness of in cleft side philtral ridge in contracted position was 10.3 mm at 1-month, which got decreased to 7.1 mm at 3 months (mean difference = 3.1) and further at the end of 6 months, the mean value was 14.2 mm (mean difference = 3.9). Which was not statistically significant ($P = 0.17$). This also could be correlated with the study conducted by van Hees *et al.* (mean difference = 1.0).

From a review of the literature on lip echography, it is evident that the muscles are visualized as relatively hypoechoic zones between more reflective layers of connective tissues. In the present paper, it was found that muscles are producing echo levels that are approximately 19 dB lower than those of the proximal loose connective tissue layer, which corresponds to a factor of 9 times less reflectiveness and 10 dB less than those of the dense connective tissue layer, which is equivalent to 3 times less. The effect of contraction of the orbicularis oris muscle on the reflectivity levels is marginal. The largest effect is observed for the dense connective tissue layer.^[2]

This study showed that with the use of ultrasound imaging the various anatomical structures of the upper lip can easily be identified and distinguished. Although the feasibility of imaging lip structures was shown previously by the other authors, the present study adds new quantitative information about the lip tissues, both in the healthy lip and reconstructed lip.

The study was meant to be a feasibility study for the use of echographic imaging in the assessment of cleft

lip reconstructive surgery and should be considered as limited to such. The conclusions about absolute values of the thickness of the various layers of the lip indicate the order of magnitude.

CONCLUSION

A tool for functional assessment of the reconstructed lip might be electromyography. In our study there was increase in muscle thickness in the operated side over a time period and was similar to the nonoperated side, which can be correlated with the increased muscle activity on the cleft side compared to contra lateral side; which can be studied with electromyography. In future research, the standardized contraction movements of the lip by electromyography can be done.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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