

Using Ultrasound Technique to Quantify the Effect of Prosthetic Palatal Plate on Tongue Position in Cleft Palate Infants

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Abstract: Cleft lip and palate represent the most frequently observed congenital maxillofacial deformity. One of the important problems in the cleft palate infants is the abnormal position of the tongue as it falls backwards and penetrates nasopharynx during swallowing causing ulceration in the posterior part of the vomer. Ultrasound technology is currently the most active modality for tongue imaging. Aim of study: To evaluate the effects of the presurgical prosthetic palatal plates on tongue position in cleft palate infants. Materials & Methods: Fourteen infants were selected for this study from Pediatric clinic-Tanta University, seven cleft lip and palate infants and seven healthy (non-cleft) infants. Acrylic palatal plates were constructed for infants with cleft palate. Ultrasound examination was carried out with real-time equipment provided by a 5 MHz convex transducer. Infants were examined in supine position with the neck hyper extended, transverse scans of the submental region were obtained. The infants with cleft palate were examined with and without the plate while the healthy infants used as a control. Results: Ultrasound image of the tongue position in cleft palate infants significantly changed ($P < 0.05$) after insertion of the prosthetic palatal plates. Conclusion: Position of the tongue in the cleft palate infants significantly changed by using the prosthetic palatal plate and retracted to its adequate position.

[Ibrahim R. El-Torky; Mohamed M. El-Sheikh, Azza A El-Segai and Faten Abu A. Talep. **Using Ultrasound Technique to Quantify the Effect of Prosthetic Palatal Plate on Tongue Position in Cleft Palate Infants.** *Life Sci. J.* 2013; 10(2): 1322-1326]. (ISSN: 1097-8135). <http://www.lifesciencesite.com>.

Key words: Presurgical prosthetic appliance, cleft palate infants, tongue position, ultrasonography.

1. Introduction:

Cleft palate is a congenital deformity that causes a multitude of problems and represents a special challenge to the medical community. Special care is needed for patients with cleft palate. Typically, they require complex multidisciplinary treatment throughout childhood and may have lifelong medical and psychosocial implications for affected individuals. The two main types of oral clefts are cleft lip and cleft palates which are considered the widest spread congenital abnormalities affecting newly born infants.⁽¹⁾ Hereditary is thought to be a factor for this malformation but the exact etiology of this syndrome is poorly understood.⁽²⁾ The average prevalence of cleft lip with or without cleft palate is 7.94 per 10,000 live births internationally.⁽³⁾ Cleft lip with or without cleft palate is observed more frequently in males, while isolated cleft palate is more typically seen in females.⁽⁴⁾

Cleft palate is the congenital failure of the palate to fuse properly, forming a grooved depression or fissure in the roof of the mouth. Clefts of the lip and palate can occur individually, together, or in conjunction with other congenital malformations. This may happen in any single joining site, or simultaneously in several or all of them.⁽⁵⁾

A suckling baby with cleft palate uses its tongue to push the nipple against the roof of its mouth. The cleft makes it hard to seal the mouth properly over

the nipple, preventing the vacuum necessary to draw milk out of the breast or bottle.⁽⁶⁾

In those infants with cleft palate, tongue lies in an abnormal position as it falls backwards due to separation of pterygoid process that may cause tongue blocking the nasopharynx. Tongue humping or falling back possibly develops in those infants when they start manipulating the soft palate with the posterior region of the tongue.⁽⁷⁾

In new born infants with unilateral cleft lip and palate, congenital decubital ulcers were found in the posterior part of the vomer. These ulcerations were caused mechanically by the motor activity of the tongue during fetal and new born period.⁽⁸⁾

Tongue position is considered one of the factors for occlusion abnormalities in cleft lip and palate patients. Microglossia, anomalous position and form of the tongue cause tongue tip to be pressed to the incisal part of the lower alveolar bone not exerting physiological impact on the upper alveolar bone.⁽⁹⁾

Also, Starikova *et al.*, considered tongue position and function as one of the causes for lower promacrognathia and lingual inclination of incisors in cleft lip and palate patients as well as the absence of tongue impact on the upper alveolar bone causes upper retromicrognathia.⁽¹⁰⁾

The abnormal position of the tongue is associated with the loss of natural hard palate, which

may be related to the anatomical changes of the oral environment. Kaplan *et al.*, advised early closure of the palate to correct anatomical deformities, to allow for normal development of breathing, swallowing, hearing and speech.⁽¹¹⁾

The traditional timing of palatal repair has been at the age of 12 and 18 months. This timing is based on the belief that palatal repair should be left as late as possible to facilitate maxillary growth.⁽⁸⁾

The palatal plate has been widely used as a preoperative treatment for children with cleft palate. Suzuki *et al.*, concluded that continuous use of the orthopedic palatal plate up to the time of palatoplasty appeared to be effective for children with complete cleft lip and palate.⁽¹²⁾

Infants with orofacial clefts are best cared for by an obturator to close defects that surgery is not capable of early closure. These appliances are retained in the mouth, usually by pins in the maxilla, external strapping or without strapping. These appliances are intermittently adjusted to properly guide the growth of the palatal shelves.⁽⁷⁾ The rationale and effect of presurgical orthopedics are still under discussion.⁽¹³⁾

Tongue position in babies with cleft lip and palatal was studied by many authors.^(8,14) They found that tongue measurement was difficult because the tongue is positioned deep within the oral cavity and inaccessible to most instruments. To measure the tongue, it requires a device to be inserted into the mouth and must be unaffected by temperature or moisture, and should not disturb the tongue's motion. This is so problematical until the advent of ultrasound techniques.⁽¹⁵⁾

Nowadays, ultrasound technology is the most attractive modality for imaging the tongue position as it is non-invasive, unobtrusive, and provides real-time images of planar tongue surface.⁽¹⁶⁾ Earlier, ultrasound has been under-utilized in research because, as a clinical instrument, it needed additional modifications to make reliable research measurements.⁽¹⁷⁾ Recently, ultrasound reduced cost, improved reliability and increased interest in its unique data, have made this instrument a popular research tool.⁽¹⁸⁾

Aim of the Work:

The aim of this study was to evaluate the effects of the presurgical prosthetic palatal plates on tongue position in cleft palate infants using ultrasound technique.

2. Material and Methods:

Fourteen infants were selected for this study from pediatric clinic-Tanta University, seven infants had cleft lip and palate and seven were non-cleft infants. Their age ranged from 3-12 months. (Fig. 1)



Fig (1). cleft lip and palate infant

Fabrication of the prosthetic plate:

Silicone rubber impression (Speedex, Coltene A.G., Alsatten, Switzerland) was made for the maxilla with the cleft palate area. The impression material was pressed to the convex surface of spatula and molded to the shape of a block of the needed size, and then it was inserted into the baby's mouth to the back of the pharynx with a light upward and forward movement. After setting of the impression it was taken out of the cleft by first moving the spatula from front to back and then downward and forward. (Fig. 2)

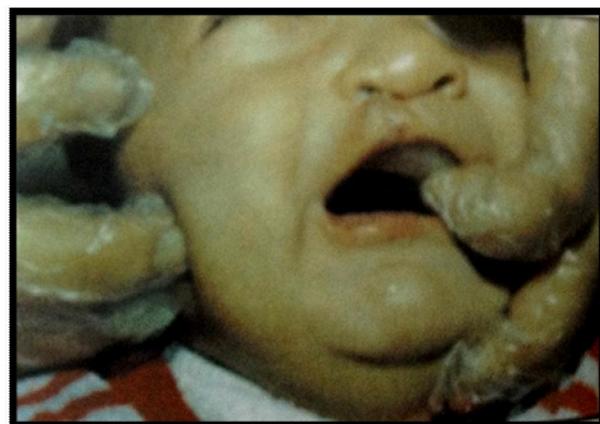


Fig (2). silicone rubber impression

On the working cast; (Fig. 3) the undercut areas were blocked out to produce normal palatal contouring. Light cured acrylic resin (Triad, DENTSPLY, York, PA) was used to fabricate the acrylic palatal plate. After conventional finishing and polishing, try in of the plate in patient's mouth was performed for any necessary adjustments of the peripheries and posterior extension. Soft denture liner (Tokuyama corp., Tokyo, Japan), was applied to the palatal side of the plate for increasing retention in the mouth and to help the child for rapid adaptability with the appliance.



Fig (3). working cast for cleft palate infant

Ultrasound assessment:

Ultrasound examination was carried out with real-time equipment (Siemens, Sonoline SL., Germany) provided by 5 Mhz convex transducer. Infants were examined in supine position with the neck hyper extended. Transverse scans of the submental region were obtained using a mobile transducer, tongue measurements are made with the jaw as reference.

The infants with cleft palate were examined with and without the plate while the normal infants used as a control. Each image was printed with a laser printer, and the contour of tongue surface was traced.

The distance from both the lowest point of the tongue (A) and the highest point of the tongue (B) were measured. (Fig. 4)

The ratio of A: B for each image was calculated. The mean ratios in each groups (n=7) was statistically analyzed.

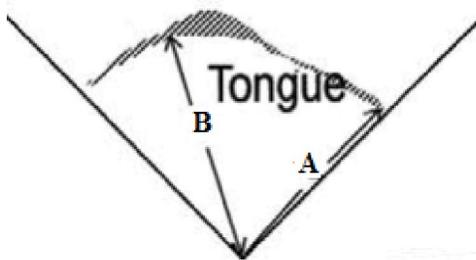


Fig (4). Diagram showing the lowest point of the tongue (A) and the highest point of the tongue (B)

3. Results:

Ultrasound Without The Plate:

The Transverse Ultrasound Scans Of The Submental Region Of Cleft Palate Infants Showed That The Tongue Was Clearly Inserted In The Cleft

- The mean ratios of A:B in the two groups with cleft palate (0.7814± 0.0498) for those without

Palatal Area. (Fig. 5) Ultrasonic Scan For The Non Cleft Palate Infants Is Shown In Figure (6)



Fig (5). tongue inserted in the cleft palatal area



Fig (6). Ultrasound showing tongue position in healthy (non cleft) infants

Ultrasound with the palatal plate:

After the insertion of the prosthetic palatal plates the tongue retracted to its adequate position. (Fig.7 a & b)



Fig (7 a & b). Tongue is in its adequate position.

- the palatal plate and (0.8829 ± 0.0160) for those with the palatal plate) were lower than that in the normal infants (0.9071 ± 0.0243)
- The paired t test revealed that there was a significant difference in the A: B ratio between healthy infants and cleft palate infants without the palatal plate. ($t = 6.0016, P = 0.0002$)
 - The ratio A: B among the healthy infants and cleft palate infants with the palatal plate did not reach a significant level ($t = 2.2070, P = 0.0518$).
 - A significant difference was observed in A: B ratio between cleft palate infants without the palatal plate and cleft palate infants with the palatal plate ($t = -5.1284, P = 0.0014$)

Table (1). Shows the mean and standard deviation of the distance from the lowest point of the tongue (A) and the highest point of the tongue (B) in healthy infants and in cleft palate infants with and without PP.

group	Normal infants	Cleft palate infants without plate	Normal infants	Cleft palate infants with plate	Cleft palate infants without plate	Cleft palate infants with plate
Mean	0.9071	0.7814	0.9071	0.8829	0.7814	0.8829
±SD	±0.0243	±0.0498	±0.0243	±0.0160	±0.0498	±0.0160
t	6.0016		2.2070		-5.1284	
P	0.0002*		0.0518		0.0014*	
t -Critical	2.2622		2.2281		2.3646	

* Significant, ($P < 0.05$)

4. Discussion:

Cleft lip and cleft palate are common birth defects. The standard protocol for the treatment of infants with cleft lip and palate in our department begins with the insertion of palatal plate as soon as referral of the infant. Clinical observations of numerous cases of those infants showed that the tongue has been retracted posteriorly and upwards into the palatal defect. This is confirmed by Bacher *et al.*, who stated that insertion of the tongue into the cleft may lead to mucosal ulceration caused by mechanical irritation due to the motor activity and the position of the tongue and these lesions disappeared after the implantation of the acrylic plate⁽¹⁹⁾.

All infants had presurgical palatal plate until palatal repair at age 18 months. Critics, however, have argued that presurgical palatal plate may actually restrain palatal growth, exacerbating growth deficiencies.⁽²⁰⁾ Many authors retrospectively examined palatal dimensions at birth, 3 and 6 months of age in infants with unilateral clefts of the lip and palate.^(21,22) No adverse effects on growth were found; indeed, their patients demonstrated greater transverse arch dimensions than patients who had not presurgical palatal plates.^(23, 24) Molsted *et al.*, noted no detrimental effect on maxillary dimensions in children with cleft lip and palate treated by presurgical plates.⁽²⁵⁾

Ultrasound is a commercially available machine. It is excellent to use for children because it is non-invasive and non-intrusive diagnostic tool.⁽¹⁶⁾

Once the ultrasound images are scanned, the tongue surface contours need to be measured. Lack of a physiological reference during measuring ultrasound images is a challenge. Although the tongue contours are clearly visible, there are no hard structure references, making it difficult to determine an exact position for the tongue in the vocal tract.⁽¹⁵⁾

Using a mobile transducer, tongue measurements were taken with the jaw as reference. The transducer moves up and down with the jaw, thus tongue motion occurs relative to jaw motion and not head motion.⁽²⁶⁾

Brogan *et al.* used lateral vedioradiography to study tongue movement or position in the cleft and non- cleft babies. On the contrary to our study they found no detectable deference in tongue position whether the plate was worn or not.⁽⁸⁾ This result may be due to the limitation of the technique they were used for assessment of the position of the tongue. Our study was confirmed by the work of Stuffin, who stated that if the palatal plate is fitted soon after birth, it reduces the available area of the oral cavity to average dimension and normalizes the position of the tongue.⁽²⁷⁾ Also, it was reported that the neonatal prostheses allow for normal feeding and help to direct proper tongue position.⁽²⁸⁾

Our clinical results supported the hypothesis that cleft palate patient perform an abnormal posterior tongue position.

Conclusion:

The tongue position in cleft palate infants significantly changed by using the prosthetic palatal plates and retracted to its adequate position. Ultrasound also gave detailed images of the shape and position of the tongue.

References:

1. Samanich J. Cleft palate. *Pediatr Rev.* 2009;30(6):230-232
2. Fraser FC: the genetics of cleft lip and palate. *Am J Hum Genet.* 1970; 22:336.
3. Tanaka SA, Mahabir RC, Jupiter DC, Menezes JM. Updating the epidemiology of cleft lip with or without cleft palate. *Plast Reconstr Surg.* 2012; 129(3):511e-518.
4. Mossey, PA, Little J. Epidemiology of Oral Clefts: an International Perspective. In: Wyszynski, D.F., ed. *Cleft Lip and Palate: from Origins to Treatment.* NY: Oxford University Press, 2002: 127-158.
5. Dudas M, Li WY, Kim J, Yang A, Kaartinen V. Palatal fusion — where do the midline cells go? A review on cleft palate, a major human birth defect. *Acta Histochem* 2007; 109(1):1–14.
6. Benacerraf BR. Ultrasound Evaluation of the Fetal Face. In: Callen P (ed), *Ultrasonography in Obstetrics and Gynecology*, 3rd ed. Philadelphia, WB Saunders, 1994; pp: 239-242.
7. Winters JC, Hurwitz DJ: Presurgical orthopedics in the surgical management of unilateral cleft lip and palate. *Plast Reconstr Surg.* 1995; 95:755-764.
8. Borgan WF, Foulner DM, Turner RA. Vedoradiographic investigation of the position of the tongue prior to palatal repair in babies with cleft lip and palate. *Cleft palate j* 1987; 24:336-338.
9. Nadtochiĭ AG, Starikova NV, Fomina GI. Morphofunctional tongue features revealed by multispiral CT in cleft lip and palate patients. *Stomatologiia (Mosk)* 2012; 91(4):54-59.
10. Starikova NV, Nadtochiĭ AG, Safronova IuA, Fomina GI, Volkova KN. Tongue structure, position and function in cleft lip and palate children assessed by ultrasound examination. *Stomatologiia (Mosk).* 2012; 91(3):56-60.
11. Kaplan I, Dresner J, Radian I. The simultaneous repair of cleft lip palate in early infancy. *Br J Plast. Surg* 1974; 27: 134 -.138.
12. Suzuki K, Yamazaki Y, Sezaki K, Nakakita N. The Effect of preoperative use of an orthopedic plate on articulatory function in children with cleft lip and palate. *Cleft Palate–Craniofacial Journal*, 2006; 43: 406 - 414.
13. Severens JL, Prah C, Kuijpers-Jagtman AM, Prah-Andersen B. Short-term cost-effectiveness analysis of presurgical orthopedic treatment in children with complete unilateral cleft lip and palate. *Cleft Palate Craniofac J.* 1998; 35:222–226.
14. Tanimoto K, Henningsson G, Isberg A, Ren YF. Comparison of tongue position during speech before and after pharyngeal flap surgery in hypernasal speakers. *Cleft Palate Craniofac J.* 1994; 31(4):280-286.
15. Stone M. and Davis E. A head and transducer support (HATS) system for use in ultrasound imaging of the tongue during speech. *J Acoust Soc Am* 1995; 98: 3107-3112.
16. Stone M. A Guide to Analysing Tongue Motion from Ultrasound Images, *Clin Linguist Phon* 2005; 19:450-455.
17. Shawker T, Sonies BC, Stone M. Soft tissue anatomy of the tongue and floor of the mouth: An ultrasound demonstration. *Brain and Language* 1984; 21: 335-350.
18. Epstein, M. Ultrasound and the IRB. *Clin Linguist Phon.* 2005; 19(6-7):567-572.
19. Bacher M, Goz G, Thinh P, Ney T, Ehrenfeld M. Congenital palatal ulcers in new born infants with cleft lip and palate: diagnosis, frequency, and significance. *Cleft palate craniofa j.*1996; 33:37-42.
20. Huddart AG. Presurgical changes in unilateral cleft palate subjects. *Cleft Palate J* 1979;16:147-157.
21. DiBiase D, Hunter SB. A method of pre-surgical orthopaedics. *Br J Orthod* 1983; 10:25-31.
22. Ball JV, DiBiase DD, Sommerlad BC. Transverse maxillary arch changes with the use of preoperative orthopedics in unilateral cleft palate infants. *Cleft Palate Craniofac J* 1995; 32:483-488.
23. Harding RL, Mazaheri M. Growth and spatial changes in the arch form in bilateral cleft lip and palate patients. *Plast Reconstr Surg* 1972; 50:591-599.
24. Wada T, Miyazaki T. Growth and changes in maxillary arch form in complete unilateral cleft lip and cleft palate children. *Cleft Palate J* 1975; 12:115-130.
25. Molsted K, Dahl E, Skovgaard LT, *et al.*, A multicentre comparison of treatment regimens for unilateral cleft lip and palate using a multiple regression model. *Scand J Plast Reconstr Hand Surg* 1993, 27: 277-284.
26. Stone M, Parthasarathy V, Pabla T, Sutton M, Crouse U. Exploring the effects of gravity on tongue motion using ultrasound image sequences. *J Acoust Soc Am* 2002; 111(5):2476-2482.
27. Stuffs GM. Speech and mental attitudes in the older presurgical child. *International symposium* 1981; 199.
28. Moore DJ. The continuing role of the prosthodontist in the treatment of patients with cleft lip and palate. *J Prosthet Dent* 1976; 36:186-192.