A Co-relative Study of Dento-skeletal, Oro-pharyngeal Patterns and Speech Performance in Cleft Lip and/or Cleft Palate Anomaly

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The study was conducted on twenty cleft lip (CL)/cleft lip and palate (CLP) patients in age group of 10 to 23yrs.The severity of the cleft ranged from simple alveolar cleft to complete bilateral cleft of lip and palate. Impressions and lateral cephalograms were taken to evaluate the dento-skeletal and oro-pharyngeal form. The speech performance of each individual was recorded and assessed for nasality and misarticulation. Based on speech assessment, the cleft sample was further divided into subgroups. It was seen that all the cleft individuals demonstrated some degree of nasality and misarticulation, however the severity of the speech defects did not co-relate with the deviations in dento-skeletal and oro-pharyngeal form.

Key words: - dento-skeletal, oro-pharyngeal, speech

The interdependence of form and function is a well established fact, so is the ability of the organism to make a homeostatic response to a given situation. The functional matrix theory proposed by Moss[1] suggests that the pathogenesis of clefting is due to an abnormality of the oro-nasopharyngeal cavity matrix that results in subsequent spatial abnormalities of the oral, nasal and pharyngeal cavities. Relative positional changes in teeth, basal jaw relationships and form of the resonating chambers may deflect the outgoing stream, as a result of which abnormal speech sounds are produced. As function and form are interdependent, the altered neuromuscular physiology and speech mechanism may in turn influence the dento-skeletal and oro-pharyngeal form. There is a paucity of research on the inter-relationship of dento-skeletal form, oro-pharyngeal form and speech in cleft palate patients. The objective of the present study was to observe the co-relation between these three aspects in the cleft palate patients.

MATERIAL AND METHODS

The present study was conducted on a sample of twenty cleft patients which included ten males and ten females, in age range of 10-23 years (Table 1A). The severity of the cleft ranged from simple alveolar cleft to complete bilateral cleft lip and palate. Any individual having cranio-facial deformity other than congenital cleft palate/cleft lip and palate, hearing loss or mental retardation was not included in the study.

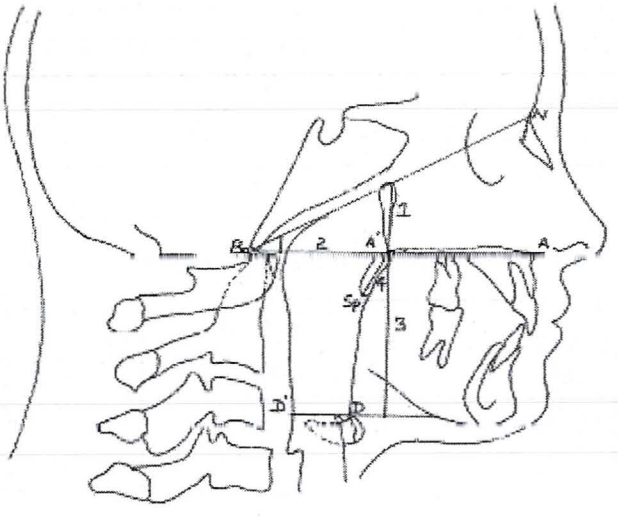


Fig. 1. LINEAR MEASUREMENTS USED IN THE STUDY OF DENTO-SKELETAL FORM

(1) maxillary bony length, (2) mandibular bony length, (3)anterior lower facial height, (4) posterior facial height, (5) anterior upper facial height, (6) upper incisor-APog

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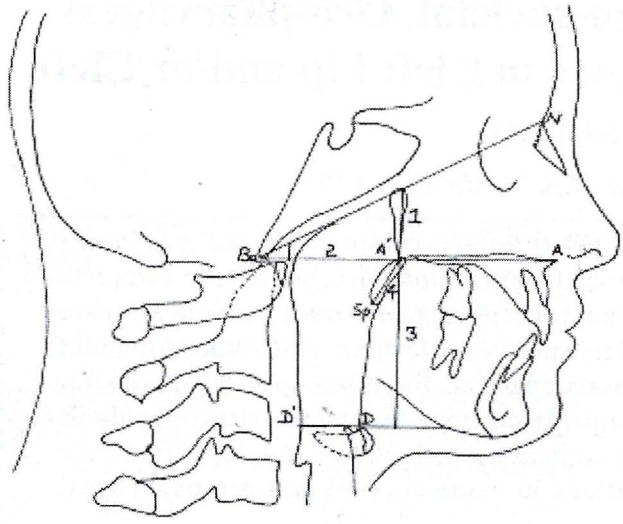


Fig. 2. LINEAR MEASUREMENTS FOR THE STUDY OF ORO-PHARYNGEAL FORM

(1) Nasopharyngeal height, (2) nasopharyngeal depth, (3) vertical dimension of oropharynx, (4) Soft palate length

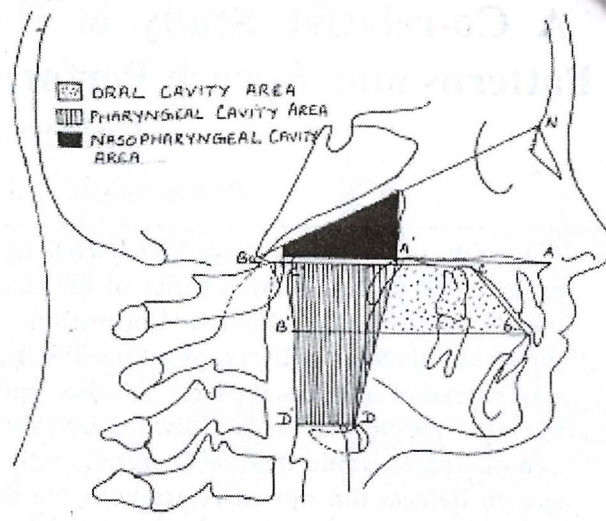


Fig.3. MEASUREMENTS OF ORAL, PHARYNGEAL AND NASOPHARYNGEAL CAVITY AREAS

All the individuals were of average Indian socioeconomic status and had received basic school education. The study was carried out in the Department of Orthodontics, in collaboration with Department of Plastic Surgery, King George's Medical College Lucknow. A careful appraisal was made of each patient with the help of lateral cephalograms, study casts and by assessment of speech.

a) Cephalometric Assessment of Dento-skeletal and Oro-pharyngeal form

Linear parameters as described by DiPaolo[2] (Fig 1) in his cephalometric analysis were used. Data on the oral and pharyngeal cavities were recorded with respect to the landmarks and planes presented by Proffit and McGlone[3], Proffit et al[4], Ricketts[5], Handelman & Osborne[6]. (Fig 2 & Fig 3) The area of the respective cavities was measured graphically[7]. Two

Table 1A Shows distribution of cases according to type of cleft anomaly

Sex	CL + Al	Uni. CL +P	Bil. CL +P	Total
Male	1	6	3	10
Female	2	6	2	10
Total	3	12	5	20

Table 1B Evaluation of cleft cases for nasality

GROUP	Mild	Moderate	Severe	Total
Number of cases	4	9	7	20

Table 1C Evaluation of cleft cases for misarticulation

GROUP	Mild	Moderate	Severe	Total
Number of cases	7	5	8	20

readings of the same area were taken to avoid error. The mean oral cavity area was multiplied by the width between the upper first molars (measured on the cast) to obtain the oral cavity volume. The pharyngeal cavity volume was calculated similarly.

b) Cast Analysis

Upper and lower alginate impressions were taken and study casts were prepared to evaluate overjet, overbite, intermolar width, height of palatal vault and number of teeth in cross bite.

c) Assessment of Speech

Each cleft individual was made to answer a standard set of questions, read out a word list and a paragraph. The speech was recorded on an audio cassette and analyzed by a speech therapist for nasality and articulation. Nasality was assessed as normal or hypernasal.Hypernasality was graded as mild, moderate or severe.(Table1B). Articulation was assessed as normal articulation or misarticulation. Misarticulation was likewise graded as mild, moderate or severe. The degree of misarticulation was based on the number of phonemes that were incorrectly articulated. 0-5 phonemes misarticulated was rated as mild misarticulation, 6-10 phonemes misarticulated was rated as moderate misarticulation whereas more than 10 phonemes misarticulated was rated as severe misarticulation. (Table 1C).

Based on nasality and misarticulation respectively the cleft palate sample was divided into 3 subgroups mild, moderate and severe.

Statistical Analysis

The standard tracing error was determined by calculating the't' test for paired observations. Between two readings the't' values calculated were found to be statistically insignificant. The mean, standard deviation, standard error of mean coefficient of variation(CV) were calculated for all the cephalometric and cast analysis values. In this study, the unpaired t test was used to see the difference in two means. If the data were not normally distributed the equivalent test (Mann Whitney U test) was used. ANOVA or the analysis of variance (F test) was used to compare more than two means and for non normal data Kruskall Wallis test was used.

OBSERVATIONS AND RESULTS

The cleft sample comprising twenty individuals was evaluated for speech quality. The criteria for speech evaluation were hypernasality and misarticulation. The sample was divided into three subgroups, first based on the degree of hypernasality i.e. mild, moderate or severe (Table1B). The sample was again divided into three subgroups, this time based on the number of phonemes misarticulated while reading a given paragraph (Table1C).

Table 2 – Shows comparison of skeletal attributes for the 3 subgroups based on hypernasality

Parameter of study	Subgroup	Mean	S.D.	S.E.	C.V.	F value
Posterior lower facial height (mm) (PLFH)	Mild	43.750	5.560	2.78	12.708	0.252
	Moderate	43.111	5.802	1.954	13.597	
	Severe	42.429	6.425	2.429	15.142	
Maxillary bony length Mandibular bony length	Mild	0.908	0.089	0.044	10.706	0.646
	Moderate	0.976	0.099	0.033	10.143	
	Severe	0.933	0.183	0.069	19.614	
ALFH/AUFH	Mild	1.228	0.243	0.121	19.788	0.394
	Moderate	1.172	0.186	0.062	15.87	
	Severe	1.179	0.088	0.033	7.463	

F statistic for 2 and 17 degree of freedom is non-significant.

In the subgroups, formed on the basis of hypernasality, five skeletal parameters were considered to evaluate the proportionality of the craniofacial form. The Mean, SD, SE and CV of the skeletal proportions in each subgroup are given in Table2. No significant differences were found for either linear dimensions or proportionality ratios amongst the 3 subgroups. F statistic for 2 and 17 degrees of freedom is non-significant.

The oro-pharyngeal form was evaluated in the same subgroups (formed on the basis of hypernasality) using 3 linear parameters and 2 ratios. No statistical difference was observed for any of these parameters or ratios amongst the 3 subgroups. (Table 3). F statistic for 2 and 17 degrees of freedom is non-significant.

Three subgroups formed on the basis of misarticulation (mild, moderate and severe) were compared with each other taking five dental cast measurements into consideration (i.e. overjet, overbite, intermolar width, no of teeth in crossbite and height of palatal vault). The Mean, SD, SE, and CV of the dental attributes are given in Table 4. A non-significant difference was found between the subgroups for all the five dental parameters considered.

DISCUSSION

Speech is an extremely complex form of human behavior and problems encountered in cleft palate individuals are hypernasality, nasal emission and misarticulation. The oral, nasal and pharyngeal cavities are basic in speech physiology. The relative positional changes in hard and soft tissues deflect the outgoing air stream and vocal tone as a result of which normal or abnormal speech sounds are produced. Due to palatal insufficiency cleft palate individuals are unable to control flow and path of air. This is evident in their nasal tone and frequent misarticulation of vowels and consonants. Previous research has revealed that oral and nasal breath pressure can influence dento-skeletal

Table 3 - Shows comparison of oro-pharyngeal attributes for the 3 subgroups based on hypernasality

Parameter of study	Subgroup	Mean	S.D.	S.E.	C.V.	F value
Soft palate length (mm)	Mild	28.250	4.924	2.462	17.430	1.56
	Moderate	27.0	6.481	2.160	24.0	
	Severe	20.143	8.552	3.322	42.456	
Oral cavity volume	Mild	0.976	0.305	0.152	31.25	0.364
Pharyngeal cavity volume	Moderate	1.036	0.342	0.144	33.011	
(C. Cm)	Severe	1.074	0.243	0.091	22.625	
Nasopharyngeal depth (mm)	Mild	32.5	5.0	2.5	15.384	1.513
	Moderate	28.333	4.123	1374	14.551	
	Severe	26.0	5.598	2.116	21.539	
Nasopharyngeal height(mm)	Mild	24.5	3.512	1.756	14.334	0.667
	Moderate	21.944	4.065	1.355	18.524	
	Severe	21.857	6.362	2.405	29.107	
Oral cavity area	Mild	1.786	0.214	0.107	11.982	0.888
Nasopharyngeal cavity area	Moderate	2.483	0.733	0.244	28.52	
	Severe	3.129	2.779	1.050	88.814	

F value for 2 and 17 degrees of freedom is non-significant

form in humans beings[8]. The present study tried to observe the co-relation of altered speech physiology with skeleto-dental and oro-pharyngeal deviations in a sample of cleft palate individuals.

Wardhill, Gaines and Wepman[9] had positively co-related velo-pharygeal adequacy (VPA) with hypernasality while Harrington, Dorrance, Nausbaum et al and Kaltenborn[10]opposed this view. In this sample, on evaluating the soft palate length, the nasopharyngeal height and depth, no significant difference was found between the mild, moderate and severely nasal subgroups. (Table 3).

Mac Donald and Baker[11] considered nasality to be related to disturbances in the resonance balance of various resonating chambers like oral, pharyngeal and nasal cavities. To evaluate the balance between the nasal, oral and pharyngeal cavities we computed their ratios to each other in terms of height, area and volume and compared these ratios in the various subgroups. However an insignificant difference was seen for all the parameters considered whether cranial or oro-pharyngeal, both in terms of absolute linear measurements and ratios.(Tables 2 and 3).

Three subgroups were formed on the basis of degree of misarticulation. They too showed insignificant indifference for all five dental parameters considered. (Table 4). This indicated a lack of relationship of dental deviations (overjet, overbite, intermolar width, number of teeth in cross bite and height of palatal vault) and misarticulation.

Mc Dermott[12] clinically observed 54 cleft individuals above 8 years of age and found that only a single factor that varied significantly in relation to articulation proficiency was the anteroposterior dental arch relationship.

Subtelny and Subtelny[13] and Powers[14] failed to find co-relations between misarticulation and dental deviations in the cleft population. They indicated that good articulation existed in many cases despite severe dental deviation.

Table 4 – Shows comparison of dental cast variables for the 3 subgroups based on misarticulation

Parameter of study	Subgroup	Mean	S.D.	S.E.	C.V.	F value
Overbite (mm)	Mild	2.50	2.082	1.041	83.28	0.232
	Moderate	1.889	2.977	0.992	157.596	
	Severe	2.143	3.716	1.404	173.401	
Overjet (mm)	Mild	0.250	1.708	0.854	683.2	0.957
	Moderate	-0.333	1.732	0.557	520.12	
	Severe	1.286	3.251	1.229	252.79	
Intermolar width (mm)	Mild	3.075	0.310	0.155	10.081	0.587
	Moderate	3.211	0.551	0.183	17.159	
	Severe	3.314	0.389	0.147	11.738	
Height of palatal vault (mm)	Mild	16.0	3.651	1.825	22.818	0.765
	Moderate	17.167	3.041	1.013	17.71	
	Severe	15.286	3.946	1.491	25.814	
Crossbite	Mild	2.250	2.630	1.315	116.888	0.962
	Moderate	4.444	2.789	0.929	62.758	
	Severe	3.00	3.266	1.234	108.866	

F value for 2 and 17 degrees of freedom is non-significant

A lack of co-relation of both nasality and misarticulation with oro-pharyngeal and skeletodental pattern in cleft individuals was observed in our study. This may be attributed to the highly complex mechanism of speech. Moreover in cleft individuals speech performance is largely influenced by the ability of the individual to compensate for the dental and occlusal deviations through compensatory and highly adaptive pharyngeal, laryngeal and glottal movements.

CONCLUSION

No co-relation was observed between the degree of nasality, misarticulation and the skeleto-dental and oro-pharyngeal form in the cleft lip and/or cleft palate sample.

SUGGESTIONS

The sample considered for this study being very limited, it is advisable to extend this analysis to a larger sized cleft population. Moreover, non- invasive and superior investigative procedures like magnetic resonance imaging (MRI) are now available to study the compensatory and adaptive laryngeal, glottal and pharyngeal movements adopted by the cleft individuals in an effort to produce acoustically normal speech. Even the skeleto-dental and oro-pharyngeal form can be evaluated with greater accuracy using cone beam CT.

References

1. Moss ML. Facial growth; the functional matrix concept In: Grabb W Rosenstein, S Bzoch Keds. Cleft lip and palate: Surgical dental and speech aspects. Little Brown & Co, Boston 1971; 97- 107
2. DiPaolo RJ, Chinappi AS, Langley JS. A quadrilateral analysis of lower face skeletal patterns. Am J Orthod 1970; 58(4): 341-50.
3. McGlone RE, Proffit WR. Co-relation between functional lingual pressure and oral cavity size. Cleft Palate J 1972; 9:229-35.
4. McGlone RE, Proffit WR, Barrett MJ. Lip, tongue pressures related to dental arch and oral cavity size in Australian aborigines. J Dent Res 1975; 54:1161-72.
5. Ricketts RM. The cranial base and soft tissue structures in cleft palate speech and breathing Plast Reconstr Surg 1954; 14:14-61.
6. Handelman CS, Osborne C. Growth of oropharynx and adenoid development from one to eighteen years Angle Orthod 1976; 46:243-9.
7. Kapoor DN, Dayal D, Sharma VP, Agarwal V. Adenoid obstruction and its relation to craniofacial morphology – A cephalometric study. Thesis submitted in partial fulfillment of the requirement for the degree of Master of Dental Surgery (Orthodontics), Lucknow University Sept. 1990.
8. Graber TM. Oral and nasal structures in cleft palate speech. JADA1956; 53: 693-706.
9. Wardhill, Gaines, Wepman cited in: McDonald ET, Baker HK. Cleft Palate speech: An integration of research and clinical observation. J speech Hearing Dis 1951; 16: 9-21
10. Harrington RA cited in: McDonald ET, Baker HK. Cleft Palate speech: An integration of research and clinical observation. J Speech Hearing Dis1951; 16: 9-21.
11. McDonald ET, Baker HK. Cleft Palate Speech: An integration of speech and clinical observation. J Speech Hearing Dis 1951; 16: 9-21
12. McDermott RP. A study of /S/ sound production by individuals with cleft palates. University of Iowa PhD Thesis 1962 cited from: Starr CD. Dental and Occlusal Hazards to normal speech production In: Grabb W, Rosenstein S, Bzoch K. Eds. Cleft lip and palate: Surgical, dental and speech aspects. Little Brown & Co, Boston 1971; 670-80.
13. Subtelny JD, Hestre JC, Subtelny JD. Comparative study of normal and defective articulation of /S/ as related to malocclusion and deglutition. J Speech Hearing Dis 1964; 29: 269 cited from: Starr CD. Dental and Occlusal Hazards to normal speech production In: Grabb W, Rosenstein S, Bzoch K. Eds. Cleft lip and palate: Surgical, dental and speech aspects. Little Brown & Co, Boston 1971; 670-80.
14. Powers GR. Cinefluorographic investigation of articulatory movements of selected individuals with cleft palates. J Speech Hearing Res 1962; 5: 59. Cited from: Starr CD. Dental and Occlusal Hazards to normal speech production In: Grabb W, Rosenstein S, Bzoch K. Eds. Cleft lip and palate: Surgical, dental and speech aspects. Little Brown & Co, Boston 1971; 670-80.

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