

Two Dimensional Photographic Comparison of Craniofacial Morphology of Parents of Children with Cleft Lip and Palate with Parents of Children without Cleft Lip and Palate

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Abstract: *Introduction: Literature studies have inferred that if facial shape is genetically determined and predisposed to cleft anomaly, then parents of children with cleft lip and palate (CL/P) should have facial dimensions different from those of general population. The purpose of this study was to evaluate the morphological features of unaffected parents of children with CL/P, and compare them with those of parents with non-cleft children, in rural Vidarbha region, with the help of facial photographs. Aim and objectives: To assess and compare facial morphological features in parents of non-syndromic cleft lip and palate children with parents of children without cleft lip and palate using two-dimensional photography. Method: Total 20 pairs of unaffected parents selected and were divided equally into: 1) Experimental group (n=10 pairs)- Unaffected parents of children with non-syndromic CL/P, and 2) Control group (n=10 pairs)- Unaffected parents of children without CL/CP. Total ten linear parameters were accessed to check significant finding. Comparisons were also made between males and females of both groups. Results: The result of above study suggested of wider frontoparietal, wider endocanthion and byzygomatic width in males and increased mid and lower face height in females. Conclusion: The facial morphological features of unaffected parents of children with non-syndromic CL/P were found to be distinct from those of unaffected parents of children without orofacial deformities.*

Keywords: craniofacial morphology of parents of cleft lip and palate

1. Introduction

The cleft lip and/or cleft palate (CL/P) anomaly is among the most commonly encountered congenital malformations. The vast majority are non-syndromic (70%) where CL/P transpires in isolation of other phenotypes. When one or more additional features are involved, clefts are denoted as syndromic.¹ Non-syndromic orofacial clefts, which include cleft lip, cleft lip accompanied with cleft palate, and cleft palate alone, comprise a range of disorders affecting the lips and oral cavity.² The occurrence ranges between 1/300 and 1/2500 births for cleft lip with or without cleft palate (CLP) and around 1/1500 births for cleft palate alone (CP).¹ It has been reported that CLP occurs more frequently in males, while the sex bias is reversed for CP, which is more prevalent in females.¹ Race affects the incidence of this disorder with the Mongoloid race having a higher incidence than Caucasians, and Caucasians having a higher incidence than Negroids.³ According to a study conducted by Kalasakar et al, the prevalence for nonsyndromic CLP and CP in the Nagpur region was found to be 0.66 percent and 0.27 percent, respectively.⁴

As a general model, it is thought that both genes and environmental factors, acting either independently or in combination, are accountable for facial clefting.¹ Some clefts are caused by single mutant genes, some are due to chromosomal aberrations, and some are caused by specific environmental agents; the vast majority are caused by the interaction of genetic and environmental factors, each with a relatively small effect.³

Investigation of the relationship between face shape and cleft predisposition in humans has focused chiefly on documenting the facial phenotype of unaffected relatives from cleft families when compared with unrelated controls.⁵

The reason behind this approach is straightforward: CLP is a heritable condition and as family members share a large number of genes, relatives of affected individuals are also expected to carry a higher proportion of alleged cleft loci than non-relatives with a negative family history.⁵

Ward et al. found a substantial genetic component in at least one of the parents in many cases of sporadic cleft lip/palate.³ Fraser and Pashayan inferred that if facial shape is genetically determined and also related to a predisposition to the cleft anomaly, then the parents of children with cleft lip/palate should have facial dimensions different from those of the general population.³ Existing literature on comparative cephalometric studies has shown that unaffected parents of children with CL/P possess significantly wider interorbital width, nasal cavity distance and upper facial dimensions, narrower cranial vaults, longer cranial bases, longer and more protrusive mandibles, shorter upper faces and longer lower faces compared with controls.⁶ Despite the fact that all such studies have identified differences in the craniofacial complex of unaffected cleft relatives vs. controls, specific results have been so inconsistent across studies that a clear picture is yet to emerge, as to exactly how these unaffected relatives can be discriminated from the general population.⁶

Various studies measuring various anthropologic parameters have employed 2-dimensional records such as lateral cephalograms, photographs, PA Water radiographs, etc. and 3-dimensional modalities such as stereophotogrammetry, surface imaging, etc. to determine genetic predisposition of CL/P. Photographs are non-invasive 2-D imaging tools, which pose no harm to the subjects, and has been used as a study aid to assess facial anthropometry. Also, the equipment required to produce photographs is feasible, and various anthropometric measurements can be made on the

photographs, and even directly on the individuals while they're being photographed with the help of callipers.⁷

The identification of clinically unaffected, but morphologically and genetically distinctive, family members has the potential to enhance the power of gene mapping approaches and to improve recurrence risk estimates.⁶ Before this can take place, however, a clearer understanding of the craniofacial phenotype in unaffected CL/P relatives must be obtained.⁶

Thus, the purpose of this study was to evaluate the morphological features of unaffected parents of children with CL/P, and compare them with those of parents with non-cleft children, in rural Vidarbha region, with the help of facial photographs.

2. Materials and Method

The current study was carried out after University Ethical Approval in the Department of Orthodontics and Dentofacial Orthopaedics at Sharad Pawar Dental College, Datta Meghe Institute of Medical Sciences, Sawangi (M) Wardha, Maharashtra.

Inclusion Criteria

- Biological parents of children native to central India below 40 years of age.
- No history of any other congenital defect, trauma or surgery in craniofacial area.
- No history of cleft lip and palate in control group.

A sample of 20 pairs of unaffected parents, were selected for the study which were divided into:

- **Group 1** (n = 10 pairs): Experimental group (unaffected parents of children with non-syndromic CL/P)
- **Group 2** (n = 10 pairs): Control group (unaffected parents of children without orofacial deformity)
- Both groups were further divided into two subgroups of males (n=10) and females (n=10).

For the purpose of this study, a photographic setup was arranged while maintaining certain specific conditions, to ensure uniformity of the procedure and elimination of bias.

3. Standardisation of Photographs

Creation of a setup

A room with adequate space for arrangement of equipment was selected and made light-proof by covering the windows with thick black paper to avoid any stray radiation or sunlight. Patients were photographed while being positioned in front of a green backdrop.

Positioning of subject from the camera

The position of each subject for all photographs was decided and marked with a tape. Accordingly, a square of one-foot

side was made, and the patient was asked to stand in the box, positioned in front of the backdrop.

Position of auxiliary photographic equipment

The position of tripod was marked 10 feet from the position of subject in a straight line. The flashlights used in the study were placed besides the tripod stand at a distance of 5 feet bilaterally. The vertical handle of tripod stand was adjustable and was changed as per subject's height.

Position of camera

The camera lens was positioned at the eye level of patient while taking frontal and lateral view photographs, and parallel to head form while taking parietal view.

Patient Posture

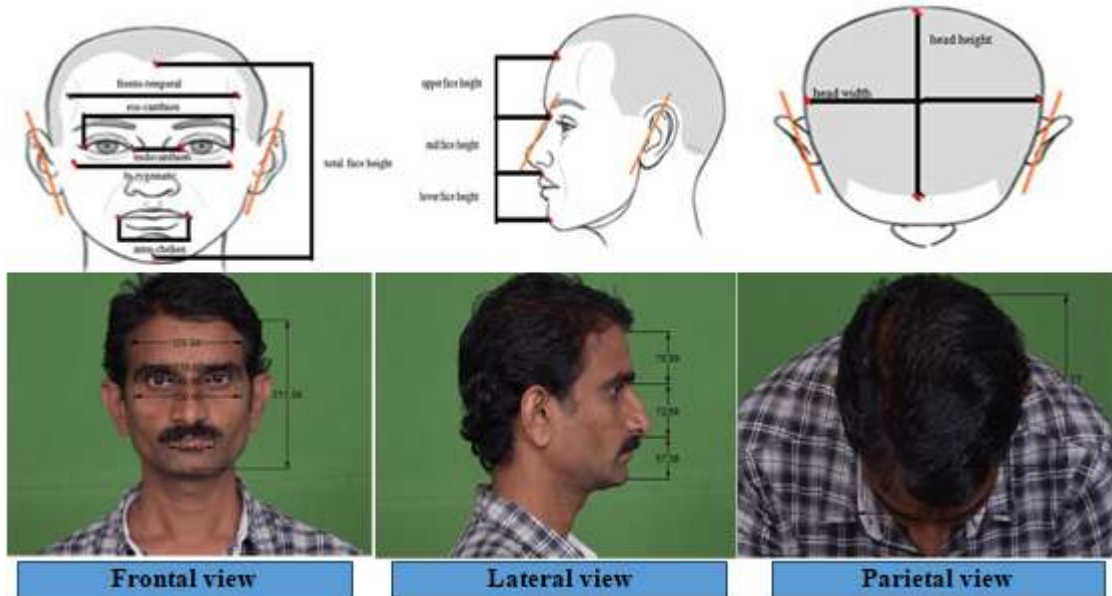
The frontal and lateral photographs were taken in a standing position, while asking the patient to maintain an upright posture, and maintaining the head in its physiological position. The patient's head was positioned by detecting the Frankfort Horizontal (F-H) plane clinically, and maintaining it parallel to the floor. The parietal view photographs were taken in a manner where, the subject was asked to bend taking support from the knees, and to look at the floor, so that the head was perpendicular to the floor and parallel to the lens. Subject was asked to pose still and photographs were clicked.

Digitization of photographs

Photographs were used as a digital record for this study. Digital standardised photo plates of the patients were made using Adobe Photoshop application, so that uniform dimensions were maintained for each photograph. Once the dimensions of all photographs were standardized, the pictures were subjected to analysis using digital AutoCAD software. For achieving 1:1 ratio, the scale determined for analysis on AUTO-CAD software was of (1 inch =25.4) dimension. All the landmarks important to the study were identified and marked as points on the photographs. Necessary lines between the landmarks were drawn to assess the distances of facial and cranial parameters. Different facial measurements were made, and the findings were noted down for each photograph.

Landmarks Determined

Fronto-Temporal Distance	EU-EU
Exocanthion Distance	EX-EX
Endocanthion Distance	EN-EN
Bizygomatic Width	ZY-ZY
Chelion Distance	CH-CH
Total Face Height	TR-ME
Upper Face Height	TR-N
Mid Face Height	N-SN
Lower Face Height	Sn-ME



4. Observations and Results

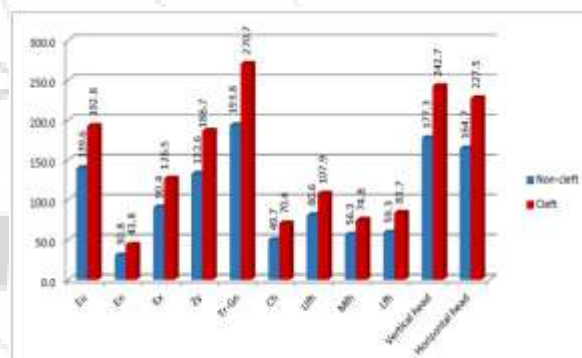
40 samples (20 pairs) were studied to evaluate and compare facial morphological features of unaffected parents of children with non-syndromic CL/P with unaffected parents of children without CL/P using two-dimensional photography.

Statistical analysis for assessment and comparison of craniofacial morphology of asymptomatic parents of CL/P, using 2-D photographs was done with SPSS version 17.0 software and Mann-Whitney test was employed to investigate the differences between parents of children with CL/P and parents of non-cleft children.

On comparing the male parents of children with CL/P with male parents of children without CL/P, four parameters were statistically significant out of 11 parameters measured during analysis.

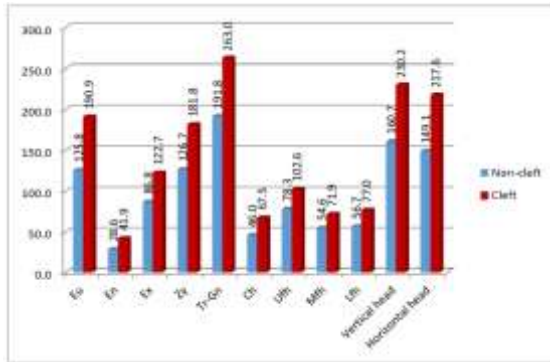
The mean value of fronto-temporal distance (192.7), exocanthion distance (126.54), bi-zygomatic width (186.72) and total face height (270.67) in male parents of children with CL/P was larger than value of fronto-temporal distance (139.62), exocanthion distance (90.35), bi-zygomatic width (193.81) and total face height (193.81) in male parents of children without CL/P. The p-value was statistically significant for these. The upper, mid and lower facial height of experimental male group, was also larger than that of control but it was not statistically significant. While analysing vertical and horizontal head form, the length and width of head form of the experimental group was larger than of control group. But it was not statistically significant. While comparing the female parents of children with CL/P with female parents of children without CL/P, two parameters were statistically significant out of 11 parameters measured during analysis. The mean values of upper face height (102.63) and mid facial height (71.93) of experimental group females, were larger than that of mean values of upper face height (78.30) and mid facial height (54.57) of control group females. The p value of upper face height and mid-facial height was statistically significant. All other parameters of the experimental group, including

frontotemporal distance, endocanthion, exocanthion distance, and lower face height were also found wider than control but were statistically insignificant. While analysing vertical and horizontal head form, the length and width of head form was larger than of control. But it was not statistically significant



Graph 1

Graph 1 shows that all the parameters measured i.e. Eu (frontotemporal), En (endocanthion), Ex (exocanthion), Zy (bi-zygomatic), Tr-Me (total face height), Ch (chelion distance), vertical head (head length) and horizontal (head width) were more in male parents of cleft patients compared to male parents of non-cleft patients. These values were compared by Mann-Whitney U test and Eu (frontotemporal), Ex (exocanthion) & Zy (bi-zygomatic) were found statistically significant ($p < 0.05$) and all other differences were statistically insignificant ($p > 0.05$).



Graph 2

Graph 2 shows that all the parameters measured i.e. Eu (frontotemporal), En (endocanthion), Ex (exocanthion), Zy (bizygomatic), Tr-Me (total face height), Ch (chelion distance), vertical head (head length) and horizontal (head width) were more in female parents of cleft patients compared to female parents of non-cleft patients. These values were compared by Mann-Whitney test and Ufh (upper face height) & Mfh (mid face height) were found statistically significant ($p < 0.05$) and all other differences were statistically insignificant ($p > 0.05$).

5. Discussion

The results were in favour of the studies that show parents of children with CL/P tend to differ from general population. Specifically, they appear to have longer endocanthion distance and wider bizygomatic width

In the study, while comparing male parents with control group, frontotemporal width was found to be wider and statistically significant. Similar findings were reported by Frazer and Prashyan (1970)⁸ and by Sato (1982)⁹, while some cephalometric studies (Kurusu 1974)¹⁰ showed decreased front temporal width. The distance between canthion is also found to be wider when compared to control group in the study and was also stated by many researchers (Frazer 1970⁸, Nakasima 1983¹¹, Sato 1989⁹, Figalova 1974¹², Suzuki 1999¹³) Out of these findings, those related to endocanthion was more statistically significant. This widened endocanthion distance was found to be average by Cocaro (1972)¹⁴ and Kurisu (1974)¹⁰. The bizygomatic width of parents with CL/P children was found wider than that of parent of non-cleft children and it was reported by Nakasima¹¹, Kurisu¹⁰, Niswander⁹, while some other studies (Frazer and Prashyan 1974)⁸ found it to be narrower when compared with non-cleft parents. Kumar SD¹⁵ observed narrower nasomaxillary width in his study conducted in the year 2010.

While comparing female parents, all parameters were found wider but none were statistically significant except upper face height and mid face height. The upper face height was also found significant by Nakasima (1983)¹¹, Kurisu (1974)¹⁰ in their study while Weinberg (2010)⁵ displayed some evidence of reduced upper face height. The mid face height was found of importance while comparing female parent with control group. This was also reported by Frazer and Prashyan (1970)⁸. However Weinberg (2010)⁵ and Kurisu (1974)¹⁰ did not agree with their findings and in their

study the mid face height was found to be shorter compared to female of non-cleft children.

The upper face height in father of CL/P children was found larger than the control though they were statistically not significant. Various studies (fraser and parshyan 1970⁸, kurisu 1974)¹⁰ were in favour of increased upper face height. While studies done by cocarro (1972)¹⁴, nakasima (1983)¹¹, raghvan (1993)³, de weilu (2008)¹⁶ stated decreased upper face height. The mid face height of father of cleft lip and palate was wider than the control group which is opposite to the findings by the de weilu (2008)¹⁶ and weinberg (2009)⁵. The study by da-we lu (2008)¹⁶, ward (1989)¹⁷ sato (1989)⁹ reported increased lower facial height in father of cleft lip and palate which is similar to finding of current study. The female parent of cleft lip and palate child when compare for fronto parietal width, it was found that the distance is wider than control group. This was also reported by Frazer and Prashyan (1970)⁸, sato (1982)⁹, while some cephalometric studies (Kurusu 1974¹⁰ weinberg 2008⁵) showed average frontoparietal width. The exocanthion and endocanthion was also found to be larger in current study when compared with non cleft group. Studies by fraser and prashyan⁸ show similar findings. This widened endocanthion and exocanthion distance was found to be average by Cocaro (1977)¹⁴ and Kurisu (1974)¹⁰.

Bizygomatic width was found more in female as compared in control group also supported by Nakasima (1983)¹¹, kurisu (1974)¹⁰ but frazer (1970)⁸ found width less as compared to non cleft individuals

Upper facial height and Mid face height appeared to be increased in females which was also reported by Frazer (1970)¹⁰ but Weinberg⁴ and Kurisu¹² found it decreased as compared to control group.

Lower facial height is also increased in females which were also concluded by Weingberg⁴, Sato²⁷ but Nakasima¹⁴ and Kurisu¹² reported studies which were against it.

6. Limitations

- Methodologic shortcomings associated with the use of two dimensional photography seem to be inevitable.
- All linear, angular measurements which seemed significant in previous studies were not included in the current study due to software limitations.
- Solely photographic assessment of parents cannot be relied upon to suspect probability of child being born with cleft lip and palate.
- Wider fronto-temporal distance, bizygomatic width, endocanthion and exocanthion distance can also be found in normal individuals as a result of genetic makeup and may not necessarily serve as predictors of cleft offspring.
- Due to ethnic diversity, results cannot be applied to all populations.
- By judging only facial parameters it is unjustifiable to predict cleft lip and palate, as it is experimentally proven a multifactorial disorder.

7. Implications

Many of the facial characteristics observed in unaffected parents are plausible, from a developmental perspective, as risk markers for CL/P.

The discovery of reliable phenotypic markers associated with elevated CL/P risk may offer a number of benefits. These markers may facilitate the detection of clinically unaffected but genetically informative individuals; these are individuals who may be carrying putative susceptibility alleles but due to reduced penetrance they do not display any visible manifestation of an overt cleft. At a practical level, the identification of at-risk individuals within CL/P families can improve the accuracy of recurrence risk estimation, ultimately leading to improvements in genetic counselling. For researchers seeking to uncover the genetic and environmental factors that lead to CL/P, the subphenotyping approach will likely enhance the power of epidemiological and statistical mapping methods

8. Summary and Conclusion

On assessment of facial morphological features, remarkable differences were found between those of unaffected parents of children with CL/P and unaffected parents of children without orofacial deformity. Hence, it was concluded, that unaffected parents of children with non-syndromic CL/P have wider fronto-temporal width, wider bizygomatic width, increased exocanthion and endocanthion distance, and greater upper and mid-face height, as compared to parents of children without orofacial deformity. The male parents of children with CL/P have significantly wider fronto-temporal width, wider exocanthion and endocanthion distance, and greater bizygomatic width than male parents of children without CL/P. The female parents of children with CL/P have greater upper face height and mid face height, as compared to the female parents of children without orofacial deformity. Hence, the facial morphological features of unaffected parents of children with non-syndromic CL/P are distinct from those of unaffected parents of children without orofacial deformities.

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