

Understanding Genderwise Inheritance of Facial Characteristics in Class II Subjects from Their Parents

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Abstract

Introduction : Some of traits have strong genetic influences whereas some may be strongly influenced by environmental factors. Thus, information derived from parental data, can be helpful in prediction of various parameters in their children and such knowledge would be useful in formulating orthodontic treatment plan.

Aim and objective: The purpose of this study is to compare the heritability of facial characteristics between parents and their off springs of Class II malocclusion. Both frontal and lateral photographic analysis based on

correlation between measurements of areas and distance of face between parents and off springs.

Material and method: Frontal and lateral true size photographs in a natural head position of 60 subjects/children and their parents were taken from 60 families of Gujarati population. 60 Subjects (18-25 years) were divided into 2 groups: For Class II div 1 (n=30) and Class II div 2 (n=30). All measurements done using Adobe Photoshop Software CS3 version 10.0. Data thus obtained was analysed using SPSS version 23. Statistical analysis was done by applying student t test.

Results: Results indicate that there lies a high correlation between father-son and mother- daughter group for Class II div 1 group and father-daughter and mother- daughter group for Class II div 2 group.

Conclusion: This study gave an indication regarding fair genetic control in the transmission of soft tissue facial characteristics between parents and off springs and consideration of the same can be done in prediction of growth and treatment planning in orthodontic practice.

Keywords: Facial parameters, Genetics, Heritability, Malocclusion, Photographs, Soft tissue

Introduction

Research into inheritance of craniofacial complex began as early as 1957 when Kniesal and Charles Delourde proposed that there is a transmission of pattern of growth of face from parents to offspring¹. Since Mendelian era, there has been a pursuit to understand heritability and is still fascinating the scientists. Wylie² was pioneer in demonstrating familial inheritance of traits using lateral cephalograms. Various other methods also estimate heritability like Twin studies Mendelian segregation, Genetic markers, Fingerprints, Taste sensitivity, Blood group system and Photographs using various parameters like DNA, blood, saliva, fingerprints and facial features. Photographs, a noninvasive method can popularly be used to estimate heritability in the families. These can be used to estimate both facial features and craniofacial morphology which may descend in families.

Craniofacial morphology is influenced by both genetic and environmental factors and varies with geographical location, racial groups and ethnicity. Although genes form blue print of craniofacial complex, environmental factors do exert its influence on craniofacial morphology and this interplay of heredity and environmental factors are responsible for biologic variability³. Therefore a child may

have facial features that may resemble either of the parents and/or siblings.

This study was planned to assess craniofacial morphology by using various parameters and their impact on facial characteristics between parents and children. Also study of sum of traits has been reported to have strong genetic influences by using various facial parts length which is helpful for orthodontic treatment strategies. Similar study was conducted by Lahoti et al on heritability of facial characteristics between parents and their offspring by using photograph. The purpose of this study was only limited data available regarding to compare the hereditary pattern of facial characteristics of parents and their children.

Material and methods

The present study was carried out in the Department of Orthodontics and Dentofacial Orthopedics, Government Dental College & Hospital, Ahmedabad. It was approved by The Institutional Ethical committee. 60 subjects (18-25 years) who visited Government Dental College & Hospital, Ahmedabad for dental treatment were selected. These subjects and their families were selected for this study, after their consent.

Inclusion criteria:-Only those families having all- Father, Mother, Son and Daughter were chosen for the study. Subjects were divided into 2 groups based on Angle's Classification of malocclusion, (One of the sibling is examined clinically to determine the group for the family), **Group 1**= Angle's Class II Division 1 malocclusion, Class II canine & molar relation, increased overjet & overbite.(n=30), **Group 2**= Angle's Class II Division 2 malocclusion, Class II canine & molar relation, retroclined maxillary central & proclined maxillary lateral incisors and increased overbite.(n=30). Family members who had no previous history of orthodontic treatment, surgery or trauma, no apparent facial asymmetry, presence

of all permanent teeth at least up to 2nd molars were included. **Exclusion criteria:**-If any of the family member had craniofacial anomaly or syndrome, patient wearing partial dentures, history of any facial trauma or surgery, patient who did not give consent for the study were excluded from study.

Armamentarium for Full Face Frontal And Lateral Photography

- Drafter.
- Canon camera with macro lens of 100mm.
- Studio photo light.
- Tripod.
- Adobe photoshop software CS3 VERSION 10.0.

True size frontal & lateral facial photographs of all the 60 subjects, their siblings & their parents were captured under standard conditions. The digital camera (CANON) mounted with the lens (EF 100mm, 100 Macro Lens, shutter speed 1/200, ISO-100 and aperture (f=25) flash was used for all photographic records. It was secured on a tripod for stabilization and adjusted according to the subject's height. A drafter was placed parallel to mid sagittal plane and Reid's horizontal plane (Reid's horizontal plane passes through the outer cantus of the eye and the superior attachment of the ear). Magnification of camera was set at 1:10 with distance fixed at 1 meter from Reid's horizontal plane to camera lens. The 100-mm macro lens was chosen to avoid distortion and maintain natural proportions. The camera was used in its manual mode to achieve maximum image quality given the local lighting condition. Studio light was used for illumination. Patient asked to look straight ahead into the camera to get natural head position and camera position middle of the face and in portrait format (Fig. 1A, 1B). Light should come diagonally from the front, leaving the patient shadow out of view of the camera. Portrait view with the frame extending to just above the top of head and lower

frame line around the larynx. Photograph obtained should be symmetrical with the inter-pupillary line parallel to floor. Female subjects should have no makeup. Space should be left on all sides of the photograph. A focusing screen with grid is very useful.

The true size frontal & lateral photos of families [Photographs of family (Fig:- 2)] thus obtained are processed in Adobe Photoshop software version 10.0. Grid (1cm x 1cm) is superimposed and integrated (Fig:- 3) according to drafter which is parallel to Reid's horizontal plane and mid sagittal plane. Adjustment of approximately 5% zoom in or zoom out done to obtain 1:1 true size photograph. After plotting the points and lines(Fig:- 4)(Fig:- 5)(Fig:- 6) measurements [9 parameters on Frontal photograph- (Fig:- 7), 15 parameters on Lateral photograph- (Fig:- 8), 3 proportional parameters on Lateral photograph- (Fig:- 9)] taken using Adobe Photoshop software CS3 version 10.0. Data of 60 families thus obtained was subjected to statistical analysis.

Statistical Analysis

After dividing samples into respective groups, frontal and lateral photographs of true size for each family was taken. 9 linear parameters on frontal photograph and 15 linear parameters and 3 proportional parameters on lateral photograph were measured. All measurements done using Adobe Photoshop software CS3 version 10.0. Data thus obtained was analysed using SPSS version 23. Subjects were paired as father- mother, mother- daughter, mother-son, father-son, father- daughter and son-daughter. Descriptive statistics for scale data, Independent T test, Pearson correlation was done to find the relation between various pairs.

Formulation of Hypothesis

Null Hypothesis: H₀ = There is no difference in inheritance of various traits in various groups.

Alternate Hypothesis: H_a = There is difference in inheritance of various traits in various groups.

P value < 0.05 is considered as statistically significant.

If P value < 0.05 we can reject the null hypothesis and consider the alternate hypothesis.

The statistical significance was calculated with the help of student t test.

Results

Table- 1, Table- 2, Table- 3, Table- 4, Table- 5, Table- 6, Table- 7 and Table- 8.

Discussion

Inheritance plays an important role in determination of craniofacial morphology. It is variable and is influenced by both genetic and environmental factors. The quest to estimate heritability is of interest to both Orthodontists and Maxillofacial plastic surgeons as few parameters of face are under strong influence of inheritance which can be studied using both cephalograms and photographs. Suzuki and Takahama stated that the face of offspring often resembles to that of at least one of his or her parents⁴. Therefore, this study is conducted to analyse heritability of facial characteristics between parents and off springs with the help of true size photographs.

Table 1, shows mean and SD values of various parameters of parents in Class-II div 1 Group. When difference in various values between father and mother were estimated by “unpaired t test”, amongst nine frontal parameters only two parameters “MFH” and “Nasal width” were found statistically significantly differing at $p=0.011$ and $p=0.006$ respectively. The values for both these parameters were higher in the father than in the mother. Rest seven parameters , UFH, LFH, TFH, Intercanthal width, Lip width, Lip length at philtrum and Lip length at corner of mouth did not differ significantly.

On comparing fifteen lateral parameters for the same group, only three parameters namely “TVL to G” at $p=0.003$, “TVL to Labrale superius” at $p=0.02$ higher in father than in mother while “chin projection” at $p=0.009$ differed significantly more in mother as compared to father. Rest parameters, Upper lip prominence to E line, Lower lip prominence to E line, Upper lip prominence to S line, Lower lip prominence to S line, Soft tissue Sn to H line, TVL to Tip of nose, TVL to Sn, TVL to Soft tissue Point A, TVL to soft tissue Point B , TVL to Labrale inferius , TVL to Pg’ and Nasal prominence did not differ significantly.

Amongst the three proportions/ratios estimated, **The vertical lip –chin ratio** showed significantly higher value for the mother when compared with that of the father at $p=0.001$. The other 2 ratios, vertical height ratio and lower vertical height –depth ratio were not differing significantly.

Table 2, correlates various parameters between the father & daughter and the father & son in Class II Div1 group to understand the heritability between them.

Amongst the 9 frontal parameters, out of 9, 5 parameters showed significant high correlation between the father & daughter while 8 parameters showed significant correlation between the father & son. Amongst the significant correlated parameters between the father & daughter, the highest level of correlation found at $p=0.001$ for “**UFH and Lip width**”. The parameters showed significant correlation at $p = 0.01$ between the father & daughter were LFH and nasal width, while the parameter MFH showed significant correlation at $p=0.05$. No correlation was found for TFH, Intercanthal width and Lip length at philtrum between the father & daughter. Between the father & son , 6 parameters which were found highly correlating at $p=0.001$ were “**UFH, MFH, LFH, Intercanthal width, Lip length at philtrum and**

Lip length at corner of mouth”, while TFH and Nasal width showed significant correlation at $p=0.01$. The only parameter did not have significant correlation was the lip width.

Amongst the 15 lateral parameters, 7 parameters showed significant correlation between the father & daughter, while 14 parameters showed significant correlation between the father & son. Between the father & daughter, 4 parameters showed highly significant correlation at $p=0.001$ were “**Upper lip prominence to E line, TVL to G’, TVL to Tip of nose and TVL to Labrale superius**” while 3 parameters showed significant correlation at $p=0.05$ were Soft tissue Sn to H line, TVL to Labrale inferius and Chin projection and 8 parameters, Lower lip prominence to E line, Upper lip prominence to S line, Lower lip prominence to S line, TVL to Sn, TVL to Soft tissue Point A, TVL to soft tissue Point B, TVL to Pg’ and Nasal prominence were not having significant correlation. As again this between father & son, 13 parameters, “**Upper lip prominence to E line, Lower lip prominence to E line, Upper lip prominence to S line, Lower lip prominence to S line, Soft tissue Sn to H line, TVL to G’, TVL to tip of nose, TVL to Soft tissue Point A, TVL to Labrale superius, TVL to Labrale inferius, TVL to Pg’, Nasal prominence and Chin projection**” showed highly significant correlation at $p=0.001$ and 1 parameter TVL to Soft tissue Point B showed significant correlation at $p=0.01$. The number of parameters having no correlation between the father & son is 1 which was TVL to Sn. Thus, the number of parameters showed significant correlation between the father & son are much more and at higher level of significance, then the significant correlation values found between the father & daughter.

Comparing the correlation value for the 3 parameters showing proportions between the father & daughter as

well as between the father & son. The vertical height ratio did not show significant correlation between the father & daughter as well as the father & son. The lower vertical height –depth ratio showed significantly high correlation at $p=0.05$ between the father & daughter but not between the father & son. The vertical lip chin ratio showed the reverse trend as compared to lower vertical height – depth ratio.

Looking to above significance levels, it is observed that more number of frontal parameters showed significant correlation between the father & son than between the father & daughter. But when lateral parameters were compared, more number of significant correlation and that too at a higher level of significance were found between the father & son than in the father & daughter. As regard to the proportions and ratios, no uniformity is found between the father & his children of different gender.

Here, in the above table it was found that between the father & daughter MFH, LFH, Soft tissue Sn to H line, TVL to G’, TVL to Labrale inferius and lower vertical height-depth ratio were found having negative correlation, other significantly correlating parameters showed positive correlation while between the father & son only 1 parameter vertical lip chin ratio showed negative correlation while the rest parameters were significantly positive. The results of this study are in **accordance** with the study by **Sertac Aksakalli et al**⁵ which showed more heritability for father-off-springs in Class II group.

Table 3, correlates various parameters between the mother & daughter and the mother & son of Class II Div1 group to understand the heritability between them.

Amongst the 9 frontal parameters, out of 9, 8 parameters showed significant high correlation between the mother & daughter while only 3 showed significant correlation between the mother & son. Amongst the significant correlated parameters between the mother & daughter, the

highest level of correlation found at $p=0.001$ for “UFH, MFH, LFH, TFH, Intercanthal width, Lip length at philtrum and Lip length at corner of mouth” while significant correlation at $p=0.01$ was found for Nasal width. The only 1 remaining parameter lip width did not have significant correlation between mother & daughter. Between mother & son, the 2 parameters which were found highly correlating at $p=0.001$ were Intercanthal width and Nasal width while the parameters showed significant correlation at $p=0.01$ was UFH. All other parameters showed insignificant correlation.

Amongst the 15 lateral parameters, 12 parameters showed significant correlation between the mother & daughter, while 5 parameters showed significant correlation between the mother & son. Between the mother & daughter, 11 parameters, “Lower lip prominence to E line, Upper lip prominence to S line, Lower lip prominence to S line, soft tissue Sn to H line, TVL to Soft tissue Point A, TVL to labrale superius, TVL to Soft tissue Point B, TVL to Labrale Inferius, TVL to Pg’, Nasal prominence and Chin projection” showed highly significant correlation at $p=0.001$, while 1 parameter Upper lip prominence to E line showed significant correlation at $p=0.01$. Remaining 3 parameters, TVL to G’, TVL to Tip of nose and TVL to Sn were not having significant correlation. As against this, between mother & son, 4 parameters TVL to Tip of nose, TVL to Labrale Superius, Nasal prominence and Chin projection showed highly significant correlation at $p=0.001$ and 1 parameter TVL to Labrale Inferius showed significant correlation at $p=0.01$. Rest 10 parameters, Upper lip prominence to E line, Lower lip prominence to E line, Upper lip prominence to S line, Lower lip prominence to S line, Soft tissue Sn to H line, TVL to G’, TVL to Sn, TVL to soft tissue Point A, TVL to soft tissue Point B and TVL to Pg’ were insignificantly correlated. Thus, the number of

parameters showed significant correlation between the mother & daughter were much greater and most of them were having significantly high correlation at $p=0.001$.

Comparing the correlation value for the 3 parameters showing proportions between mother & daughter as well as between the mother & son. In the mother & daughter, only 1 parameter vertical lip-chin ratio was found having significant correlation at $p=0.05$ while in the mother & son, only 1 parameter, lower vertical height-depth ratio show significant correlation at $p=0.05$.

Looking to above significance levels, it is observed that more number of frontal parameters showed significant correlation between the mother & daughter than between the mother & son. Similarly, when lateral parameters were compared, more number of parameters at high level of significance were found between the mother & daughter than in the mother & son. As regard to the proportions and ratios, different trend was observed between the mother & her children of different gender.

In above table it was found that amongst all significantly correlating parameters only 1 in between mother & daughter showed negative correlation which was vertical lip chin ratio while only 1 showed negative correlation between the mother & son was TVL to tip of the Nose. Rest all other significantly correlating parameters between the mother & daughter as well as between the mother & son showed positive correlation. The results of this study are in **accordance** with the study by **O.P Mehta et al³** who observed facial heights inherited from mother to offspring and **contrast** with the study by **Tina D. Alkudhairi et al⁶, Berglind Johannsdottir et al⁷** which showed father-offspring heritability values were higher than those in the mother-offspring group.

Table 4, shows mean and SD values of various parameters of son and daughter of Class-II Div 1 group. When difference in various values between son and daughter were estimated by “**unpaired t test**”, the frontal parameter, MFH differ significantly between the son & daughter at **p=0.017** and daughters were found having greater mean value for this parameter than son. Similar trend was found for lateral parameter, lower lip prominence to E line which also differ significantly at **p=0.035** and again daughters having greater dimensions for these parameters than son. Similar trend was also found for parameter, TVL to labrale superius having significant difference at **p=0.025** with higher value for this parameter for the daughters than son. Rest all other parameters showed insignificant difference statistically.

Table 5, shows mean and SD values of various parameters of parents of Class-II div 2 group. When difference in various values between the father and the mother were estimated by “**unpaired t test**”, amongst nine frontal parameters only two parameters “TFH” and “Nasal width” were found statistically significantly differing at **p=0.001** and **p=0.01** respectively. The values for these both parameters were higher in father than in mother. Rest seven parameters did not differ significantly.

On comparing fifteen lateral parameters for the same group, not a single parameter showed significant difference between father & mother.

Amongst the three proportions/ratios estimated, only 1 parameter, vertical height ratio show significant difference between the father & the mother at **p=0.04** and the value for this ratio was found higher for the mother than for the father.

Table 6, correlates various parameters between the father & daughter and the father & son of Class II Div2 group to understand the heritability between them. Amongst the 9 frontal parameters, out of 9, 4 parameters showed

significant high correlation between the father & daughter while 4 parameters showed significant correlation between the father & son. Amongst the significant correlated parameters between the father & daughter, the highest level of correlation found at **p= 0.001** for “**LFH, Intercanthal width and Lip length at corner of mouth.**” The parameters showed significant correlation at **p = 0.01** between the father & daughter was UFH. Rest all parameters MFH, TFH, Nasal width, Lip width and Lip length at Philtrum were correlated insignificantly. Between the father & son, significant correlation found at **p=0.01** for MFH, LFH and lip width along with at **p=0.05** for intercanthal width. Rest all parameters UFH, TFH, Nasal width, Lip length at philtrum and Lip length at corner of mouth were insignificant.

Amongst the 15 lateral parameters, 9 parameters showed significant correlation between the father & daughter, while 5 parameters showed significant correlation between the father & son. Between the father & daughter, 6 parameters showed highly significant correlation at **p=0.001** were “**Lower lip prominence to E line, Lower lip prominence to S line, Soft tissue Sn to H line, TVL to G’, and TVL to Soft tissue Point B**”, while 4 parameters, Upper lip prominence to S line, TVL to Tip of nose, TVL to Pg’ and Nasal prominence showed significant correlation at **p=0.01** and rest parameters, Upper lip prominence to E line, TVL to Sn, TVL to Soft tissue Point A, TVL to Labrale Superius, and TVL to Labrale Inferius were not having significant correlation. As against this, between father & son, 2 parameters, Upper lip prominence to E line and nasal prominence showed highly significant correlation at **p=0.001** and 1 parameter Chin projection showed significant correlation at **p=0.01** and 2 parameters Upper lip prominence to S line and TVL to G’ showed at **p=0.05**, remaining parameters were insignificant. Thus, the number of parameters

showed significant correlation between the father & daughter were much more and at higher level of significance, then the significant correlation values found between the father & son in Class II Div2 group.

Comparing the correlation value for the 3 parameters showing proportions, no significant correlation was found at any level between the father & daughter as well as between the father & son.

Looking to above significance levels, it is observed that more number of frontal parameters showed significant correlation between the father & daughter and also at higher level of significance than between the father & son. Same trend was found for lateral parameters. While the ratios were not found having any kind of correlation at any place between any comparison. The result of this study are in **accordance** with the study by **Sertac Aksakalli et al**⁵ which showed heritability of father-off springs group is more for Class II group.

Table 7, correlates various parameters between the mother & daughter and the mother & son of Class II Div2 group to understand the heritability between them. Amongst the 9 frontal parameters, out of 9, All 9 parameters showed significant high correlation between the mother & daughter while only 4 parameters showed significant correlation between the mother & son. Amongst the significant correlated parameters between the mother & daughter, the highest level of correlation found at **p=0.001** for all the 9 parameters, “**UFH, MFH, LFH, TFH, Interanthal width, Nasal width, Lip width, lip length at philtrum and lip length at corner of Mouth.**” Between mother & son, 2 parameters which were found highly correlating at **p=0.001** were “**MFH and LFH.**” while at **p=0.01**, the parameter nasal width & lip width were significant correlation. Rest all other parameters UFH, TFH, Interanthal width, Lip length at philtrum and

Lip length at corner of mouth showed insignificant correlation.

Amongst the 15 lateral parameters, 14 parameters showed significant correlation between the mother & daughter, while 1 parameter was insignificant. When these parameters were studied between mother & son, significant correlation was found at **p=0.01** for soft tissue Sn to H line and TVL to Labrale superius and at **p=0.05** for TVL to labrale inferius. Rest parameters did not show significant correlation. Thus, the number of parameters showing significant correlation between the mother & daughter were much greater and at high level of significance compared to the mother & son.

Comparing the correlation value for the 3 parameters showing proportions between the mother & daughter as well as between the mother & son. In the mother & daughter, all 3 parameters showed statistically significant high correlation while only 1 parameter showed significantly high correlation between the mother & son, amongst the parameters showed high correlation at **p=0.01** were “**the lower vertical height-depth ratio and vertical lip- chin ratio**” for mother & daughter while for vertical height ratio when correlated with mother & son. The parameter vertical height ratio showed significant correlation at **p=0.05** between the mother & daughter.

Looking to above significance levels, it is observed that more number of frontal parameters showed significant correlation between the mother & daughter than between the mother & son. Same was true for the lateral parameters as well as for the proportional and ratios. The above comparison showed very strong genetic heritability between the mother & daughter having Class II div 2 type of dental arch relationship. The results of this study are in **contrast** with the study by **Sertac Aksakalli et al**⁵ who showed increased heritability of father off spring in Class II group. This can be attributed to ethnic variation.

Table 8, shows mean and SD values of various parameters of son and daughter of Class-II Div2 group. When difference in various values between son and daughter were estimated by “**unpaired t test**”, only 1 frontal parameter showed statistically significant difference between the son & daughter at **p=0.03** was TFH which showed higher values for this parameter in the daughters than found for son. Rest all other parameters did not show statistically significant difference. Amongst the 15 lateral parameters, not a single parameter differs statistically significantly between siblings. When the proportional parameters were compared, only vertical height ratio differs statistically significantly between the son & daughter at **p=0.03** and these parameter showed higher value for son than daughter. The other 2 ratios did not show any kind of significant difference.

Summary & conclusion

The soft tissue facial contour is under genetic control and is formed chiefly by musculature covered with skin. The underlying dentoalveolar pattern affects it to great extent. This study is carried out on 30 subjects each with Class II Div1 and Class II Div2 dentitions having sibling of opposite sex and both their parents. True size frontal and lateral photographs are obtained. 9 frontal parameters, 15 lateral parameters and 3 ratios are measured and analysed for heritability. Following conclusions are derived:

For Class II Div1 Group

- a. Middle Facial Height (MFH), Nasal Width, True Vertical Line to Glabella, True Vertical to Labrale Superius, Chin Projection and Vertical Lip Chin Ratio showed significant difference between the father and mother.
- b. More number of parameters with higher level of correlations are found between the father and son than between the father and daughter.

- c. More number of parameters were found showing significant correlation and to the higher level between the mother and daughter than with mother and son showing that Class II Div1 group has increased heritability between the father and son and the mother and daughter.

For Class II Div2 Group

- a. Total Facial Height (TFH), Nasal Width and Vertical Height Ratio between the father and mother showed significant difference.
- b. Father has more number of parameters with higher level of correlations are found between the father and daughter than between the father and son.
- c. More number of parameters were found showing significant correlation and to the higher level between the mother and daughter than with the mother and son showing highly increased heritability of Class II Div2 trait to daughters from both /either of the parents.

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- Abbreviations**
1. T – Tragion
 2. Or’ – Orbitale
 3. G’ - Glabella
 4. Tr – Trichion
 5. N’ – Soft tissue nasion
 6. Sn’ – Subnasale
 7. Pg’ – Pogonion
 8. UFH – Upper facial height
 9. MFH – Middle facial height
 10. LFH – Lower facial height
 11. TFH – Total facial height
 12. InCw – Intercanthal width
 13. Nw – Nasal width
 14. Lw – Lip width
 15. LIPh – Lip length at philtrum
 16. LIcm – Lip length at corner of mouth
 17. Cp – Chin projection
 18. ULp – Upper lip prominence
 19. LLp – Lower lip prominence
 20. Np – Nasal prominence
 21. Tvl - True vertical line
 22. Tn – Tip of nose
 23. A’ – Soft tissue point A
 24. Ls – Labrale superius
 25. B’ – Soft tissue point B
 26. Li – Labrale inferius
 27. Gn’ - Soft tissue gnathion
 28. C- Cervical point
 29. Cl: Class
 30. Div: Divison
 31. S.D: Standard deviation

Legend Figure and Tables

Fig. 1A: Position of patient and camera for frontal photograph

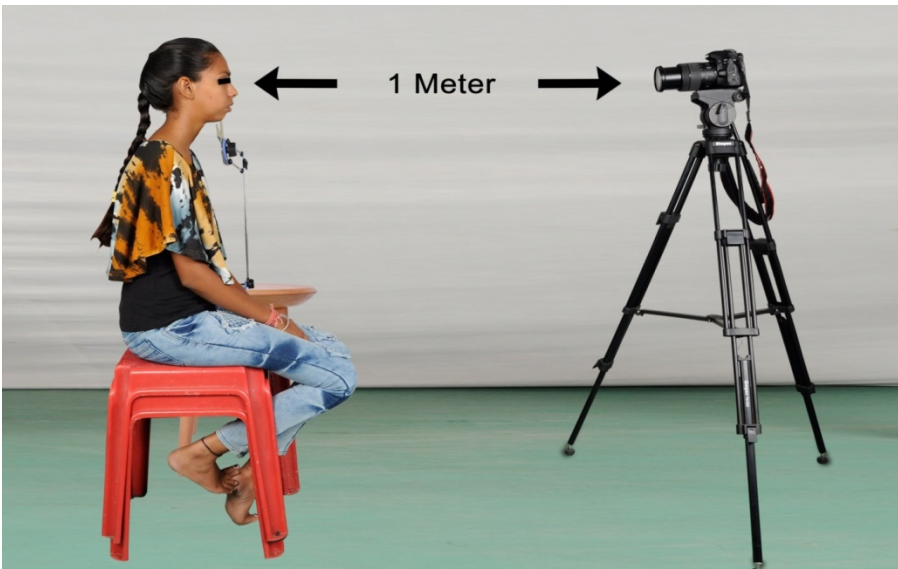


Fig. 1 B: Position of patient and camera for lateral photograph

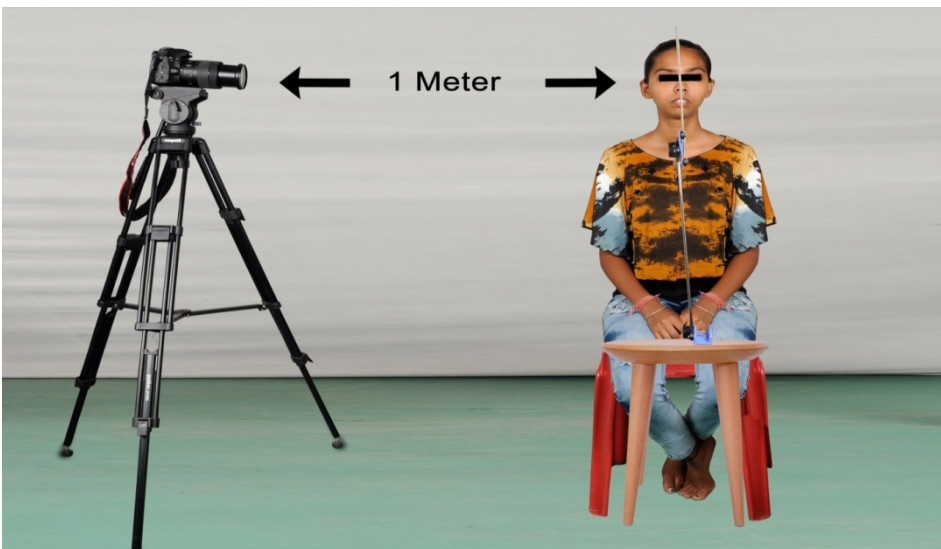


Fig. 2: Photographs of family

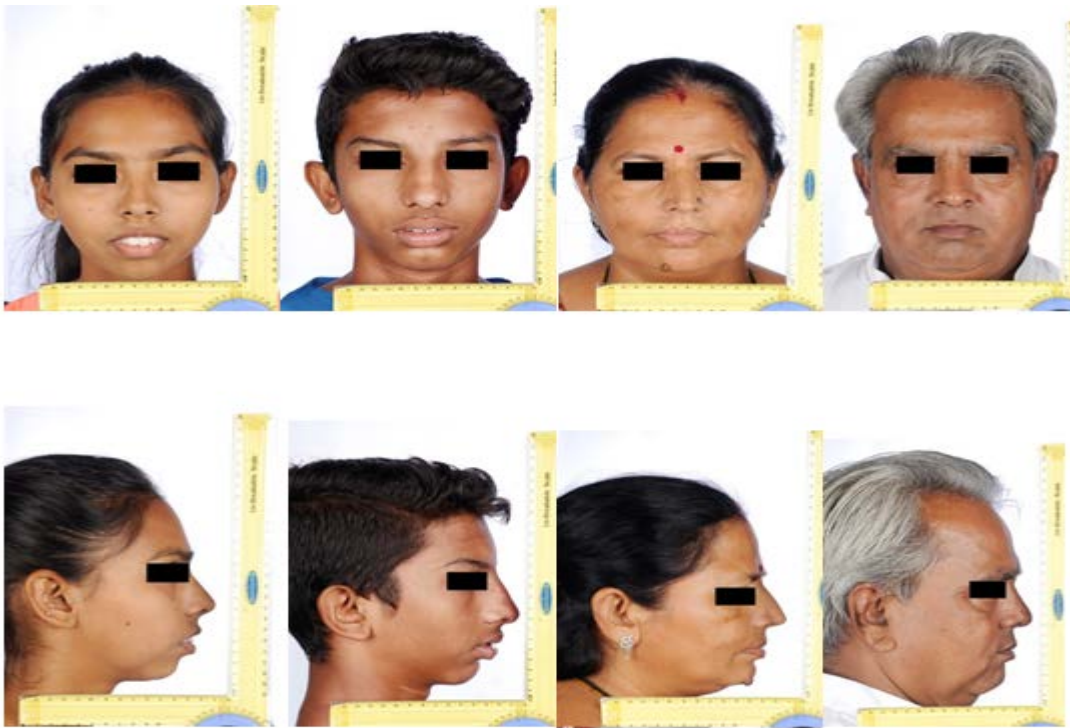


Fig. 3: True size frontal photo with calibrated grid



Fig. 4: Various points on frontal photograph- 1. Tr (Trichion) 2. N' (Soft tissue Nasion)3. Ic (Inner canthus of eye) 4. Or' (Soft tissue Orbital) 5. Aln (Ala of Nose) 6. Sn' (Subnasale) 7. Ls (Labrale superius) 8. Cm (Corner of mouth) 9. Sto (Stomion) 10. Pg' (Soft tissue Pogonion) 11. Me' (Soft tissue Menton)

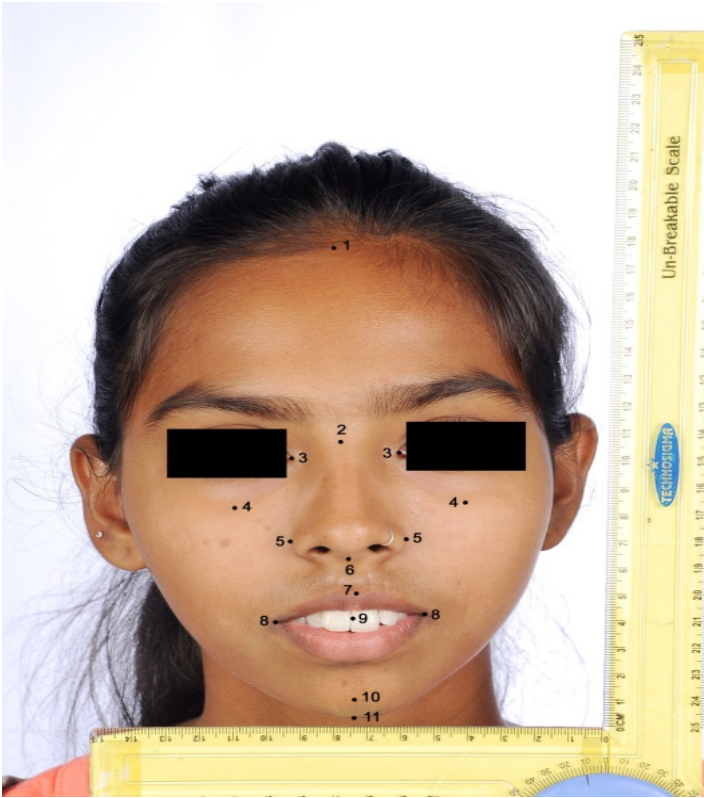


Fig. 5 : Various points on lateral photograph- 1. G' (Glabella) 2. N' (Soft tissue Nasion) 3. Or' (Soft tissue Orbital) 4. Sn' (Subnasale) 5. A' (Soft tissue Point A) 6. Ls (Labrale superius) 7. Li (Labrale Inferius) 8. B' (Soft tissue Point B) 9. Pg' (Soft tissue Pogonion) 10. Gn' (soft tissue Gnathion) 11. Me' (Soft tissue Menton) 12. Point C' (Cervical Point) 13. T (Tragus)

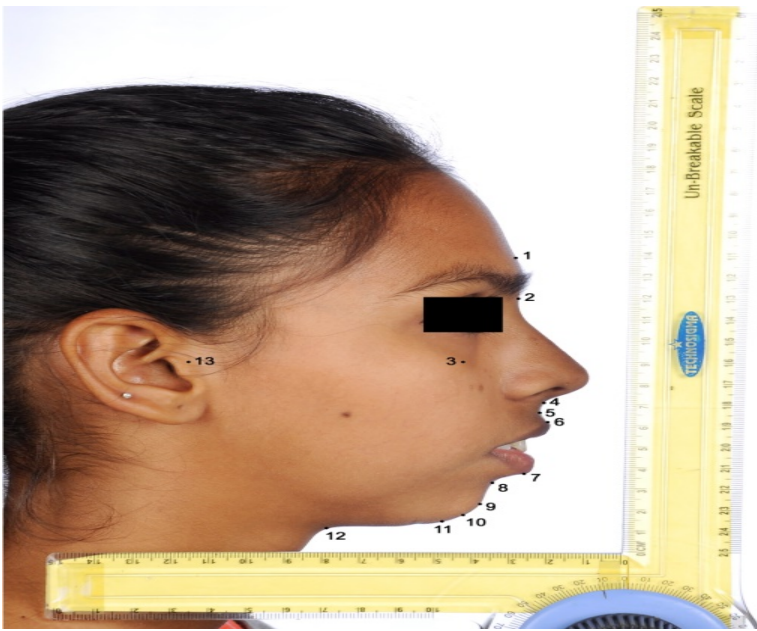


Fig. 6: Plane and lines on lateral photograph- 1. Frankfort Horizontal plane (FH plane) 2. True vertical line (Tv1) 3. Steiner line (S line) 4. Harmony line (H line) 5. Esthetic line (E line) 6. Zero Meridian Line

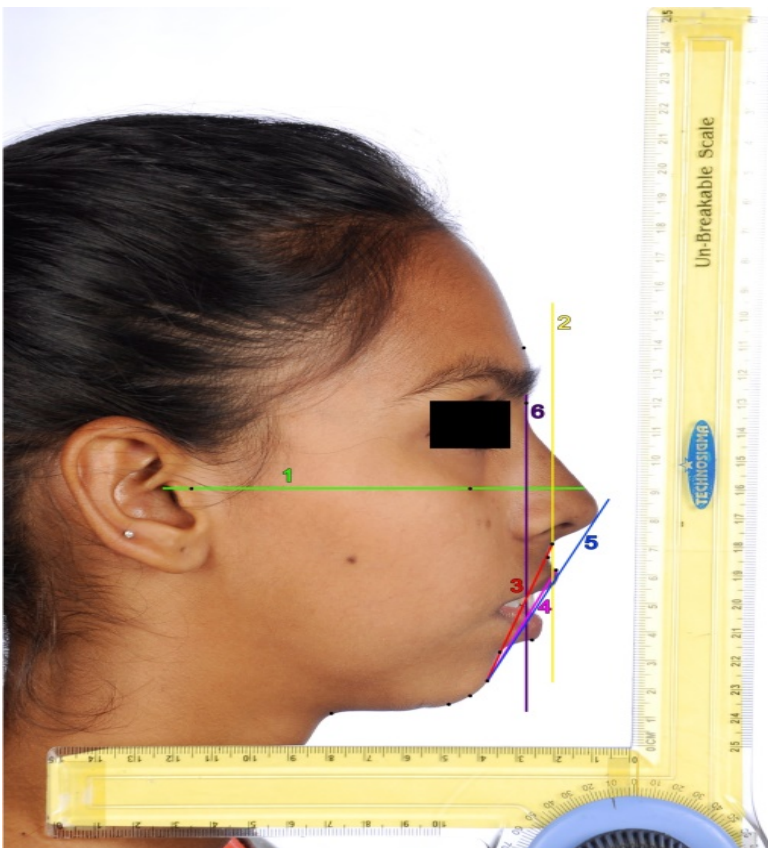


Fig. 7: Parameters measured on frontal photograph- 1. Upper Facial Height (UFH): Tr to Na'

2. Middle Facial Height (MFH): Na' to Sn'
3. Lower Facial Height (LFH): Sn' to Me'
4. Total Facial Height (TFH): Tr to Me'
5. Intercanthal Width (InCw): Ic to Ic
6. Nasal Width (Nw): Aln to Aln
7. Lip Width (Lw): Cm to Cm
8. Lip length at Philtrum (LIPh): Sn to Ls
9. Lip length at Corner of mouth: Sn to Cm

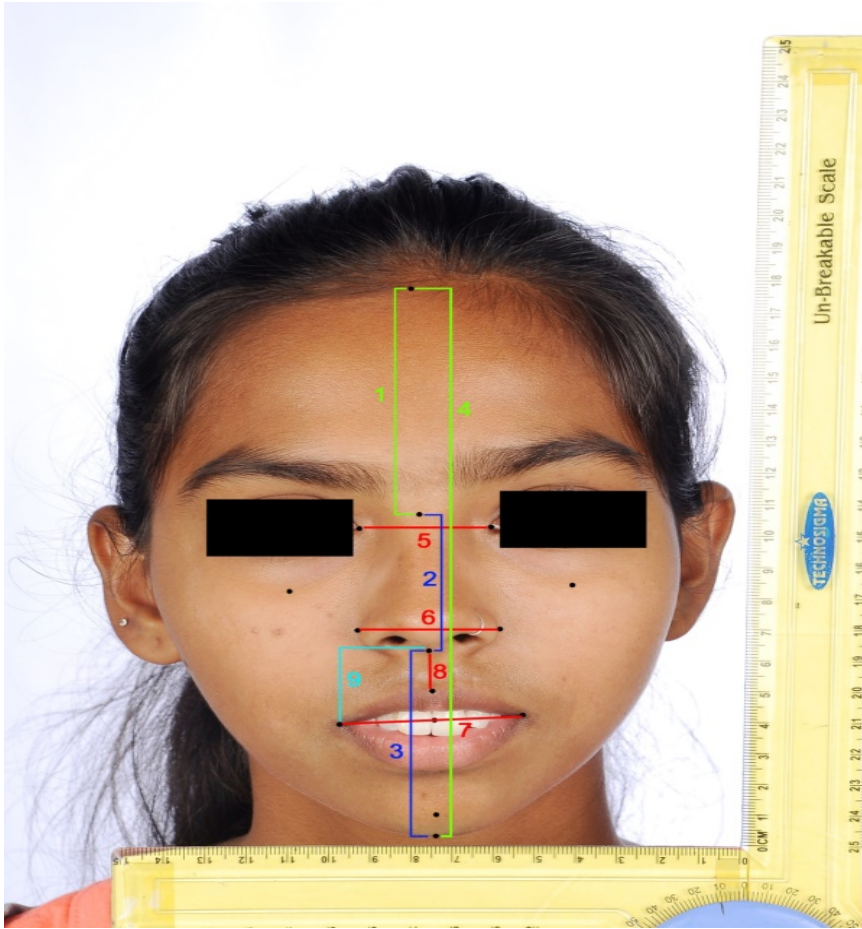


Fig.8: Parameters measured on lateral photograph- 1. Chin projection(Cp): Zero-meridian line to pog' 2.Lip prominence to E line – Upper (ULp): E line to Upper lip prominence. 3. Lip prominence to E line – Lower (LLp): E line to lower lip prominence. 4. Lip prominence to S line- Upper: S line to upper lip prominence. 5. Lip prominence to S line – Lower: S line to lower lip prominence. 6. Nasal prominence (Np): Line drawn perpendicular to FH and running tangent to the vermilion border of the upper lip. 7.Soft tissue subnasale to H line (SnH): H line to Sn' 8.True vertical to Glabella (Tv-G') : True vertical line to G' 9.True vertical to Tip of nose (Tv-Tn) :True vertical line to Tip of nose. 10. True vertical to subnasale (Tv-Sn):True vertical line to Sn'. 11. True vertical to soft tissue point A (Tv- A') :True vertical line to Point A' 12. True vertical to labrale superius (Tv-Ls) :True vertical line to Labrale superius.13. True vertical to Soft tissue point B (Tv-B') :True vertical line to Point B' 14.True vertical to labrale inferius (Tv-Li):True vertical line to Labrale inferius. 15.True vertical to Pogonion (Tv-Pg') :True vertical line to Pog'

Fig : 9 Proportional measurements on lateral photograph – a. Vertical height ratio (G’-Sn/Sn-Me’) : Ratio of G’-Sn to Sn- Me’ (1-2) b. Lower vertical height- depth ratio (Sn’-Gn’/C-Gn’) : Ratio of Sn’-Gn’ to C-Gn’(3-4) c. Vertical lip – chin ratio (Sn’-Ls/Li-Me’): Ratio of Sn’- Ls to Li- Me’ (5-6)

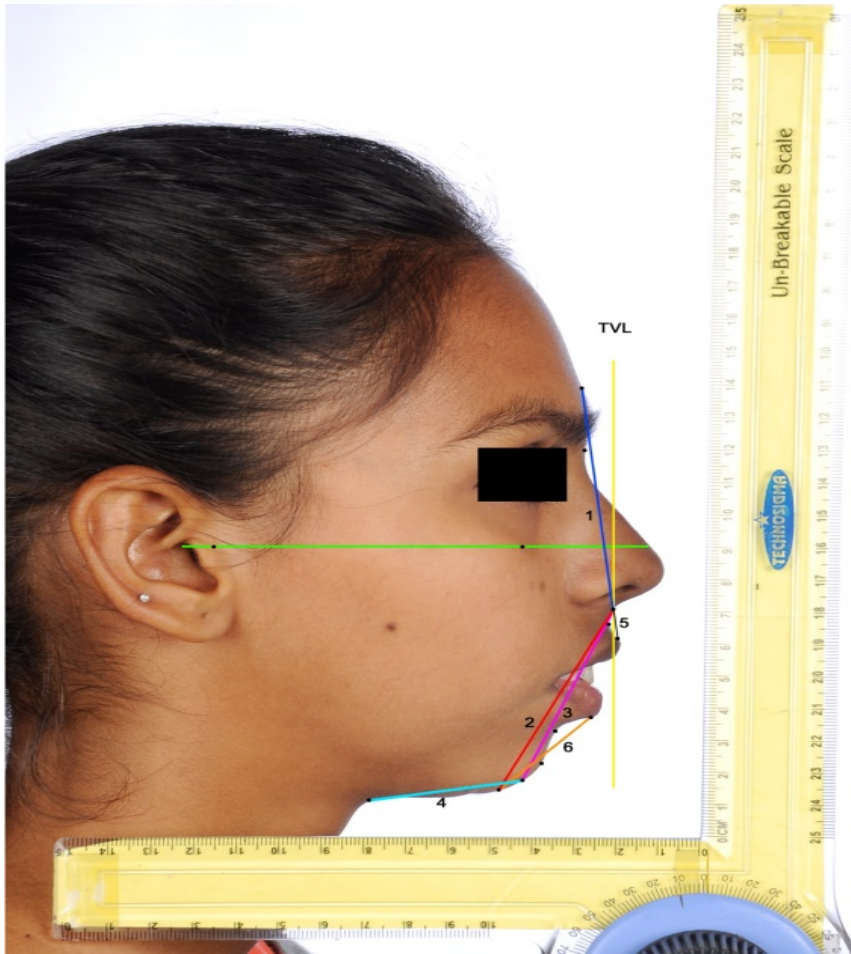


Table 1: MEAN and SD values of various parameters of FATHER and MOTHER and their comparison in CLASS-II DIV 1 GROUP

	Parameter	Father (30)		Mother (30)		unpaired 't'	probability level
		Mean	Std. Deviation	Mean	Std. Deviation		
Frontal	UFH	72.31	6.4	75.62	4.6	1.732	0.093
	MFH	49.85	3.23	47.29	2.21	2.697	0.011
	LFH	62.51	4.05	61.62	3.8	0.66	0.514
	TFH	184.55	8.17	184.45	7.25	0.04	0.968
	Intercanthal width	33.46	2.69	33.24	2.23	0.264	0.794
	Nasal Width	40.38	3.52	37.53	1.91	2.929	0.006
	Lip Width	48.39	9.88	49.28	2.59	0.358	0.722
	Lip Length At	13.71	2.59	13.69	2.69	0.02	0.985

	Philtrum						
	Lip Length At Corner Of Mouth	19.49	2.59	20.4	2.88	0.963	0.343
Lateral	Upper Lip Prominence To E line	3.22	2.09	2.86	1.67	0.554	0.583
	Lower Lip Prominence To E line	-0.11	2.12	-0.39	1.78	0.421	0.677
	Upper Lip Prominence To S line	-4.02	3.72	-2.54	3.81	1.143	0.261
	Lower Lip Prominence To S line	-4.71	3.15	-2.36	4.53	1.753	0.089
	Soft Tissue Sn To H Line	5	1.94	5.23	2.25	0.318	0.752
	TVL To G'	5.35	1.38	3.57	1.78	3.264	0.003
	TVL To Tip Of Nose	13.92	1.76	13.02	1.47	1.629	0.113
	TVL To Sn	0	0	0	0	-	-
	TVL To Soft Tissue Point A	-0.06	1.09	0.32	1.02	1.04	0.306
	TVL To Labrale Superius	2.91	2.31	0.64	3.02	2.457	0.02
	TVL To Soft Tissue Point B	8.39	2.84	8.52	4.68	0.102	0.919
	TVL To Labrale Inferius	0.57	4.15	1.53	2.77	0.791	0.435
	TVL To Pg'	3.95	5.9	3.21	7.24	0.327	0.746
	Nasal Prominence	9.98	5.38	8.68	4.17	0.784	0.439
Chin projection	0.94	2.98	4.93	5.13	2.776	0.009	
Proportional	G'-Sn/Sn-Me' (vertical height ratio)	1.13	0.12	1.13	0.09	0	1

Sn'-Gn'/C-Gn' (lower vertical height -depth ratio)	2.05	0.49	1.85	0.25	1.536	0.134
Sn'-LS/Li-Me' (vertical lip-chin ratio)	0.35	0.07	0.43	0.08	3.476	0.001

Table 2: Correlating various parameters of FATHER with their SON and DAUGHTER in CLASS-II DIV 1 GROUP

	PARAMETERS	F V/S D	F V/S S
		r	r
Frontal	UFH	0.420	0.729
	MFH	-0.256	0.863
	LFH	-0.338	0.653
	TFH	0.043	0.376
	Intercanthal width	0.115	0.607
	Nasal Width	0.372	0.366
	Lip Width	0.791	0.248
	Lip Length At Philtrum	0.037	0.684
	Lip Length At Corner Of Mouth	0.299	0.742
LATERAL	Upper Lip Prominence To E line	0.473	0.451
	Lower Lip Prominence To E line	-0.012	0.821
	Upper Lip Prominence To S line	0.021	0.932
	Lower Lip Prominence To S line	0.036	0.897
	Soft Tissue Sn To H Line	-0.267	0.469
	TVL To G'	-0.445	0.456
	TVL To Tip Of Nose	0.533	0.480
	TVL To Sn	-	-
	TVL To Soft Tissue Point A	-0.083	0.722
	TVL To Labrale Superius	0.537	0.826
	TVL To Soft Tissue Point B	-0.228	0.344
	TVL To Labrale Inferius	-0.278	0.811
	TVL To Pg'	0.216	0.806
	Nasal Prominence	0.37	0.915
Chin projection	0.264	0.712	
PROPORTIONAL	G'-Sn/Sn-Me' (vertical height ratio)	0.211	-0.073
	Sn'-Gn'/C-Gn' (lower vertical height -depth ratio)	-0.267	0.063
	Sn'-LS/Li-Me' (vertical lip-chin ratio)	0.076	-0.290

at df 58

at p=0.05 0.250

at p=0.01 0.325

at p=0.001 0.408



Table 3: Correlating various parameters of MOTHER with their SON and DAUGHTER in CLASS-II DIV 1 GROUP

	PARAMETERS	M V/S D	M V/S S
		r	r
Frontal	UFH	0.898	0.376
	MFH	0.606	0.19
	LFH	0.419	-0.152
	TFH	0.769	-0.03
	Intercanthal width	0.633	0.559
	Nasal Width	0.331	0.804
	Lip Width	-0.148	-0.053
	Lip Length At Philtrum	0.468	0.071
	Lip Length At Corner Of Mouth	0.798	0.097
LATERAL	Upper Lip Prominence To E line	0.362	0.206
	Lower Lip Prominence To E line	0.649	0.213
	Upper Lip Prominence To S line	0.828	0.07
	Lower Lip Prominence To S line	0.908	0.116
	Soft Tissue Sn To H Line	0.614	-0.219
	TVL To G'	-0.08	-0.191
	TVL To Tip Of Nose	-0.103	-0.408
	TVL To Sn	-	-
	TVL To Soft Tissue Point A	0.733	-0.215
	TVL To Labrale Superius	0.87	0.545
	TVL To Soft Tissue Point B	0.891	-0.151
	TVL To Labrale Inferius	0.427	0.332
	TVL To Pg'	0.737	-0.066
	Nasal Prominence	0.805	0.623
Chin projection	0.848	0.499	
PROPORTIONAL	G'-Sn/Sn-Me' (vertical height ratio)	0.058	-0.03

Sn'-Gn'/C-Gn' (lower vertical height - depth ratio)	0.032	0.270
Sn'-LS/Li-Me' (vertical lip-chin ratio)	-0.251	-0.095

at df 58

at p=0.05

0.250

at p=0.01

0.325

at p=0.001

0.408



Table 4: MEAN and SD values of various parameters of SON and DAUGHTER and their comparison in CLASS-II DIV 1 GROUP

	Parameter	SON (30)		DAUGHTER (30)		unpaired 't'	probability level
		Mean	Std. Deviation	Mean	Std. Deviation		
Frontal	UFH	74.17	4.95	70.51	8.5	1.537	0.134
	MFH	47.3	2.33	49.51	2.74	2.524	0.017
	LFH	60.79	3.95	60.79	3.69	0	1
	TFH	182.46	7.03	180.43	7.69	0.805	0.427
	Intercanthal width	32.34	2.05	33.38	1.92	1.527	0.137
	Nasal Width	37.78	2.38	37.58	2.53	0.237	0.814
	Lip Width	48.11	3.86	48.62	4.08	0.371	0.713
	Lip Length At Philtrum	13.08	2.14	13.33	2.54	0.307	0.761
	Lip Length At Corner Of Mouth	20.08	2.36	19.67	2.56	0.48	0.634
	Upper Lip Prominence To E line	2.55	1.69	2.65	1.92	0.152	0.88
	Lower Lip Prominence To E line	-1.51	2.37	0.22	2.22	2.204	0.035
	Upper Lip Prominence To S line	-2.71	3.56	-4.08	3.84	1.08	0.288
	Lower Lip Prominence To S line	-2.59	4.52	-4.54	3.52	1.401	0.171
	Soft Tissue Sn To H	4.16	2.02	5.33	2.23	1.604	0.118

Lateral	Line						
	TVL To G'	4.45	2.44	5.26	1.5	1.162	0.254
	TVL To Tip Of Nose	13.11	1.34	13.46	1.11	0.838	0.408
	TVL To Sn	0	0	0	0	-	-
	TVL To Soft Tissue Point A	0.29	1.44	0.22	1.41	0.144	0.886
	TVL To Labrale Superius	0.59	2.68	2.71	2.58	2.348	0.025
	TVL To Soft Tissue Point B	8.35	4.72	9.22	4.9	0.528	0.601
	TVL To Labrale Inferius	2.19	5.03	2.09	4.88	0.055	0.956
	TVL To Pg'	3.02	9.89	4.02	7.93	0.325	0.747
	Nasal Prominence	9.34	4.56	10.08	4.55	0.474	0.639
	Chin projection	4.14	4.81	1.73	3.64	1.649	0.109
Proportional	G'-Sn/Sn-Me' (vertical height ratio)	1.12	0.13	1.09	0.09	0.599	0.553
	Sn'-Gn'/C-Gn' (lower vertical height -depth ratio)	1.95	0.4	1.84	0.22	1.008	0.321
	Sn'-LS/Li-Me' (vertical lip-chin ratio)	0.36	0.09	0.36	0.08	0	1

Table 5: Mean and Sd Values Of Various Parameters Of Father And Mother And Their Comparison For class-Ii Div 2 Group

	Parameter	Father (30)		Mother (30)		unpaired 't'	probability level
		Mean	Std. Deviation	Mean	Std. Deviation		
	UFH	75.19	7.34	75.87	6.17	-0.3	0.766
	MFH	52.75	4.37	51.62	3.06	0.902	0.374
	LFH	53.63	5.04	54.41	4.45	-0.491	0.627
	TFH	184.87	6.34	177.56	6.19	3.503	0.001
	Inter-canthal width	35.88	3.23	35.63	3.21	0.228	0.821
	Nasal Width	41.04	2.83	38.06	3.75	2.693	0.01
	Lip Width	53.92	2.51	53.52	5.2	0.294	0.77

FRONTAL	Lip Length At Philtrum	16.68	2.44	16.15	2.74	0.61	0.546
	Lip Length At Corner Of Mouth	19.69	2.25	20.39	3.58	-0.697	0.49
LATERAL	Upper Lip Prominence To E line	-4.61	2.8	-3.53	1.94	-1.343	0.188
	Lower Lip Prominence To E line	-2.74	1.67	-2.68	2.32	-0.099	0.922
	Upper Lip Prominence To S line	-3.32	2.12	-3.09	2.22	-0.315	0.755
	Lower Lip Prominence To S line	-3.12	1.78	-2.97	2.59	-0.21	0.835
	Soft Tissue Sn To H Line	-3.22	1.73	-3.12	1.68	-0.176	0.861
	TVL To G'	-6.32	3.07	-6.26	3.12	-0.059	0.953
	TVL To Tip Of Nose	14.99	4.87	14.7	3.25	0.212	0.834
	TVL To Sn	0	0	0	0	-	-
	TVL To Soft Tissue Point A	-1.73	1.42	-1.29	0.89	-1.11	0.275
	TVL To Labrale Superius	-2.39	1.64	-3.47	1.71	1.93	0.062
	TVL To Soft Tissue Point B	9.15	8.05	10.12	6.67	-0.392	0.697
	TVL To Labrale Inferius	9.24	4.88	11.01	4.63	-1.118	0.271
	TVL To Pg'	-11.13	8.84	-13.31	3.04	0.988	0.33
	Nasal Prominence	14.11	3.49	14.08	2.58	0.022	0.983
	Chin projection	8.76	3.28	8.87	1.83	-0.126	0.901
PROPORTIONAL	G'-Sn/Sn-Me' (vertical height ratio)	1.42	0.3	1.66	0.38	-2.136	0.04
	Sn'-Gn'/C-Gn' (lower vertical height –depth ratio)	2.07	0.66	2.22	0.79	-0.605	0.549
	Sn'-LS/Li-Me' (vertical lip chin ratio)	0.72	0.28	0.66	0.17	0.827	0.414

Table 6: Correlating various parameters of FATHER with their SON and DAUGHTER in CLASS-II DIV 2 GROUP

	PARAMETERS	F V/S D	F V/S S
		r	R
Frontal	UFH	0.340	0.124
	MFH	-0.021	-0.377
	LFH	0.950	-0.351
	TFH	0.208	-0.064
	Intercanthal width	0.719	-0.252
	Nasal Width	-0.055	0.073
	Lip Width	-0.024	0.401
	Lip Length At Philtrum	-0.087	0.02
	Lip Length At Corner Of Mouth	0.966	0.078
LATERAL	Upper Lip Prominence To E line	0.179	-0.496
	Lower Lip Prominence To E line	0.933	0.072
	Upper Lip Prominence To S line	0.387	-0.315
	Lower Lip Prominence To S line	0.962	-0.06
	Soft Tissue Sn To H Line	0.985	-0.218
	TVL To G'	0.635	-0.272
	TVL To Tip Of Nose	0.396	0.204
	TVL To Sn		-
	TVL To Soft Tissue Point A	0.207	-0.047
	TVL To Labrale Superius	0.097	-0.177
	TVL To Soft Tissue Point B	0.834	-0.177
	TVL To Labrale Inferius	0.032	-0.152
	TVL To Pg'	-0.327	0.242
	Nasal Prominence	0.384	0.744
Chin projection	-0.048	0.334	
PROPORTIONAL	G'-Sn/Sn-Me' (vertical height ratio)	-0.036	-0.11
	Sn'-Gn'/C-Gn' (lower vertical height - depth ratio)	-0.157	-0.054
	Sn'-LS/Li-Me' (vertical lip-chin ratio)	0.023	0.083

at df 58

at p=0.05

0.250

at p=0.01 0.325
 at p=0.001 0.408



Table 7: Correlating various parameters of MOTHER with their SON and DAUGHTER in CLASS-II DIV 2 GROUP

	PARAMETERS	M V/S D	M V/S S
		r	R
FRONTAL	UFH	0.978	-0.011
	MFH	0.899	0.498
	LFH	0.679	-0.429
	TFH	0.984	-0.062
	Intercanthal width	0.904	0.09
	Nasal Width	0.986	-0.382
	Lip Width	0.935	0.335
	Lip Length At Philtrum	0.698	-0.04
	Lip Length At Corner Of Mouth	0.916	-0.185
LATERAL	Upper Lip Prominence To E line	0.713	-0.205
	Lower Lip Prominence To E line	0.567	0.102
	Upper Lip Prominence To S line	0.620	-0.236
	Lower Lip Prominence To S line	0.990	0.174
	Soft Tissue Sn To H Line	0.621	-0.256
	TVL To G'	0.984	-0.192
	TVL To Tip Of Nose	0.512	0.047
	TVL To Sn	-	-
	TVL To Soft Tissue Point A	0.920	0.029
	TVL To Labrale Superius	0.922	-0.250
	TVL To Soft Tissue Point B	0.943	-0.215
	TVL To Labrale Inferius	0.68	-0.396
	TVL To Pg'	0.829	0.024
	Nasal Prominence	0.948	0.052
Chin projection	0.810	-0.034	

PROPORTIONA L	G'-Sn/Sn-Me' (vertical height ratio)	0.302	-0.576
	Sn'-Gn'/C-Gn' (lower vertical height - depth ratio)	0.552	0.131
	Sn'-LS/Li-Me' (vertical lip-chin ratio)	0.708	-0.06

at df 58

at p=0.05

0.250

at p=0.01

0.325

at p=0.001

0.408



Table 8: Mean And Sd Values Of Various Parameters Of Son And Daughter And Their Comparison For Class-II Div 2 Group

	Parameter	SON (30)		DAUGHTER (30)		unpaired 't'	probability level
		Mean	Std. Deviation	Mean	Std. Deviation		
FRONTAL	UFH	75.61	6.21	75.97	5.69	-0.157	0.877
	MFH	51.28	2.68	50.92	2.77	0.352	0.728
	LFH	53.73	5.23	51.56	4.22	1.161	0.256
	TFH	177.38	6.62	187.37	9.66	-3.311	0.003
	Intercanthal width	35.19	3.76	37.27	2.57	-1.618	0.117
	Nasal Width	37.4	4.53	39.79	2.5	-1.601	0.121
	Lip Width	53.23	5.5	53.81	4.6	-0.29	0.774
	Lip Length At Philtrum	15.65	2.24	15.22	3.83	0.385	0.703
	Lip Length At Corner Of Mouth	19.38	2.63	18.35	2.72	1.017	0.318
Upper Lip Prominence To E line	-3.48	1.73	-3.5	1.71	0.025	0.98	
Lower Lip Prominence To	-2.88	1.72	-3.61	1.47	1.172	0.251	

LATERAL	E line						
	Upper Lip Prominence To S line	-3.27	3.07	-3.85	1.08	0.595	0.557
	Lower Lip Prominence To S line	-3.14	2.1	-3.17	1.96	0.043	0.966
	Soft Tissue Sn To H Line	-3.13	1.63	-3.05	1.78	-0.113	0.911
	TVL To G'	-5.57	3.53	-5.35	2.81	-0.169	0.867
	TVL To Tip Of Nose	14.51	3.09	14.12	2.87	0.336	0.739
	TVL To Sn	0	0	0	0	-	-
	TVL To Soft Tissue Point A	-1.37	0.79	-1.32	1.33	-0.138	0.891
	TVL To Labrale Superius	-3.14	1.4	-2.46	1.38	-1.264	0.217
	TVL To Soft Tissue Point B	10.34	6.22	6.29	10.07	1.346	0.189
	TVL To Labrale Inferius	11.46	3.91	9.95	5	0.903	0.374
	TVL To Pg'	-12.72	3.34	-14.37	3.18	1.313	0.20
	Nasal Prominence	14.21	2.81	14.95	1.44	-0.817	0.421
	Chin projection	9.04	1.56	10.09	2.13	-1.524	0.139
	PROPORTION AL	G'-Sn/Sn-Me' (vertical height ratio)	1.59	0.36	1.27	0.33	2.381
Sn'-Gn'/C-Gn' (lower vertical height -depth ratio)		2.13	0.79	2.24	0.85	-0.352	0.727
Sn'-LS/Li-Me' (vertical lip-chin ratio)		0.69	0.17	0.59	0.25	1.218	0.234