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A treatment module in orthodontics for the cleft palate patients

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Abstract:

Polygons named polycon and polynew that involve a limited number of cephalometric parameters were identified in cephalograms of cleft patients; these can be implemented in the diagnosis and treatment planning of the cleft on a long term basis; and also in comparison of the cleft with the ideal, Class II and Class III malocclusions. A chart displaying 95% confidence limits for various parameters in the cleft and ideal was developed; this can be used for cephalometric analysis and interpretation for the cleft subjects. A treatment module in orthodontics for the cleft palate patients is thus enabled.

Key words: polycon, polynew, polygon in cephalograms, polygon in cleft palate, cephalograms of cleft patients, cephalometric chart for the cleft, treatment module for cleft patients, cleft palate

Introduction

Background and Rationale:

Cephalograms are Xray views of head, routinely used in orthodontics. Measurements are taken from Xrays (cephalograms), to aid the diagnosis and treatment planning in orthodontics.

Many points (cephalometric landmarks)[1,2] are identified on these cephalograms and usually, measurements are taken by measuring the distances between these points (linear measurements). Angles between these points are also measured (angular measurements). But the measurement taking from the Xrays (cephalograms) and analysis is a lengthy time consuming process, involving a number of parameters. Many points like S, N, P, O, ANS, PNS, A, B, D, Go, Gn etc are used. Measurements are taken, relating to these points, these are many in number; much time is taken up for analyses (linear and angular measurements).

Need for research and relevance of topic:

A successful attempt was made in the previous SBMR project[3], to simplify this lengthy time consuming analyses procedure, by reducing the number of measurements taken, thereby reducing the time taken for analysis. For this, a polygon with a very limited number of measurements was developed; and Cephalometric Polygon Norms as a Guide towards a Harmonious Individual Craniofacial Pattern was developed. In patients with cleft palate, where there is cleft in the palate and where the maxillary growth is impaired, the necessity for the development of a new polygon was felt.

It was planned to include some parameters free from the influence of growth[4]; ie, to include a parameter that may show no further change with age, among the values to be obtained for the polygon to be developed in this project.

Aims and Objectives

Aims

This study aims to: Estimate the factors that account for the greatest time consuming factors in orthodontic diagnosis, determine the best possible simplified procedure in the cleft palate patients, Explain and analyze the observed impact of project outcome (polygon) developed for cleft palate patients, and to use the project outcomes in day to day practice. The study is global in scope, since the involved points are global in nature.

Objectives

To identify a polygon in cephalograms of cleft patients, that involves a limited number of cephalometric parameters. A treatment planning module for the cleft patients is to be developed after defining this polygon.

Primary objective

To find the mean ± SD values for the polygon in the cleft and in the ideal and Five-number summaries (minimum value, maximum value and quartiles)

Secondary objectives

1. To see if there is any Correlation between the angular, linear and area measurements of the cleft
2. To see if there is any Correlation between the angular, linear and area measurements of the ideal
3. To see if there is statistically significant difference between males and females for the study variables.
4. To compare the values obtained for the cleft population with ideal, Class II and Class III groups.

Materials and Methods

Methodology

Study design; Study setting, Study population, Sample size:

This cross-sectional study was conducted in the Department of Orthodontics, Govt: Dental College, Thiruvananthapuram. Cephalograms of cleft patients aged 10 years or above and cephalograms of the ideal, Angle Class II and Angle Class III malocclusion groups of age group 18-21 were included in the study. For each category, a statistically approved sample number was used.

Sample size All the cases satisfying the inclusion criteria will be included in the cleft group in the study. Twenty numbers of ideal, 28 Angle Class II and 50 Angle Class III malocclusion cases of age group 18-21, from records available in the department were also included.

Sample size

$$n = \frac{2\sigma^2 (Z_{1-\alpha/2}+Z_{1-\beta})^2}{d^2}$$

$$\sigma^2 = \frac{\sigma_1^2+\sigma_2^2}{}$$

2

σ_1= standard deviation of the first sample

σ_2= standard deviation of the second sample

d=μ_1-μ_2

=observed difference between the mean values of the two samples

α=Probability of committing Type I error

1-β =Probability of committing Type II error

From pilot study

Class II

Values from pilot study

μ_1=28599 μ_2=35923 σ=9762

$$n = \frac{2*7.8498*9762^2}{(35923-28599)^2} = 28$$

Class III

Values from pilot study

μ_1=40821 μ_2=38634 σ= 3845

$$n = \frac{2*7.849*3845^2}{(40821-38634)^2} = 49$$

Cleft

Standard deviation in group I(Angle I)	5.4
Standard deviation in group II (cleft)	6.3
Mean difference	7.78
Effect size	1.33
Alpha error (%)	5
Power (1- beta) %	80
1 or 2 sided	2
Required sample size per group	9

The final sample size was be 107 after incorporating 9 cleft + 20 ideal + 28 Class II + 50 Class III = 107

Sampling:

Purposive sampling

Inclusion criteria

Inclusion criteria were the following:

Presence of cleft palate. Should belong to Kerala by birth and domicile.

Exclusion Criteria

Absence of cleft palate

Data Collection

Data collection tools

Cephalometric tracing paper, pencils for tracing, scale, protractor, scanner for scanning of the cephalogram. Linear, angular and area measurements were taken with the software program ImageJ.

Data collection procedure/method

Cephalograms of cleft palate patients, 10 years or above, available in the Dept: of Orthodontics obtained for treatment purposes, and thesis purposes were evaluated for these specific parameters proposed to be included, to see if the proposed points permit drawing of the polygon in all cases. Study variables that can be applied to cephalograms of cleft palate patients were selected. Tracings of osseous, dental and soft tissue structures were made and landmarks identified as per standard textual definitions and journal citations. Cephalometric tracings were conducted by a single investigator (after standardization). Cephalometric tracings of ideal, Angle Class II and Angle Class III malocclusion cases were also incorporated.

The hand drawn cephalometric tracings were scanned with a flatbed scanner (at 600 dpi). Measurements were taken with the software program ImageJ.

2. Points, lines, planes, angles, best fit circles, polygons and areas used are as listed below:

S(sella), P(porion), O(orbitale), FH, Long axis of U1, ANS-PNS, P1 (the point of intersection of the Long axis of U1 to ANS-PNS is marked as P1), Sn, P1-Sn , P2 (Intersection of P1-Sn on the anterior curve is marked as P2), mandibular plane(MP), Long axis of L1 , P3 (Long axis of L1 to MP is marked as P3), P1-P3, P4 (Intersection of P1 P3 on the palatal floor is marked as P4), Draw the best fit circle fitting inside the premaxilla area, and mark the centre of this best fit circle as M. Find the area of best fit circle. Also draw the triangle P1-P2-P4 and find the area of P1-P2-P4. Draw circle, to mark G as the centre of the best fit circle, at the chin. Linear distances from S to points G, P, M; and linear distance from P to G are drawn as SG, SP, SM and PG respectively. Perpendicular is drawn from M to SG, the point of intersection is marked as P. (Fig 1) (Fig 2). Go' is also marked. Draw the best fit circle at the sella (S best fit). The following lines are also drawn:

1. S per to FH: A perpendicular through the mesial side of the best fit circle on Sella is drawn perpendicular to FH.
2. P per to FH: A perpendicular through the mesial side of Porion is drawn, perpendicular to FH.
   Then measure the horizontal distance perpendicular to these lines from M, G, Sn and Go'

Two more linear measurements used in the analysis are: Length 1 is taken as P2-P1 and length 2 is taken as P2-P3 (direct measurement from P2 to P3 in a straight line). (Fig 3).

4. Polygons were drawn, on the ideal cephalogram for obtaining the ideal values for the polygon. The following are the steps in drawings of the polygons Polycon and Polynew

Draw the polygon conventional (polycon), as cited in ref 3. All the landmark points of the polycon are the same as in polygon ABCDE in the reference 3 cited[3]. But In this study, it is landmarked/named as polygon conventional (polycon) P2-P1-P3-D-E, with point P2, P1 and P3 replacing points A,B and C to get the polycon in the ideal. Now, draw the polygon new (polynew), with the point M replacing P1 of the polycon. It is landmarked/named as Polygon P2-M-P3-D-E, the polynew in the ideal.

These lines, planes, angles, best fit circles and polygons are drawn for the ideal and for the cleft. (Fig 4, Fig 5).

Fig 6, Fig 7 shows the polygon, polycon in the cleft and Fig 4 Fig 5 Fig 8 Fig 9 shows the polygon, polynew in the cleft. Fig 10, Fig 11, Fig 12, Fig 13, Fig 14, Fig 15 and Fig 16, Fig 17 allows a comparison between the polygons polycon and polynew, in the cleft and in the ideal respectively.

Measurements taken:

Linear*:* See Fig 18, Fig 19 and Fig 20

1. Length 1
2. Length 2
3. SG
4. SP
5. PG
6. SM
7. M - S per to FH
8. M - P per to FH
9. G - S per to FH
10. G - P per to FH
11. Sn - S per to FH
12. Sn - P per to FH
13. Go' - S per to FH
14. Go' - P per to FH

Angles*:* See Fig 21, Fig 22 for angle 1, angle 2 and angle 3 (Text already cited in ref 3); Fig 23, Fig 24 for angle PSM; Fig 25 for angle P1P4P2; Fig 26 for the SP angle.

1. PSM
2. SMP
3. P1-P4-P2
4. P4-P1-P2
5. P1-P2-P4

The angles are read as angular 1 (PSM); angular 2(SMP), angular 3 (P1-P4-P2), angular 4 (P4-P1-P2); angular 5(P1-P2-P4).

6. SP angle is the angle that the SP line makes with the FH; the inferior inside angle is read; (in this study, a minus sign is given for this SP angle, indicating that it is measured below the FH; the inferior inside angle being read).
7. angle 1
8. angle 2
9. angle 3

Areas***:*** See Fig 21 for circles, Fig 6 for polycon, Fig 10 for polynew

1. SMP
2. P1-P4-P2
3. M circle best fit
4. S best fit
5. G circle best fit
6. Polycon
7. Polynew

Areas are taken for the two triangles [SMP (area 1) and P1-P4-P2 (area 2)]; for three circles [M circle best fit (area 3), S best fit (area 4), and G circle best fit (area 5)]; and for areas of the two polygons (polycon and polynew).

Sample tracing from the Class II population is presented in Fig 27-28, from the Class III in Fig 29-30, cleft in Fig 31-32, ideal in Fig 33-34; all with the polycon shaded.

Analysis

Linear, angular and area measurements in the cephalograms of the cleft, ideal, Class II and Class III malocclusions were taken and data were analysed using SPSS version 20.0. The mean and standard deviation, and five number summary values of the study variables were computed for the polygons and other parameters, for the cleft, ideal, Class II and Class III groups, for linear, angular and area measurements. The parameters were compared between the cleft and ideal values and also to the Class II and Class III malocclusions. A treatment planning module was developed by defining a polygon polynew on the cleft and ideal cephalograms.

Also, the correlation between the three linear, nine angular and seven area measurements in the ideal group and also in the cleft group; and the statistically significant differences between males and females for the study variables were examined. Differences in mean values were evaluated by student t test and F test and Pearson correlation coefficients were used to study the correlation.

Results are presented below; linear measurements in pixels and angular in degrees.

Results

In the 'ideal' population, 50% were males and 50% were females. In the cleft population, 33% were males and 67% were females. 43% of the Class II and 52% of the Class III population were males and 57% of the Class II and 48% of the Class III subjects were females. Out of the total population, 48% were males and 52% were females. (Table 1).

Ideal subjects were mostly ≥20 years (75%), while the in the cleft group it was mostly <20 years (89%). (Table 2).

A statistically significant difference was observed in the mean length 1, length 2, angle 1, angle 2, angle 3 and polycon area among the 4 groups. The cleft group showed the lowest values in the mean length 1, length 2, angle 2 and in the polycon area. The mean length 1 in the cleft was 255.08±57.29 and in the Class III malocclusion it was 349.16±46.95 (highest). In the Class II malocclusion (329.03±37.23) also, the mean length 1 was more than that in the ideal (303.9±44.84). The mean length 2 was the lowest in the cleft (757.24±100.09) and highest in the Class II malocclusion (930.39±86.35). In the Class III malocclusion (847.35±96.63) also, the mean length 2 was more than that in the ideal (776.09±63.17). Angle 1, Angle 2 and Angle 3 had the highest mean values in the Class II. Mean values of Angle 1 and Angle 3 were lowest in the ideal. Mean values of Angle 2 was the lowest in the cleft group.

The mean polycon area was highest in the Class II malocclusion; In the Class III mal occlusion also, the mean area was more than that in the ideal and the cleft. (Table 3).

The mean and SD for the parameters compared between the ideal and cleft groups only are listed in Table 4. Linear measurements SG and PG were more in the cleft where as the angular measurements angle 2 and angle 4 were more in the ideal. (Table 4).

There is a statistically significant difference in the mean area of polycon and polynew in the cleft. (Table 5).

There is a statistically significant difference in the mean area of polycon and polynew in the ideal group also. (Table 6).

Higher values were observed in males of the cleft group in horizontal distances measured perpendicular to 'S per' from points G, Sn and Go', ($p<.05$), than in females of the group. (Table 7).

Males of the ideal showed higher mean values than the females in linear parameters length 1, area 1, SP linear, SM, M- P per, Sn-S per, Sn-P per, Go'-P per and SG linear and for the parameter area 1. Females showed higher mean values in angle 1. ($p<.05$).(Table 8).

Comparison between the cleft and the ideal among males showed higher mean values for males of cleft in area 2 and area 4. ($p<.05$). (Table 9).

Comparison between the cleft and the ideal among females showed higher mean values in females of ideal for 'angle 2' and for measure 'angular 4'. The males showed higher mean values in the linear parameters SG and PG than the females. ($p<.05$). (Table 10).

The cleft group (combined males and females) had higher mean values in angle 1, while the ideal (combined males and females) showed higher values than the cleft in angle 2 and length 1. ($p<.05$). (Table 11). No statistically significant difference was observed in the mean area of the polycon between the ideal and the cleft groups (Table 11). POLYNEW area also showed no statistically significant difference between the ideal and the cleft groups (combined males and females) (Table 4). No statistically significant difference is observed between males of the cleft and males of the ideal in the mean values for angle 1, angle 2, angle 3, length 1, length 2 and polycon area. (Table 9).

Statistically significant difference is observed in angle 1, angle 2, length 1, length 2 and polycon on comparison between cleft and Class II among males.

Mean length 1 was less in males of the cleft than that in males of Class II and Class III. ($p<.05$)(Table 12, Table 13)). Mean angle 1, angle 2, length 2 and polycon area was less in males of the cleft than in males of Class II. ($p<.05$) (Table 12).

Statistically significant difference is observed in angle 2, angle 3, length 1, length 2 and polycon on comparison between cleft and Class II among females.

Mean Angle 2 was less in females of the cleft than that in females of ideal, Class II and Class III. ($p<.05$).(Table 14, Table 15, Table 10). Angle 3, length 1 and polycon area was less in females of the cleft than in females of Class II and Class III. ($p<.05$). (Table 14, Table 15). Length 2 was less in females of the cleft than in females of Class II. ($p<.05$). (Table 14).

Mean Angle 1 of the cleft was more in the cleft than in the ideal, and less than that in Class II. Mean values of Angle 2 and length 1 were less in the cleft than in the ideal, Class II and Class III. Mean in Angle 3, length 2 and polycon area were less in the cleft group than in the Class II and Class III. ($p<.05$)(Table 16, Table 17, Table 11).

Correlations observed between the angular, linear and area measurements of the ideal, and that of the cleft are presented in Table 18 and Table 19 respectively; Figures 35-42. Good correlation is observed between the polycon and polynew in both the groups (.924).
Correlation of polycon and polynew with the other parameters in the ideal group is presented in Table 18. Good correlation was observed between polycon and polynew in the ideal group. Length 2, Length 1, SG linear and Angle 3 showed good correlation with both the polygons; the polycon and the polynew. P1-P2-P4, SMP angle, P1-P4-P2 angle and SP angle showed correlation with polycon only.

Correlation of polycon and polynew with all parameters the cleft group is presented in Table 19. Good correlation was observed between polycon and polynew in the cleft group. Length 2, SG linear and P4-P1-P2 angle showed good correlation with both the polycon and polynew. Length 1 and SMP angle showed a positive correlation with the polycon. Negative correlation was observed between P1-P4-P2 angle and the polynew.

Length 2 and SG linear showed good correlation with both the polycon and polynew; both in the ideal and in the cleft. Table 18 and Table 19.

Five-number summary for the males and females of ideal, cleft, Class II and Class III groups are presented in Table 20-Table 27, and Five-number summary for the whole data are presented in Table 28.

95% Confidence Interval (CI) for the ideal and the cleft groups are presented in Table 29-Table 33

Discussion

A very short discussion: Functional efficiency is the main objective of treatment in the early stages of many of the cleft patients; aesthetic enhancement is not secondary to this once the level/age of self perception has reached, esp in this 'selfie' age. Correction for profile enhancement is sought by them along with the dental/orthodontic procedures; this may necessitate surgery in the later years, after the growth is complete. The age is highly critical when it comes to a combination of orthodontic and surgical treatment for a cleft patient for aesthetic enhancement.

The values for the cleft and the ideal, for the polycon and the polynew, help in analysing where the 'discrepancy' is and how much it is when it comes to orthopaedic/orthodontic/surgical treatment. The polycon area values along with the supporting linear and area measurements can be used to analyse and evaluate the situation of the cleft in relation to the Class II, Class III and the ideal situations for the age groups available, and plan treatment in a long term perspective with reference to the available treatment protocol for the cleft and aimed in treatment to achieve an ideal value.

Point S, point M, and point G are three stable points [4]. Polynew uses the point M. In this context, the correlation observed in this study, of the polynew to the SG line and the SP line angle deserves a special consideration in the treatment planning of the cleft patients, since the treatment is prolonged over the years where the growth is occurring. SG is concerned with the mandibular length in cleft palate patients; SP angle reflects the anterior facial height, both in the cleft and in the ideal.

The stability of the SG line in growth[4] makes this SG linear parameter support for the cleft treatment evaluation relevant, especially since this parameter shows statistically significant difference between the cleft and ideal groups (p=.033) [this parameter shows statistically significant difference between females of the cleft and ideal groups also (p=.036)] and the statistically significant positive correlations observed in this study for SG linear measurement to both the polycon and polynew areas, both in the ideal and in the cleft groups.

The tooth to bone relations achieved through the incisor positioning by the orthodontist in known to the orthodontist only, changes in the skeletal parameters in surgical repositioning is known to the surgical team only, but the change achieved by treatment in the hard and soft components, reflected in the soft tissue, in front and profile views and in whole, is visualised by the patient and the perceivers too. The shape of the polygon is based on the cleft/malocclusion (Class I, Class I or Class III), this in itself can reveal the facial form to some extent. Figures 27-34.

The shape (area) of the polygon is dependent on the subnasale (Sn) and the lower incisor position; these ensure that a soft tissue variable along with hard tissue variables relating to the teeth and bone are incorporated in the polygon in the area measurement.

Shape of the polygon, derives contribution from the many linear and angular measurements of the craniofacial region and also from many 'stable' landmarks of the region, this is unique in the long term treatment planning of the cleft patients for the functional and aesthetic enhancement in the cleft.

In this study, values have been computed for the ideal, Class II and Class III study groups, for angle 1, angle 2, angle 3, length 1, length 2, and polycon area. Progress to be achieved for the profile of cleft can be evaluated based on values available for the Class II and Class III groups. Ie, the value for the cleft should be definitely less than the value for Class II for some parameters, while it should be more for some other parameters, when an adult final positioning to the ideal is to be attained. (Table 3, Table 13-Table 17)

Length 1 showed a statistically significant difference between the ideal and the cleft groups. The mean value for length 1 in the ideal was 303.9±44.8; in the cleft, it was 255.1±57.3 ($p<0.05$) (Table 3). Length 1 refers to the distance AB (of ref 3) which is same as P2-P1 (of the present study). Both the polycon and polynew uses Length 1, a measurement of the maxillary length. The growth of the maxilla in the cleft may differ from the ideal pattern, or the rates of growth in the different times of the spurts in growth may differ between the ideal and the cleft. Comparison of maxillary arch lengths[5] and arch widths[6] in cleft palate patients has been reported.

PG linear, SG linear and Sn-S per linear also showed a statistically significant difference between the 'ideal' group and the cleft group. Ie, parameters relating to G point and S point showed significant differences between the ideal and the cleft. The S point being relatively stable during growth, this is to be considered in the clinical perspective.

Measurement of SP line angle is a useful sagittal parameter during the period when facial growth is taking place vertically; No statistically significant difference was observed in SP line angle between the ideal and the cleft in this study.

Angular measurements P4-P1-P2, SMP and PSM also differed between the ideal and the cleft groups. In triangle SMP, angle at P remains without change; but the angles at S and M differ between the cleft and the ideal (Fig 22, 23). Again, in triangle P4-P1-P2, it is the angle at P1 that changes, not that at P2 or P4. Fig 24. Other angular parameters showed no statistically significant difference between the study groups.

Thus, this polygon polynew involves a combination of linear and angular reflections, thus adding itself as a valuable tool for *assessment of jaw relationship* for cleft patients. *No significant difference* is observed in polycon and polynew, between the ideal and the cleft. (Table 4, Table 9, Table 10, Table 11). The polycon and the polynew showed no statistically significant difference between the males and the females. The measurement of polygon areas can be a valuable tool *in growth assessment* in the cleft during transitional period when facial growth is taking place. The polycon and the polynew reflect the true changes in skeletal and soft tissues too, achieved by growth/growth modification/orthodontic/ surgical procedures, thus enabling *comparison between the pre and post treatment values*.

Orthodontic diagnosis and treatment plan on the cleft depends on the time of report by the patient; the time consuming factors in treatment from the early period to the adulthood are dependent on various factors, like: the negative overjet for which protraction appliances may be given; constricted maxillary arch when expansion appliances are to be given and so on. The expansion procedures depend on the amount of constriction present; the alignment procedures are dependent on the arch length. Comparison of the mandibular arch lengths, arch widths and arch chords in cleft palate patients has been reported[7,8,9]. Methods of expansion (dental / skeletal) for arch widening and alignment of teeth that are usually done in cleft patients were reported[10,11]. Treatment outcome in all these factors are reflected in the area determined by the polynew 'area' measurement, and always a comparison will be available to the final result to be attained by comparing with the ideal adult values. The polynew, *uses the parameter M,* hence the relevance of polynew; esp in this situation of prolonged treatment of the cleft during the period of growth. Braun et al[12] refer to the point M, as a single point which cannot by itself summarise the growth of the dento maxillary complex in the sagittal plane; but when associated with the ANS-PNS plane, describes the downward and forward migration more accurately than was previously possible. The M point was first described in orthodontics by Nanda and Merrill[13].

Statistically significant difference was observed between males and females of the ideal group in Angle 1, linear measurements Length 1, SG, SP linear, SM, M- P per, Sn-S per, Sn-Pper, Go'-P per and area measurement SMP. (Table 8)

The cleft group showed statistically significant difference between the males and females in G-S per, Go'-S per and in PSM angle (Table 7). These statistically significant differences in gender in the cleft group were seen in parameters relating to the mandible and the Sella. The subjects in the cleft group in the study were in the growing age where the growth spurts were still remaining. The growth spurts in the males and females occur at different times, so this difference observed is justifiable in the normal pattern of growth of the mandible. Gender differences are observed in the ideal in M-P per, Sn-P per and Sn-S per, and gender differences are observed in the cleft in Sn-S per. Cases requiring chin recountour may be dealt with taking into consideration the gender differences in the cleft in Go'-S per and G-S per; and gender differences in the ideal in Go’-P.

Suggestions: The study can be repeated elsewhere with improved sample number.

Flow Chart

Flow Chart in the study was as follows:

1. Cephalograms were examined to see if the proposed points permitted drawing of the polygon in cephalograms, so that the study variables could be applied to all the cephalograms.

2. The lines, angles and polygons were drawn and measured.

3. The data was statistically analysed in the cleft, ideal, Class II and Class III malocclusions.

4. The values from the polygons drawn on the ideal cephalograms were used to find out the ideal values for the polygon.

5. To apply for clinical use, draw and analyse individual cleft cases, compare to the values observed for the ideal, Class II and Class III malocclusions.

Ethical Issues

Cephalograms already available in the department for treatment purposes, and thesis purposes were used. Patients were not directly involved. There was no liability on patients. So, there were no ethical issues. Institutional ethical clearance was obtained.

The study was done as a project under the State Board of Medical Research (SBMR), at Government Medical College, Thiruvananthapuram.

Clinical Implications

The treatment of the cleft palate extends to over years. Polycon and polynew, involving skeletal and soft tissue parameters, with number of linear and angular parameters involved and gaining support from a combination of linear and angular measurements from the surrounding craniofacial area, can be taken for analyses for treatment outcome purposes.

A treatment planning module is developed; A chart for cephalometric analysis of the cleft subject is developed. (Table 34)

How to apply for clinical use: Analyse individual cleft cases for diagnosis and treatment, by drawing the polygons in the individual cephalogram and then compare the patient values to the observed ideal values and observed values in Class II and Class III malocclusions. A treatment plan can then be implemented to the cleft protocol, to develop and implement the cephalometric polygons towards the ideal. It is proposed to undertake a series of studies in this topic; this is a first of its kind as regards the cleft patients.

Conclusions

The study has succeeded in determining the best possible simplified cephalometric analysing procedure in the cleft palate patients viable for a long term basis; A polygon in cephalograms of cleft patients that involves a limited number of cephalometric parameters was identified, to aid in the treatment planning of the cleft.

Attempts were made to explain and analyze the observed impact of project outcome (polygon) developed for cleft palate patients. For the parameters and for the polygons defined, the values for the cleft and ideal groups are defined. Two linear, three angular and one polygon area are defined for Class II and Class III malocclusion groups also. This can be implemented in the diagnosis and treatment planning according to the different treatment options according to the age of the cleft patient.

To use the project outcomes in day to day practice, a chart displaying 95% confidence limits in the cleft and ideal was developed; this chart can be used for cephalometric analysis for the cleft subjects. This chart is useful not only in the orthodontic and surgical clinical grounds but also in the academic setup, in treatment planning.

Measurements taken from cephalograms of cleft population in the age group 10 years and above, with 33% males and 67% females; and also, measurements from cephalograms of young adults in the age group 18-21, with 50% of males and 50% of females in the ‘ideal’ population; with 43% males and 57% females in the Class II population; and with 52% males and 48% females in the Class III; were statistically analysed. The following were the conclusions:

Mean±SD of the angular, linear and area measurements for the ideal and the cleft study groups:

1. The mean values for length 1, length 2, angle 1, angle 2 and angle 3 and polycon in the cleft were 255.08±57.29, 757.24±100.09, 78.99±7.39, 76.76±12.31, 20.91±6.19 and 97348.67±26334.3

respectively (p<0.001). (Table 3). The mean values for length 1, length 2, angle 1, angle 2 and angle 3 and polycon in the ideal were 303.9±44.84, 776.09±63.17, 72.78±5.11, 88.72±6.34, 20.27±3.42 and 106362.3±22670.58 respectively (p<0.001). (Table 3).

2. The mean value of angular 4 in the ideal was 84.7±9.5 and that in the cleft was 72.4±17.4 (p=.020). The mean values of polynew, angular 3, angular 5, area 2 and area 3 in the cleft were 79473.2±22470.6, 57.5±21.5, 51.3±13.4, 6645.7±3187.4 and 15453.1±7036.6 and those in the ideal were 89493.4±16864.8, 51.1±12.6, 43.9±13.4, 5378.3±907.9 and 15437.0±3709.4 respectively. (p>.05). (Table 4)
3. The mean values for angle 1, angle 2, angle 3, length 1, length 2 and polycon in males of the cleft were 75.52±4.65, 84.97±14.13, 23.21±1.44, 258.88±24.47, 816.31±52.40 and 112412.00±16339.53 and those in females were 80.72±8.24, 72.66±10.10, 19.76±7.46, 253.18±70.71, 727.70±108.58 and 89817.00±28259.27 respectively. The mean values for polynew, angular 3, angular 4, angular 5, area 2 and area 3 in males of the cleft were 93313.00±12259.52, 53.40±16.11, 84.41±13.44, 43.67±0.88, 7258.00±1165.01 and 19948.00±2154.15; and those for the females of the cleft were 72553.33±23987.04, 59.61±24.84, 66.44±16.75, 55.93±15.66, 6339.50±3921.08 and 13205.67±7692.97 respectively. (p>.05). (Table 7).
4. The mean values for angle 1, angle 2, angle 3, length 1, length 2 and polycon in males of the ideal were 69.60±4.73, 88.07±6.66, 20.27±4.13, 323.77±50.72, 799.85±63.86 and 114439.80±26744.91 respectively and those in females were 75.96±3.20, 89.36±6.29, 20.27±2.77, 284.03±28.21, 752.34±55.60 and 98284.70±14991.11 respectively. The mean values for polynew, angular 3, angular 4, angular 5, area 2 and area 3 in males of the ideal were 95407.60±19896.04, 52.21±15.53, 82.16±9.08, 45.53±15.43, 5343.60±995.77 and 16319.20±3770.90 and those for the females of the ideal were 83579.20±11263.49, 50.06±9.45, 87.27±9.77, 42.30±11.54, 5412.90±863.63 and 14554.80±3619.30 respectively. There was significant difference between the mean values of the males and females in angle 1 and length 1. (Table 8).

5. Linear measurements SG and PG were more in the cleft (1371.8±115.6 and 570.7±110.1 respectively) where as the angular measurements angular 2 and angular 4 were more in the ideal. (p<0.05). (Table 4).

6. A statistically significant difference was observed between parameters polycon and polynew in the cleft (p=<0.001). (Table 5).

7. A statistically significant difference was observed between polycon and polynew areas in the ideal group also. (p<0.001). (Table 6).

8. There was no statistically significant difference observed in the mean area of polycon between the ideal and the cleft groups. (Table 11).

9. There was no statistically significant difference observed in the mean area of polynew between the ideal and the cleft groups. (Table 4).

10. Statistically significant differences were not observed between the ideal and the cleft study groups in the linear parameters, SP linear, SM, M-S per, M- P per, G-S per, G-P per, Sn-S per, Sn-P per, Go'-S per, Go'-P per ;

in the angular parameters SP angle, angular 1, angular 3, angular 5; in the area parameters area 1, area 2, area 3, area 4, area 5, and polynew.(Table 4).

Five-number summary

11. Five-number summary for the males and females of the different study groups are presented in Table 20-Table 27.

Correlations

Correlation between the angular, linear and area measurements of the cleft

12. In the cleft group, Length 2, and SG linear and P4-P1-P2 angle showed good correlation with both the polycon and the polynew. Length 1 and SMP angle showed a positive correlation with the polycon only. Negative correlation was observed between P1-P4-P2 angle with the polynew only. (Table 19).

13. There is a good correlation observed between the polycon and polynew in both the ideal and the cleft groups(.924). (Table 18, Table 19).

Correlation between the angular, linear and area measurements of the ideal

14. In the ideal group, Length 1, Length 2, SG and Angle 3, showed good correlation with both the polycon and polynew whereas P1-P2-P4 angle, SMP angle, P1-P4-P2 angle and SP angle showed statistically significant correlation with the polycon only. Table 18.

15. Length 2 and SG linear showed good correlation with the polygons, the polycon and the polynew; both in the cleft and in the ideal.

Difference between males and females for the study variables

16. Males of the cleft group showed higher values than the females of the group in horizontal distances measured perpendicular to ‘S per’ from points G, Sn and Go’. ($p<.05$). (Table 7).

17. Males of the ideal group showed higher values than the females of the group for length 1, SP, SM, M- P per, Sn-S per, Sn-P per, Go'-P per and SG linear(linear parameters) and for area 1. Females showed higher values in angle 1. ($p<.05$). (Table 8).

18. Males of cleft showed higher values for area 2 and area 4 than males of the ideal group.($p<.05$). (Table 9).

19. Higher values were observed in females of the ideal for ‘angle 2’ and for the measure ‘angular 4’, when comparison was made between the cleft and ideal among females. (Table 10).

20. The females of the cleft group showed higher values in the linear parameters SG linear and PG than the females of the ideal, when comparison was made between the cleft and ideal among females. (Table 10). ($p<.05$).

21. Length 1 was less for males of the cleft group than that for males with Class II and Class III malocclusions. (p<.05)(Table 12, table 13). Angle 1, angle 2, length 2 and polycon area were less in males of the cleft than that in males of Class II. (p<.05) (Table 12).

22. Length 2 was less for females of the cleft than that for females of Class II. (p<.05) (Table 14). Angle 3, length 1 and polycon area was less for females of the cleft than that for females of Class II and Class III. (p<.05) (Table 14, Table 15). Angle 2 was less for females of the cleft than that for females of ideal, Class II and Class III groups. (p<.05)(Table 11, Table 14, Table 15).

23. The cleft group (combined males and females) showed higher values for angle 1 and linear parameters PG and SG linear, where as the ideal (combined males and females) presented higher values than the cleft in angle 2, length 1, angular 2 and angular 4. (p<.05). (Table 4, Table 11).

24. Statistically significant differences were not observed between males and females among cleft in the linear parameters length 1, length 2, SG, SP linear, PG, SM, M- P per, M-S per, G-P per, Sn-P per, Go'-P per; in the angular parameters angle 1, angle 2, angle 3, SP angle, angular 1, angular 2, angular 3, angular 4, angular 5; in the area parameters area 1, area 2, area 3, area 4, area 5, polycon and polynew. (Table 7).

25. Statistically significant differences were not observed on comparison between males and females among ideal in the linear parameters length 2, PG, M-S per, G-S per, G-P per, Go'-S per; in the angular parameters angle 2, angle 3, SP angle, angular 1, angular 2, angular 3, angular 4, angular 5; in the area parameters polycon, polynew, area 2, area 3, area 4 and area 5.(Table 8).

26. Statistically significant differences were not observed on comparison between cleft and ideal among males in the linear parameters length 1, length 2, SG, SP linear, PG, SM, M-S per, M- P per, G-S per, G-P per, Sn-S per, Sn-P per, Go'-S per, Go'-P per ; in the angular parameters angle 1, angle 2, SP angle, angle 3, angular 1, angular 2, angular 3, angular 4, angular 5; in the area parameters area 1, area 3, area 5, polycon and polynew. (Table 9).

27. Statistically significant differences were not observed on comparison between cleft and ideal among females in the linear parameters length 1, length 2, SP linear, SM, M-S per, M- P per, G-S per, G-P per, Sn-S per, Sn-P per, Go'-S per, Go'-P per; in the angular parameters angle 1, angle 3, SP angle, angular 1, angular 2, angular 3, angular 5; in the area parameters area 1, area 2, area 3, area 4, area 5, polycon and polynew (Table 10).

Comparison of the values obtained for the cleft population with ideal, Class II and Class III groups

28. A statistically significant difference was observed among the 4 groups in all the linear, angular and area measures (length 1, length 2, angle 1, angle 2, angle 3 and polycon area). The cleft group had the lowest values in length 1, length 2, angle 2 and in the polycon area among the 4 groups. Class II had the highest values for Angle 1, Angle 2 and Angle 3. (Table 3).

29. Angle 1 of the cleft group was more than that of the ideal, and less than that in Class II. Angle 2 and length 1 was less in the cleft group than in the ideal and Class II. Angle 3, length 2 and polycon area was less in the cleft than in the Class II and Class III groups. (p<.05)(Table 11, Table 16, Table 17).

Features of polynew

Polynew uses a stable landmark; so it is useful in the long term assessment of growth. It is independent of the cranial base length. A soft tissue parameter is incorporated in the analysis along with the skeletal and dental components. The polynew area shows a statistically significant difference from the polycon area, in the cleft ($p=<0.001$). (Table 5). It differs in the ideal also. ($p<0.001$). (Table 6.)

Chart

The chart displaying 95% confidence limits for the different parameters in the cleft and in the ideal groups can be used for cephalometric analysis for the cleft subjects.

Budget

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References

1. Jacobson, Alex/Ed by. Radiographic Cephalometry. Carol Stream: Quintessence; (1995).
2. Athanasiou, Athanasios E. Orthodontic Cephalometry. London, England:Geoff Greenwood; (1995).
3. Suja Ani G. A treatment module in orthodontics: Cephalometric Polygon Norms as a Guide towards a Harmonious Individual Craniofacial Pattern among Keralites, International Journal of Interdisciplinary and Multidisciplinary Studies (IJIMS), 2014, Vol 2 No.1: 9-23.
4. Wasundhara A. Bhad, Subash Nayak, Umal H. Doshi. 2013, Epub 2011 Feb 8, A new approach of assessing sagittal dysplasia: The W angle, Eur J Orthod, 2013, Feb 8, 35(1):66-70.
5. Dr. Suja Ani G, Dr. Jayan James, Dr. Babu E.C. "comparison of maxillary arch lengths in cleft palate patients", JIDAS, 2013 January, Vol-5 No 1: Pages: 10 – 14.
6. Suja Ani G, Dhiraj Agrawal, Jayan James. "Comparison of arch width in cleft palate patients", Kerala Dental Journal, 2012 April, Vol-35 No-2.
7. Suja Ani G, Jayan James, Anuj Parashar, Krishnakumar. "comparison of the mandibular arch lengths in cleft palate patients", JIDAS, 2012, July, Vol 4 No-3.
8. Suja Ani G. "Comparison of mandibular arch width in cleft palate patients", International journal of bioassays, 2013, Vol 2 No 3.
9. Suja Ani G. "comparison of mandibular arch chords in cleft palate patients", journal of anthropological survey of India, 2013 January, Vol 61 and 62 No-(2) and (1): 689.
10. Suja Ani G and Vishal Shah. "Arch expansion in cleft lip and palate patients", Indian journal of Fundamental and Applied Life Sciences, 2013, Vol 3.
11. Suja Ani G, Dhiraj Agrawal. "widening the scope of cleft management with slow expansion", Indian journal of Fundamental and Applied Life Sciences, 2013, Vol 3 No-1: 61 - 64
12. Stanley Braun, Robert T. Rudman, Hugh J. Murdoch, Shaun Hicken, Russell Kittleson, and Donald J. Ferguson. C-axis: A growth vector for the maxilla, The Angle Orthodontist, 1999, 69:6, 539-542.
13. Nanda, RS, Merrill, RM. Cephalometric assessment of sagittal relationship between maxilla and mandible, Am J Orthod Dentofac Orthop, 1994, 105:328–344.

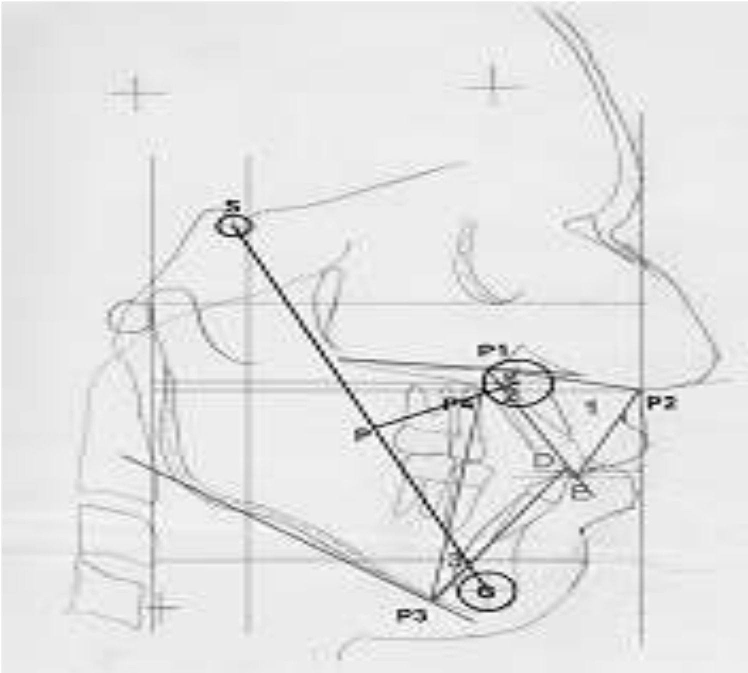

Fig 1: A sample tracing from the 'ideal population' showing the polycon with landmarks marked

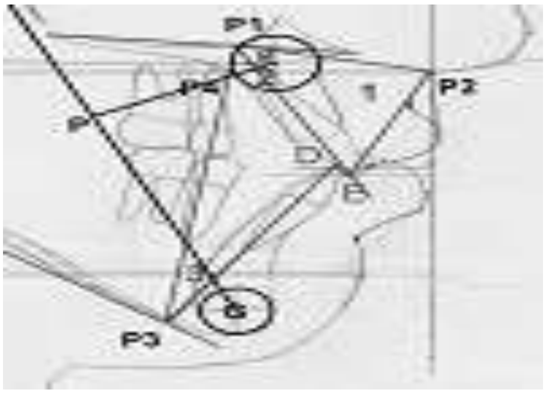

Fig 2: A sample tracing from the 'ideal population' showing the polycon with landmarks - relevant portion enlarged

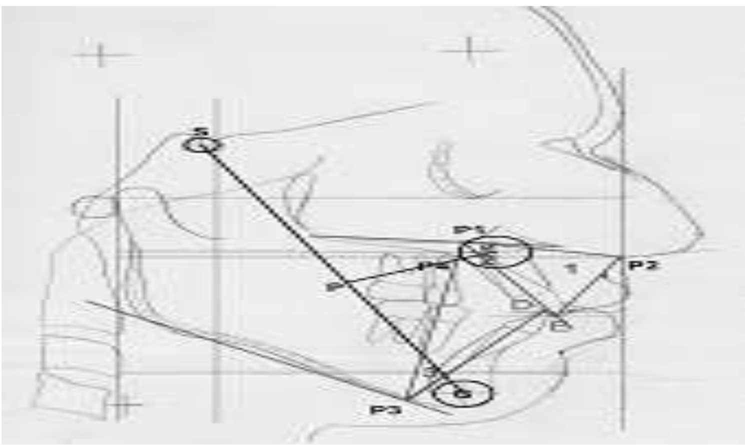

Fig 3: P2-P1 (length 1) and P2- P3 (length 2, taken as direct measurement from P2 to P3 in a straight line) in Polycon P2-P1-P3-D-E

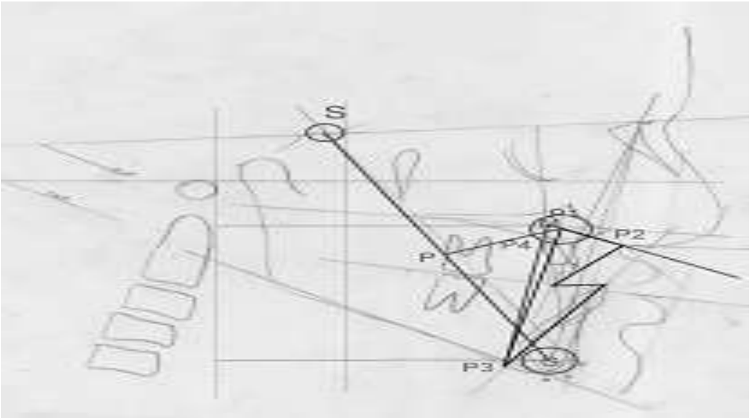

Fig 4: A sample tracing from the ‘cleft population’ showing the polynew with landmarks

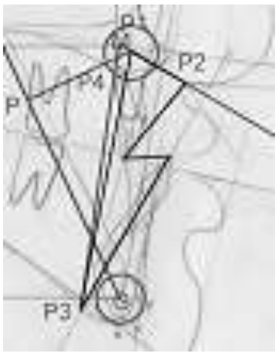

Fig 5: A sample tracing from the ‘cleft population’ showing the polynew with landmarks - relevant portion enlarged

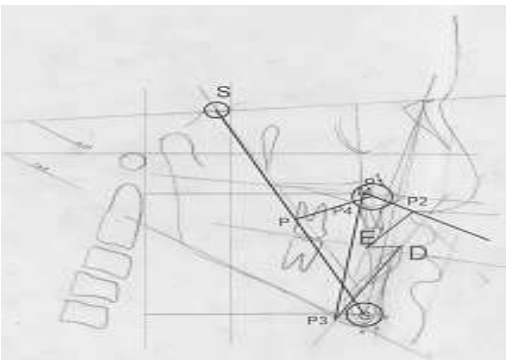

Fig 6: A sample tracing from the ‘cleft population’ showing the polycon with landmarks marked

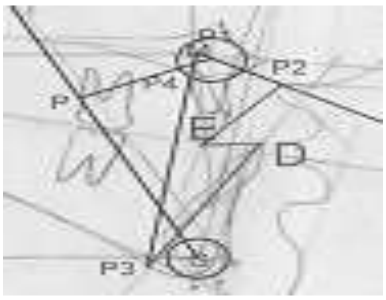

Fig 7: A sample tracing from the ‘cleft population’ showing the polycon with landmarks - relevant portion enlarged

Fig 8 Relevant portion of the polynew enlarged and cut from a sample tracing from the 'cleft population': showing filled/shaded portion (polynew)

Fig 9: polynew relevant portion enlarged and cut from a sample tracing from the 'cleft population' showing the unfilled portion. A filled/shaded polynew kept by side

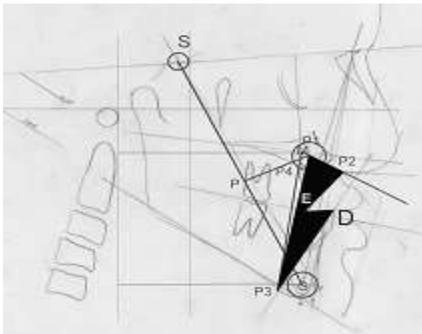

Fig 10: A sample tracing from the 'cleft population' showing the polynew with landmarks – the polynew portion filled/shaded

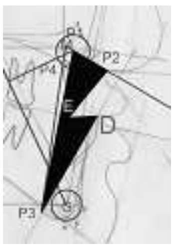

Fig 11: A sample tracing from the 'cleft population' showing the polynew with landmarks - relevant portion enlarged and filled/shaded

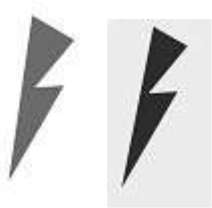

Fig 12: polycon and poly new filled/shaded portion kept by side from relevant portion enlarged and cut from a sample tracing from the 'cleft population' –

polycon  and poly new 

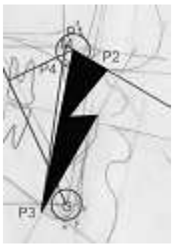

Fig 13: overlapping of polycon and poly new

Fig 14: Figure showing area difference between polycon and polynew- enlarged and shaded

Fig 15: Figure showing area difference between polycon and polynew – area enlarged and presented in white

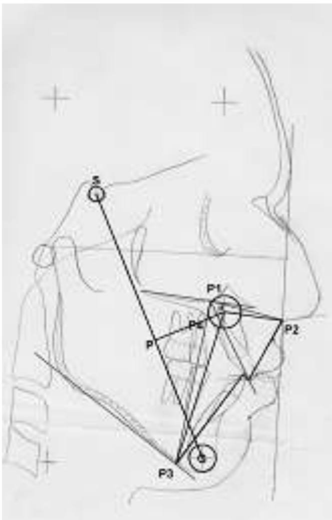

Fig 16: Polynew and polycon in ideal- for comparison

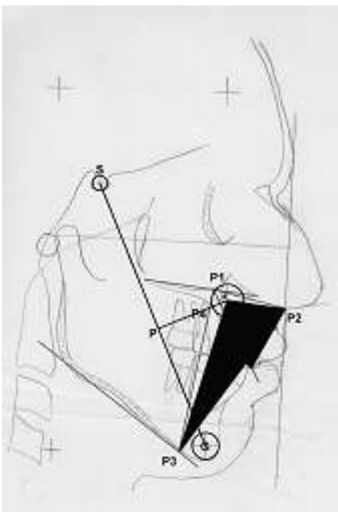

Fig 17: Polynew (shaded portion) and polycon in the ideal

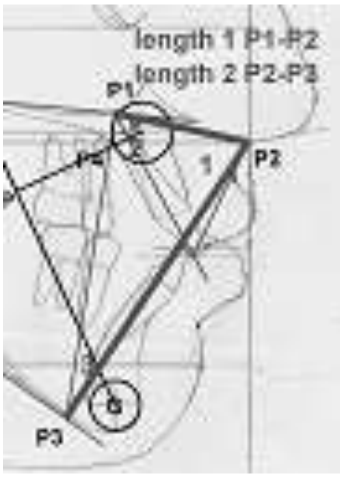

Fig 18: length 1 and length 2

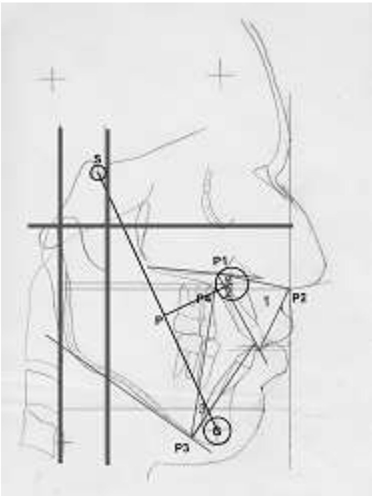

Fig 19: S per and P per

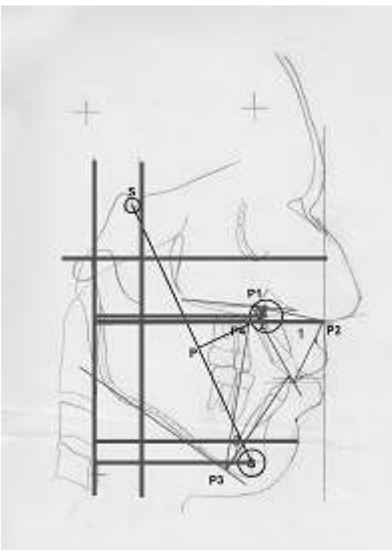

Fig 20: G,Go’,M,Sn to ‘P per to FH’ and ‘S per to FH’

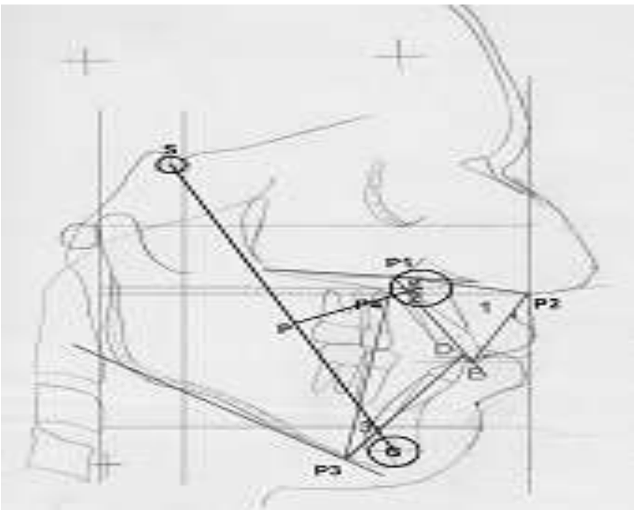

Fig 21: A cephalometric tracing to show angle 1, angle 2, angle 3.

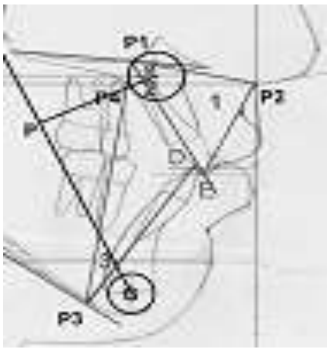

Fig 22: A section of a cephalogram tracing enlarged to show angle 1, angle 2 and angle 3.

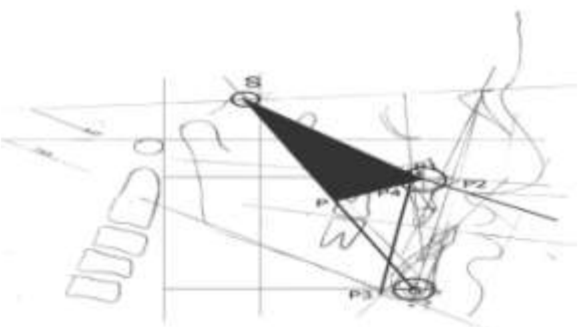

Fig 23: A sample tracing from the 'cleft population' showing the triangle SMP (shaded reg

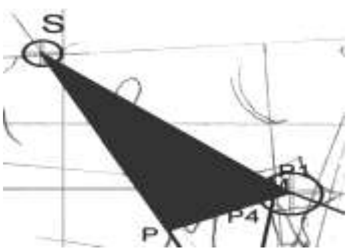

Fig 24: A sample tracing from the 'cleft population' showing the triangle SMP –enlarged

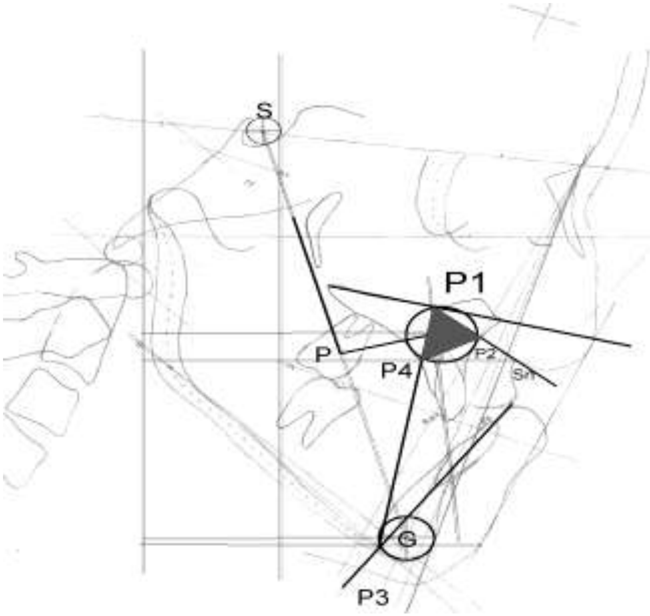

Fig 25: P1-P4-P2

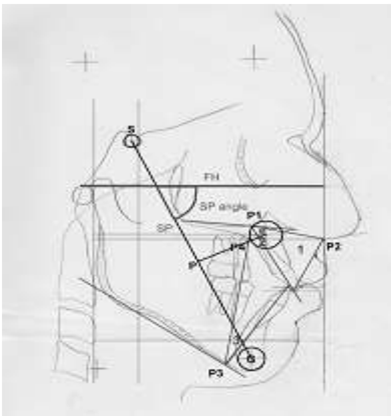

Fig 26: SP angle

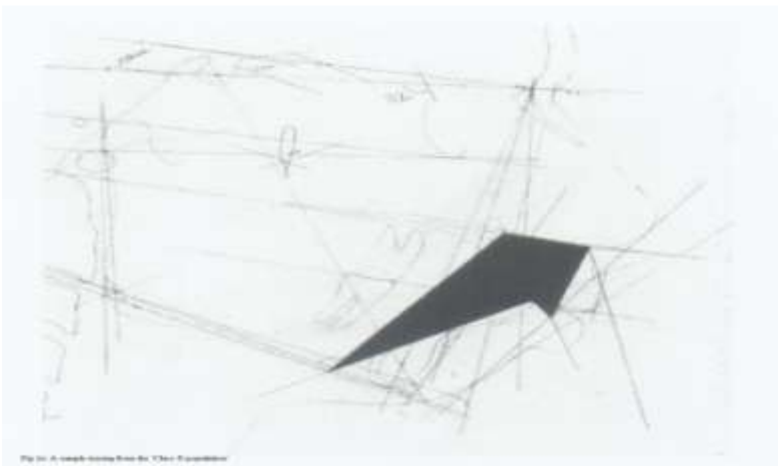

Fig 27: A sample tracing from the 'Class II population'

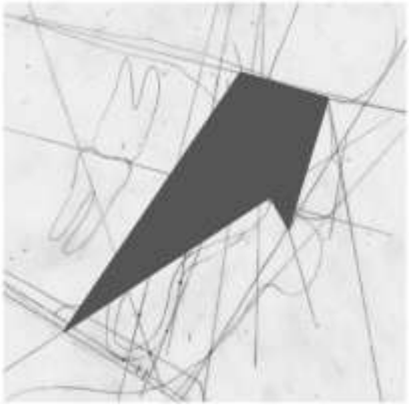

Fig 28: A sample tracing from the 'Class II population' – relevant portion enlarged

Fig 29: A sample tracing from the 'Class III population'

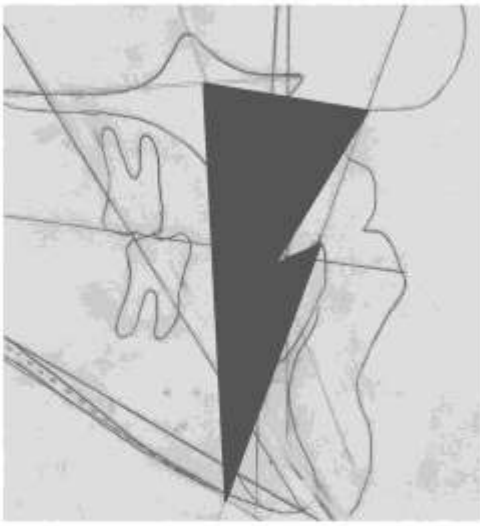

Fig30: A sample tracing from the 'Class III population' – relevant portion enlarged

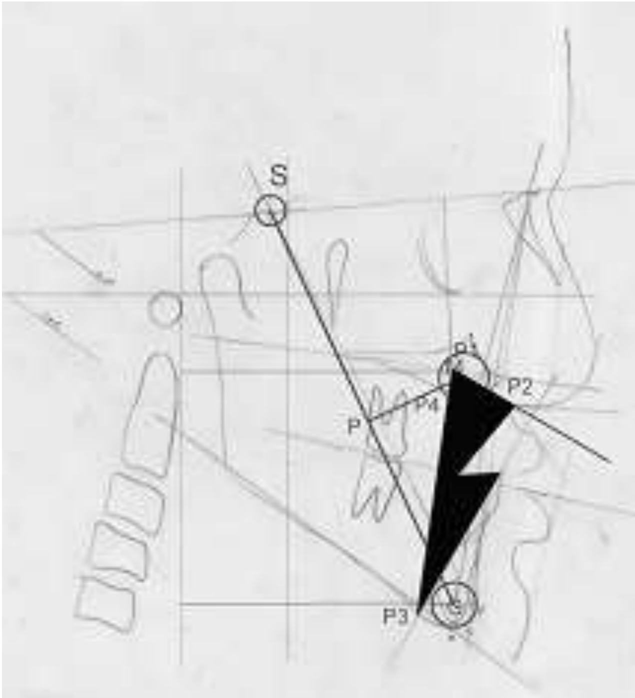

Fig 31: A sample tracing from the 'cleft population' showing the polycon filled/shaded

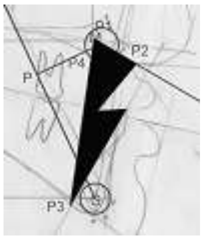

Fig 32: A sample tracing from the ‘cleft population’ showing the polycon filled/shaded-relevant portion enlarged

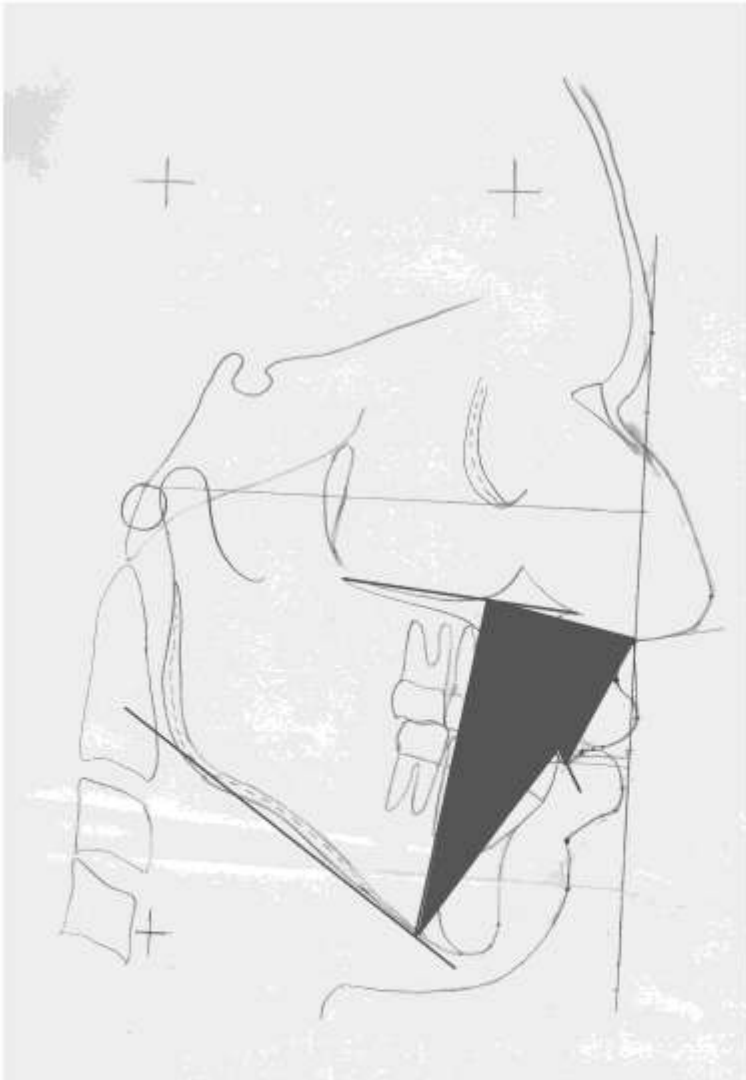

Fig 33: A sample tracing from the 'ideal population' showing the polycon – (shaded area)

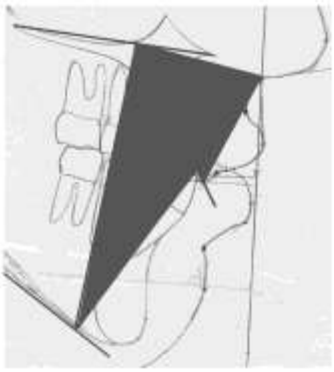

Fig 34: A sample tracing from the 'ideal population' showing the polycon – (shaded area)-relevant portion enlarged

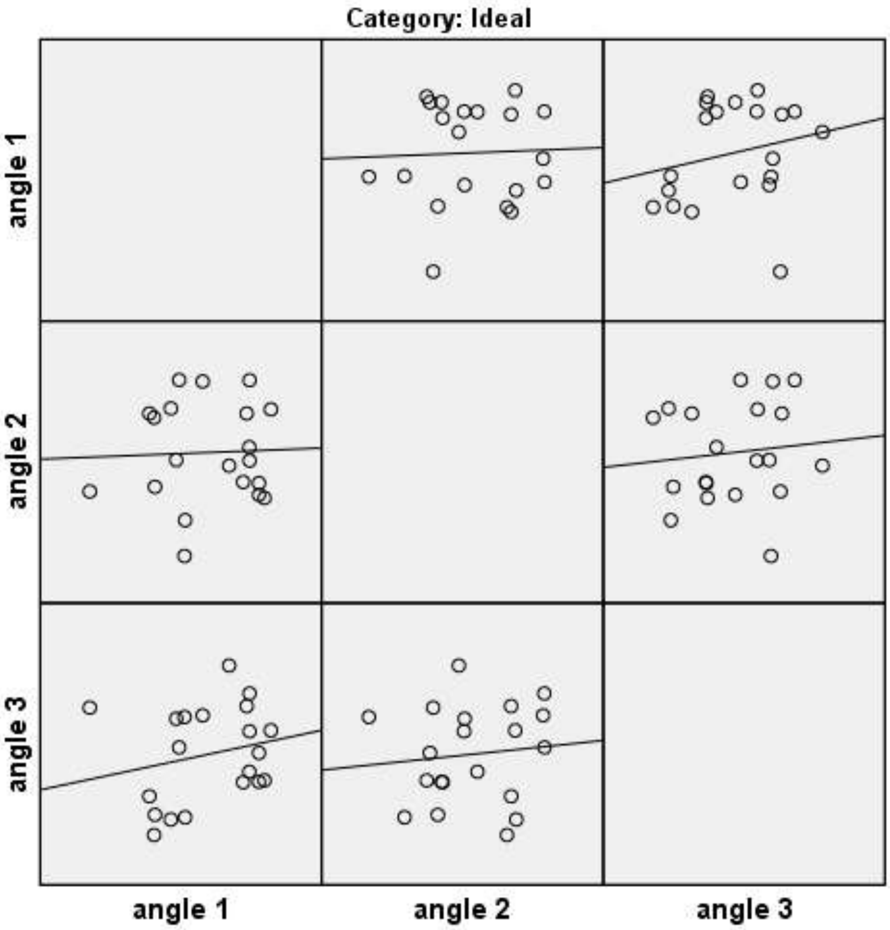

Fig35: Correlations between angle 1, angle 2 and angle 3 in the ideal

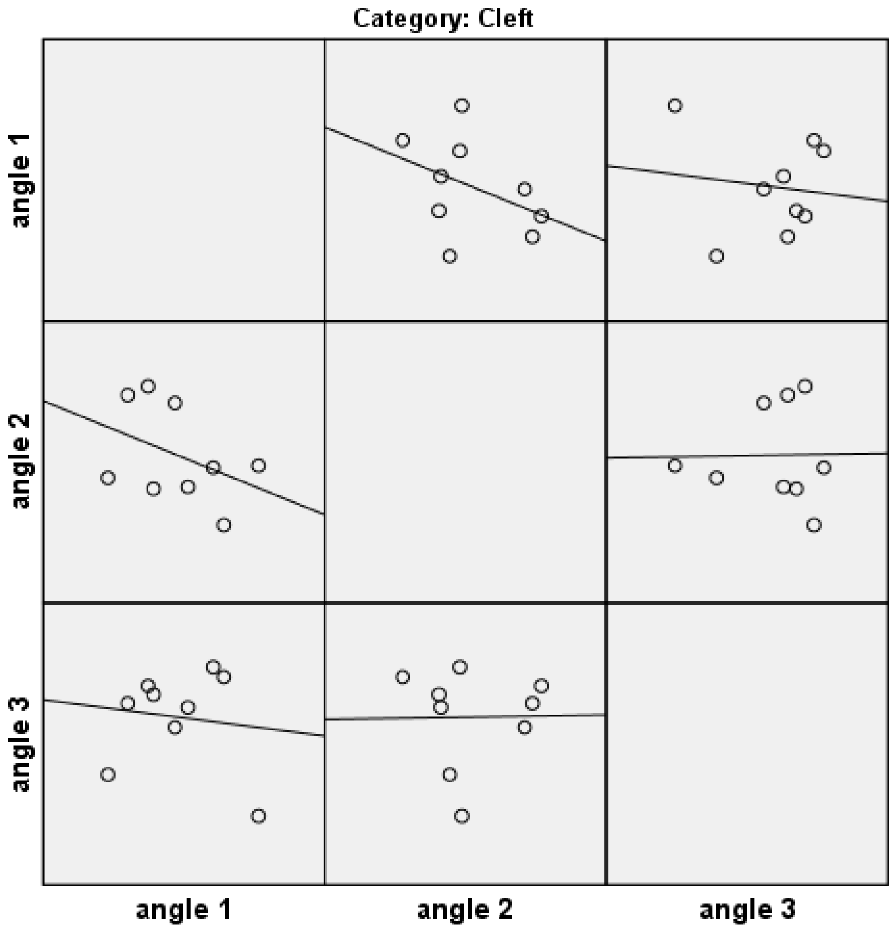

Fig36: Correlations between angle 1, angle 2 and angle 3 in the cleft

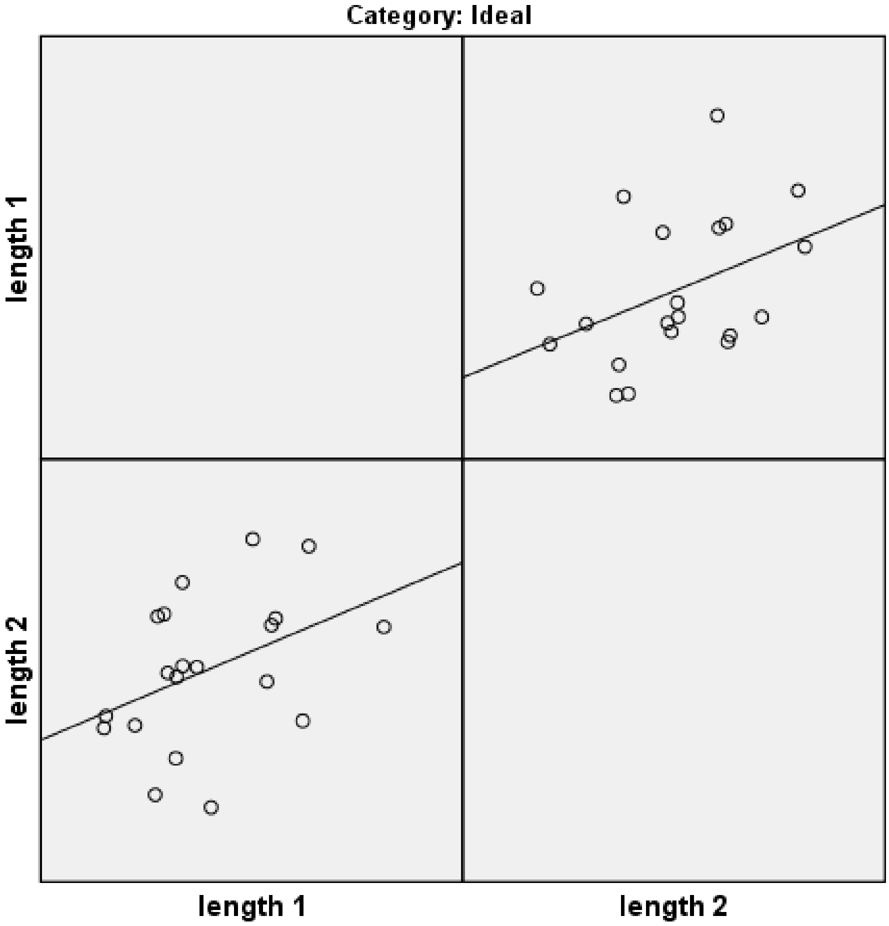

Fig37: Correlations between length 1and length 2 in the ideal

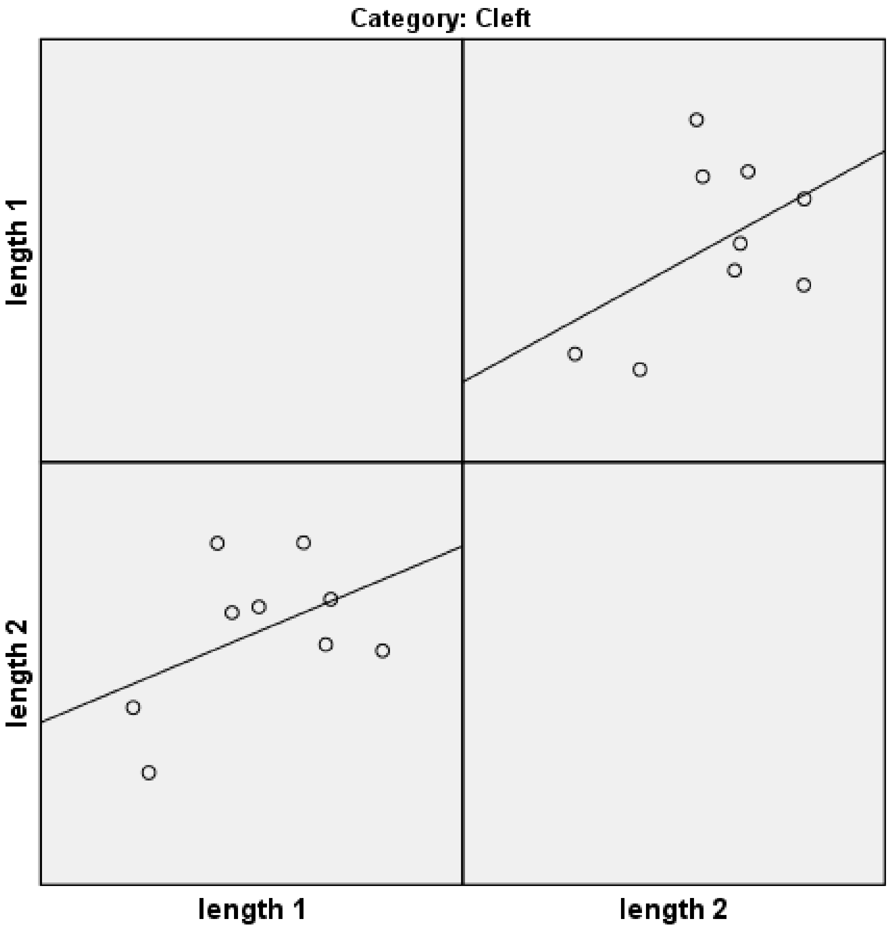

Fig38: Correlations between length 1and length 2 in the cleft

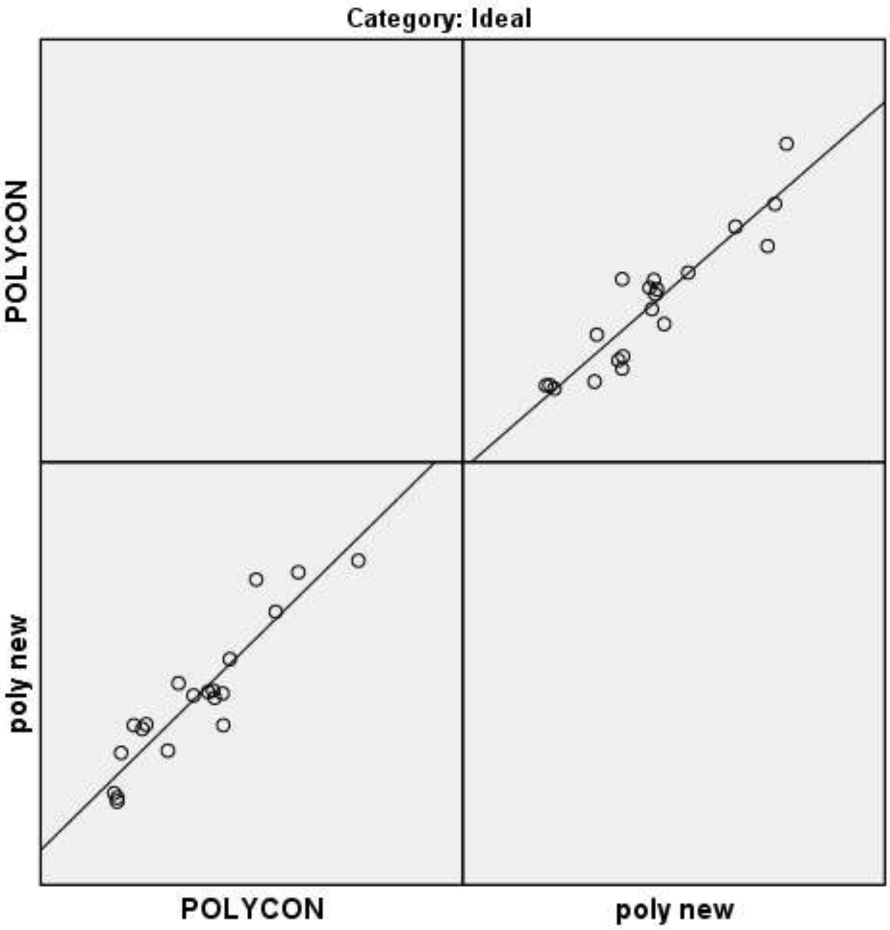

Fig39: Correlations between polycon and polynew in the ideal

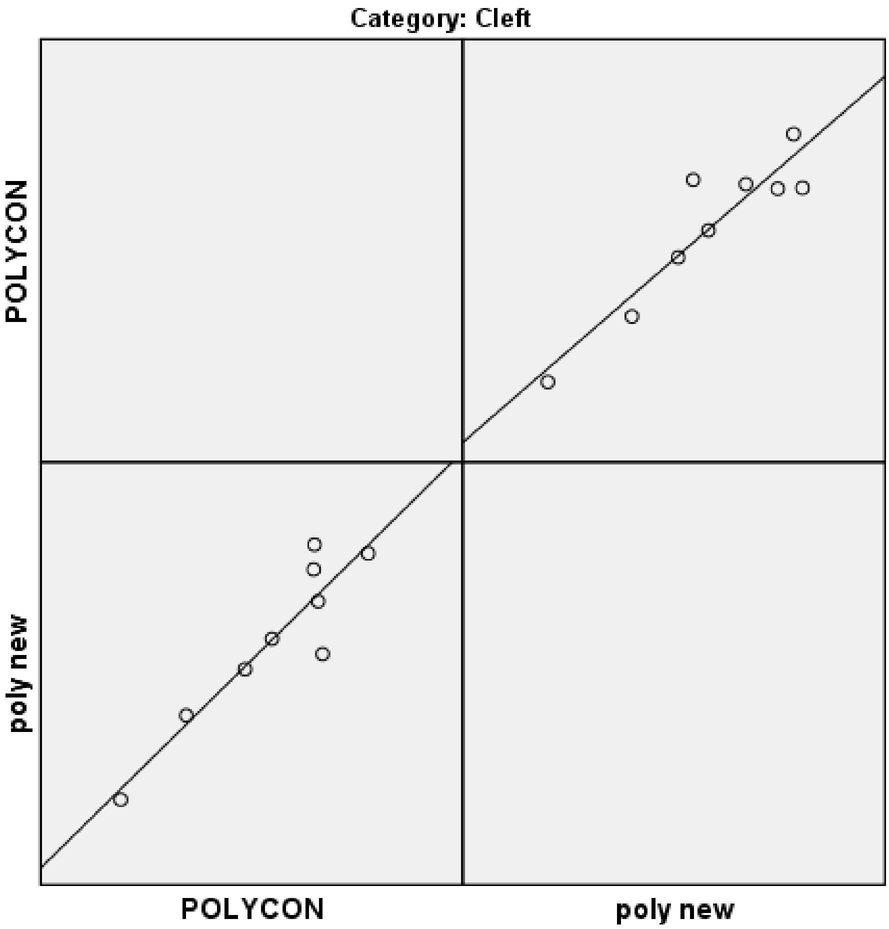

Fig40: Correlations between polycon and polynew in the cleft

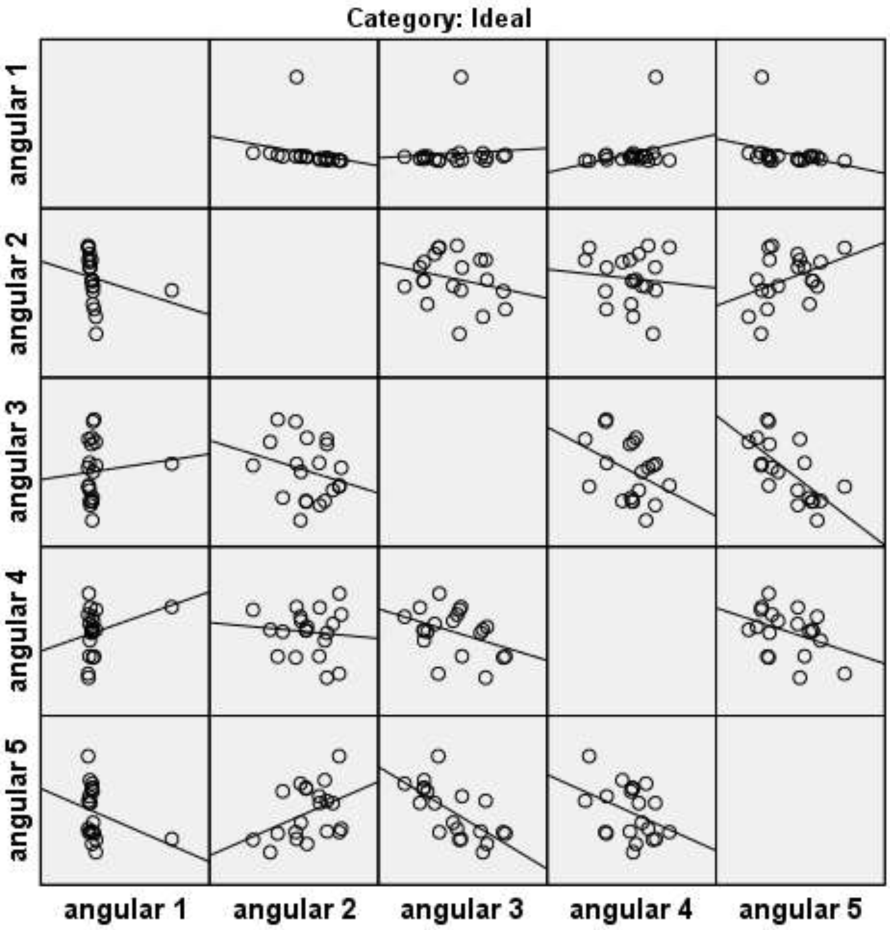

Fig41: Correlations between angular 1, ...angular 5 in the ideal

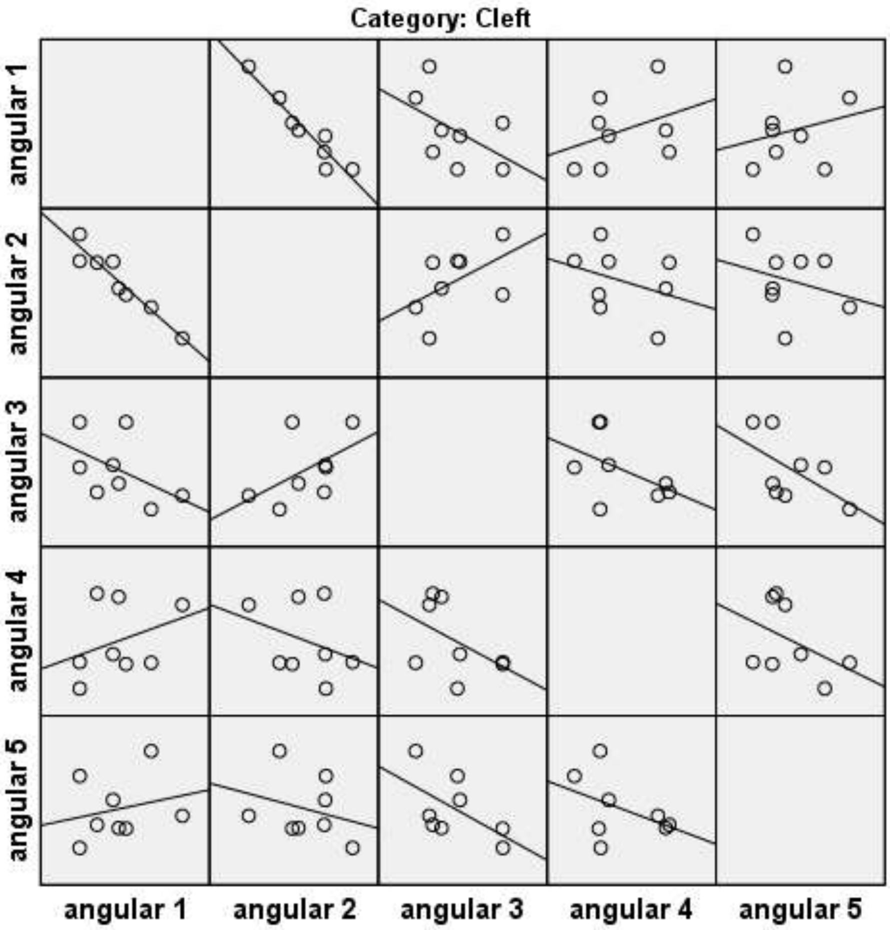

Fig42: Correlations between angular 1, ...angular 5 in the cleft

Table 1: Gender wise distribution in the study groups

Category	Sex				Total	
	Male		Female			
	N	%	N	%	N	%
Ideal	10	50.0	10	50.0	20	100.0
Cleft	3	33.3	6	66.7	9	100.0
Class II	12	42.9	16	57.1	28	100.0
Class III	26	52.0	24	48.0	50	100.0
Total	51	47.7	56	52.3	107	100.0

Table 2: Age wise distribution of the subjects in the study groups

Category	Age in years				Total	
	<20		≥20			
	N	%	N	%	N	%
Ideal	5	25.0	15	75.0	20	100.0
Cleft	8	88.9	1	11.1	9	100.0
ClassII	15	53.6	13	46.4	28	100.0
Class III	29	58	21	42	50	100.0
Total	57	54.3	50	45.7	107	100.0

Table 3: Mean±SD of angle 1, angle 2, angle 3, length 1, length 2 and polycon for the study groups

parameter	Ideal (N=20)		Cleft (N=9)		Class II (N=28)		Class III (N=50)		ANOVA	
	mean	sd	mean	sd	mean	sd	mean	sd	F	p
angle 1	72.78	5.11	78.99	7.39	85	6.05	78.8	9.72	9.296	<0.001
angle 2	88.72	6.34	76.76	12.31	98.89	5.93	83.07	7.43	34.596	<0.001
angle 3	20.27	3.42	20.91	6.19	25.14	3.89	27.02	5.16	12.208	<0.001
length 1	303.9	44.84	255.08	57.29	329.03	37.23	349.16	46.95	13.389	<0.001
length 2	776.09	63.17	757.24	100.09	930.39	86.35	847.35	96.63	15.492	<0.001
polycon	106362.3	22670.58	97348.67	26334.3	171951.5	30938	156383.9	43201.74	19.929	<0.001

Table 4: Mean±SD of the angular, linear and area measurements for the ideal and the cleft study groups

parameter	Ideal (N=20)		Cleft(N=9)		t	p
	mean	SD	mean	SD		
polynew	89493.4	16864.8	79473.2	22470.6	1.335	.193
SP angle	-63.4	4.0	-65.9	4.5	1.508	.143
SG	1288.3	80.9	1371.8	115.6	-2.250	.033
SP linear	802.9	56.3	798.4	76.3	.175	.862
PG	484.6	64.7	570.7	110.1	-2.653	.013
SM	865.6	57.7	874.0	82.9	-.315	.755
M-S per	602.6	60.1	595.3	91.0	.258	.798
M-P per	830.2	79.8	902.4	112.2	-1.985	.057
G-S per	532.6	79.9	510.3	91.6	.663	.513

G-P per	771.7	76.8	818.0	97.5	-1.382	.178
Sn-S per	863.4	70.1	829.9	159.7	.783	.441
Sn-P per	1102.9	69.2	1075.1	130.0	.741	.466
Go'-S per	747.3	79.5	717.5	114.0	.793	.435
Go'-P per	986.5	80.8	1022.4	112.6	-.949	.351
angular 1	25.0	15.3	23.5	3.4	.285	.778
angular 2	68.2	2.1	63.4	9.9	2.146	.041
angular 3	51.1	12.6	57.5	21.5	-1.015	.319
angular 4	84.7	9.5	72.4	17.4	2.470	.020
angular 5	43.9	13.4	51.3	13.4	-1.324	.197
area 1	127946.3	17046.0	140730.2	32425.9	-1.402	.172
area 2	5378.3	907.9	6645.7	3187.4	-1.666	.107
area 3	15437.0	3709.4	15453.1	7036.6	-.008	.994
area 4	5685.9	1986.3	6090.8	3274.1	-.413	.683
area 5	15536.6	4738.2	17039.8	5060.2	-.774	.445

Table 5: Comparison of Polycon and Polynew among cleft

parameter	N	Mean	sd	t	p
polycon	9	97348.7	26334.3	5.223	.001
polynew	9	79473.2	22470.6		

Table 6: Comparison of Polycon and polynew among ideal

Ideal	N	Mean	sd	t	p
polycon	20	106362.3	22670.6	7.882	<0.001
polynew	20	89493.4	16864.8		

Table 7: Comparison between males and females among cleft

parameter	Male (N=3)		Female(N=6)		t	p
	mean	sd	mean	sd		
angle 1	75.52	4.65	80.72	8.24	-.994	.354
angle 2	84.97	14.13	72.66	10.10	1.528	.170
angle 3	23.21	1.44	19.76	7.46	.768	.468
length 1	258.88	24.47	253.18	70.71	.132	.899
length 2	816.31	52.40	727.70	108.58	1.306	.233
POLYCON	112412.00	16339.53	89817.00	28259.27	1.257	.249
polynew	93313.00	12259.52	72553.33	23987.04	1.378	.211

SP angle	-62.69	2.34	-67.48	4.66	1.639	.145
SG	1439.04	63.48	1338.23	125.28	1.282	.241
SP linear	838.69	55.23	778.31	81.44	1.140	.292
PG	595.04	95.47	558.49	123.29	.446	.669
SM	916.33	55.73	852.83	90.16	1.098	.309
M-S per	644.00	67.71	570.89	96.30	1.161	.284
M- P per	909.78	8.32	898.64	141.62	.132	.899
G-S per	601.50	37.05	464.75	73.45	2.968	.021
G-P per	873.06	36.73	790.47	109.26	1.237	.256
Sn-S per	1030.54	164.70	763.00	93.88	3.008	.024
Sn-P per	1032.21	151.62	1089.39	134.41	-.510	.629
Go'-S per	873.10	18.98	665.60	72.07	3.836	.009
Go'-P per	1103.92	19.20	995.26	118.95	1.222	.267
angular 1	22.87	1.53	23.77	4.12	-.355	.733
angular 2	66.32	2.01	61.87	12.12	.611	.561
angular 3	53.40	16.11	59.61	24.84	-.387	.710
angular 4	84.41	13.44	66.44	16.75	1.601	.153
angular 5	43.67	0.88	55.93	15.66	-1.312	.237
area 1	151800.33	17255.53	135195.17	38117.10	.701	.506
area 2	7258.00	1165.01	6339.50	3921.08	.385	.712
area 3	19948.00	2154.15	13205.67	7692.97	1.444	.192
area 4	8913.67	3493.11	4679.33	2258.21	2.243	.060
area 5	19972.67	5040.01	15573.33	4802.72	1.277	.242

Table 8: Comparison between males and females among ideal

parameter	Male (N=10)		Female (N=10)		t	p
	mean	sd	mean	sd		
angle 1	69.60	4.73	75.96	3.20	-3.521	.002
angle 2	88.07	6.66	89.36	6.29	-.444	.662
angle 3	20.27	4.13	20.27	2.77	-.003	.998
length 1	323.77	50.72	284.03	28.21	2.165	.044
length 2	799.85	63.86	752.34	55.60	1.774	.093
POLYCON	114439.80	26744.91	98284.70	14991.11	1.666	.113
polynew	95407.60	19896.04	83579.20	11263.49	1.636	.119
SP angle	-63.53	3.87	-63.21	4.25	-.175	.863
SG	1341.15	69.38	1235.43	52.73	3.836	.001
SP linear	828.68	51.35	777.05	50.76	2.261	.036
PG	510.41	65.84	458.77	54.99	1.904	.073
SM	893.04	51.93	838.23	51.64	2.366	.029

M-S per	622.30	51.51	582.87	64.09	1.517	.147
M- P per	868.43	72.38	791.94	70.27	2.398	.028
G-S per	553.17	74.47	511.93	83.53	1.165	.259
G-P per	797.50	82.87	745.90	64.04	1.558	.137
Sn-S per	898.85	62.39	827.93	60.61	2.578	.019
Sn-P per	1144.25	67.27	1061.53	42.31	3.292	.004
Go'-S per	778.83	60.60	715.86	86.44	1.886	.076
Go'-P per	1022.23	75.55	950.80	72.32	2.160	.045
angular 1	21.76	1.99	28.15	21.67	-.929	.365
angular 2	68.09	1.87	68.35	2.34	-.276	.786
angular 3	52.21	15.53	50.06	9.45	.375	.712
angular 4	82.16	9.08	87.27	9.77	-1.211	.242
angular 5	45.53	15.43	42.30	11.54	.529	.603
area 1	136460.80	14580.92	119431.70	15482.56	2.532	.021
area 2	5343.60	995.77	5412.90	863.63	-.166	.870
area 3	16319.20	3770.90	14554.80	3619.30	1.067	.300
area 4	5209.60	1878.92	6162.10	2072.47	-1.077	.296
area 5	14788.70	4295.31	16284.40	5263.39	-.696	.495

Table 9: Comparison between cleft and ideal among Males

parameter	Cleft (N=3)		Ideal (N=10)			
	mean	sd	mean	sd	t	p
angle 1	75.5	4.7	69.6	4.7	-1.907	.083
angle 2	85.0	14.1	88.1	6.7	.553	.591
angle 3	23.2	1.4	20.3	4.1	-1.182	.262
length 1	258.9	24.5	323.8	50.7	2.095	.060
length 2	816.3	52.4	799.8	63.9	-.404	.694
POLYCON	112412.0	16339.5	114439.8	26744.9	.122	.905
polynew	93313.0	12259.5	95407.6	19896.0	.170	.868
SP angle	-62.7	2.3	-63.5	3.9	-.354	.730
SG	1439.0	63.5	1341.1	69.4	-2.176	.052
SP linear	838.7	55.2	828.7	51.4	-.292	.776
PG	595.0	95.5	510.4	65.8	-1.782	.102
SM	916.3	55.7	893.0	51.9	-.672	.515
M-S per	644.0	67.7	622.3	51.5	-.601	.560
M- P per	909.8	8.3	868.4	72.4	-.958	.359
G-S per	601.5	37.0	553.2	74.5	-1.061	.311
G-P per	873.1	36.7	797.5	82.9	-1.499	.162
Sn-S per	1030.5	164.7	898.9	62.4	-2.156	.056

Sn-P per	1032.2	151.6	1144.3	67.3	1.812	.100
Go'-S per	873.1	19.0	778.8	60.6	-2.105	.062
Go'-P per	1103.9	19.2	1022.2	75.5	-1.466	.173
angular 1	22.9	1.5	21.8	2.0	-.881	.397
angular 2	66.3	2.0	68.1	1.9	1.421	.183
angular 3	53.4	16.1	52.2	15.5	-.115	.910
angular 4	84.4	13.4	82.2	9.1	-.342	.739
angular 5	43.7	0.9	45.5	15.4	.203	.843
area 1	151800.3	17255.5	136460.8	14580.9	-1.543	.151
area 2	7258.0	1165.0	5343.6	995.8	-2.827	.016
area 3	19948.0	2154.1	16319.2	3770.9	-1.561	.147
area 4	8913.7	3493.1	5209.6	1878.9	-2.490	.030
area 5	19972.7	5040.0	14788.7	4295.3	-1.774	.104

Table 10: Comparison between cleft and ideal among females

parameter	Cleft (N=6)		Ideal (N=10)			
	mean	sd	mean	sd	t	p
angle 1	80.7	8.2	76.0	3.2	-1.659	.119
angle 2	72.7	10.1	89.4	6.3	4.113	.001
angle 3	19.8	7.5	20.3	2.8	.199	.845
length 1	253.2	70.7	284.0	28.2	1.247	.233
length 2	727.7	108.6	752.3	55.6	.606	.554
POLYCON	89817.0	28259.3	98284.7	14991.1	.791	.442
polynew	72553.3	23987.0	83579.2	11263.5	1.260	.228
SP angle	-67.5	4.7	-63.2	4.2	1.876	.082
SG	1338.2	125.3	1235.4	52.7	-2.315	.036
SP linear	778.3	81.4	777.1	50.8	-.038	.970
PG	558.5	123.3	458.8	55.0	-2.249	.041
SM	852.8	90.2	838.2	51.6	-.416	.684
M-S per	570.9	96.3	582.9	64.1	.301	.768
M- P per	898.6	141.6	791.9	70.3	-2.032	.062
G-S per	464.8	73.5	511.9	83.5	1.141	.273
G-P per	790.5	109.3	745.9	64.0	-1.039	.316
Sn-S per	763.0	93.9	827.9	60.6	1.694	.112
Sn-P per	1089.4	134.4	1061.5	42.3	-.619	.546
Go'-S per	665.6	72.1	715.9	86.4	1.193	.253
Go'-P per	995.3	119.0	950.8	72.3	-.939	.364
angular 1	23.8	4.1	28.2	21.7	.484	.636
angular 2	61.9	12.1	68.4	2.3	1.678	.116

angular 3	59.6	24.8	50.1	9.4	-1.110	.286
angular 4	66.4	16.8	87.3	9.8	3.172	.007
angular 5	55.9	15.7	42.3	11.5	-1.921	.077
area 1	135195.2	38117.1	119431.7	15482.6	-1.177	.259
area 2	6339.5	3921.1	5412.9	863.6	-.734	.475
area 3	13205.7	7693.0	14554.8	3619.3	.481	.638
area 4	4679.3	2258.2	6162.1	2072.5	1.341	.201
area 5	15573.3	4802.7	16284.4	5263.4	.270	.791

Table 11: Comparison between cleft and ideal

parameter	Cleft (N=9)		Ideal (N=20)			
	mean	sd	mean	sd	t	p
angle 1	79.0	7.4	72.8	5.1	-2.630	.014
angle 2	76.8	12.3	88.7	6.3	3.481	.002
angle 3	20.9	6.2	20.3	3.4	-.360	.722
length 1	255.1	57.3	303.9	44.8	2.489	.019
length 2	757.2	100.1	776.1	63.2	.618	.542
polycon	97348.7	26334.3	106362.3	22670.6	.943	.354

Table 12: Comparison between cleft and Class II among males

parameter	Cleft (N=3)		Class II (N=12)			
	mean	sd	mean	sd	t	p
angle 1	75.52	4.65	82.45	4.83	-2.233	0.044
angle 2	84.97	14.13	100.69	6.87	-2.898	0.012
angle 3	23.21	1.44	23.88	3.77	-0.297	0.771
length 1	258.88	24.47	327.35	32.68	-3.362	0.005
length 2	816.31	52.40	974.18	98.66	-2.628	0.021
polycon	112412.00	16339.53	177892.92	38023.64	-2.853	0.014

Table 13: Comparison between cleft and Class III among males

parameter	Cleft (N=3)		Class III (N=26)			
	mean	sd	mean	sd	t	p
angle 1	75.52	4.65	76.06	8.60	-0.105	0.917
angle 2	84.97	14.13	83.46	6.23	0.349	0.730
angle 3	23.21	1.44	26.38	6.17	-0.875	0.389
length 1	258.88	24.47	365.01	47.94	-3.734	0.001
length 2	816.31	52.40	886.81	82.30	-1.437	0.162
polycon	112412.00	16339.53	166977.92	48663.19	-1.903	0.068

Table 14: Comparison between cleft and Class II among females

parameter	Cleft (N=6)		Class II (N=16)		t	p
	mean	sd	mean	sd		
angle 1	80.72	8.24	86.92	6.29	-1.895	0.073
angle 2	72.66	10.10	97.54	4.93	-7.860	0.000
angle 3	19.76	7.46	26.09	3.82	-2.650	0.015
length 1	253.18	70.71	330.28	41.32	-3.202	0.004
length 2	727.70	108.58	897.55	59.99	-4.722	0.000
polycon	89817.00	28259.27	167495.50	24763.21	-6.318	0.000

Table 15: Comparison between cleft and Class III among females

parameter	Cleft (N=6)		Class III (N=24)		t	p
	mean	sd	mean	sd		
angle 1	80.72	8.24	81.77	10.17	-0.233	0.817
angle 2	72.66	10.10	82.65	8.66	-2.450	0.021
angle 3	19.76	7.46	27.71	3.79	-3.737	0.001
length 1	253.18	70.71	331.98	40.07	-3.671	0.001
length 2	727.70	108.58	804.61	94.15	-1.739	0.093
polycon	89817.00	28259.27	144907.08	33732.44	-3.677	0.001

Table 16: Comparison between cleft and Class II

parameter	Cleft (N=9)		Class II (N=28)		t	p
	mean	sd	mean	sd		
angle 1	79.0	7.4	85.0	6.0	-2.461	0.019
angle 2	76.8	12.3	98.9	5.9	-7.345	0.000
angle 3	20.9	6.2	25.1	3.9	-2.444	0.020
length 1	255.1	57.3	329.0	37.2	-4.524	0.000
length 2	757.2	100.1	930.4	86.3	-5.039	0.000
polycon	97348.7	26334.3	171951.5	30938.0	-6.501	0.000

Table 17: Comparison between cleft and Class III

parameter	Cleft (N=9)		Class III (N=50)		t	p
	mean	sd	mean	sd		
angle 1	79.0	7.4	78.8	9.7	0.055	0.956
angle 2	76.8	12.3	83.1	7.4	-2.101	0.040
angle 3	20.9	6.2	27.0	5.2	-3.177	0.002
length 1	255.1	57.3	349.2	46.9	-5.353	0.000
length 2	757.2	100.1	847.4	96.6	-2.562	0.013
polycon	97348.7	26334.3	156383.9	43201.7	-3.952	0.000

Table 18:correlations-ideal N=20

parameter	angle 1	angle 2	angle 3	length 1	length 2	POLYCON	poly new	SG angle	SG linear	angular 1	angular 2	angular 3	angular 4	angular 5	area 1	area 2	area 3	area 4	area 5
angle 1	1	.040	.221	-.300	.094	.104	.167	-.176	-.405	.313	-.190	-.123	.154	-.029	-.324	.019	-.080	.141	.159
angle 2	.040	1	.109	-.433	.271	.021	.062	.248	.086	.184	.167	-.282	.337	.050	.346	-.346	-.550*	-.142	-.234
angle 3	.221	.109	1	.591**	.420	.805**	.641**	-.496*	.288	.194	-.511*	.648**	.116	-.764**	.267	.357	.067	.063	-.070
length 1	-.300	-.433	.591**	1	.414	.725**	.585**	-.455*	.445*	-.112	-.305	.629**	-.140	-.542*	.156	.483*	.391	.020	.084
length 2	.094	.271	.420	.414	1	.796**	.833**	-.340	.672**	.209	-.294	-.014	.197	-.170	.409	.252	.120	-.147	.014
POLYCON	.104	.021	.805**	.725**	.796**	1	.924**	-.501*	.585**	.186	-.475*	.460*	.007	-.511*	.342	.380	.222	-.206	.090
poly new	.167	.062	.641**	.585**	.833**	.924**	1	-.356	.501*	.184	-.429	.163	.028	-.227	.222	.154	.096	-.328	.126
SG angle	-.176	.248	-.496*	-.455*	-.340	-.501*	-.356	1	-.288	-.049	.564**	-.513*	.065	.482*	-.080	-.557*	-.397	-.263	-.086
SG linear	-.405	.086	.288	.445*	.672**	.585**	.501*	-.288	1	.142	-.159	.263	-.031	-.241	.719**	.392	.316	-.116	-.007
angular 1	.313	.184	.194	-.112	.209	.186	.184	-.049	.142	1	-.235	.093	.282	-.298	.348	.045	-.051	-.170	.132
angular 2	-.190	.167	-.511*	-.305	-.294	-.475*	-.429	.564**	-.159	-.235	1	-.256	-.101	.405	-.285	-.459*	-.530*	-.096	.101
angular 3	-.123	-.282	.648**	.629**	-.014	.460*	.163	-.513*	.263	.093	-.256	1	-.401	-.682**	.196	.563**	.414	.105	.147
angular 4	.154	.337	.116	-.140	.197	.007	.028	.065	-.031	.282	-.101	-.401	1	-.385	.179	-.115	-.446*	.274	-.388
angular 5	-.029	.050	-.764**	-.542*	-.170	-.511*	-.227	.482*	-.241	-.298	.405	-.682**	-.385	1	-.329	-.515*	-.123	-.285	.141
area1	-.324	.346	.267	.156	.409	.342	.222	-.080	.719**	.348	-.285	.196	.179	-.329	1	.205	.189	-.032	-.151
area2	.019	-.346	.357	.483*	.252	.380	.154	-.557*	.392	.045	-.459*	.563**	-.115	-.515*	.205	1	.773**	.299	.265
area3	-.080	-.550*	.067	.391	.120	.222	.096	-.397	.316	-.051	-.530*	.414	-.446*	-.123	.189	.773**	1	.114	.283
area4	.141	-.142	.063	.020	-.147	-.206	-.328	-.263	-.116	-.170	-.096	.105	.274	-.285	-.032	.299	.114	1	-.513*
area5	.159	-.234	-.070	.084	.014	.090	.126	-.086	-.007	.132	.101	.147	-.388	.141	-.151	.265	.283	-.513*	1

Table 19: correlations-cleft N=9

parameters	angle 1	angle 2	angle 3	length 1	length 2	POLYCON	poly new	SG angle	SG linear	angular 1	angular 2	angular 3	angular 4	angular 5	area 1	area2	area 3	area 4	area 5
angle 1	1	-.405	-.128	-.651	-.652	-.617	-.561	-.149	-.507	-.139	-.518	.693*	-.697*	-.002	-.084	-.091	.004	.025	.345
angle 2	-.405	1	.016	-.194	.501	.305	.497	.528	.118	.375	-.058	-.377	.723*	-.381	.667*	-.412	-.215	.259	.186
angle 3	-.128	.016	1	.274	-.037	.573	.535	-.111	.121	-.542	.869**	-.431	.552	-.439	-.409	.382	.519	.041	.090
length 1	-.651	-.194	.274	1	.478	.729*	.480	-.457	.674*	-.392	.617	-.392	.277	.031	-.182	.663	.400	.070	-.219
length 2	-.652	.501	-.037	.478	1	.747*	.801**	-.203	.882**	.376	.153	-.510	.617	-.131	.643	.141	.258	.328	-.261
POLYCON	-.617	.305	.573	.729*	.747*	1	.924**	-.330	.816**	-.203	.684*	-.594	.742*	-.443	.208	.492	.536	.337	-.113
poly new	-.561	.497	.535	.480	.801**	.924**	1	-.253	.744*	.051	.580	-.728*	.854**	-.293	.339	.302	.491	.225	-.156
SG angle	-.149	.528	-.111	-.457	-.203	-.330	-.253	1	-.434	.049	-.169	.101	.182	-.275	.053	-.451	-.315	.180	.444
SG linear	-.507	.118	.121	.674*	.882**	.816**	.744*	-.434	1	.032	.299	-.333	.406	-.163	.396	.486	.566	.444	-.177
angular 1	-.139	.375	-.542	-.392	.376	-.203	.051	.049	.032	1	-.462	-.203	.139	.234	.574	-.686*	-.540	-.255	-.561
angular 2	-.518	-.058	.869**	.617	.153	.684*	.580	-.169	.299	-.462	1	-.627	.611	-.275	-.494	.446	.452	-.132	-.163
angular 3	.693*	-.377	-.431	-.392	-.510	-.594	-.728*	.101	-.333	-.203	-.627	1	-.788*	-.573	.078	-.172	-.196	.293	.502

angular 4	-.697*	.723**	.552	.277	.617	.742*	.854**	.182	.406	.139	.611	-.788*	1	-.430	.261	-.042	.148	.082	-.131
angular 5	-.002	-.381	-.439	.031	-.131	-.443	-.293	-.275	-.163	.234	-.275	-.573	-.430	1	-.431	.239	.034	-.520	-.591
area1	-.084	.667*	-.409	-.182	.643	.208	.339	.053	.396	.574	-.494	.078	.261	-.431	1	-.398	-.222	.431	.068
area2	-.091	-.412	.382	.663	.141	.492	.302	-.451	.486	-.686*	.446	-.172	-.042	.239	-.398	1	.827**	.326	.090
area3	.004	-.215	.519	.400	.258	.536	.491	-.315	.566	-.540	.452	-.196	.148	.034	-.222	.827**	1	.386	.257
area4	.025	.259	.041	.070	.328	.337	.225	.180	.444	-.255	-.132	.293	.082	-.520	.431	.326	.386	1	.419
area5	.345	.186	.090	-.219	-.261	-.113	-.156	.444	-.177	-.561	-.163	.502	-.131	-.591	.068	.090	.257	.419	1

Table 20: Five-number summary for the ideal male

Parameter	Ideal Male					
	N	Minimum	25th percentile	Median	75th percentile	Maximum
angle 1	10	60.75	67.15	69.24	72.87	77.91
angle 2	10	75.62	83.67	87.40	93.83	97.72
angle 3	10	14.54	15.89	21.58	23.17	26.57
length 1	10	241.23	281.96	335.00	362.01	410.46
length 2	10	700.75	735.49	812.58	857.06	885.94
polycon	10	79544.00	87182.50	113931.00	135030.00	161118.00
poly new	10	65612.00	81135.25	89529.50	117646.75	121716.00
SP angle	10	68.31	67.47	-64.19	-58.92	58.11
SG	10	1,192.01	1302.95	1357.34	1394.15	1424.67
SP linear	10	731.78	788.18	834.00	863.81	908.42
PG	10	420.86	458.02	504.83	559.83	629.78
SM	10	790.52	861.89	895.18	925.13	972.90
M-S per	10	553.00	576.67	627.67	652.00	715.00
M- P per	10	730.00	801.92	884.83	921.08	969.00
G-S per	10	444.00	490.17	557.67	640.67	650.34
G-P per	10	672.00	739.92	784.67	878.33	927.67
Sn--S per	10	783.33	847.63	912.67	938.67	993.33
Sn--P per	10	1035.33	1073.75	1155.25	1191.00	1240.33
Go'-S per	10	683.34	720.90	785.33	834.17	862.50
Go'-P per	10	915.34	941.67	1018.83	1090.63	1131.00
angular 1	10	18.74	19.93	22.13	23.02	25.30
angular 2	10	65.00	66.77	68.06	69.46	70.83
angular 3	10	30.38	38.16	49.65	66.95	73.02
angular 4	10	67.04	74.21	85.43	88.82	95.03
angular 5	10	23.70	31.88	48.63	56.91	72.39
area1	10	109104.00	123050.25	138830.00	147228.50	156944.00
area2	10	3645.00	4437.00	5506.00	6215.50	6645.00

area3	10	11786.00	13708.25	14532.50	19682.75	23364.00
area4	10	2217.00	3913.00	4980.00	6773.25	8584.00
area5	10	8906.00	12933.00	13792.00	16147.25	25168.00

Table 21: Five-number summary for the cleft male

Parameter	Cleft Male					
	N	Minimum	25th percentile	Median	75th percentile	Maximum
angle 1	3	71.4	71.4	74.5		80.6
angle 2	3	68.7	68.7	92.0		94.2
angle 3	3	22.1	22.1	22.7		24.8
length 1	3	236.7	236.7	254.8		285.1
length 2	3	782.3	782.3	789.9		876.7
polycon	3	96856.0	96856.0	110944.0		129436.0
poly new	3	79379.0	79379.0	98117.0		102443.0
SP angle	3	-64.8	-64.8	-63.0		-60.2
SG	3	1368.0	1368.0	1459.0		1490.2
SP linear	3	776.0	776.0	859.9		880.1
PG	3	492.3	492.3	611.8		681.0
SM	3	857.0	857.0	924.4		967.6
M-S per	3	566.0	566.0	678.3		687.7
M- P per	3	900.3	900.3	913.0		916.0
G-S per	3	560.3	560.3	612.0		632.2
G-P per	3	843.0	843.0	862.2		914.0
Sn--S per	3	914.1	914.1	1030.5		1147.0
Sn--P per	3	925.0	925.0	1032.2		1139.4
Go'-S per	3	859.7	859.7	873.1		886.5
Go'-P per	3	1090.3	1090.3	1103.9		1117.5
angular 1	3	21.2	21.2	23.4		24.1
angular 2	3	64.8	64.8	65.5		68.6
angular 3	3	42.3	42.3	46.0		71.9
angular 4	3	68.9	68.9	91.6		92.7
angular 5	3	43.1	43.1	43.3		44.7
area1	3	139405.0	139405.0	144488.0		171508.0
area2	3	6264.0	6264.0	6970.0		8540.0
area3	3	17574.0	17574.0	20492.0		21778.0
area4	3	5957.0	5957.0	8016.0		12768.0
area5	3	16292.0	16292.0	17909.0		25717.0

Table 22: Five-number summary for the Class II male

Parameter	Class II Male					
	N	Minimum	25th percentile	Median	75th percentile	Maximum
angle 1	12	77.0	78.8	80.7	85.6	92.2
angle 2	12	94.0	94.4	99.1	104.3	114.6
angle 3	12	18.5	21.4	23.6	25.5	30.8
length 1	12	247.4	314.0	324.4	357.0	365.8
length 2	12	789.4	926.9	964.4	1052.8	1161.6
polycon	12	138858.0	146397.3	172087.5	193645.5	274392.0

Table 23: Five-number summary for the Class III male

Parameter	Class III Male					
	N	Minimum	25th percentile	Median	75th percentile	Maximum
angle 1	26	55.4	70.3	77.5	81.7	90.4
angle 2	26	67.6	79.5	83.9	88.1	92.7
angle 3	26	12.7	22.2	26.0	30.7	36.8
length 1	26	227.6	345.1	371.2	393.4	441.7
length 2	26	778.0	828.6	856.9	958.4	1113.3
polycon	26	87606.0	130259.5	159498.0	196014.0	291248.0

Table 24: Five-number summary for the ideal female

Parameter	Ideal Female					
	N	Minimum	25th percentile	Median	75th percentile	Maximum
angle 1	10	69.8	74.8	76.9	78.1	79.1
angle 2	10	80.1	84.4	88.5	95.1	97.9
angle 3	10	15.8	18.3	19.9	22.4	24.6
length 1	10	240.1	268.2	281.6	298.8	344.5
length 2	10	659.4	712.3	771.4	788.8	820.6
polycon	10	78426.0	83708.8	98445.0	112752.8	117596.0
poly new	10	64727.0	74243.5	86507.0	91409.0	98393.0
SP angle	10	-70.7	-65.6	-63.1	-59.4	-56.9
SG	10	1151.2	1199.2	1230.0	1264.8	1330.9
SP linear	10	711.6	735.8	760.1	824.3	853.7
PG	10	345.6	412.4	479.2	500.3	509.5
SM	10	792.4	794.2	814.3	893.1	921.2

M-S per	10	499.0	533.8	568.0	660.8	679.7
M- P per	10	615.0	772.1	805.8	841.2	862.0
G-S per	10	353.3	457.3	503.0	590.4	610.0
G-P per	10	669.3	701.7	742.0	767.4	899.3
Sn--S per	10	748.0	774.3	817.2	888.0	924.3
Sn--P per	10	1009.0	1029.7	1060.3	1088.2	1149.0
Go'-S per	10	541.7	648.6	721.5	781.3	831.0
Go'-P per	10	849.7	917.8	954.3	963.1	1120.0
angular 1	10	18.7	19.3	21.8	23.6	89.5
angular 2	10	63.6	66.9	68.8	70.1	71.0
angular 3	10	38.3	39.6	51.8	56.4	64.7
angular 4	10	65.4	83.5	87.4	94.3	100.9
angular 5	10	30.0	33.0	37.1	54.9	60.2
area1	10	100116.0	108001.5	116444.5	131797.8	150676.0
area2	10	3606.0	4802.3	5758.0	6061.8	6214.0
area3	10	7696.0	11539.5	14858.0	17354.8	19604.0
area4	10	3521.0	4202.5	6300.0	7736.0	9410.0
area5	10	11046.0	13277.0	13899.0	20347.0	26317.0

Table 25: Five-number summary for the cleft female

Parameter	Cleft Female					
	N	Minimum	25th percentile	Median	75th percentile	Maximum
angle 1	6	68.4	73.6	81.5	87.4	91.4
angle 2	6	59.1	65.9	72.3	78.1	90.0
angle 3	6	8.4	12.3	21.7	26.3	27.2
length 1	6	169.8	177.7	263.4	312.3	338.6
length 2	6	566.1	632.0	734.9	819.3	876.0
polycon	6	45661.0	62290.8	99470.5	112868.5	113962.0
poly new	6	35879.0	52967.0	73211.5	93353.8	104825.0
SP angle	6	-74.6	-71.3	-67.4	-63.0	-62.1
SG	6	1131.5	1211.6	1391.9	1434.3	1445.0
SP linear	6	671.4	681.9	802.7	851.1	859.3
PG	6	378.7	438.2	577.0	669.5	701.2
SM	6	726.1	758.1	869.9	937.2	949.2
M-S per	6	428.0	501.8	556.7	677.3	682.0
M- P per	6	755.3	785.8	875.2	989.0	1157.3
G-S per	6	334.0	412.8	483.1	516.0	542.0
G-P per	6	697.0	699.5	760.1	879.3	979.3

Sn--S per	6	627.8	661.2	795.0	829.3	873.2
Sn--P per	6	895.3	967.7	1111.5	1175.3	1288.7
Go'-S per	6	534.0	618.6	678.3	726.8	730.7
Go'-P per	6	893.7	901.9	969.4	1074.4	1203.0
angular 1	6	19.4	19.4	23.7	27.4	29.8
angular 2	6	38.8	54.4	66.0	69.6	71.9
angular 3	6	35.1	39.4	53.3	79.8	103.2
angular 4	6	37.9	55.0	69.4	76.4	88.9
angular 5	6	34.9	41.7	55.2	70.5	75.8
area1	6	93227.0	105722.8	123454.0	173241.5	195239.0
area2	6	2425.0	3607.0	5428.0	8869.8	13393.0
area3	6	8184.0	9103.5	10404.5	16298.8	28649.0
area4	6	1804.0	2536.0	4710.0	6706.0	7696.0
area5	6	9088.0	10894.0	15956.0	19490.0	22436.0

Table 26: Five-number summary for the Class II female

Parameter	ClassII Female					
	N	Minimum	25th percentile	Median	75th percentile	Maximum
angle 1	16	74.0	83.4	87.9	92.8	94.8
angle 2	16	85.6	96.4	98.9	100.4	104.7
angle 3	16	16.0	24.4	27.0	28.4	33.2
length 1	16	248.9	308.1	334.6	357.7	400.5
length 2	16	798.2	867.0	895.2	938.0	996.8
polycon	16	115119.0	152949.5	163115.0	179395.5	215409.0

Table 27: Five-number summary for the Class III female

Parameter	Class III Female					
	N	Minimum	25th percentile	Median	75th percentile	Maximum
angle 1	24	60.6	74.9	82.7	88.4	100.5
angle 2	24	55.5	78.3	82.1	86.8	99.2
angle 3	24	18.5	26.1	27.7	30.0	34.2
length 1	24	250.9	309.1	336.5	355.5	398.9
length 2	24	569.2	741.7	813.4	882.2	969.0
polycon	24	90472.0	118962.3	133464.0	173891.5	218203.0

Table 28: Five-number summary for the whole data

Parameter	N	Minimum	25th percentile	Median	75th percentile	Maximum
angle 1	107	55.4	74.0	78.7	85.6	100.5
angle 2	107	55.5	81.4	87.1	95.5	114.6
angle 3	107	8.4	21.7	24.8	27.9	36.8
length 1	107	169.8	287.8	336.4	361.5	441.7
length 2	107	566.1	782.3	849.4	913.4	1161.6
polycon	107	45661.0	112504.0	140805.0	174303.0	291248.0
poly new	29	35879.0	75739.0	89251.0	98255.0	121716.0
SP angle	29	-74.6	-67.6	-63.7	-61.1	-56.9
SG	29	1131.5	1230.0	1315.7	1391.9	1490.2
SP linear	29	671.4	747.3	813.7	853.8	908.4
PG	29	345.6	459.4	498.2	572.7	701.2
SM	29	726.1	804.3	882.5	919.1	972.9
M-S per	29	428.0	552.2	582.3	670.8	715.0
M- P per	29	615.0	796.3	857.7	912.2	1157.3
G-S per	29	334.0	467.3	508.0	596.8	650.3
G-P per	29	669.3	704.8	764.0	854.1	979.3
Sn--S per	29	627.8	786.8	858.1	918.5	1147.0
Sn--P per	29	895.3	1035.5	1091.3	1148.6	1288.7
Go'-S per	29	534.0	684.3	729.4	801.5	886.5
Go'-P per	29	849.7	927.2	967.2	1077.5	1203.0
angular 1	29	18.7	19.9	22.2	23.9	89.5
angular 2	29	38.8	65.6	68.0	69.7	71.9
angular 3	29	30.4	40.4	52.6	64.1	103.2
angular 4	29	37.9	70.9	85.2	91.3	100.9
angular 5	29	23.7	34.0	46.6	55.7	75.8
area1	29	93227.0	113327.5	131637.0	145955.5	195239.0
area2	29	2425.0	4437.0	5668.0	6428.0	13393.0
area3	29	7696.0	11745.0	14636.0	18575.5	28649.0
area4	29	1804.0	4060.0	5684.0	7160.5	12768.0
area5	29	8906.0	13230.0	14214.0	18208.5	26317.0

Table 29: 95% CI for the ideal and the cleft for angle 1, angle 2........SP angle

Parameter	Group	95% Confidence Interval for Mean	
		Lower	Upper
angle 1	Ideal Male	66.22	72.99
	Cleft Male	53.31	92.66
	Ideal Female	73.67	78.25
	Cleft Female	69.73	87.45
angle 2	Ideal Male	83.31	92.84
	Cleft Male	79.08	107.13
	Ideal Female	84.86	93.86
	Cleft Female	58.38	86.37
angle 3	Ideal Male	17.32	23.22
	Cleft Male	9.80	37.69
	Ideal Female	18.29	22.25
	Cleft Female	15.17	28.91
length 1	Ideal Male	287.49	360.05
	Cleft Male	77.72	462.24
	Ideal Female	263.85	304.22
	Cleft Female	189.77	349.96
length 2	Ideal Male	754.16	845.53
	Cleft Male	282.45	1384.15
	Ideal Female	712.56	792.11
	Cleft Female	600.29	884.60
polycon	Ideal Male	95307.64	133571.96
	Cleft Male	2708.43	237671.57
	Ideal Female	87560.70	109008.70
	Cleft Female	73405.22	123891.18
poly new	Ideal Male	81174.83	109640.37
	Cleft Male	72796.48	127763.52
	Ideal Female	75521.78	91636.62
	Cleft Female	57825.65	101950.75
SP angle	Ideal Male	-66.30	-60.77
	Cleft Male	-79.58	-43.63
	Ideal Female	-66.25	-60.17
	Cleft Female	-74.12	-62.51

Table 30: 95% CI for the ideal and the cleft for SG, SP linear... Go'-P per

Parameter	Group	95% Confidence Interval for Mean	
		Lower	Upper
SG	Ideal Male	1291.51	1390.78
	Cleft Male	652.88	2205.25
	Ideal Female	1197.71	1273.15
	Cleft Female	1198.11	1518.31
SP linear	Ideal Male	791.94	865.41
	Cleft Male	741.63	998.45
	Ideal Female	740.74	813.36
	Cleft Female	663.37	860.87
PG	Ideal Male	463.31	557.52
	Cleft Male	-207.36	1311.48
	Ideal Female	419.43	498.11
	Cleft Female	474.72	714.19
SM	Ideal Male	855.89	930.19
	Cleft Male	671.71	1220.27
	Ideal Female	801.29	875.18
	Cleft Female	724.18	949.33
M-S per	Ideal Male	585.46	659.15
	Cleft Male	623.71	742.29
	Ideal Female	537.02	628.71
	Cleft Female	438.38	658.96
M- P per	Ideal Male	816.65	920.21
	Cleft Male	826.20	987.14
	Ideal Female	741.66	842.21
	Cleft Female	759.17	934.64
G-S per	Ideal Male	499.90	606.44
	Cleft Male	493.97	750.19
	Ideal Female	452.18	571.69
	Cleft Female	358.47	554.01
G-P per	Ideal Male	738.22	856.78
	Cleft Male	730.88	974.30
	Ideal Female	700.09	791.72
	Cleft Female	672.01	833.39
Sn--S per	Ideal Male	854.22	943.48
	Cleft Male	-449.18	2510.27
	Ideal Female	784.57	871.29
	Cleft Female	627.17	878.17

Sn--P per	Ideal Male	1096.13	1192.37
	Cleft Male	-330.00	2394.42
	Ideal Female	1031.26	1091.80
	Cleft Female	921.29	1177.78
Go'-S per	Ideal Male	735.47	822.18
	Cleft Male	702.55	1043.66
	Ideal Female	654.03	777.70
	Cleft Female	562.85	742.31
Go'-P per	Ideal Male	968.18	1076.27
	Cleft Male	931.42	1276.42
	Ideal Female	899.06	1002.53
	Cleft Female	868.22	1039.21

Table 31: 95% CI for the ideal and the cleft for angular 1 ......angular 5

		95% Confidence Interval for Mean	
Parameter	Group	Lower	Upper
angular 1	Ideal Male	20.34	23.18
	Cleft Male	8.32	36.19
	Ideal Female	12.65	43.65
	Cleft Female	17.91	29.30
angular 2	Ideal Male	66.75	69.43
	Cleft Male	47.68	86.46
	Ideal Female	66.68	70.02
	Cleft Female	60.36	72.59
angular 3	Ideal Male	41.10	63.32
	Cleft Male	20.77	67.55
	Ideal Female	43.30	56.82
	Cleft Female	33.28	68.50
angular 4	Ideal Male	75.66	88.65
	Cleft Male	84.77	99.57
	Ideal Female	80.27	94.26
	Cleft Female	59.29	84.99
angular 5	Ideal Male	34.49	56.57
	Cleft Male	35.09	52.85
	Ideal Female	34.05	50.56
	Cleft Female	36.49	75.37

Table 32: 95% CI for the ideal and the cleft for area 1........area 5

Parameter	Group	95% Confidence Interval for Mean	
		Lower	Upper
area1	Ideal Male	126030.24	146891.36
	Cleft Male	-13662.83	329658.83
	Ideal Female	108356.15	130507.25
	Cleft Female	80434.64	177670.16
area2	Ideal Male	4631.27	6055.93
	Cleft Male	-2219.37	17729.37
	Ideal Female	4795.10	6030.70
	Cleft Female	1568.67	12013.33
area3	Ideal Male	13621.66	19016.74
	Cleft Male	494.65	37571.35
	Ideal Female	11965.71	17143.89
	Cleft Female	4091.24	24328.76
area4	Ideal Male	3865.50	6553.70
	Cleft Male	33908.48	52633.48
	Ideal Female	4679.54	7644.66
	Cleft Female	1705.66	6446.34
area5	Ideal Male	11716.02	17861.38
	Cleft Male	38873.49	80882.49
	Ideal Female	12519.20	20049.60
	Cleft Female	9439.57	18962.03

Table 33: 95% CI for the Whole data

Parameter	95% Confidence Interval for Mean	
	Lower	Upper
angle 1	71.6	76.1
angle 2	82.2	89.9
angle 3	19.3	22.4
length 1	275.9	314.3
length 2	744.6	803.5
polycon	97366.1	114549.9
poly new	81865.0	95162.3
SP angle	-65.9	-62.4
SG	1273.1	1350.3
SP linear	775.4	825.2
PG	477.4	542.5
SM	840.0	892.5
M-S per	570.9	626.2
M- P per	808.7	869.2
G-S per	491.2	558.9
G-P per	744.8	803.6
Sn--S per	814.5	896.1
Sn--P per	1055.3	1120.2
Go'-S per	703.1	775.2
Go'-P per	956.6	1021.7
angular 1	19.3	29.7
angular 2	66.7	68.9
angular 3	45.7	55.4
angular 4	78.7	87.2
angular 5	40.7	51.6
area1	121306.1	139448.2
area2	5025.7	6606.2
area3	13632.6	17319.7
area4	4701.4	6618.8
area5	13797.3	17591.1

Table 34: Chart for cephalometric analysis for the cleft subjects:

parameter	male				female				Observed value	Inference
	ideal		cleft		ideal		cleft			
	Mean ± SD	95% CI	Mean ± SD	95% CI	Mean ± SD	95% CI	Mean ± SD	95% CI		
Linear										
length 1	323.77±50.7	287.49-360.05	258.9± 24.5	77.72-462.24	284.0± 28.2	263.85-304.22	253.2± 70.7	189.77-349.96		
length 2	799.85±63.9	754.16-845.53	816.3± 52.4	282.45-1384.15	752.3± 55.6	712.56-792.11	727.7± 108.6	600.29-884.60		
SG	1341.15±69.4	1291.51-1390.78	1439.0± 63.5	652.88-2205.25	1235.4± 52.7	1197.71-1273.15	1338.2± 125.3	1198.11-1518.31		
SP linear	828.68±51.4	791.94-865.41	838.7± 55.2	741.63-998.45	777.1± 50.8	740.74-813.36	778.3± 81.4	663.37-860.87		
PG	510.41±65.8	463.31-557.52	595.0± 95.5	-207.36-1311.48	458.8± 55.0	419.43-498.11	558.5± 123.3	474.72-714.19		
SM	893.04±51.9	855.89-930.19	916.3± 55.7	671.71-1220.27	838.2± 51.6	801.29-875.18	852.8± 90.2	724.18-949.33		
M-S per	622.30±51.5	585.46-659.15	644.0± 67.7	623.71-742.29	582.9± 64.1	537.02-628.71	570.9± 96.3	438.38-658.96		
M- P per	868.43±72.4	816.65-920.21	909.8± 8.3	826.20-987.14	791.9± 70.3	741.66-842.21	898.6± 141.6	759.17-934.64		
G-S per	553.17±74.5	499.90-606.44	601.5± 37.0	493.97-750.19	511.9± 83.5	452.18-571.69	464.8± 73.5	358.47-554.01		
G-P per	797.50±82.9	738.22-856.78	873.1± 36.7	730.88-974.30	745.9± 64.0	700.09-791.72	790.5± 109.3	672.01-833.39		
Sn-S per	898.85±62.4	854.22-943.48	1030.5± 164.7	-449.18-2510.27	827.9± 60.6	784.57-871.29	763.0± 93.9	627.17-878.17		
Sn-P per	1144.25±67.3	1096.13-1192.37	1032.2± 151.6	-330.00-2394.42	1061.5± 42.3	1031.26-1091.80	1089.4± 134.4	921.29-1177.78		
Go'-S per	778.83±60.6	735.47-822.18	873.1± 19.0	702.55-1043.66	715.9± 86.4	654.03-777.70	665.6± 72.1	562.85-742.31		
Go'-P per	1022.23± 75.5	968.18-1076.27	1103.9 19.2	931.42-1276.42	950.8± 72.3	899.06-1002.53	995.3± 119.0	868.22-1039.21		
Angular										
angle 1	69.60± 4.7	66.22-72.99	75.5± 4.7	53.31-92.66	76.0± 3.2	73.67-78.25	80.7± 8.2	69.73-87.45		
angle 2	88.07± 6.7	83.31-92.84	85.0± 14.1	79.08-107.13	89.4± 6.3	84.86-93.86	72.7± 10.1	58.38-86.37		
angle 3	20.27± 4.1	17.32-23.22	23.2± 1.4	9.80-37.69	20.3± 2.8	18.29-22.25	19.8± 7.5	15.17-28.91		
SP angle	-63.53± 3.9	-66.30- -60.77	-62.7± 2.3	-79.58- -43.63	-63.2± 4.2	-66.25- -60.17	-67.5± 4.7	-74.12- -62.51		
angular 1	21.76± 2.0	20.34-23.18	22.9± 1.5	8.32-36.19	28.2± 21.7	12.65- 43.65	23.8± 4.1	17.91-29.30		
angular 2	68.09± 1.9	66.75-69.43	66.3± 2.0	47.68-86.46	68.4± 2.3	66.68-70.02	61.9± 12.1	60.36-72.59		
angular 3	52.21± 15.5	41.10-63.32	53.4± 16.1	20.77-67.55	50.1± 9.4	43.30-56.82	59.6± 24.8	33.28-68.50		
angular 4	82.16± 9.1	75.66-88.65	84.4± 13.4	84.77-99.57	87.3± 9.8	80.27-94.26	66.4± 16.8	59.29-84.99		
angular 5	45.53± 15.4	34.49-56.57	43.7± 0.9	35.09-52.85	42.3± 11.5	34.05-50.56	55.9± 15.7	36.49-75.37		
Areas										
area 1	136460.80±14580.9	126030.24-146891.36	151800.3± 17255.5	-13662.8-329658.83	119431.7± 15482.6	108356.15-130507.25	135195.2± 38117.1	80434.64-177670.16		
area 2	5343.60±995.8	4631.27-6055.93	7258.0± 1165.0	-2219.37-17729.37	5412.9± 863.6	4795.10-6030.70	6339.5± 3921.1	1568.67-12013.33		
area 3	16319.20±3770.9	13621.66-19016.74	19948.0± 2154.1	494.65-37571.35	14554.8± 3619.3	11965.71-17143.89	13205.7± 7693.0	4091.24-24328.76		
area 4	5209.60± 1878.9	3865.50-6553.70	8913.7± 3493.1	33908.48-52633.48	6162.1± 2072.5	4679.54-7644.66	4679.3± 2258.2	1705.66-6446.34		
area 5	14788.70±4295.3	11716.02-17861.38	19972.7± 5040.0	38873.49-80882.49	16284.4± 5263.4	12519.20-20049.60	15573.3 4802.7	9439.57-18962.03		
POLYCON	114439.80±26744.9	95307.64-133571.96	112412.0± 16339.5	2708.43-237671.57	98284. ±7 14991.1	87560.70-109008.70	89817.0± 28259.3	73405.22-123891.18		
polynew	95407.60±19896.0	81174.83-109640.37	93313.0± 12259.5	72796.48-127763.52	83579.2± 11263.5	75521.78-91636.62	72553.3± 23987.0	57825.65-101950.75		