COMPARATIVE ASSESSEMENT OF ORTHOPANTOMOGRAM AND LATERAL CEPHALOGRAM FOR LINEAR AND ANGULAR MEASUREMENT OF MANDIBLE IN SKELETAL CLASS I AND CLASS II CASES IN HYPODIVERGENT AND HYPERDIVERGENT GROWTH PATTERN – A DIGITIZED STUDY.

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CONTENTS

LIST OF TABLES

LIST OF GRAPHS OF LINEAR MEASUREMENTS

LIST OF DIAGRAMS

LIST OF COLOUR PLATES

List of ABBREVIATIONS

Sr. No.	Abbreviations	Full form
1.	Lat Ceph	Lateral Cephalogram
2.	OPG	Orthopantomogram
3.	Gonion	Go
4.	Condyleon	Co
5.	Menton	Me
6.	Sella	S
7.	Nasion	N
8.	FH	Frankfort horizontal plane
9.	FMA	Mandibular plan angle
10.	GA	Gonial angle
11.	Rl	Ramal height
12.	Bl	Body length
13.	Cl	Class
14.	S	Sella

INTRODUCTION

The discovery of lateral cephalogram in 1931 by Broadbent in the United States and Hofrath in Germany provided both a clinical and a research tool to assess the underlying skeletal disproportions. However, Lat Ceph falls short in measuring the right and left sides of the cranial structure individually, due to overlapping of both the sides and interference of superimposed images appearing on lateral cephalogram.[1]

In orthodontic treatment planning the diagnosis involves the detailed study of the hard, soft tissue proportions and the dental occlusion. The orthodontic diagnosis database is derived from three major sources that are history, clinical examination,

and evaluation of diagnostic records including dental casts, radiographs, and photographs. Cephalograms and OPG play an important role in orthodontic diagnosis. The goal of the cephalometric analysis is to evaluate the horizontal and vertical relationship of five major functional components like the cranium and cranial base, skeletal maxilla, skeletal mandible, the maxillary dentition, and alveolar process, and the mandibular dentition and alveolar process.[23]

OPG gives interim of the orthodontist with a comprehensive overview of the cranial complex with comparatively decreased risk of radiation. It forms a remarkable diagnostic aid by its capability to obtain a single view of the teeth, jaw, TMJ, the whole stomatognathic system, and sinuses. It also gives essential information about the dentition, their eruption status, axial inclinations, and the surrounding tissues in orthodontic practice. Both right and left side landmarks could be seen separately using panoramic radiography, preventing structures' overlapping or superimposition observed in lateral cephalograms.[3]

Orthopantomogram seems to be a superfluous orthodontic screening tool as it is mostly used in orthodontic practice to provide important information about the teeth, their axial inclinations, maturation stages, and surrounding tissues. It is essential to do measurement of the gonial angle in orthodontic treatment and orthognathic surgery. It is important to assess the symmetry of the craniofacial skeleton. Therefore, it is essential to determine the gonial angle accurately assessing the orthodontic cases. Regularly, the lateral cephalometric radiograph is used to evaluate the gonial angle, as

a mean value of the right and left side angles due to the superimposed of both sides of the mandible.[4]

In the craniofacial complex, the gonial angle plays an important role. It is very important for the diagnosis of craniofacial disorders. It is one of the relevant parameters indicating the vertical parameter as well as the symmetry of the facial skeleton. The Gonial angle can also be determined more easily in an Orthopantomogram than in a lateral cephalogram.

While performing the cephalometric tracing the gonial angle gives the most important values used to measure the extraction pattern in class II and class II patients, the growth pattern of the patients, and surgical decision in class III skeletal base patients, and age estimation in forensic medicine. The gonial angle measured from orthopantomogram is found to be more reliable than the lateral cephalometric radiograph.[5]

The archiving of the digital image could be reduced the required space, staff, and timing for the storage of cephalometric radiograph. Archiving cephalometric radiographs would be of better benefit in studying craniofacial growth or assessing the effect of treatment, where large numbers of radiographs are analyzed. Radiographs like lateral and posteroanterior cephalograms, oblique mandibular radiographs, and orthopantomograms are most commonly used to analyse morphology and treatment modalities. Value of the gonial angle can be obtained by two ways of measurement. One way is that a tangent is drawn to the posterior border of the mandibular ramus and it is intersected with another line that passes through the

gonion and gnathion of the mandible. The other way is to construct a tangent on the mandible lower border and another tangent to the posterior border of the ramus and condyle and measure the angle between these two lines. The second method was used to measure the gonial angle, as it was not easy to locate the gnathion on the lateral cephalogram.

Usually, Go-Angle is measured on lateral cephalograms. However, the accuracy of Go-Angle measurements may be affected by the superimposition of the patient‘s right and left sides. To measure the Go-Angle accurately, orthopantomograms are used instead as the right and left Go-Angle are not superimposed and can be measured individually. There is a little disagreement between orthodontic analysts on the determination of the mandibular plane. Depending on these differences, three of the most commonly constructed mandibular planes are:

Down's: line connecting Gonion(GO) and Menton(Mn).

Steiner's: line connecting Gonion(GO) and Gnathion(Gn).

Tweed's: tangent to the lower border of the mandible.

Because of these differences, derivation of gonial angle also differs depending upon the relative mandibular plane used.[6]

Skeletal divergence is important from the point of view of the rotation of the mandible, which has the main role in the facial position, growth direction of the

condyles, and the form of the mandible. The various skeletal discrepancies in the vertical plane might be studied with by measuring the skeletal divergence angle.[7]

However, there is a lack of research in the literature examining orthopantomograms' ability to determine skeletal patterns. The accuracy of orthopantomograms to determine gonial angle would provide clinicians to evaluate the growth pattern of a patient without the need for an extra x-ray; and also helps general dentists while directing the patients to specialists. [8]

AIM AND OBJECTIVES

AIM –

The present study aimed to compare orthopantomogram and lateral cephalogram for linear and angular measurement of mandible in skeletal class I and class II cases in hypodivergent and hyperdivergent growth pattern.

OBJECTIVES

1) To compare Orthopantomogram and Lateral Cephalogram for linear and angular measurement of mandible in Skeletal Class I Hyperdivergent and Hypodivergent individuals.

2) To compare Orthopantomogram and Lateral Cephalogram for linear and angular measurement of mandible in Skeletal Class II Hyperdivergent and Hypodivergent individuals.

Primary research question:

Is there any difference between Orthopantomogram and Lateral Cephalogram for linear and angular measurements of the mandible in skeletal Class I & Class II individuals in different growth pattern?

Null hypothesis:

There is no relevant difference between Orthopantomogram and Lateral Cephalogram for linear and angular measurements of the mandible in skeletal Class I & Class II individuals in different growth pattern.

Primary Hypothesis:

There is difference between the linear and angular measurement of mandible in Skeletal Class I and Skeletal Class II Hyperdivergent and Hypodivergent individuals.

REVIEW OF LITERATURE:

Charles H.Tweed[9] (1946) in their study were the result of constant clinical observation covering a period of many years. While not unexpected, it is nevertheless gratifying to find that in his main clinical findings, although arrived at independently, bear an extremely high degree of correlation to, and actually provide additional emphasis and concrete evidence of, the validity of the results and conclusions obtained by some of the outstanding scientific laboratory research workers in the field of orthodontics.

T. M. GRABER[10] (1967) Concluded that the panoramic radiograph, utilizing a laminaghraphie or tomoghraphie principle, was a new and important

diagnosis tool. It re-established the pre-eminence of diagnosis and importance of counting dynamic value judgment during active therapy as well as afterward in orthodontic guidance.

Keijo Mattila et. al[11] (1977) demonstrated that the size of the gonial angle can be determined from the OPG with the same degree of accuracy as from the generally used lateral cephalogram, the gonial angle is formed by the tangent of the lower border of the mandible and the distal border of the ascending ramus and the condyle on each side. It also shows that the right and left gonial angle can be quite easier if determined individually from OPG.

T. A. Larheim et. al[12] (1986) concluded that the observations on the precision of vertical dimensions and gonial angle have encouraged us to continue the research with the panoramic machine. The reproducibility of nine mandibular variables (linear dimensions and angles) assessed from panoramic radiographs with the Orthopantomograms were investigated. Attention was given to the possible influence of recording the reference number of the head positioner with one or two radiographers. Two separate exposures of three groups of patients were made under different radiographic conditions, each group representing one method. The intention was to position the patient during exposure in such a way that even horizontal dimensions may be measured with acceptable reliability.

W. D. McDavid et. al[13] (1986) concluded the customary mathematical expressions for magnification in rotational panoramic radiography were examined. It was shown that although these expressions yield correct results for small objects

placed perpendicularly to the central ray of the beam, they must be corrected in other situations. For estimation and measurements of length dimensions in the rotational plane, corrections have to be made for the oblique projection.[12]

Surender K. Nanda[14] (1990) in their study the angular measurements based on longitudinal lateral cephalometric radiographs were used. Subjects were selected on the basis of lower face height (ANS-Me) as a percentage of morphologic face height (N-Me). A single x-ray photograph at age 15 for the boys and 13.5 for the girls was used to classify each subject's occlusion as either open-bite or deep-bite. Sellanasion/palatal plane, selia-nasion/mandibular plane, sella-nasion/anatomic occlusal plane, palatal plane/mandibular plane, and cranial base angle were analysed statistically and graphically. It was found that (1) with the exception of sellanasion/palatal plane and cranial base angles, all angular measurements demonstrated a progressive reduction throughout development in both open bites and deep bites; (2) the palatomandibular angle discriminated between open bites and deep bites throughout the developmental phase; (3) within each sex, typologic differences were evident in all angular measurements, with the exception of cranial base and occlusal plane; and (4) the cranial base angle demonstrated clear sexual dimorphism, and its magnitude was not associated with vertical dysplasia. The progressive reduction of angles in skeletal open bite reduced or maintained the magnitude of the imbalances, while the reduction of angles accentuated the skeletal deep bite with age. The inclination of the palatal plane and its constancy suggested that downward and backward rotation of the mandible in open bite subjects is recommitted in response to dentoalveolar compensatory changes with the center of rotation at the molars. The

magnitude of the mandibular plane angle is not adequate for assessment of diagnostic or prognostic predictive value in determining the pattern of growth

J. C. TURP et. al[15] (1996) studied the asymmetry of condylar and rami heights which was determined from orthopantomogram of 25 macerated skulls and compared with the results of the true‘ value obtained by direct measurements of the skulls. The correlation between two methods was low so concluded that the validity of the vertical asymmetries of the condyle, ramus or both in orthopantomogram is low.[13]

M. Okan Akcam et. al[16] (2003) objective of this study was to investigate the possibility of enhancing the clinical versatility of the panoramic radiograph, which was an indispensable tool for dental diagnosis. The material of study consisted of lateral cephalograms and panoramic radiographs obtained from 30 patients. A correlation test was performed between the parametric measurements, and the predictability level of the cephalometric measurements from panoramic radiograms was determined by using regression equations. The equations showed that the Go-Gn/S-N, ANS-PNS/Go-Me (palatal plane/mandibular plane), and Co-Go/Go-Me parameters could be predicted from panoramic radiographs within statistically significant levels, and their predictability levels were 20.6%, 15.6%, and 11.2%, respectively. Statistically significant correlations and predictability levels were also determined for the cephalometric and corresponding panoramic parameters in which Frankfort horizontal plane was used. It can be concluded that even though panoramic radiographs provide information on the vertical dimensions of craniofacial structures, clinicians should be very careful when predicting skeletal cephalometric parameters

from panoramic radiographs, because of their lower predictability percentages..[3]

Panagiotis Kambylafkasa et. al[17] (2006) In their study the radiographs were taken with digital panoramic system (Kodak 8000C) under standard exposure factors, as recommended by the manufacturer. Gonial angle was determined by the tangent of the inferior border of the mandible and the most distal aspect of the ascending ramus and condyle on both panoramic and cephalometric radiographs. Mean values were evaluated using z test. The statistical analysis was performed by using the Statistical Package for the Social Sciences (version 11.5). The mean gonial angle was 121.13° and 122.22° on panoramic and cephalometric radiographs, respectively. There was no statistical significant difference between the measured gonial angles on panoramic and cephalometric radiographs ($P > 0.005$). They were concluded that the panoramic radiography can be used to determine the gonial angle as accurately as lateral cephalogram.[9]

Asmaa Tahseen Uthman et. al[18] (2006) Studied 50 Lateral cephalometric radiograms. Eleven landmarks were selected to calculate 12 variables (9 angles&3 linear measurements). These traced radiographs were photographed when digitized using scan jet scanner & the same variables were measured using Dimaxis pro\ classic imaging software. Results showed that there were no statistically significant differences between traditional &digitized Linear & angular measurements except for upper incisor-Frankfort plane angle & upper incisor-lower incisor angle. Conclusion of the study was the angular & linear measurements in digital images were comparable with that of original radiograph & are clinically acceptable. This will

substantiate the benefits of digitized cephalometry in term of reliability of cephalometric analysis.

Asmaa T. Uthman, et. al[19] (2007) Divided samples into full-eruption and marginal-eruption groups. Nine variables (linear measurements and angles) were measured for every individual to determine the minimal and maximal values of each variable and these variables were correlated to each other using Pearson‘s correlation equation. Results showed that the lower eruption space measurements for the marginal-eruption group were smaller by more than 3 to 4 mm than that of the full-eruption group. The Beta-angle, the angle formed between the long axes of lower second and third molars, showed a marked increase in their values (9° to 10°) when the marginal-eruption group is compared to the full-eruption group. Conclusion was made that the third molar angle (Alpha-angle), Beta-angle, and gonial angle together with lower eruption space measurements are the variables that should be taken into consideration when early prediction of lower third molar eruption is performed.

Go kmen Kurta et. al[20] (2008) Performed study to evaluate the condylar and ramal mandibular asymmetry in a group of patients with Class II subdivision malocclusion to identify possible gender differences between male and female subjects. The Mandibular asymmetry measurements (condylar, ramal, and condylarplus-ramal asymmetry values) were performed on the panoramic radiographs of 80 subjects (34 male and 46 female). The study group consisted of 40 Class II subdivision patients (18 male and 22 female; mean age 14.53 3.14 years). The results obtained that No gender-related difference was found for any of the asymmetry indices. Comparison of condylar, ramal, and condylar-plus-ramal asymmetry index

values and gonial angle measurements for Class I and Class II sides in the Class II subdivision group and for right and left sides in the Class I group showed no statistically significant differences. However, the Class II subdivision group has longer values for condylar, ramal, and condylar-plus-ramal height measurements and only these differences were statistically significant (P .001). Conclusions made that except for condylar ramal and condylar-plus-ramal height measurements, Class II subdivision patients have symmetrical condyles when compared to normal occlusion samples according to Habbet's mandibular asymmetry indices.[8]

E.M Ongkosuwito et. al[21] (2009) Investigated the reliability of length measurements of the mandible by comparing orthopantomograms with lateral cephalograms. OPTs and lateral cephalograms were taken of 20 human dry skulls. Four orthodontists and four maxillofacial surgeons located landmarks on all radiographs using a computer program for cephalometric measurements. Intraobserver and interobserver variability in locating landmarks was assessed, as well as positioning of the skulls prior to radiography between the x-ray assistants. Magnification differences between the left and right side of the mandible on the OPG were determined for five skulls. Kappa statistics were used to calculate the intraclass correlation coefficient for intraobserver and interobserver differences. An F test was used to assess differences between methods and between types of observer. No significant differences were found in the magnification factor of the left and right side of the mandible. Compared with a lateral cephalogram, the OPG had comparable reliability in measuring mandibular distances condylion-gonion, gonion-menton, and condylion-menton. No significant differences were observed between the x-ray

assistants in taking the OPGs and lateral cephalograms or in repositioning the skulls. Significant differences were found between orthodontists and maxillofacial surgeons for landmark measurements.

Conclusion was made that an OPG was as reliable as a lateral cephalogram for linear measurements of the mandible (condylion-gonion, gonion-menton, and condylion-menton). [2]

Mostafa shahabi et. al[22] (2009) Compared the external gonial angle determined from the two mentioned radiographs in Class I patients. They collected the radiographs of 70 patients with Angle‘s Class I (22 men and 48 women).

The patient`s age ranged from 1530 years with a mean age of 18.24 years. The data gained were statistically evaluated by *t*-test. The following results were obtained. The mean value of the gonial angle in the lateral cephalogram was 125.00° (men, 124.9° and women, 125.04°) and in the orthopantomogram was 124.17° (men 123.68°, women 124.39°). The difference between these rates was 0.83° (men 1.22°, women 0.64°) and not significant (P = 0.406). Based on the obtained results, they can conclude that panoramic radiography can be used to determine the gonial angle as accurately as a lateral cephalogram. In addition, they can determine the right and left gonial angles of a patient in the orthopantomogram without interferences due to superimposed images of anatomical structures in a lateral cephalogram. For determination of the gonial angle, an orthopantomogram may be a better choice than a lateral Cephalogram.[5]

Tahmine Razi et. al23 (2009) Compared linear dimensions and angular measurements on panoramic images taken with two machines (Planmeca and

Panoura). Twenty radiographs taken with each apparatus from a human dry skull were scanned. Horizontal, vertical and angular dimensions were measured on the skull, which were compared along with the images using Corel DRAW Software, V13. According to the results, independent t-test analysis showed that horizontal magnification assessed on images from Panoura was more than that from Planmeca ($P < 0.00025$). There were no significant differences between the two groups in vertical dimensions ($P = 0.66$). Mean magnification of angular measurements assessed on images from Panoura was less than that from Planmeca ($P < 0.00025$). Independent ttest analysis showed that distortion of Planmeca images were more than that of Panoura. One sample t-test showed that angular measurements were more reliable than linear dimensions. So in conclusion panoramic radiography technique can be used for evaluation of angles but it is better to use other radiography techniques for vertical and horizontal measurements.

Sujoy Ghosh et. al[24] (2010) conducted a study where thousand patients were categorized according to age, gender and dentition status. Panoramic radiographs were traced and anterior gonial angles and depths were measured. Results showed a trend of decrease in the anterior gonial angle and increase in anterior gonial depth with age was observed in both males and females. Furthermore there were differences between right and left side anterior gonial angle and depth, with left side angle more than right and right side depth more than left. There was a significant decrease in the values of anterior gonial angle and significant increase in the values of anterior gonial depth as the dentition status changed from completely dentulous to partially dentulous and from partially dentulous to completely edentulous state. Conclusion was made that the

anterior gonial angle decreases with the advancing age and thereby increases the anterior gonial depth.

S. HUUMONEN et. al[25] (2010) Evaluated the association of tooth loss on the shape of mandible were included in the study. Clinical and panoramic radiographic examinations were carried out. The gonial angle of the mandible and the mandibular and condylar height were measured using panoramic radiographs. In edentulous subjects, the gonial angle was significantly larger, while the ramus and condylar height was significantly smaller on both sides compared with dentate subjects. Women had a significantly larger gonial angle and smaller ramus and condylar height on both sides compared with men. In conclusion, the morphology of the mandible changes as a consequence of tooth loss, which can be expressed as a widening of the gonial angle and shortening of the ramus and condylar height.

Maryam Zangouei-Booshehri et. al[26] (2012) obtained a total of 80 panoramic and 80 cephalometric radiographs from 6 to 12-year-old children and the gonial angle was determined by the tangent of the inferior border of the mandible and the most distal aspect of the ascending ramus and the condyleon both panoramic and cephalometric radiographs. They used Pearson‘s correlation coefficient and paired t-test for comparison. In result they found that the mean gonial angle was 127.07 ± 6.10 and 127.5 ± 6.67 degrees on panoramic and cephalometric radiographs, respectively. There was no statistically significant difference between the measured gonial angles on panoramic and cephalometric radiographs and also no difference between the right and left (both Ps = 0.18). They concluded that the value of the gonial angle measured on panoramic radiography was the same as that

measured on the routinely used cephalometric radiography.[10]

Rıdvan Oksayan et. al [27] (2012) Assessed gonial angle under the angle classification by comparing panoramic radiograph and lateral cephalometric radiograph. 49 patients (25 males, 24 females) with an age range of 12–29 years participated in the present study. Subjects were retrospectively selected among those categorized as skeletal and dental Class I, II, and III malocclusion group. Using lateral cephalometric radiograph, mandibular and ramal planes were drawn and based on these planes. Gonial angle was determined from two tangents which were drawn from the inferior border of the mandible and posterior borders of the condyle and ramus of both sides in the panoramic radiographs. Multiple comparison tests (ANOVA) were used to determine differences between the three angle groups. Results showed that there were no significant differences between Class I, II, and III malocclusion group values of gonial angles determined by lateral cephalometric radiograph and panoramic radiographs ($P > 0.05$). They concluded that the panoramic radiograph results were shown to be as reliable as lateral cephalometric radiograph in all angle classifications. Panoramic radiography can be used as an alternative radiographic technique to detect gonial angle in orthodontic patients.

Mandeep Kaur Bhullar et. al[2] (2014) Measured Gonial angle on lateral cephalograms and orthopantomograms of 98 patients - 44 males (mean age 25.9 years) and 54 females (mean age 21.3 years), and compared using Statistical Package for Social Sciences. Results was One-way analysis of variance demonstrated no significant differences between the values of gonial angles determined by lateral cephalogram and panoramic radiography. Pearson correlation showed a high

correlation between cephalometric and OPG gonial angle value. So, conclusion were made that the Panoramic radiography can be used to determine the gonial angle as accurately as a lateral cephalogram. For determination of the gonial angle, an OPG may be a better choice than a lateral cephalogram as there are no interferences due to superimposed images of anatomical structures as in a lateral cephalogram.

Shreya N Ajmera et. al[28] (2014) Derived an angle using panoramic radiographs which is as reliable as lateral cephalometric norms in determining the skeletal growth pattern. The sample size consisted of 60 OPGs of patients with normodivergent growth pattern evaluated from cephalometric radiographs. The mean Symphyseal Angle (SA) obtained was 134.1 ± 2.1 and correlation tests showed high, negative and statistically significant correlation for both Basal Plane Angle (BPA)1 and Frankfurt Mandibular Plane Angle (FMA) ($p = 0.0063$) and a positive correlation was shown with the Jarabak Ratio (JR)2 ($p = 0.032$). The Symphyseal Angle derived was helpful in determining the skeletal pattern of the craniofacial structure. In result depending upon the significance values, the Symphyseal Angle can be considered as an adjunct to lateral cephalograms to determine the growth pattern of the patient. So in conclusion with standard exposure conditions and high image quality, panoramic radiographs can provide information that is accurate and reliable when compared to lateral cephalograms in assessing divergent growth pattern.

Masao Araki et. al[29] (2015) Evaluated 49 PR films and LCR films from dentate young adults. Orthodontists plotted four points (articulare, menton, posterior gonion, and lower gonion) on the PR and carefully traced them.

Using a protractor, two radiologists measured the GA on LCR images. A simultaneous experimental study of two dry skulls was performed to compare the GA

on LCR and PR. The GA was slightly smaller on the PR of the dry mandible than on the LCR and tended to decrease continuously with magnitude toward the Frankfort horizontal plane. The mean GA was 115.1 ± 5.2° on PR and 122.2 ± 6.4° on the LCR. The values were highly correlated (Pearson product-moment correlation coefficient, 0.801). The GA on PR was non-significantly smaller than that measured on LCR. The difference may be due to head position, the inclination angle of the mandibular body, and/or the direction of the incident X-ray beam.

Girish Katti et. al[30] (2016) Studied to investigate whether OPGs can be used as an alternative to lateral cephalogram for measuring the gonial angle. A total of 100 radiographs were collected from patients with Angle's Class I malocclusion (50 males and 50 females) with age ranging from 15 to 30 years, with a mean age of 18.24 years. The radiographs were taken with digital panoramic system (Kodak 8000C) under standard exposure factors, as recommended by the manufacturer. Gonial angle was determined by the tangent of the inferior border of the mandible and the most distal aspect of the ascending ramus and condyle on both panoramic and cephalometric radiographs. Mean values were evaluated using z test. The statistical analysis was performed by using the Statistical Package for the Social Sciences (version 11.5). The mean gonial angle was 121.13° and 122.22° on panoramic and cephalometric radiographs, respectively. There was no statistical significant difference between the measured gonial angles on panoramic and cephalometric radiographs ($P > 0.005$). Conclusion of their study was Panoramic radiography can be used to determine the gonial angle as accurately as lateral cephalogram.[6]

Jodi Leversha et. al[31] (2016) Utilized 2699 randomly selected panoramic radiographs of patients between the ages of 19-69 years, from which 220 fulfilled the inclusion criteria. Each panoramic radiograph was analyzed and the above three parameters recorded and measured. These values were collated into appropriate age and gender groups and subjected to statistical analysis.

In result the mean age of the participants was 44.1±14.41, with males being shown to have a statistically significant larger ramus height and bigonial width than females (P<0.0001 for both). Females, on the other hand, were shown to have a significantly larger gonial angle than males (P<0.0002). General trends revealed gonial angle to increase with age, whilst bigonial width and ramus height were shown to decrease with age. Conclusions were the assessment of mandibular morphology through radiographic measurements may be useful in estimating an individual‘s age and gender when comparing to a known population standard.

Mansoor Majeed et. al[32] (2016) Analyzed lateral cephalograms and OPG of 103 patients, 27 males and 76 females. The gonial angle was determined in panoramic radiographs by two tangents drawn from the condyle‘s posterior borders and right and left ramus and inferior border of the mandible. Landmarks in the cephalogram were identified and spotted. Cephalometric protractor and calipers were used to mark and measure the angles. Angles and other parameters were rechecked to counter any missed measurement. Results: In lateral cephalograms the mean value of gonial angle was 121.77° and in panoramic radiographs 122.18°. In females, the difference among the mean gonial angle in both radiographs was 1.20 and in males 1.224 while difference among the two genders was 0.02°. As P > 0.05 for all the variables stated

above, these differences were not significant. Conclusion: OPG may be considered to evaluate the gonial angle as correctly as a lateral cephalogram because in the values of gonial angles measured in both radiographs there was non- significant difference. The plus point in OPG is that it is more accurate in evaluating patient‘s gonial angles without any overlaid images.

Sung-Hee Park et. al[33] (2017) Selected the panoramic radiographs and lateral cephalograms of 99 former orthodontic patients with skeletal class III malocclusion. In each radiograph, gonial angles, ramus heights, and distance between lower incisors and symphysis were measured. The values of the studied parameters were compared by paired t-test, Pearson‘s correlation test and regression analysis. The mean value of the gonial angle in panoramic radiographs was 125.49°, and the value in lateral cephalograms was 127.50°. The Pearson‘s correlation coefficient (ρ) between mean values of gonial angle in each radiograph was 0.945 ($p < 0.001$). The relationship between the gonial angle measurements obtained from each radiographs was represented as _Gonial angle (Lateral cephalograms) = 0.920 X Average gonial angle (Panoramic radiographs) + 12.072 in the linear function. The coefficients of ramus heights, and distance between lower incisors and symphysis portrayed weaker correlations than gonial angles. A panoramic radiograph could be used to determine the gonial angle as accurately as a lateral cephalogram, and each gonial angle showed a strong positive relation. A panoramic radiograph is a useful tool for examining vertical growth pattern of patients, as well as a lateral cephalogram.

S. Saravana kumar et. al[1] (2017)1 Studied OPG and lateral cephalogram taken from 100 patients of age group 16–35 years from Chettinad Dental College and

Research Institute. Linear measurements (body length and ramus height) and angular measurement (gonial angle) were assessed both in lateral cephalogram and OPG. Independent t-test was performed for comparison of OPG and lateral cephalogram using SPSS with a probability level of $P < 0.05$ considered to be statistically significant. The results of the present study show that there is no statistically significant difference in ramus height and gonial angle when compared between OPG and lateral cephalogram while statistically significant difference exists for body length between OPG and lateral cephalogram. It may be concluded that panoramic radiography can be used to determine the gonial angle and ramus height as accurately as a lateral cephalogram. However, clinicians should be vigilant when predicting horizontal measurement from OPGs.

Pillai Devu Radhakrishnan et. at[34] (2017) Measured the gonial angles of 50 class I malocclusion patients (25 males and 25 females; mean age: 23 years) using both a lateral cephalogram and a panoramic radiograph. In the lateral cephalograms, the gonial angle was measured at the point of intersection of the ramus plane and the mandibular plane. In the panoramic radiographs, the gonial angle was measured by drawing a line tangent to the lower border of the mandible and another line tangent to the distal border of the ascending ramus and the condyle on both sides. The data obtained from both radiographs were statistically compared. Results found no statistical significant difference between the gonial angle measured using the lateral cephalograms and that determined using the panoramic radiographs. Further, there was no statistically significant difference in the measured gonial angle with respect to gender. The results also showed a statistically insignificant difference in the mean of

the right and the left gonial angles measured using the panoramic radiographs. The conclusion was made that the gonial angle measurements using panoramic radiographs and lateral cephalograms showed no statistically significant difference, panoramic radiography can be considered in orthodontics for measuring the gonial angle without any interference due to superimposed images.

TAYYABA BIBI et. al[35] (2017) Conducted a cross – sectional study, using 100 radiographs of the patients in the form of OPG and lateral head films. The sample included 35 male subjects with mean age of 18.00±5.167 years and 65 female subjects with mean age of 18.66±4.874 years. The gonial angle was determined by tracing a tangent to the lower border of the mandible and another tangent to the posterior ramus of the mandible both on OPG and lateral cephalogram manually and measured with the help of protractor. The mean value for gonial angle on right and left side of the mandible on OPG was 124.62±7.54º and 124.31±8.37º respectively. The value was 124.65±7.99º on lateral cephalograms. The Pearson correlation showed statistically significant correlation between cephalometric and OPG gonial angle way ANOVA revealed no significant difference between the values. The results revealed a significant correlation between the cephalometric and panoramic values which concludes that panoramic radiography is as reliable as lateral cephalogram in predicting vertical facial pattern as determined by gonial angle. OPG can be used as an alternative to lateral cephalogram in determining gonial angle which shows its versatility as a diagnostic tool.

Tayisir Ganeiber and Iman Bugaighis[36] (2018) Obtained a total of 125 standardized panoramic as well as lateral cephalometric radiographs of Libyan

subjects from the orthodontic clinical records (36 males and 89 females). Mandibular inclination was computed by averaging the R and L gonial angles produced by drawing tangents to the inferior border of the mandible and to the distal aspect of the ascending ramus and the condylon on each OPG. Moreover, similar steps were followed to extract the gonial angle from the cephalometric radiographs. In results Student‘s paired t-tests revealed no significant discrepancies between the R and L gonial angle values extracted from the OPG (123.88° ± 6.53° and 123.27° ± 6.55°) at P = 0.0.070. The mean values of the gonial angle (average of the R and L mean values) extracted from the OPG (123.58° ± 6.38°) and cephalometric 553radiographs (125.14° ± 6.23°) were not significantly different (P = 0.084). Furthermore, Pearson‘s correlation coefficient revealed strong correlation between the values of the gonial angle measured in the cephalometric radiograph and the mean value extracted from the OPG (r = 0.897 at P < 0.001). Conclusion of the study were OPGs are as useful as lateral cephalometric radiographs in the assessment of mandibular inclination and steepness in Libyan subjects.[15]

Mirza Hammad ul-Haq et. al[6] (2018) Studied a total of 178 panoramic and cephalometric radiographs of patients ranging from age 12-39. Gonial angle was constructed by three methods defined by Tweed's, Steiner's and Down's on the cephalogram and was then compared to the method of gonial angle determination on an OPG. Repeated measure ANOVA with Bonferroni correction was used for comparison. Results showed the mean difference between the values of different methods of finding Gonial Angle on cephalogram and orthopantomogram of was found to be statistically significant (i.e; P = <0.05) after Bonferrroni correction among

three vertical groups. Conclusions were value of gonial angle determination on an Orthopantomogram was found to be different when compared with the three methods (Tweed's, Steiner's and down's) of gonial angle determination on lateral cephalogram.

IBAD ULLAH KUNDI et. al[5] (2018) Stated the gonial angle is one of the most important values in cephalometric tracing and is used to measure growth pattern of patients, teeth extraction pattern in Class II patients, surgical decision in class III skeletal base patients and age estimation in forensic medicine. Gonial angle measured from panoramic radiograph (OPG) is found to be more reliable than lateral cephalometric radiograph. It is difficult to measure gonial angle accurately on the cephalometric radiograph as there is superimposition of the left and right sides angle. The aim of this study was to test the similarity of left and right sides of OPG in measuring the gonial angle and to check whether these values are identical with the values of gonial angle measured from lateral cephalometric radiograph. A hospital based survey of patients visiting the staff clinic of college of Dentistry, Aljouf university from 1st October 2017 to 30th March 2018.The radiographs (Panoramic radiograph and lateral cephalometric radiograph) were prescribed and gonial angle traced to check their accuracy. Statistically significant difference was found when measurements yielded from panoramic images (right and left) and lateral Cephalometric measurements were compared (0.029 and 0.002).The gonial angles measured from left and right sides of panoramic images were equally reliable but when these measurements were compared to the gonial angles measured on the cephalometric radiographs, the measurements were found statistically different.

Emtiaz Ahmad Lone et. al[37] (2018) Included the pre-treatment records of the cases undergoing orthodontic treatment in the department with 90 subjects divided into three groups via (Gr1-30 subjects of Class I, Gr 2, 30 subjects of Class II and Gr 3, 30 subjects of Class III cases) in the age range of 12-30 years. Results showed reliability of gonial angle in orthopantomogram (OPG) in comparison with lateral cephalogram and was found highly correlated to each other and differences exhibiting statistically not significant. The study concluded that the gonial angle in orthopantomogram in class I, Class II, and Class III cases could be as reliable as found in lateral cephalogram.

Dr. Fatin Khudheir Abbas[38] (2018) Conducted study on 40 Iraqi subjects· Dentulous study group (20 subjects) Edentulous study group (20 subjects) Using digital panoramic image, the gonial angle was measured on both right and left sides for 2 study groups. In results according to the age both dentulous and edentulous study groups, there was significant difference in mean gonial angle (GA) between 2 age groups (younger and older age groups) , the mean GA was significantly higher in the older age group , P value < 0.001 - According to the gender: in dentulous study group there was non-significant difference in mean GA between males and females , P value = 0.76 while in edentulous study group , the mean GA was significantly higher in females , P value = 0.01 - According to the dentate status: the edentulous study group statistically significant higher mean GA compared to dentulous study group, P value < 0.001. The conclusion was made gonial angle does show changes with dentition status, therefore dentist role in qualitative and quantitative assessment of mandibular

gonial angle by using digital panoramic radiography has become an essential aid for human identification in forensic dentistry.

Eyas Abuhijleh et. al[39] (2019) Did a retrospective cross-sectional study, where the study sample was composed of 590 (295 males and 295 females) patients undergoing digital panoramic radiography in the College of Dentistry in University of Science & Technology of Fujairah, Fujairah, UAE . These patients were prescribed panoramic radiographs based on different factors. As a generally adopted procedure, bilateral gonial angle measurements were carried out, results were recorded, and their predictability as a determinant of gender was assessed. ANOVA and t-test procedures were utilized for statistical analysis of the collected data. In results the analysis of the present study confirmed a statistically significant difference between the right and left sides of the gonial angle in both genders. Further, the mean comparison exposed a variation between males and females, based on gonial angle values; females have a statistically significant higher mean angle values than males. Based on the analysis, the present study concludes that this difference between males and females from both sides suggests that the gonial angle helps in sex identification. It has been concluded that gender significantly influences the gonial region and has great potential to be used as a forensic tool in gender determination. Digital panoramic radiography is a good study tool and it can be used to determine the morphology of the mandible.

Tugba Haliloglu Ozkan et. al[40] (2019)[8] The sample consisted of 50 Class I, 50 Class II and 50 Class III (25 males and 25 females for each group) orthopantomograms and cephalograms obtained from previously treated orthodontic

patients. For each malocclusion group, the angle between Tweed's mandibular plane and the tangent from the line running along the gonion to the distal point of the condyle was measured on the right and left sides on orthopantomograms and the superimposed images of the mandible on cephalograms. Paired t-test demonstrated no significant difference between the values of gonial angles determined by cephalograms and orthopantomograms in Cl I patients. Pearson correlation also showed a high correlation between gonial angle values measured on the two diagnostic tools in Cl I patients. In Cl II and Cl III patients, statistical analysis showed a significant difference between the gonial angles defined by cephalograms and orthopantomograms. Orthopantomograms can be used for determining gonial angle as accurately as cephalograms in Cl I patients. However, orthopantomograms are not appropriate tools for measuring the gonial angle in Cl II and Cl III patients.

Talat Hasan Al-Gunaid et. al[41] (2019) Divided two hundred and forty subjects into two groups: impacted group: 115 subjects presented with an impacted mandibular third molar, and control group: 125 subjects with the normal mandibular third molar eruption. Digital panoramic radiographs were used, and four angular and twelve linear measurements were done. Pearson correlation and linear regression tests were used to assess the degree of relationship between retromolar space and mandibular measurements. In results Control group showed significant greater measurements in most of the variables, whereas the impacted group showed significant larger gonial angle and larger inclination of lower posterior teeth than the control group. Significant correlations were found between retromolar space and coronoid height, ramal heights, ramus notch depths, the inclination of lower posterior

teeth, and retromolar space/3M width ratio in both groups. So conclusion of the present study found that the configuration of the mandibular ramus appears to be discrete in many aspects in the erupted other than impacted lower third molars subjects, which might be a possible cause for the impaction

Marwa Sameh Shamaa et. al[3] (2019) Collected the pre-treatment OPGs and LCRs of 120 patients (ranging in age from 10-15 years) with dental and skeletal class I, II and III relationships (40 patients/group) respectively. The selected OPGs and LCRs had to be taken in the same day by the same apparatus and in ideal position according to the manufacturer‘s instructions. Two-way ANOVA was used to detect possible differences between classes and types of radiographs followed by multiple comparisons (post hoc test) between each 2 groups using the Bonferroni correction if significant differences were noted. Result showed there was a statistically significant difference in the assessed parameters using OPGs between groups for the anterior mandibular height (AHMn), the distance from the incisal edge of the most extruded lower central incisor to the anterior mandibular line (ii-Mla) and the distance from the mesial cusp tip of the mandibular permanent first molar to the mandibular line (mi-ML) only. In LCRs, there was a significant difference between classes for AHMn and mi-ML only. A significant difference was detected between OPGs and LCRs for AHMn and mi-ML only ($p<0.05$) conclusion OPG can be considered a reliable alternative for LCR for assessment of many angular and linear dento-skeletal characteristics in different classes to reduce the radiation dose involved in routine diagnostic purpose.

kRuba J Mohammad et. al[4] (2020) Included Lateral cephalometric and dental panoramic radiographs of 76 individuals of both genders with age range from 12 to 25 years in their study. The samples divided into two groups: The first group included 36 samples with non-evaluated panoramic radiographs having good quality and sharpness. The second group included 40 samples of evaluated panoramic radiographs, which were selected according to the specific criteria of success. In results the findings of the study showed a significant difference in the values of the gonial angle between the non-evaluated panoramic radiographs of right and left sides (p=0.00, 0.001) respectively as compared to the cephalometric radiograph. No significant differences observed in the value of gonial angle measurements. They were obtained from cephalometric and evaluated panoramic radiographs of both sides (p=0.888, 0.938) respectively. In conclusion the success criteria could serve as an easy and simple method to assess the quality of panoramic radiographs for accurately measuring the gonial angle on both sides and without superimposition as compared to cephalometric radiographs.

Demet Kaya[42] (2020) Examined the digital Lat Cephs and OPGs of 51 patients (9 males, 42 females) who received orthodontic treatment. The mean age of the patients was 19.51±4.92 years. All digital radiographs were acquired with the same machine. The Go-Angle measurements were performed digitally using Total Ceph software. In order to evaluate the difference between the Go-Angle measured on the digital Lat Cephs and OPGs, a paired t-test was used. To compare the two techniques (digital Lat Ceph and OPG) in terms of Go-Angle measurement, Bland-Altman analysis was used. The differences between the right and left Go-Angle

measured on the digital OPGs were evaluated using a paired t-test. The intra observer reliability was assessed with the intra class correlation coefficient (ICC) for repeated measurements. Result showed the intra observer reliability was 0.99 for repeated measurements. There were no statistically significant differences between the Go-Angle measured on digital Lat Cephs and OPGs (p=0.1). Bland-Altman analysis showed high levels of agreement between digital Lat Cephs and OPGs with a bias value of −0.4° for Go-Angle measurement. Moreover, the differences between the right and left Go-Angle measured on the digital OPGs were not statistically significant (p=0.73). So the results of this study demonstrated that the digital OPGs were as reliable as the digital Lat Cephs for measuring Go angles using a software.

Ashima Bali Behl et. al[43] (2020) Divided a total of 400 patients into age groups 10-40 years. The linear measurements were made in ramus and gonial angle region, which were calculated by using Adobe Acrobat Reader, and findings were statistically analyzed. In results Males showed a higher average value in terms of ramus breadth, condylar and coronoid ramus height than females. In addition, a significant positive correlation was seen between age and ramus linear measurements. Males have higher gonial angle than females and with increase in age, gonial angle decreases. In relation to gonial angle, females showed a higher gonial angle. ―In addition, as age increases, decrease in gonial angle was found. Study concluded that in selected north Indian populace, mandibular ramus showed higher sexual dimorphism in relation with age and sex estimation

Bernadette Kerekes-Máthé et. al[7] (2020) Used a total number of 80 orthopantomogram and cephalogram pairs for their study. There were certain

differences between the angle values obtained from the cephalograms and the orthopantomograms, but these were not statistically significant. The method described might be helpful for a preliminary determination of the skeletal divergence angle on orthopantomograms in order to decide the next steps and refer the patient to a specialist.

MATERIAL AND METHODS:

The present study was conducted on 200 untreated subjects in the Department of Orthodontics and Dentofacial Orthopedics. Subjects who had plans to undergo orthodontic treatment were included. Further screening of subjects for inclusion was done after a detailed case history and clinical examination. Written informed consent was obtained from each participant or his or her parents, and ethical clearance was obtained from the institutional ethics committee.

RESEARCH METHODOLOGY:

Study Design:

It is a Retrospective study.

STUDY SETTING:

The study was conducted in the Department of Orthodontics And Dentofacial Orthopedics. Ethical committee approval was obtained from the Institutional Ethics Committee.

STUDY POPULATION:

Patients visiting the Department Of Orthodontics And Dentofacial Orthopedics for Seeking orthodontic treatment and the subjects were included in the study as per the inclusion and exclusion criteria.

SAMPLE SIZE:

Based on mean scores of gonial angle in lateral cephalogram, Orthopantomogram and Epiinfo software was used to calculate sample size.

Power 80% and Alpha error 5%

SAMPLE TECHNIQUE:

1. Orthopantomogram and Lateral Cephalogram of skeletal Class I – 100 individuals.

   Hypodivergent - 50

   Hyperdivergent - 50

2. Orthopantomogram and Lateral Cephalogram of skeletal Class II- 100 individuals.

   Hypodivergent - 50

   Hyperdivergent -50

Inclusion Criteria:

- Patients aged 16-25 years
- Skeletal Class I patient
- Skeletal Class II patient
- Patient with horizontal & vertical growth pattern

Exclusion Criteria:

- Patients with Skeletal Class III Malocclusion
- Patients with history of trauma
- Facial asymmetry
- Patients with history of previous orthodontic treatment.
- Patients with Craniofacial deformities / Syndrome

Materials and Instruments Required

- Sample size of 200 individuals were further divided and grouped into skeletal Class I and Skeletal Class II according to ANB.(Class I: 2^0-4^0 , Class II >4^0)
- These groups were further divided into Hyperdivergent and Hypodivergent according to Tweeds analysis[16](FMA>25^0: Hyperdivergent, FMA≤

25^0:Hypodivergent) For the purpose of analysis & comparison of Orthopantomogram & Lateral Cephalogram five hard tissue landmarks will be considered.

1. Digital panoramic and cephalometric system (KODAK 8000 C)

2. Digital printer (FUJI FILM DRY PIX SMART)

3. Radiographs – lateral cephalograms

4. Nemoceph software

Methods of Measurements

Linear and angular measurements were made using established reference points on lateral cephalogram (fig 1 & 2)

Procedure

The cephalometric measurements were obtained from computerized tracing of direct digital radiographs using Nemoceph software, Version 6.0 Nemotec SRL and analyzed, by measuring 1 angular and 2 linear variables. The scanned image of lateral cephalogram was placed in the software and using the application the scanned image was set to Natural head position and a true vertical line was determined automatically by the software. A true horizontal line perpendicular to the true vertical line was made following which all the parameters are analyzed.

- X-ray records of
- They are:

1. Co (condylion)
2. Go (gonion)
3. Me (menton)
4. N (nasion)
5. S (sella)

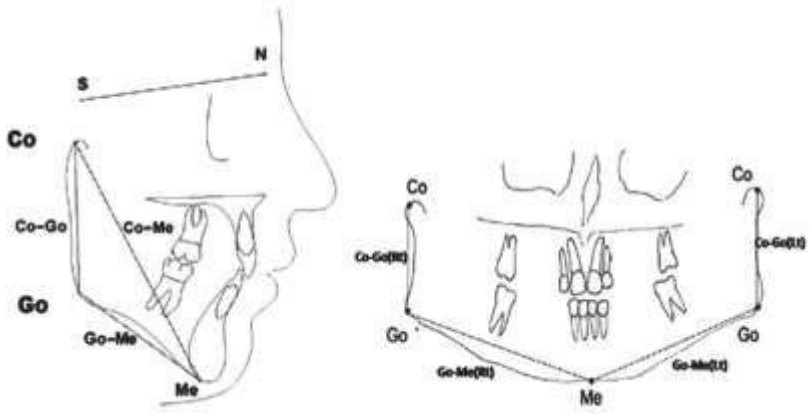


Diagram no. 1 linear measurements on Lat Ceph and OPG

Linear measurements:

Ramal height (Co-Go): A line connecting points gonion and codylion

Body length (Go-Me): A tangent to lower border of mandible i.e gonion and menton

Planes used in this study

1. S-N plane– Sella – nasion anteroposterior extent of anterior cranial base

2. Frankfort horizontal plane [FH]: A line connecting point‘s porion to Orbitale.

3. Mandibular plane [MP]: A line connecting points Gonion and menton.

4. Ramal length (RL): A tangent to posterior border of mandible. (Co-Go)

5. Body length [BL]: A tangent to lower border of mandible. (Go-me)

Angular measurement

- Gonial angle - Angle formed by the intersection of the tangent drawn to lower border of mandible and tangent drawn to ramus. (Co-Go-Gn)

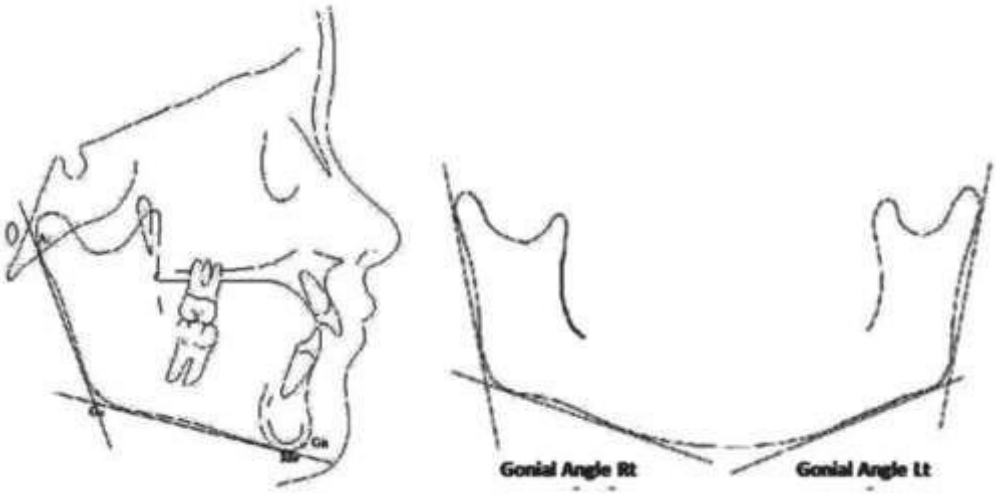


Diagram no. 2 Angular measurements on Lat Ceph and OPG

- All lateral cephalogram and Orthopantomogram radiograph records were available at the Department of Orthodontics & Dentofacial Orthopedics and Department of Oral Diagnosis Medicine & Radiology.
- Lateral cephalogram and Orthopantomogram were standardized and Calibrated using digital software.
- Digital analysis of Lateral cephalogram measurement was done using digital software.
- Digital analysis of Orthopantomogram measurement was done using digital software.

COLOUR PLATE I

Fig 1. DIGITAL LATERAL CEPHALOGRAM MACHINE

COLOUR PLATE II

Fig 2. DIGITAL PRINTER (FUJIFILM DRY PIX SMART)

COLOUR PLATE III

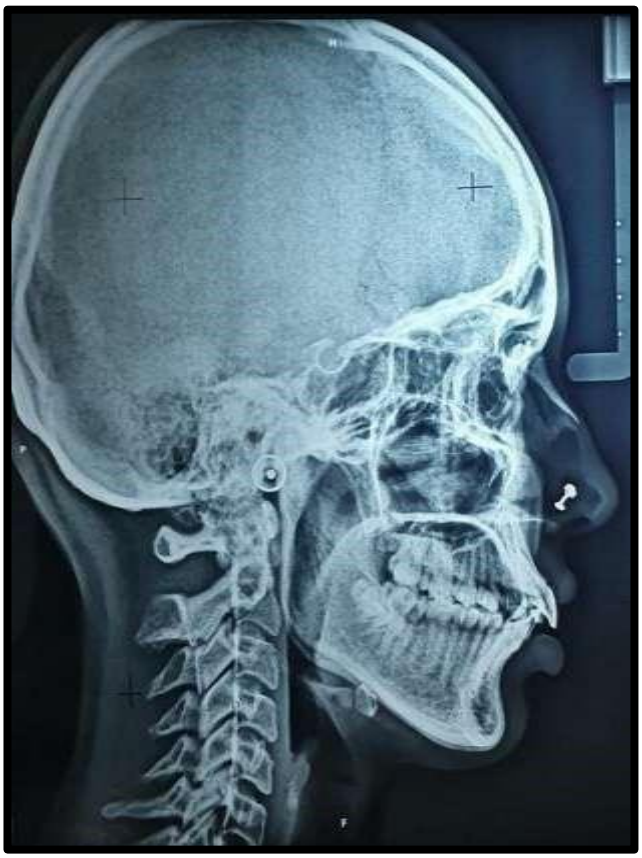


Fig 3. SOFT COPY OF LATERAL CEPHALOGRAM

COLOUR PLATE IV

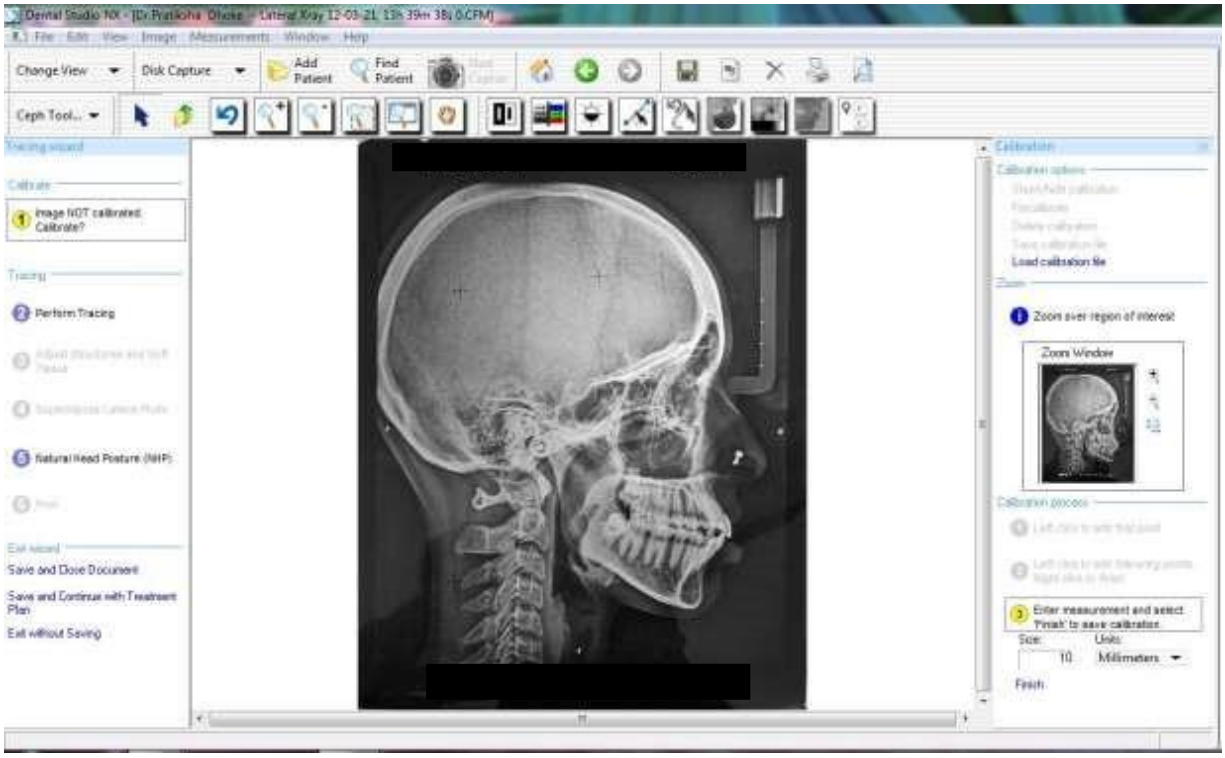


Fig 4. NEMOCEPH SOFTWARE, VERSION 6.0

NEMOTEC SRL (SPAIN)

COLOUR PLATE V

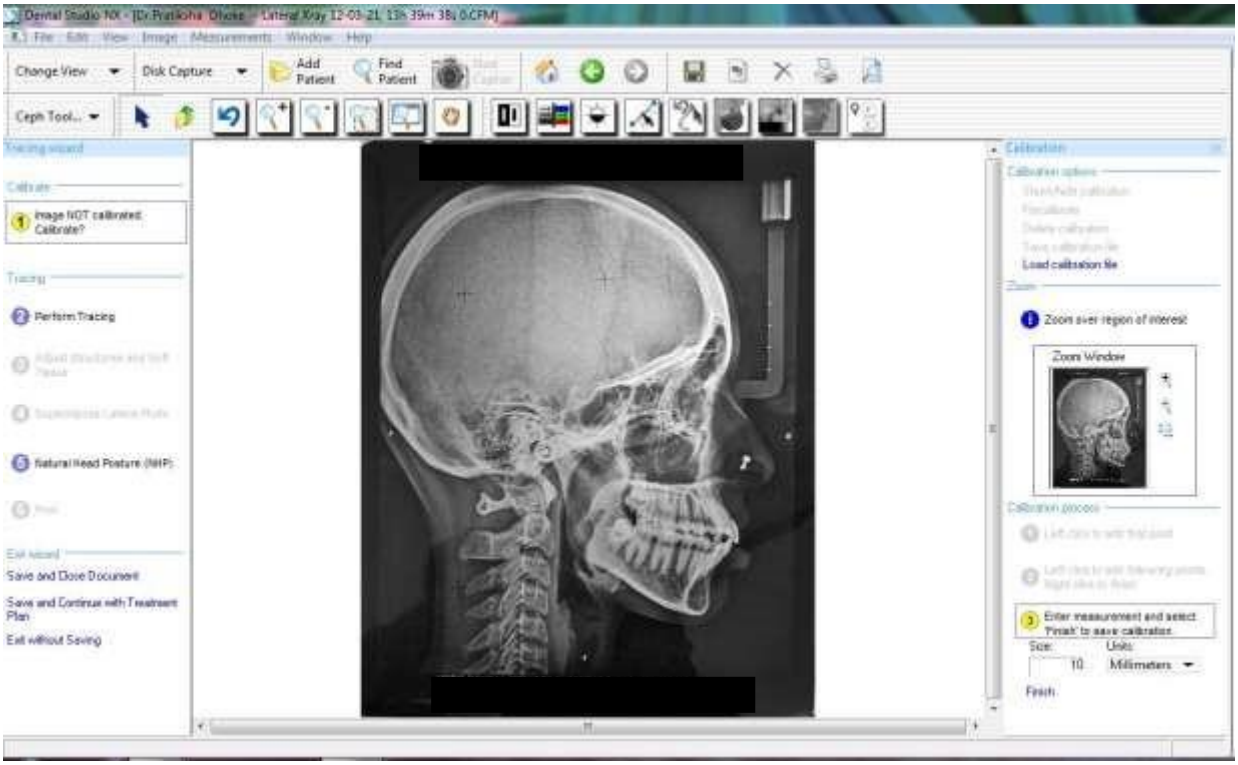


Fig 5. CALIBRATION OF LATERAL CEPHALOGRAM ON NEMOCEPH SOFTWARE

COLOUR PLATE VI

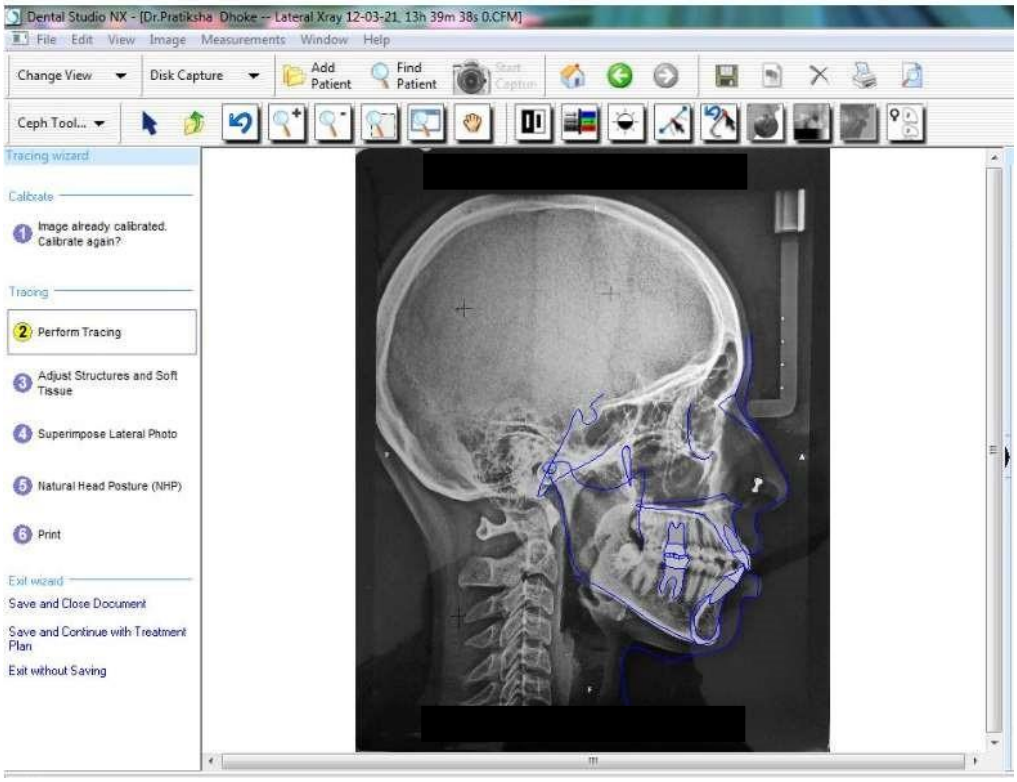


FIG. 6: TRACING OF LATERAL CEPHALOGRAM ON NEMOCEPH

COLOUR PLATE VII

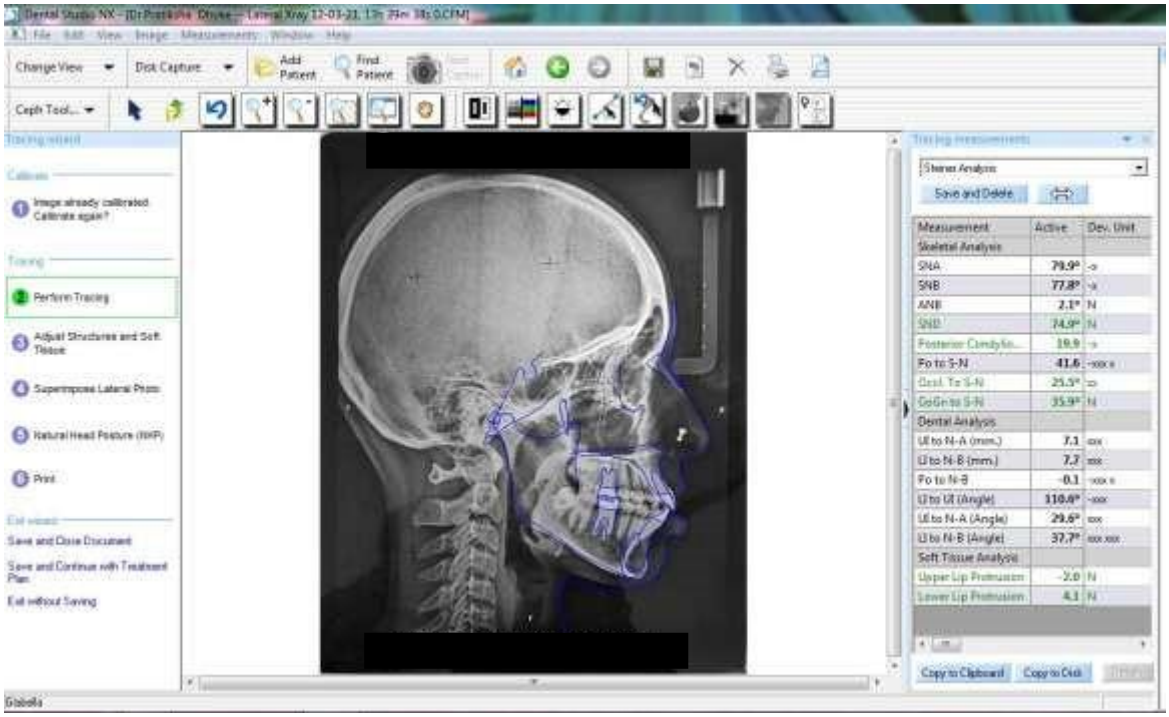


FIG. 7: SKELETAL PATTERN: STEINER' ANALYSIS

COLOUR PLATE VIII

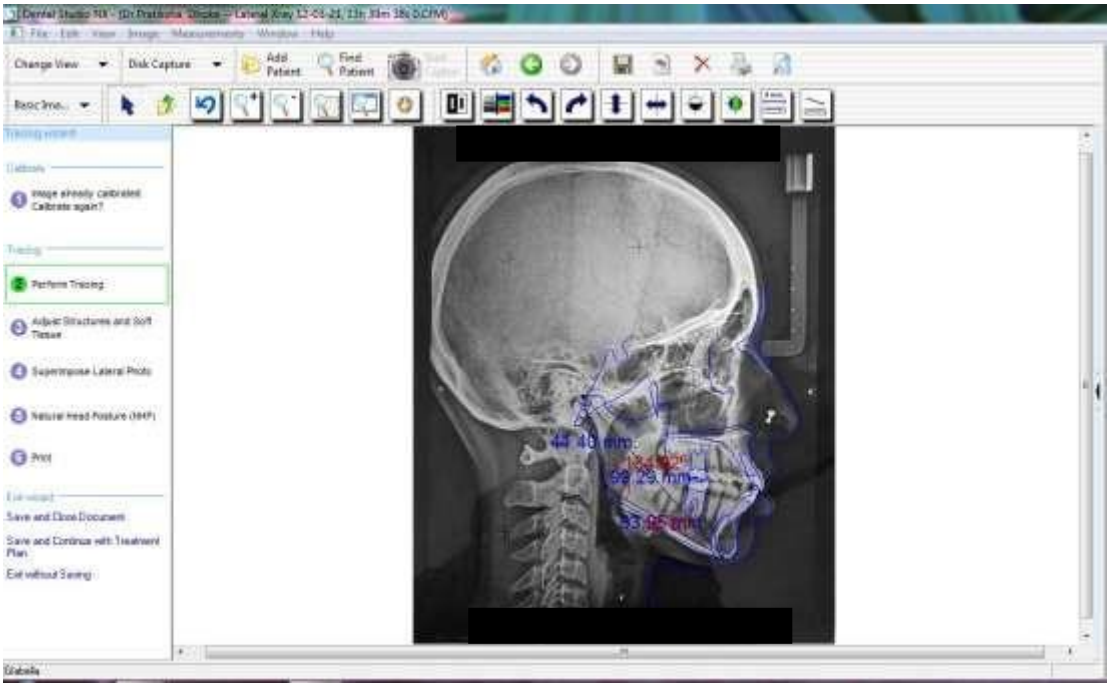


FIG. 8: GROWTH PATTERN: DOWN'S ANALYSIS COLOUR

PLATE IX

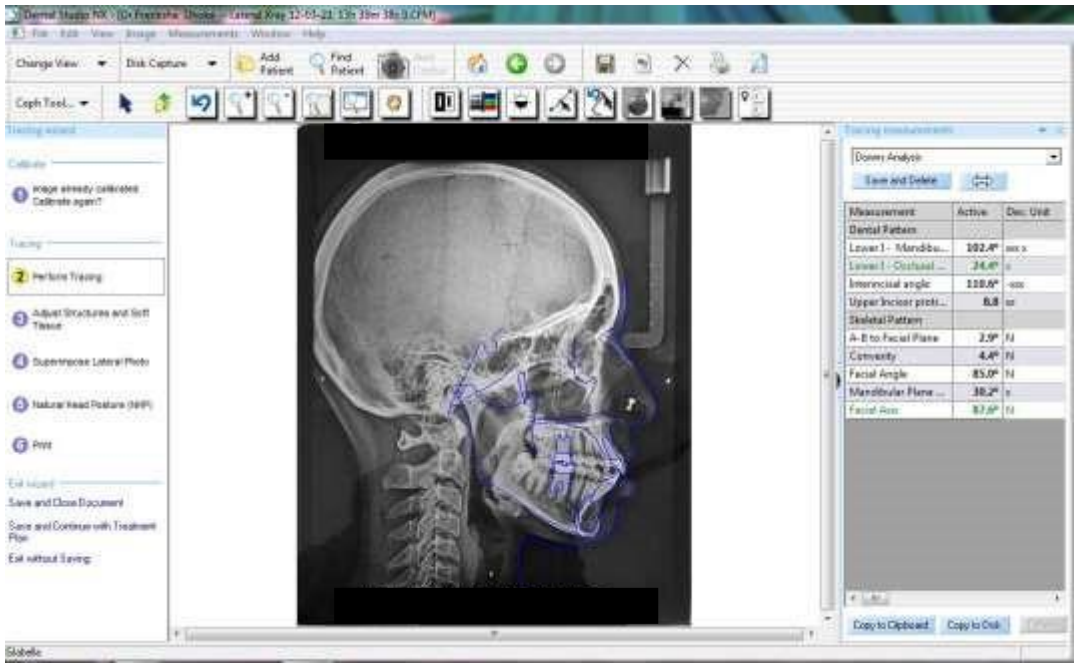


FIG.9: LINEAR AND ANGULAR MEASUREMENTS

ON LATERAL CEPHALOGRAM

COLOUR PLATE X

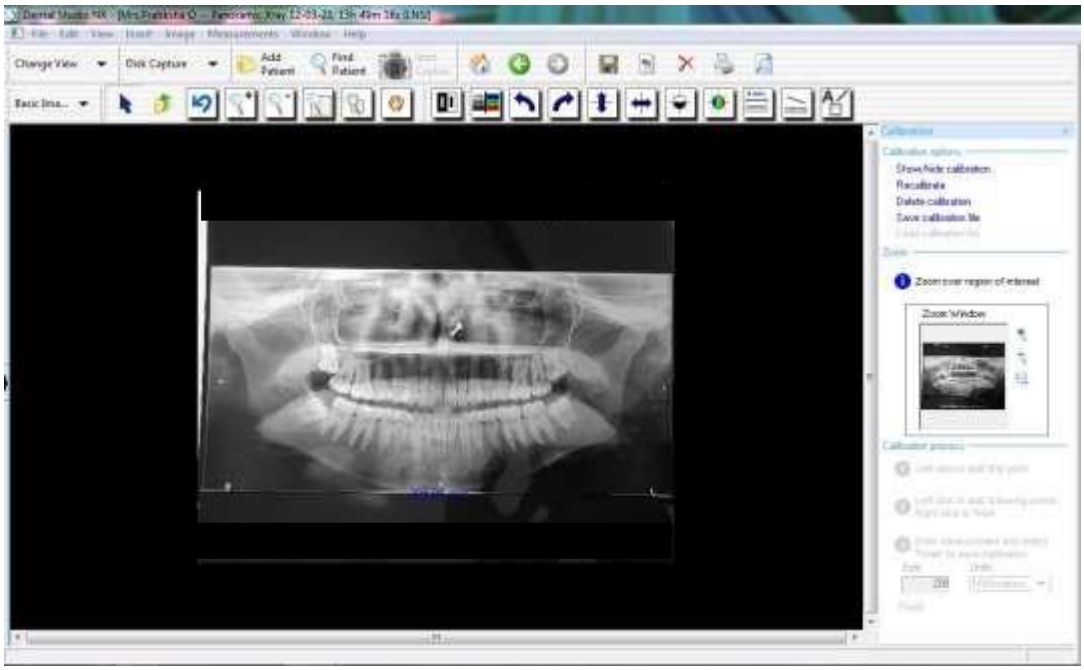


Fig10.CALIBRATION OF OROTHOPANTAMOGRAM

(OPG) ON NEMOCEPH SOFTWARE

COLOUR PLATE XI

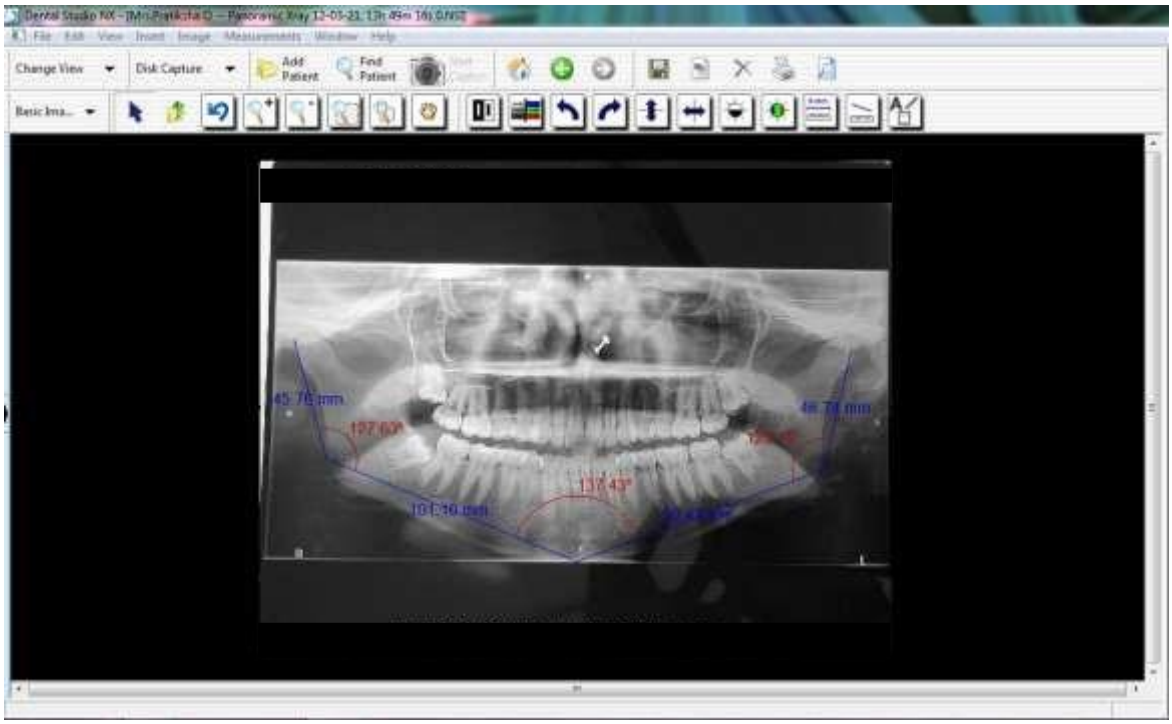


FIG. 11: LINEAR AND ANGULAR

MEASUREMENTS ON ORTHOPANTOMOGRAM (OPG)

RESULTS:

The mean values of mandibular morphological variables were calculated along with their standard deviations using descriptive statistics amongst the following two skeletal patterns:

Group 1: Orthopantomogram and Lateral Cephalogram of skeletal Class I Hypodivergent

Group 2: Orthopantomogram and Lateral Cephalogram of skeletal Class I

Hyperdivergent

Group 3: Orthopantomogram and Lateral Cephalogram of skeletal Class II Hypodivergent

Group 2: Orthopantomogram and Lateral Cephalogram of skeletal Class II Hyperdivergent

Comparison between left and right sides of orthopantomogram:

The statistical analysis was done using the Statistical Package for the Social Science (SPSS version 22, Armonk, NY: IBM Corp). The recorded values were statistically evaluated using Student-T test values and standard deviation of left and right sides of OPGs were calculated and tabulated [Table 1.1,1.2,1.3,1.4] for all the parameters. No statistically significant difference was found. Thus, there is no difference in the right and left side values of the OPG parameters.

Comparison of gonial angle, ramus height, and mandibular body length between lateral Ceph and Orthopantomogram (left and right sides)

The statistical analysis was done using the Statistical Package for the Social Science (SPSS version 22, Armonk, NY: IBM Corp). The recorded values were statistically evaluated using Chi-square test P related to mean and standard deviations were calculated for the gonial angle, ramus height, and mandibular body length measured from lateral Ceph, OPG are tabulated in

[Table 2.1,2.2,2.3,2.4,3.1,3.2,3.3,3.4,4.1,4.2,4.3,4.4]. The p values were considered significant at or below 0.05.

Gonial angle:

Class I hypodivergent pattern: The comparison of mean gonial angle left and right sides in OPG was 115.91 ± 5.71 and 116.72 ± 4.80 respectively. This difference was not statistically significant (p=0.45) [Table no:1.1]

The comparison of gonial angle on Lat Ceph and left and right sides in OPG was 120.65 ± 5.93, 116.72 ± 4.80 and 115 ± 5.71 respectively. This difference was not statistically significant for left and right (p=0.99) and (p=0.99) respectively. [Table no:2.1]

Class I hyperdivergent pattern: The comparison of mean gonial angle left and right sides in OPG was 121.76 ± 4.63 and 121.14 ± 4.22 respectively. This difference was not statistically significant (p=0.43) [Table no:1.2]

The comparison of gonial angle on Lat Ceph and left and right sides in OPG was 124.38 ± 4.91, 121.76 ± 4.63 and 121.14 ± 4.22 respectively. This difference was not statistically significant for left and right (p=0.99) and (p=0.99) respectively.[Table no: 2.2]

Class II hypodivergent pattern: The comparison of mean gonial angle left and right sides in OPG was 117.70 ± 70 and 116.69 ± 69 respectively. This difference was not statistically significant (p=0.27) [Table no: 1.3]

The comparison of gonial angle on Lat Ceph and left and right sides in OPG was 123.57 ± 6.20, 116.69 ± 4.46 and 117.70 ± 4.63 respectively. This difference was not statistically significant for left and right (p=0.99) and (p=0.99) respectively.

[Table no: 2.3]

Class II hyperdivergent pattern: The comparison of mean gonial angle left and right sides in OPG was 120.87 ± 6.14 and 123.63 ± 8.09 respectively. This difference was not statistically significant (p=0.06) [Table no:1.4]

The comparison of mean gonial angle on Lat Ceph, on left and right sides in OPG was 131.92 ± 6.44, 120.87 ± 6.14 and 123.63 ± 8.09 respectively. This difference was not statistically significant for left and right (p=0.22) and (p=0.20) respectively. [Table no:2.4]

Ramus length:

Class I hypodivergent pattern: The comparison of mean ramal length left and right sides in OPG was 53.16 ± 5.59 and 53.22 ± 5.56 respectively. This difference was not statistically significant (p=0.96) [Table no: 1.1]

The comparison of ramal length on Lat Ceph and left and right sides in OPG was 48.35 ± 7.41, 53.22 ± 5.56 and 53.16 ± 5.59 respectively. This difference was not statistically significant for left and right (p=0.98) and (p=0.98) respectively.[Table no:3.1]

Class I hyperdivergent pattern: The comparison of mean ramal length left and right sides in OPG was 45.50 ± 50 and 45.50 ± 5.20 respectively. This difference was not statistically significant (p=0.96) [Table no: 1.2]

The comparison of ramal length on Lateral Ceph and left and right sides in OPG was 47.50 ± 6.24, 45.50 ± 5.20 and 45.50 ± 5.14 respectively. This difference was not statistically significant for left and right (p=1.08) and (p=1.23) respectively.

[Table no: 3.2]

Class II hypodivergent pattern: The comparison of mean ramal length left and right sides in OPG was 54.01 ± 6.35 and 53.69 ± 6.40 respectively. This difference was not statistically significant (p=0.25) [Table no:1.3]

The comparison of ramal length on Lat Ceph and left and right sides in OPG was 51.35 ± 5.33, 54.01 ± 5.35 and 51.35 ± 5.33 respectively. This difference was not statistically significant for left and right (p=1.30) and (p=1.56) respectively. [Table no: 3.3]

Class II hyperdivergent pattern: The comparison of mean ramal length left and right sides in OPG was 53.46 ± 7.42 and 52.67 ± 7.30 respectively. This difference was not statistically significant (p=2.00) [Table no:1.4]

The comparison of ramal length on Lat Ceph and left and right sides in OPG was 50.48 ± 7.53, 53.46 ± 7.42 and 52.67 ± 7.30 respectively. This difference was not statistically significant for left and right (p=0.99) and (p=1.00) respectively. [Table no:3.4]

Body length:

Class I hypodivergent pattern: The comparison of mean body length left and right sides in OPG was 55.71 ± 4.87 and 54.06 ± 4.48 respectively. This difference was statistically significant (p=0.00*) [Table no1.1]

The comparison of body length on Lat Ceph and left and right sides in OPG was 74 ± 5.31, 55.71 ± 4.87 and 54.06 ± 4.88 respectively. This difference was not statistically significant for left and right (p=1.65) and (p=5.38) respectively. [Table no: 4.1]

Class I hyperdivergent pattern: The comparison of mean body length left and right sides in OPG was 65.48 ± 4.42 and 65.51 ± 4.43 respectively. This difference was not statistically significant (p=0.94) [Table no:1.2]

The comparison of body length on Lat Ceph and left and right sides in OPG was 85.37 ± 4.90, 64.37 ± 4.43 and 65.35 ± 4.42 respectively. This difference was not statistically significant for left and right (p=2.31) and (p=0.1.19) respectively. [Table no: 4.2]

Class II hypodivergent pattern: The comparison of mean body length left and right sides in OPG was 55.35± 5.18 and 53.69 ± 6.40 respectively. This difference was not statistically significant (p=0.60) [Table no:1.3]

The comparison of body length on Lat Ceph and left and right sides in OPG was 75.35 ± 6.29, 69.37 ± 4.19 and 67.35 ± 4.18 respectively. This difference was statistically significant for left and right (p=0.01*) and (p=0.01*) respectively. [Table no:4.3]

Class II hyperdivergent pattern: The comparison of mean body length left and right sides in OPG was 64.37 ± 4.19 and 65.93 ± 2.86 respectively. This difference was not statistically significant (p=1.34) [Table no:1.4]

The comparison of body length on Lat Ceph and left and right sides in OPG was 88.93 ± 4.86, 69.37 ± 4.19 and 68.93 ± 4.86 respectively. This difference was statistically significant for left and right (p=0.02*) and (p=0.03*) respectively. [Table no: 4.4]

Class I Hypodivergent pattern

[Table no:1.1] P related to the comparison of left and right sides in OPG

PARAMETER	OPG LEFT	OPG RIGHT	P
RAMAL	53.16±5.59703	53.228±5.5673	0.969852
BODY	55.715±4.871588585	54.06±4.88917231	0.00554334*
GONIAL	115.918±5.716312448	116.7236±4.80797827	0.452079204

[Table no:2.1] P Related to the comparison of gonial angle in Lat Ceph and OPG

LATERAL CEPH (IN DEGREE)	OPG IN DEGREE	P
120.6566±5.933045	116.7236±4.80797827 right	0.99998129
120.6566±5.933045	115.918±5.716312448 left	0.99988838

[Table no:3.1] P related to the comparison of ramal height in Lat Ceph and OPG

LAT CEPH	OPG	P
48.3538±7.41579644	53.228±5.5673Left	0.9896
48.3538±7.41579644	53.16±5.59703Right	0.98751

[Table no:4.1] P related to the comparison of body length in Lat Ceph and OPG

LAT CEPH	OPG	P
74±5.314596647	55.715±4.871588585 left	1.65462
74±5.314596647	54.06±4.88917231 right	5.3872

Class I Hyperdivergent pattern

[Table no:1.2] P related to the comparison of left and right sides in OPG

PARAMETER	OPG LEFT	OPG RIGHT	P
RAMAL	45.5002±5.1450493	45.5092±5.20556	0.969852
BODY	65.4826±4.42187155	65.518±4.437846	0.940514492
GONIAL	121.7642±4.6340429	121.1416±4.2200788	0.43584404

[Table no:2.2] P Related to the comparison of gonial angle in Lat Ceph and OPG

LATERAL CEPH (IN DEGREE)	OPG IN DEGREE	P
124.3874±4.9198084	121.7642±4.63540429 right	0.99999919
124.3874±4.9198084	121.1416±4.220078843 left	0.99988838

[Table no:3.2] P related to the comparison of ramal height in Lat Ceph and OPG

LAT CEPH	OPG	P
47.5058±6.2420887	45.5092±5.20556 Left	1.085356
47.5058±6.2420887	45.5002±5.1450493Right	1.239612

[Table no:4.2] P related to the comparison of body length in Lat Ceph and OPG

LAT CEPH	OPG	P
85.372±4.90630418	64.3742±4.43784651	2.31092
85.372±4.90630418	65.354±4.42187155	1.19054

Class II Hypodivergent pattern

[Table no:1.3] P related to the comparison of left and right sides in OPG

PARAMETER	OPG LEFT	OPG RIGHT	P
RAMAL	54.0168±6.352428	53.6956±6.4053315	0.251798472
BODY	55.354±5.1820477	55.5954±4.1820477	0.60675509
GONIAL	117.7083±4.65671467	116.69034±4.463777	0.274124

[Table no:2.3] P Related to the comparison of gonial angle in Lat Ceph and OPG

LATERAL CEPH (IN DEGREE)	OPG IN DEGREE	P
123.5726±6.2088632181	116.69034±4.463777 Left	0.995090355
123.5726±6.2088632181	117.7083±4.65671467	0.9995267

[Table no:3.3] P related to the comparison of ramal height in Lat Ceph and OPG

LAT CEPH	OPG	P
51.359±5.330732505	54.0168±5.352428098 Left	1.3080
51.359±5.330732505	51.359±5.330732505 Right	1.5681

[Table no:4.3] P related to the comparison of body length in Lat Ceph and OPG

LAT CEPH	OPG	P
75.357±6.293653443	69.3742±4.19339	0.0186*
75.357±6.293653443	67.354±4.182047	0.015*

Class II Hyperdivergent pattern

[Table no:1.4] P related to the comparison of left and right sides in OPG

PARAMETER	OPG LEFT	OPG RIGHT	P
RAMAL	53.4622±7.42251	52.67±7.307626	2.005539948
BODY	64.3742±4.1933	65.93±2.86806	1.34489983
GONIAL	120.87±6.1471	123.6352±8.097225	0.060429008

[Table no:2.4] P Related to the comparison of gonial angle in Lat Ceph and OPG

LATERAL CEPH (IN DEGREE)	OPG IN DEGREE	P
131.9214±6.444800388	120.8764±6.1471 Left	0.225751637
131.9214±6.444800388	123.6352±8.0972225 right	0.209780617

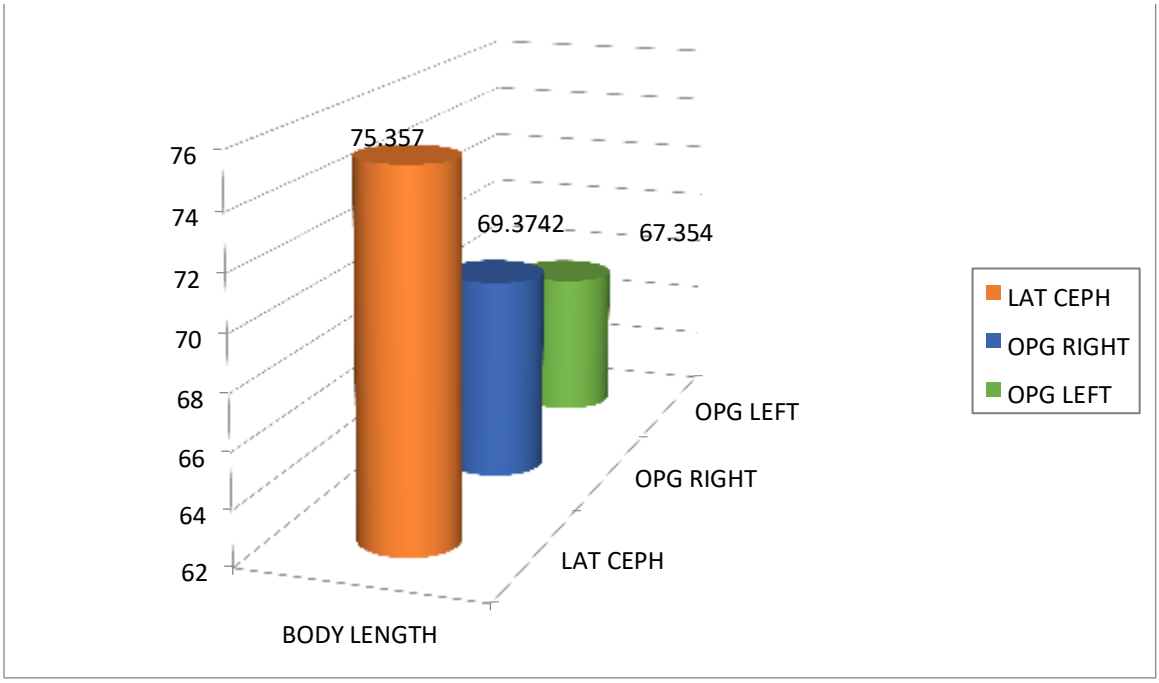
[Table no:3.4] P related to the comparison of ramal height in Lat Ceph and OPG

LAT CEPH	OPG	P
50.48±7.532488173	53.4622±7.422515083 Left	0.999999
50.48±7.532488173	52.67±7.307626613 Right	1

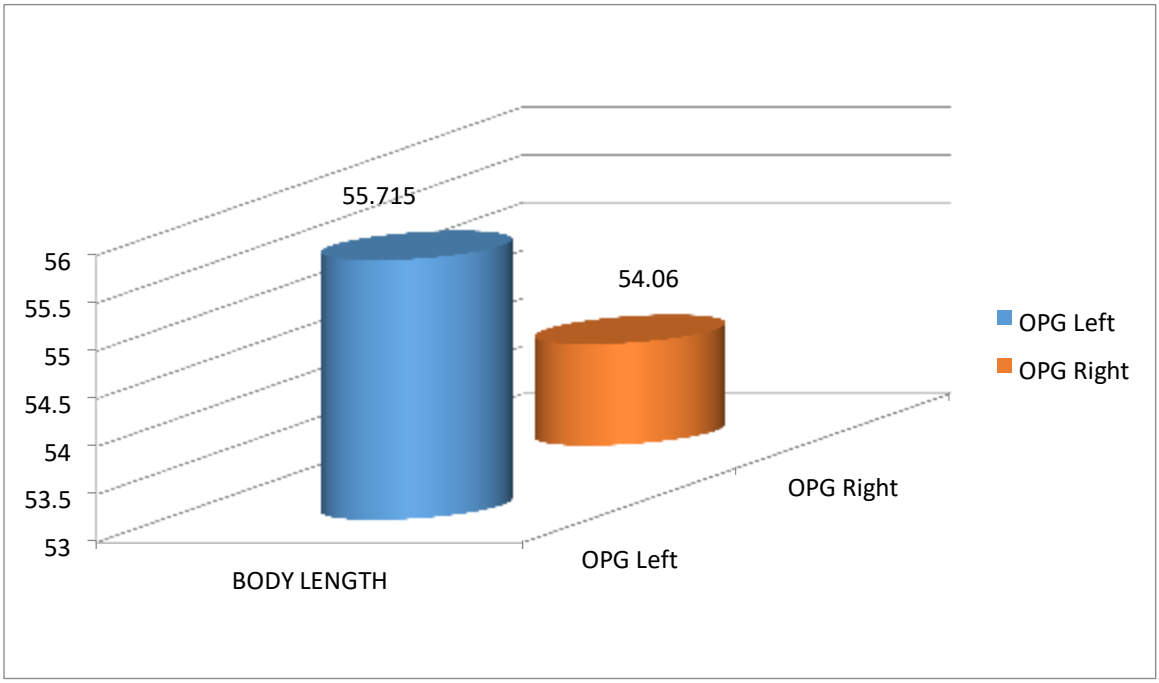
[Table no:4.4] P related to the comparison of body length in Lat Ceph and OPG

LAT CEPH	OPG	P
88.9304±4.86806622	69.3742±4.193396757	0.025539948*
88.9304±4.86806622	68.93±4.86806622	0.034489983*

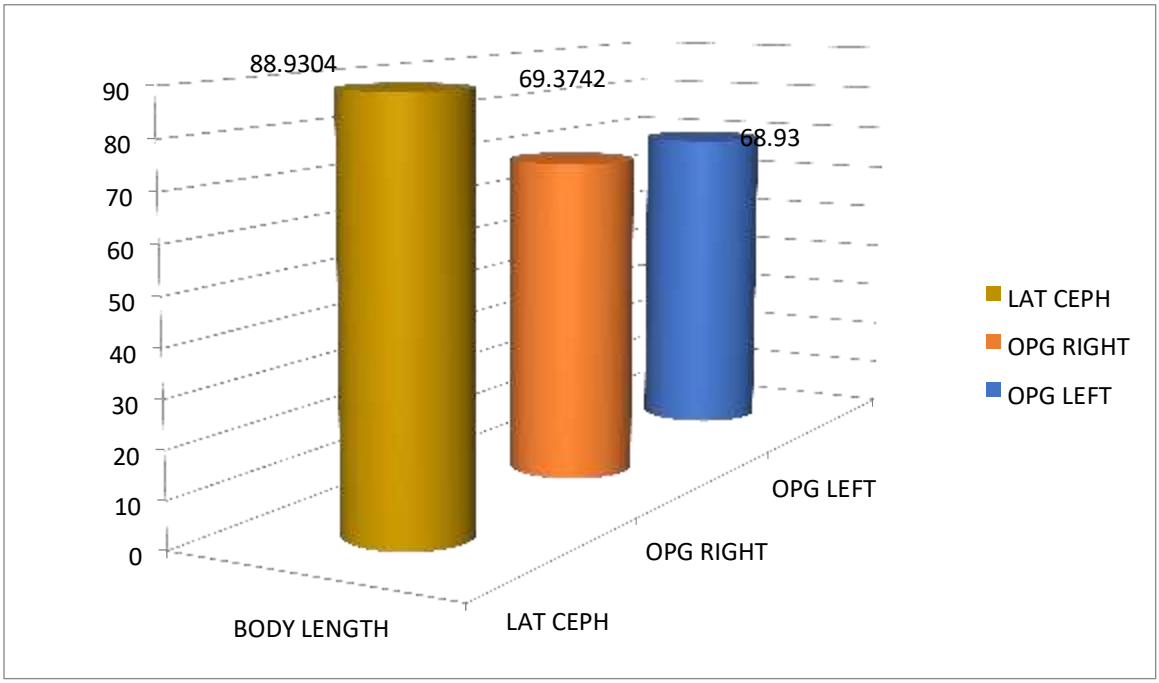
Graphs:



Graph 1: P related to the comparison of body length in Lat Ceph and OPG in Class II Hypodivergent pattern



Graph 2: P related to the comparison of Ramal height OPG in Class II Hypodivergent pattern



Graph 3: P related to the comparison of body length in Lat Ceph and OPG in Class II Hyperdivergent pattern

DISCUSSION

Orthodontists used many tools for the recognition of the growth patterns, linear and angular measurements of the facial structural parameters for better diagnosis and treatment planning.

Cephalometry became very useful after the invention of radiography to the orthodontist in treatment planning as it provided linear and angular measurements. Lateral cephalogram is mostly used for cephalometric calculations but the readings on the Lat Ceph are variable due to the points marked and the superimposition of left and right side, so the range of the norms is used.

Another radiograph i.e the panoramic radiograph permits the orthodontist to call upon his specialized knowledge and apply it. This gives him a panoramic vista of the entire developing stomatognathic system and allows him to decide when he can best institute treatment[10]

Orthopantomogram apart from giving us information about the dental caries, impactions we can measure the values of parameters like gonial angle, ramal height and floor of the mandible without any superimposition interference

The purpose of this study was to determine the diagnostic potential of OPG in assessment of parameters i.e gonial angle, ramal height and body length in comparison to Lat Ceph.[38] X-ray records of 200 individuals were further divided and were grouped into skeletal Class I and Skeletal Class II according to ANB. These groups were further divided into Hyperdivergent and Hypodivergent according to Tweeds analysis.[9] For the purpose of analysis & comparison of OPG & Lat Ceph five hard tissue landmarks considered were condyleon, gonion, menton, nasion, sella were done on the digital software Nemoceph , version6.0 NEMOTEC SRL(SPAIN).Ramal height and body length were the linear measurements and gonial angle was the angular measurements taken into consideration.

The concept of facial divergence and its two extreme patterns, hypo- and hyperdivergence were introduced by Schudy. Skeletal divergence is important from the point of view of the rotation of the mandible, which has the main role in the facial position, growth direction of the condyles and the form of the mandible.[44]

Gonial angle:

The gonial angle is defined as an angle formed by the intersection of the ramus border tangential line and the mandibular lower border tangential line. Measurement of the gonial angle is essential in orthodontic treatment and orthodontic surgery. [2] It is important to assess the symmetry of the facial skeleton. Therefore, accurate determination of the gonial angle is essential for assessing orthodontic cases. Ordinarily, the cephalometric radiograph is used to evaluate the gonial angle, as an intermediate value of the right and left sides angles due to the superimposition of both sides of the mandible. The panoramic technique was first described by Paatero in 1952.[9]

In the present study it is observed that in group 1 the comparison of mean gonial angle both sides in OPG is not statistically significant p value 0.45, and the comparison of gonial angle on Lat Ceph and both sides in OPG is not statistically significant for both p value 0.99 and p value 0.99 respectively. In group 2 the comparison of mean gonial angle both sides in OPG is not statistically significant p value 0.43, and the comparison of gonial angle on Lat Ceph and both sides in OPG is not statistically significant for both p value 0.99 and p value 0.99 respectively. In group 3 the comparison of mean gonial angle both sides in OPG is not statistically significant p value 0.27, and the comparison of gonial angle on Lateral Ceph and both sides in OPG is not statistically significant for p value 0.99 and p value 0.99 respectively. And group 4 the comparison of mean gonial angle both sides in OPG is not statistically significant p value 0.06, and the comparison of mean gonial angle on

Lateral Ceph, and both sides in OPG is not statistically significant for p value 0.22 and p value 0.20 respectively. Study shows that there is no significant for gonial angle in Lat Ceph and OPG.

Arkai et al [29] and Park et al.[33] preferred the use of cephalometric radiograph on the panoramic radiograph in the measurements of gonial angle. They found that the value of the gonial angle from a panoramic radiograph is smaller in 2 to 3.6 degrees than that obtained from a cephalometric radiograph. Similarly, **Kundi, et al**.[5] concluded that the gonial angle cannot be measured on the panoramic radiograph as accurately as a lateral cephalometric radiograph. [37] and in contrast to this study **Demet Kaya[42]** studied the difference between gonial angle values measured on digital lateral cephalograms and orthopantomograms and the study was conducted using the digital Lat Cephs and result found there were no statistically significant differences between the Go Angle measured on digital Lat Cephs and OPGs. The conclusion of this study demonstrated that the digital OPGs were as reliable as the digital Lat Cephs for measuring Go angles using a software.

Ramal height:

In the present study it is observed that in group 1 the comparison of mean ramal length of both sides in OPG is not statistically significant with p value 0.96. The comparison of ramal length on Lateral Ceph and both sides in OPG is not statistically significant for with p value 0.98 and p value 0.98respectively. In group 2 the comparison of mean ramal length both sides in OPG is not statistically significant with p value 0.96. The comparison of ramal length on Lat Ceph and both sides in OPG is statistically significant for both with p value 1.08 and p value 1.23

respectively. In group 3 the comparison of mean ramal length both sides in OPG is not statistically significant with p value 0.25. The comparison of ramal length on Lateral Ceph and both sides in OPG is not statistically significant for both with p value 1.30 and p value 1.56 respectively. In group 4 the comparison of mean ramal length both sides in OPG is not statistically significant with p value 2.00. The comparison of ramal length on Lateral Ceph and both sides in OPG is not statistically significant for both with p value 0.99 and p value 1.00 respectively. Study shows that there is no significant difference for ramal height in Lat Ceph and OPG

Panagiotis Kambylafkas et.al[17] concluded that OPGs could be used to assess vertical posterior mandibular asymmetries also **Gokmen Kurt et. Al**[20] they concluded that except for condylar ramal and condylar-plus-ramal height measurements, class II subdivision patients have symmetrical condyles when compared to normal occlusion samples according to Habbet's mandibular asymmetry indices. And in contrast **Akcam et al**[16] concluded that lateral cephalogram provides accurate information about the vertical dimensions of the craniofacial structures.

Body length:

A tangent to the lower border of the mandible i.e from gonion to menton

In present study in group 1 the comparison of mean body length both sides in OPG is statistically significant with p value 0.00. The comparison of body length on Lateral Ceph and left and right sides in OPG is not statistically significant for both with p value 1.65 and 5.38 respectively. In Group 2 the comparison of mean body length both sides in OPG is not statistically significant with p value 0.94. The

comparison of body length on Lateral Ceph and both sides in OPG is not statistically significant for left and right with p value 2.31 and 0.1.19 respectively. In Group 3 the comparison of mean body length both sides in OPG is not statistically significant with p value 0.60. The comparison of body length on Lateral Ceph and both sides in OPG is statistically significant for both with p value 0.01 and 0.01 respectively. In Group 4 the comparison of mean body length both sides in OPG is not statistically significant with p value 1.34. The comparison of body length on Lateral Ceph and both sides in OPG is statistically significant for both with p value 0.02 and 0.03 respectively. Study shows that there is significance and both for body length Lat Ceph and OPG and about result and graphical representation i.e. graph1, graph2, graph3 we can conclude that the OPG is more reliable than Lat Ceph in case of body length.

Marwa Sameh Shamaa et. al[36] in their study found that a statistically significant difference in the assessed parameters using OPGs between groups for the anterior mandibular height (AHMn) they concluded that the OPG could be considered a reliable alternative for LCR for assessment of many angular and linear dentoskeletal characteristics in different classes to reduce the radiation dose involved in routine diagnostic purposes, so that the use of LCRs could be restricted to certain indications. **Sharma et al**[45], similarly, detected a statistically significant correlation for total mandibular length between panoramic and lateral cephalometric radiographs in their studied. In contrast **S. Saravana Kumar et. al**[1] studied the **c**omparison of Orthopantomogram and Lateral Cephalogram for Mandibular Measurements to clarify the possible application of orthopantomogram (OPG) for evaluating craniofacial specifications such as angular and linear measurements of the mandible by comparing

with lateral cephalogram. They concluded that panoramic radiography can be used to determine the gonial angle and ramus height as accurately as a lateral cephalogram.

As we observed in case of linear measurements, we can rely more on OPG than the Lat Ceph as per this study as well as the other studies.

LIMITATION OF STUDY

- The study did not evaluate the differences between different genders and any deformities.

CONCLUSION

From this study following conclusions are drawn:-

Orthopantomograms, which is an already available tool, can be recommended for the determination of the gonial angle, ramal height, and body length. As this study is done with digitized method with Nemoceph software, version 6.0 NEMOTEC SRL(SPAIN) with patients having different skeletal and growth divergent pattern, the accuracy level is more than the conventional methods. However, orthopantomogram still appears the better choice for more accurate measurement of the linear measurements than on lateral cephalogram.

1. For Gonial angle measurements both digital Lat Ceph and OPG, the accuracy level is same

2. For Ramal height measurements both digital Lat Ceph and OPG, the accuracy level is same

3. For Body length measurements, the accuracy level of OPG is better than the Lat Ceph in case of patients having skeletal class II pattern

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Annexure

(Confidential)

Informed Consent Form

'**Comparative Assessment Of Orthopantomogram And Lateral Cephalogram For Linear And Angular Measurement Of Mandible In Skeletal Class I And Class Ii Cases In Hypodivergent And Hyperdivergent Growth Pattern –**

A Digitized Study.'

NAME: Mr./Master/Mrs./Miss._____

Resident of: _____

_____aged _____ years, exercising my free will/choice, without any pressure/lure of incentive in any form, hereby give my consent for the project to be conducted by **Dr. _____.**

I acknowledge the receipt of "patient's information sheet", and also the doctor has informed me about this research project suitably and sufficiently to my satisfaction.

I agree to let my X-ray to be taken as required.

I agree to take part in this project and will not mix any other projects during the period of this trial. I shall report to the dental hospital or other place where called on given appointment dates and time.

I certify that I have read or had read to me the contents of this form.

_____

Date _____

Patient /legally authorized representative signature

MASTER CHART

SKELETAL CLASS I HYPODIVERGENT

Sr. No.	Gonial Angle On Lat Ceph	GonialAngle rt	GonialAngle lft	Ramal height latceph	Ramal rt	Ramal lft	Body lat ceph	Body rt	Body left
1	128.62	120.29	126.9	47.08	50.34	50.34	70.01	50.55	53.86
2	118.8	109.1	107.09	49.76	51.67	51.67	70.67	50.9	54.67
3	125.46	121.97	125.46	48.02	54.34	54.34	70.98	51.98	55.67
4	132.9	124.66	123.97	46.89	53.34	53.34	71.89	52.45	56.98
5	111.64	102.13	101.95	49.99	54.06	50.34	72.89	53.86	58.87
6	122.93	116	115.85	47.08	54.97	51.67	72.02	54.67	59.67
7	121.5	115.17	119.46	49.76	55	54.34	73.9	55.67	50.55
8	118.91	111.8	105.87	48.02	52.87	53.34	73.67	56.98	53.86
9	124.92	118.77	119.18	47.08	50.34	54.06	74.89	58.87	54.67
10	121.08	119.43	115.28	49.76	51.67	50.34	75.78	59.67	55.67
11	129.32	120.53	124.42	51.22	54.34	51.67	75.89	50.55	56.98
12	116.26	116.7	109.62	46.89	53.34	54.34	76.77	50.9	58.87
13	120.89	112.15	106.83	47.08	54.06	53.34	78.91	51.98	59.67
14	121.56	121.95	120.7	49.76	54.97	54.06	78.02	52.45	50.55
15	136.85	129.62	126.05	48.02	55	50.34	78.3	53.86	53.86
16	127.92	120.97	110.01	46.89	52.87	51.67	79.02	54.67	54.67
17	118.4	108.96	103.45	47.08	50.34	54.34	79.89	55.67	55.67
18	117.77	111.14	109.45	49.76	51.67	53.34	79.98	56.98	56.98
19	120.08	114.15	117.81	48.02	54.34	54.06	70.01	50.55	58.87
20	116.17	118.73	116.89	46.89	53.34	50.34	70.67	50.9	59.67
21	120.49	121.09	119.63	49.99	54.06	51.67	70.98	51.98	50.55
22	120.24	113.31	115.03	47.08	54.97	54.34	71.89	52.45	53.86
23	115.9	105.83	108.07	49.76	55	53.34	72.89	53.86	54.67
24	136.26	126.56	124.13	52.23	52.87	54.06	72.02	54.67	55.67
25	133.51	110.21	106.5	47.08	50.34	54.97	73.9	55.67	56.98
26	115.76	113.89	111.5	49.76	51.67	55	73.67	56.98	58.87
27	128.53	119.58	114.29	48.02	54.34	50.34	74.89	58.87	59.67
28	126.73	117.98	115.55	46.89	53.34	51.67	75.78	59.67	50.55
29	124.91	118.46	117.22	47.08	54.06	54.34	75.89	50.55	53.86
30	119.73	121.28	120.95	49.76	54.97	53.34	76.77	50.9	54.67
31	112.56	114.59	115.25	48.02	55	54.06	78.91	51.98	55.67
32	115.85	116.63	113.85	46.89	52.87	54.97	78.02	52.45	56.98
33	111.98	115.35	116.49	47.08	50.34	55	78.3	53.86	58.87
34	116.45	113.59	116.73	49.76	51.67	50.34	79.02	54.67	59.67
35	114.85	115.76	116.85	48.02	54.34	51.67	79.89	55.67	50.55
36	118.56	116.49	119.85	46.89	53.34	54.34	79.98	56.98	53.86
37	116.24	114.59	117.46	49.99	50.34	53.34	70.01	58.87	54.67
38	119.45	118.59	120.45	47.08	51.67	54.06	70.67	59.67	55.67
39	121.25	119.49	121.46	49.76	54.34	54.97	70.98	50.55	56.98
40	115.95	116.46	114.83	48.02	53.34	55	71.89	50.9	58.87
41	116.75	118.46	116.89	46.89	54.06	50.34	72.89	51.98	59.67
42	113.54	114.85	113.25	49.99	54.97	51.67	72.02	50.55	50.55
43	116.78	119.46	116.85	47.08	50.34	54.34	73.9	50.9	53.86
44	118.45	116.85	114.56	49.76	51.67	53.34	73.67	51.98	53.86

45	119.45	118.46	119.56	48.02	54.34	54.06	74.89	52.45	54.67
46	120.86	118.96	119.45	47.08	53.34	54.97	75.78	53.86	55.67
47	116.89	114.89	117.23	49.76	54.06	55	75.89	54.67	56.98
48	117.89	115.49	113.86	48.02	54.97	54.06	76.77	55.67	58.87
49	118.56	118.56	116.96	46.89	55	54.06	78.91	56.98	59.67
50	116.48	116.25	114.96	49.99	52.87	54.06	78.02	58.87	50.55

SKELETAL CLASS I HYPERDIVERGENT

Sr. No.	Gonial Angle on Lat Cepth	Gonial Angle on OPG	Gonial AngleOPG rt	Ramal lat cep	Ramal left	Ramal right	Body lat ceph	Body left	Body right
1	127.13	113.28	114.85	45.98	45.33	45.33	81.67	61.89	61.89
2	124.16	115.89	113.36	49.12	44	44	82	63.9	63.9
3	124.16	114	117.43	46.96	46.43	46.43	90	65.78	65.78
4	131.34	129.13	134.8	47.23	47.32	47.32	88.34	64.34	64.34
5	127.58	121.88	127.88	48.88	45.33	45.33	86.54	67.89	67.89
6	127.87	121.33	119	49.98	44	44	84.65	65.21	65.21
7	128.09	122.26	118.22	45.98	45.33	45.33	86.78	68.77	68.77
8	126.59	121.04	117.62	49.12	44	44	83	69.07	69.07
9		118.79	116.18	46.96	45.33	46.43	85.45	62.45	61.89
10	134.15	126.84	128.1	47.23	44	47.32	89.76	68.56	63.9
11	137.73	121.75	118.1	48.88	45.33	45.33	83.33	61.89	65.78
12	138.88	126.37	120.79	45.98	44	44	82.13	63.9	64.34
13	127.15	116.08	115.33	49.12	46.43	46.43	86.56	65.78	67.89
14	126.3	114.48	116.41	46.96	47.32	45.33	81.67	64.34	65.21
15	128.63	123.88	119.45	47.23	45.33	44	82	67.89	68.77
16	120.3	124.39	117.22	45.98	44	46.43	90	65.21	61.89
17	139	127.23	120.5	49.12	46.43	47.32	88.34	68.77	63.9
18	124.65	120.46	112	46.96	47.32	45.33	86.54	69.07	65.78
19	126.42	118.85	121.45	45.98	45.33	44	84.65	62.45	64.34
20	123.95	118.49	120.42	49.12	44	46.43	86.78	61.89	67.89
21	124.85	117.15	119.96	46.96	46.43	47.32	83	63.9	65.21
22	130.51	124.89	123.4	47.23	47.32	45.33	81.67	65.78	68.77
23	126.89	119.85	121.04	48.88	45.33	44	82	64.34	69.07
24	128.25	125.46	124.9	45.98	44	46.43	90	67.89	61.89
25	123.45	118.2	116.28	49.12	46.43	45.33	88.34	65.21	63.9
26	126.62	121.85	123.42	46.96	47.32	44	86.54	68.77	65.78
27	122.03	119.3	118.2	47.23	45.33	46.43	84.65	61.89	64.34
28	128.62	125.86	124.25	48.88	44	47.32	86.78	63.9	67.89
29	124.26	121.3	120.46	45.98	45.33	45.33	83	65.78	65.21
30	126.05	122.46	120.96	49.12	44	44	85.45	64.34	61.89
31	126.45	124.56	125.86	46.96	46.43	46.43	89.76	67.89	63.9
32	129.22	126.89	129.46	47.23	47.32	45.33	83.33	65.21	65.78
33	124.96	121.46	120.89	45.98	45.33	44	81.67	68.77	64.34

34	123.06	120.2	121.46	49.12	44	46.43	82	69.07	67.89
35	122.22	123.16	120.54	46.96	45.33	45.33	90	62.45	65.21
36	123.55	119.46	118.56	45.98	44	44	88.34	68.56	68.77
37	120.56	117.89	119.56	49.12	46.43	46.43	81.67	61.89	61.89
38	126.84	123.85	125.4	46.96	47.32	45.33	81.67	63.9	63.9
39	127.96	125.76	123.56	47.23	45.33	44	82	65.78	65.78
40	126.56	122.4	123.89	45.98	44	46.43	90	64.34	64.34
41	128.5	126.49	125.83	49.12	46.43	47.32	88.34	67.89	67.89
42	126.46	123.48	125.83	46.96	45.33	45.33	86.54	61.89	65.21
43	122.56	119.48	118.19	45.98	44	45.33	84.65	63.9	61.89
44	126.78	123.46	122.86	49.12	46.43	45.33	86.78	65.78	63.9
45	125.89	123.48	120.2	46.96	47.32	45.33	83	64.34	65.78
46	126.44	120.9	122.56	47.23	45.33	44	85.45	67.89	64.34
47	128.22	126.32	124.56	45.98	45.33	46.43	89.76	65.21	67.89
48	124.56	119.45	121.8	49.12	44	47.32	83.33	68.77	65.21
49	126.45	122.22	120.56	46.96	46.43	45.33	82.13	69.07	68.77
50	126.52	124.56	123.53	47.23	47.32	44	86.56	62.45	69.07

SKELETAL CLASS II HYPODIVERGENT

Sr. No.	Gonial Angle Lat.ceph	GonialAngleOPG	Go angle left	Go angle right	Ramal height lat ceph	Ramal hightOPG rt	Ramal heightopg lft	Body length lft	Body length rt	Body length lat cep
1	115.47	112.12	115.16	109.08	52.55	54.55	54.55	51.67	51.67	70.56
2	123.91	115.64	114.2	117.09	51.76	53.76	53.76	54.44	54.44	71.99
3	119.54	110.16	111.52	108.81	49.37	52.37	52.37	55.43	55.43	78.45
4	120.15	112.34	110.94	113.75	51.65	54.65	54.65	53.54	53.54	79.67
5	120.87	121.38	122.06	120.7	52.8	56	56	56.87	56.87	76.34
6	128.79	117.85	119.59	116.12	49.21	51.21	51.21	56.39	56.39	75.34
7	112.12	113.32	114.54	112.1	52.55	55.4	55.4	58.44	58.44	78.22
8	124.63	120.73	120.94	120.52	51.76	53.45	54.55	58.11	58.11	72.54
9	134.12	125.36	127.01	123.71	49.37	54.43	53.76	59.67	59.67	73.55
10	119.75	114.36	115.18	113.55	51.65	54.55	52.37	51.67	51.67	70.56
11	122.12	113.78	115	112.56	52.8	53.76	54.65	54.44	54.44	71.99
12	123.98	119.8	122	117.6	52.55	52.37	54.55	55.43	55.43	78.45
13	115.53	108.03	109.88	116.19	51.76	54.65	53.76	53.54	51.67	79.67
14	130.32	122.49	123.67	121.32	52.55	56	52.37	56.87	54.44	76.34
15	125.08	113.86	113.21	114.51	51.76	51.21	54.65	56.39	55.43	75.34
16	118.99	112.03	111.22	112.84	49.37	55.4	54.55	51.67	53.54	70.56
17	123.13	111.365	115.62	107.11	51.65	53.45	53.76	54.44	56.87	71.99
18	121.33	108.18	109.3	107.06	52.55	54.43	52.37	55.43	56.39	78.45
19	131.67	118.75	119	118.5	51.76	54.55	54.55	53.54	58.44	79.67
20	126.06	120.8	118.61	123	49.37	53.76	53.76	56.87	58.11	76.34
21	121.42	115.75	116.17	115.33	51.65	52.37	52.37	56.39	59.67	75.34

22	124.82	118.21	118.89	117.54	52.55	54.65	54.55	58.44	51.67	70.56
23	126.04	122.05	123.97	120.13	51.76	56	53.76	58.11	54.44	71.99
24	134.89	124.45	126.21	122.7	49.37	51.21	52.37	59.67	55.43	78.45
25	122.51	114.28	114.46	114.1	51.65	55.4	54.65	51.67	53.54	79.67
26	124.87	115.06	119.66	110.47	52.8	54.55	56	54.44	56.87	76.34
27	126.85	113.63	115.96	111.31	52.55	53.76	54.55	55.43	56.39	75.34
28	112.34	115.53	117.01	114.06	51.76	52.37	53.76	53.54	58.44	70.56
29	109.16	107.79	105.43	110.16	49.37	54.65	52.37	56.87	58.11	71.99
30	112.65	113.67	119.86	107.48	52.55	54.55	54.65	56.39	59.67	78.45
31	134.69	119.86	119.74	119.28	51.76	53.76	54.55	58.44	51.67	79.67
32	126.04	115.54	117.92	113.17	49.37	52.37	53.76	51.67	54.44	76.34
33	132.98	116.51	120.48	112.55	51.65	54.65	52.37	54.44	55.43	75.34
34	128.7	117.5	117.76	117.24	52.8	56	54.65	55.43	53.54	70.56
35	137.18	125.65	127.52	123.79	49.21	54.55	54.55	53.54	56.87	71.99
36	119.9	123.88	122.51	125.26	52.55	53.76	54.55	56.87	56.39	78.45
37	129.25	119.81	122.97	116.66	51.76	52.37	53.76	56.39	58.44	79.67
38	115.96	110.93	114.3	107.52	49.37	54.65	54.55	51.67	51.67	76.34
39	127.1	116.922	117.49	116.53	51.65	56	53.76	54.44	54.44	70.56
40	124.56	117.27	117.98	116.56	52.8	51.21	52.37	55.43	55.43	71.99
41	121.54	122.38	124.21	120.56	49.21	55.4	54.65	53.54	53.54	78.45
42	131.25	121.64	120.75	122.56	52.55	54.55	56	56.87	56.87	79.67
43	125.45	119.17	118.56	119.78	51.76	53.76	51.21	56.39	56.39	70.56
44	120.56	117.27	117.98	118.78	49.37	52.37	55.4	51.67	58.44	71.99
45	123.48	121.67	122.56	120.78	51.65	54.65	53.45	54.44	58.11	78.45
46	125.51	115.41	116.45	114.37	52.8	54.55	54.43	55.43	59.67	79.67
47	115.25	113.72	114.56	112.89	49.21	53.76	49.43	53.54	51.67	76.34
48	119.98	112.7	111.85	113.56	52.55	52.37	50.56	56.87	54.44	75.34
49	120.58	117.67	116.75	118.12	51.76	54.65	51.56	56.39	55.43	78.22
50	125.56	116.25	116.58	115.9	49.37	56	52.6	58.44	51.67	72.54

SKELETAL CLASS II HYPERDIVERGENT

Sr. No.	gonial angle Lat. Ceph	gonial angle OPG left	Gonial angle right	Ramal height lat ceph	Ramal height left OPG	Ramusheight right	Mand. Body length Lat ceph	man. Body length L	man body length R
1	133.53	124.83	122.86	48.25	51.25	51.25	61.31	81.31	81.31
2	135	122.68	124.21	49.43	52.23	52.23	62.13	82.13	82.13
3	132.67	128.63	124.77	50.56	53.27	53.27	61.98	81.98	81.98
4	136.13	121.44	122.75	51.56	54.09	54.09	61.86	81.86	81.86
5	122.34	112.22	166.21	52.6	55.03	55.03	62.29	82.29	82.29
6	131.82	125.89	118.42	48.25	51.29	51.29	62	82	82

7	122.78	118.63	126.72	49.43	52.24	52.24	62.33	82.33	82.33
8	125.8	125.74	120.95	50.56	53.29	53.29	63.58	83.58	83.58
9	121.13	115.04	119.5	51.56	54.26	54.26	60.92	80.92	80.92
10	131.81	125	129.95	52.6	55.27	55.27	68.14	88.14	88.14
11	124.58	114.65	116.53	48.25	51.25	51.25	64.64	84.64	84.64
12	120.72	107.64	111.61	49.43	52.02	52.02	65.95	85.95	85.95
13	128.41	124.81	128.4	50.56	53.08	53.08	66.89	86.89	86.89
14	117.74	111.69	112.07	51.56	54.27	54.27	64	84	84
15	127.12	117.88	123.68	52.6	55.67	55.67	64.67	84.67	84.67
16	126.35	125.08	120.44	48.25	51.26	51.26	69.1	89.1	89.1
17	129.16	112.12	120.21	49.43	55	55	61	81	81
18	138.44	122.67	122.22	50.56	54	54	66	86	86
19	135.52	117.63	125.59	51.56	54.54	54.54	67.26	87.26	87.26
20	127.67	115.73	123.98	52.6	56	56	69.18	89.18	89.18
21	134.34	118.31	119.09	48.25	54.34	54.34	67.34	87.34	87.34
22	139.01	126.31	132.35	49.43	52	52	63.83	83.83	83.83
23	134.96	117.71	121.79	50.56	53.31	53.31	62.05	82.05	82.05
24	138.16	126.49	130.63	51.56	52.02	52.02	69.85	89.85	89.85
25	141.3	117.91	120.87	52.6	54.89	54.89	67.8	87.8	87.8
26	134.8	119.99	123	48.25	55.23	55.23	65.12	85.12	85.12
27	122.41	121.03	117.22	49.43	53.28	53.28	70	90	90
28	133.77	122.49	119.16	50.56	51.28	51.28	66.14	86.14	86.14
29	129.77	115.87	116.56	51.56	54.23	54.23	69.44	89.44	89.44
30	138.33	128.13	126.66	52.6	55.25	55.25	64	84	84
31	132.63	128.07	124.82	48.25	53.35	53.35	66.34	86.34	86.34
32	135.1	122.7	121.85	49.43	54.23	54.23	70	90	90
33	131.71	121.8	123.93	50.56	55.25	55.25	64	84	84
34	130.48	120.29	124.31	51.56	54.23	54.23	67.91	87.91	87.91
35	122.43	114.91	113.38	52.6	54.28	54.28	69	89	89
36	131.24	118.8	119.82	48.25	53.26	53.26	67	87	87
37	136.12	122.64	127.33	49.43	53.92	53.92	64	84	84
38	129.13	118.6	118.64	50.56	54.8	54.8	63.11	83.11	83.11
39	142.19	136.99	136.74	51.56	54.34	54.34	69.11	89.11	89.11
40	140.32	136.99	136.74	52.6	56	56	68.34	88.34	88.34
41	136.2	118.72	119.77	48.25	53	53	69.44	89.44	89.44
42	137.82	121.3	125.25	49.43	54	54	63.7	83.7	83.7
43	135.22	124.3	127.57	50.56	54.29	54.29	66.77	86.77	86.77
44	134.61	111.45	119.25	51.56	51.3	51.3	69.3	89.3	89.3
45	130.73	118.49	126.08	52.6	51.6	51.6	70	90	90
46	126.78	112.95	117.42	48.25	52.27	52.27	65.7	85.7	85.7
47	134.95	126.15	119.28	49.43	52.24	52.24	66.8	86.8	86.8
48	123.34	111.44	116.35	50.56	52.33	52.33	65.77	85.77	85.77
49	148.83	130.21	126.91	51.56	52.25	52.25	69.65	89.65	89.65
50	140.67	122.78	127.92	52.6	51.03	51.03	69.78	89.78	89.78