EVALUATION OF MANDIBULAR MORPHOLOGY OF SKELETAL CLASS II MALOCCLUSIONS WITH DIFFERENT DIVERGENT PATTERNS
- A SOFTWARE STUDY.

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LIST OF ABBREVIATIONS

Sr. No.	Abbreviations	Full form
1.	SFH	Short face height
2.	LFH	Long face height
3.	MPA	Mandibular Plane angle
4.	NHP	Natural head position
5.	FHP	Frankfort horizontal plane
6.	Go-A	Gonial angle
7.	PP	Palatal plane
8.	RAM-I	Ramus inclination
9.	Pog	Pogionion
10.	Na	Nasion
11.	RAM-H	Ramus height
12.	TAFH	Total anterior facial height
13.	TPFH	Total posterior facial height
14.	S	Sella
15.	ANOVA	Analysis of variance
16.	3D	Three dimensional
17.	POP	Posterior occlusal plane
18.	MGP	Mandibular growth patterns
19.	ICR	Idiopathic condylar resorption

INTRODUCTION

Growth of mandible plays a crucial role in facial growth and development. It is of deep concern to the practitioner, as a result of amount and direction of growth will significantly alter the need for orthodontic biomechanics. Orthodontists are interested in the multitude of the difference in the diagnosis, treatment, and responses between different facial types.[1]

The relationship between mandibular morphology, skeletal mechanics, and functional demands is clearly relevant once morphological comparisons are made between different divergent patterns.[2] Whereas genetic factors can impose a dominant control, changes in function, such as patients with chronic oral respiration, can induce increase in the vertical facial dimension.[3,4,5,6] Also, the growth of the craniofacial region involves significant changes in the vertical facial dimension.[7,8,9]

Class II malocclusion represents the foremost skeletal discrepancy which orthodontists see in daily practice. The understanding of the morphology is a key component in planning dentofacial orthopedic treatment depends on the type of malocclusion.[10] Clinically widely accepted term “skeletal Class II” does not specify whether the mandible is retruded in relation to the maxilla, or whether the maxilla is protruded in relation to the mandible. The findings from the literature reviews are still inconclusive regarding the dentofacial characteristics of Class II division 1. The opinions of leading orthodontic researchers are controversial. McNamara[11] concluded that mandibular skeletal retrusion was the most common characteristic of the Class II sample, whereas maxillary skeletal protrusion was not common finding. In contrast, Rothstein[12] stated that, “The mandible was most often within the range of normal size, form and positional characteristics”. Rosenblum[13] found that 56.6% of subjects with Class II malocclusion had maxillary protrusion and only 26.7% had mandibular retrusion. Bishara[14] reported that maxilla is positioned normally. Also, some reports stated that maxilla in this malocclusion is even in a retrognathic position[15].

Knowledge of mandibular morphology is critical in the development of balanced dentofacial structures. Glenoid fossa position plays an important role in the establishment of different craniofacial patterns[.16]

Morphology of mandibular symphysis is also important because it serves as the primary reference for the esthetics of the facial profile and it is important in planning the lower incisor position during orthodontic treatment and in orthognathic surgical procedures[17]

The cranial base plays a key role in craniofacial growth, helping to integrate, spatially and functionally, different patterns of growth in various adjoining regions of the skull.

Two distinct types of facial form have been characterized in the literature as “skeletal open bite” or hyperdivergent and “skeletal deep bite” or hypodivergent. ‘, whereas relatively long or disproportionately excessive anterior lower facial heights have also been described by the term “long face syndrome.”[18,19]

The direction and amount of mandibular growth are important factors in orthodontic diagnosis and treatment planning as normal maxillary and mandibular growth being essential for well-balanced craniofacial development. [8,9]

Research directions will benefit from continued comparative exploration of mandibular variation across primate clades and integration with other subfields. Relatively wide-open research areas include the development and genetics as well as the ecological morphology of primate mandibles.[20]

The use of conventional cephalometric points reduces a curvilinear biologic form to a geometric collection of straight lines, and therefore the information regarding shape and size changes during growth may be poorly described or misunderstood[21.] Therefore, the way that would allow more comprehensive measurement of shape than conventional cephalometric should be used. Many studies showed that software studies are more accurate when compared with the hand traced cephalometric studies.

Vertical divergences have great emphasis on facial morphology as they contribute to large extent in diagnosis and treatment planning. Many studies have been undertaken in an attempt to evaluate the relationships between the mandibular morphology in different divergent patterns in Class I malocclusion and found that definite morphological differences were present between subjects. The relationship between vertical facial types and mandibular morphology in Class II malocclusion have not investigated in detail. In present study an attempt was made to determine whether different vertical facial types were associated with mandibular morphological in Class II malocclusion in both genders using Software to increase the accuracy.

AIM AND OBJECTIVES

AIM –

The present study aimed to evaluate mandibular morphology in Skeletal CLASS II malocclusion in different divergent patterns in Central India Population.

OBJECTIVES –

- Evaluation of mandibular morphology in skeletal CLASS II malocclusion

  Normodivergent pattern

  Hypodivergent pattern

  Hyperdivergent pattern

- Evaluation of mandibular morphology in Males

  Normodivergent pattern

  Hypodivergent pattern

  Hyperdivergent pattern

- Evaluation of mandibular morphology in Females

  Normodivergent pattern

  Hypodivergent pattern

- Comparison of mandibular morphology in Skeletal CLASS ll malocclusion

  Normodivergent Male and Female

  Hypodivergent Male and Female

  Hyperdivergent Male and Female

REVIEW OF LITERATURE

Review of literature are under following heads:

1) Influence of Mandibular morphology on facial patterns.

2) Relationship of Mandibular morphology in skeletal class II malocclusion.

3) Mandibular morphological difference in males and females.

William A. Gilmore(1950)[22] studied morphology of mandible in adults of age (16-42years). Out of the total 128 samples 67 were of CLASS II division 1 malocclusion (37 males and 30 females) and 61 of normal occlusion (control group). No significant difference was found in the size of cranial base within the groups or between the groups. Also there was no statistical difference found in the relative mandibular position identified using gonial angle and posterior border of ramus.

Blair(1954)[23] conducted a cephalometric roentgenographic appraisal of the skeletal morphology of Class I, Class II division 1 and division 2(Angle's) malocclusion by using 11 angular and 5 linear measurements and found that high degree of variability of facial skeletal pattern in each malocclusion groups and minor difference found between Class I and Class II division 1 malocclusion but the skeletal pattern of Class II division 2 compared to Class I and Class II division 1 differs, found that gonial angle is acute ,decreased effective mandibular length and more forward position of anterior outline of both maxilla and mandible.

Riedel (1957)[24] analysed dentofacial relationship of 30 seattle seafair princesses and their queen by using pictures and radiographs in which skeletal patterns of girls compared with studies of Down which included male subject found the same skeletal characteristics on the basis of normal occlusion only.

Garn(1963)[25] investigated the size of symphysis using serial and two generational radiogrammetric measurements of mandibular symphysis in 258nadult and 177 childrens of 8 to 16 years of age with various parental combinations(high high,high low)and suggested that genetic simplicity for both symphysis height and thickness and possibility of mendelian inheritance of symphyseal thickness.The study concluded that the prediction can be done for growth of child using parent specific growth data.

Sassouni and Nanda(1964)[26] analysed dentofacial vertical proportions using eight persons with skeletal deep bite and eight with skeletal open bite from the age of 6years to adulthood and found three basic differences that Ramus is short, condyle is higher and maxillary molars are lower in open bite case and vice versa with deep bite cases.

Schudy (1964)[27]stated that vertical facial morphology and its effect on orthodontic treatment is of great interest for clinician because amount and direction of facial growth may alter biomechanics, treatment planing and ultimately the outcome. The terms hyperdivergent and hypodivergent were used and SN-MP angle used to measure the facial divergence. He concluded that high angle cases showed low values for posterior to anterior height percentage.

Schudy(1965)[28] done a longitudinal study of 270 untreated patients of age 10 to 14 years to study the effect of facial proportions on overbite and function. He explained that the term retrognathic and prognathic are not adequate to describe facial types and terms Hypodivergent and Hyperdivergent suggests extremes of facial divergences. Also showed that high angle cases showed low posterior to anterior height ratio.

Creekmore T.D (1967)[29] studied vertical growth relation to anterior and posterior growth and showed that anteroposterior relation of maxilla to mandible decreased with the growth. Difference between vertical growth of condyle and total vertical growth result in rotation of mandible. Any technique or philosophy which treat all cases without consideration of facial types is inadequate.

Balbach(1969)[30] studied cephalometric relationship between the morphology of mandible and its future occlusal position with sample size of 41 males and series of two lateral cephalograms taken at 7 and 11 years of age and conclusion was made that summation of number of morphological traitrs of mandible will allow more accurate prediction of changes occurs in occlusal position of mandible with time.

Sassouni(1969)[31] classified four skeletal facial types, for vertical disproportions it is divided into Skeletal deep bite and open bite and for anteroposterior disproportions it is divided into skeletal Class II and Class III types and explained that classification is used to distinguish skeletal and dental malocclusion, evaluate physiological difference, explain variation in facial esthetics, describe racial difference, to study hereditary transmission and to predict growth.

Sassouni(1970)[32] presented two cases of Class II problems which can be subdivided into 128 dentofacial Class II situations with 128 different treatment plans in which he used openbite and deep bite as main subclasses and explained that treatment plans are different in different rotational pattern.

Issacson(1971)[33] conducted a study to examine the relationship between vertical parameters and associated Skeletal and dental relation and to examine extreme variations in facial growth. Lateral cephalograms of 183 patients with SN-MP angles greater than 38 degrees and of 60 patients with lesser than 26 degrees were selected and from these groups, 20 records were selected. Third group of 20 patients whose mandibular plane was recorded at 32 degrees were selected. Cephalometric tracings were done and results showed that high MP-SN angles resulted from relatively large amount of vertical alveolar growth, the vertical length of upper and lower molars as well as anterior dental height. As teeth or skeletal parts are located posteriorly, the mandibular plane angle increased and with anterior positioning, the angle decreased.

Bjork and Skieller,(1972)[34]stated that hypodivergent individuals are characterized by shorter lower anterior facial height with longer posterior facial height and have more forward rotation of the mandible during growth. Also, hyperdivergent individuals typically have longer lower anterior face height and have more backward rotation of mandible during growth.

Nahoum HI.(1975)[35] in his study on open bite showed that in patient with extreme vertical patterns have longer total facial height with palatal plane tipped upwards anteriorly so that upper anterior face height was shorter and lower anterior face height was longer. Posterior facial height was shorter when compared to normal value and obtuse gonial angle was seen with a steep and notched mandibular plane.

Schendel et al(1976)[36] conducted a cephalometric study on 31 patients (17-25years) with vertical maxillary excess and conclusion was that the total anterior face height, particularly lower anterior face height was increased .This study also classified long face in patients having open bite and those with non-open bite. Those who have long face but no open bite had increased ramus height. Also, both groups have high mandibular plane angle.

Biggerstaff(1977)[37] studied vertical dimensions of craniofacial complex using ratios.Vertical dimensions are differ according to age and sex. Also, analysis detected that there is specific areas of dysplasia for each patient.

Issacson JR,et al (1978)[38] conducted a study to evaluate jaw rotations and concluded that when the vertical growth at the condylar fossa and alveolar process area exceeded, forward rotation occurred. While when the amount of vertical growth at the alveolar process was equal to vertical growth at the condyle, backward rotation occurred.

OpdebeeckH.(1978)[39] studied lateral cephalograms of 27 untreated adult Caucasians. Various linear and angular parameters were compared in SFS and LFS groups. The LFS group was characterized by a clockwise rotation of the mandible “in concert” with the hyoid, tongue, pharynx, and cervical spine. The mandible of the SFS group rotated similarly, but in the opposite counterclockwise direction. The vital need to maintain patency of the upper airway at the level of the base of the tongue may account for rotation in the LFS.

Haskell B.S(1979)[40] concluded that chin increased in the size when growth pattern is progressed towards vertical to horizontal. Vertical development of mandible suggested smaller proportion of protruding chin. Also, chin increased in size as mandibular basal arch form varied from tapered in vertical cases to more square in horizontal cases.

R E Bibby (1979)[41] studied sexual dimorphism using lateral cephalometric radiographs in 144 males and 124 females using manual hand tracing. Different angular and linear measurements suggests that frmales have smaller craniofacial dimensions when compared to corresponding males. Also, the pattern of morphology is same in all areas except in posterior facial height.

Bruce W. Hultgren et al(1980)[42] studied growth and its contribution to CLASS II corrections based on models of mandibular morphology and concluded that CLASS II corrections are greater when the condyle is anteroposteriorly closest to the molar.

Moyer(1980)[43] studied facial types associated with Class II malocclusion and classified into 6 horizontal types out of which with 4 having severe syndromesand one loose, ill defined group and 5 vertical types.Vertical and horizontal types are not associated with each other. So, classification of Class II malocclusion according to growth pattern is essential.

Samir Bishara(1981)[44] examined the changes in mandibular dimensions in 20 males and 15females of age between 8-17 years. The available method of prediction was not accurate to determine pubertal growth spurt .The changes in mandibular relationship in the pre maximum,and maximum periods were of similar magnitudes clinically and statistically.

Ricketts et al (1982)[45] Stated that Hypodivergent individual has short and wide face with a square mandible and wide dental arches.

Fields HW et al (1984)[46]carried out the study to describe vertical facial morphology and to identify morphologic factors associated with long face syndrome. 42 children of 6-12 years old and 42 young adults with varied vertical types were examined clinically and categorized into 3 vertical classifications- long, normal and short face. Lateral radiographs were taken, 7 angular, 18 linear and 6 ratio measurements were calculated. Results showed that for both long faced children and adults, anterior total face height, mandibular plane angle, gonial angle, and mandibular plane to palatal plane angle were significantly greater than normal. There was a tendency for long faced adults to have a short ramus.

Vibeke Skieller, Arne Bjork (1984)[47] estimated the possibility of predicting the direction and the amount of growth rotation of the mandible on the basis of morphologic criteria observed on a single profile radiograph at pubertal age in twenty-one persons in which mandibular growth rotation was determined from metallic implants over a year period at around the time of puberty in 21 samples. Changes in molar inclination, shape of lower border of mandible and inclination of symphysis were observed. In forward rotators convex shape of lower anterior border was seen and linear shape of lower anterior border was observed in backward rotators. Forward rotation of mandible characterized by retroclination of symphysis and backward growth rotation was characterized by proclination of symphysis and larger inclination of mandible.

Sirwat (1985)[48] did an epidemiological study to check the hypothesis that malocclusion and facial morphology have any correlation or not. Sample of 500 randomly selected orthodontic patients with different malocclusion groups showed that there is strong correlation found between facial height, gonial angle,saddle angle ,articular angle,mandibular plane angle and also sexual dimorphism is present between Class II and Class III malocclusion groups.

Bishara et al (1985)[49] compared the dentofacial relationships between three facial types (long, average, and short) in 20 males and 15 females between 5 years and 25.5 years of age. Incremental changes were compared at ages 5, 10, 15, arid 25.5 years and concluded that there is a strong tendency to maintain the original facial type with age. Growth curves of the different parameters except for the incremental curves for MP: SN and Pog : NB in males consistently demonstrated parallelism of the curves, regardless of the facial type. On the other hand, curve magnitude indicated significant differences among the three facial types. Also found that there is Significant differences in the dentofacial parameters between males and females with the same facial type.

Singer et al (1987)[50] orthodontically treated patients with deep mandibular antegonial notch were compared with a similar group of 25 shallow notch subjects by the use of longitudinal lateral cephalometric radiographs. Deep notch cases had more retrusive mandibles with a shorter corpus, smaller ramus height, and a greater gonial angle than did shallow notch cases. The lower facial height in the subjects with a deep mandibular notch was found to be longer and both the mandibular plane angle and facial axis were more vertically directed. The results of this study suggested that the clinical presence of a deep mandibular antegonial notch was indicative of a diminished mandibular growth potential and a vertically directed mandibular growth pattern.

Rodney s lee (1987)[51] used 21 implant subjects with extreme growth patterns against a sample of 25 implant patients with less extreme facial patterns. Mandibular plane angle, intermolar angle, symphysis inclination and facial height were calculated and found that predicting future growth was highly successful in extreme cases than normal cases. Also said that orthodontist must continue to rely more on clinical observations than upon predictions made using pretreatment records.

Nanda (1988)[52] examined the patterns of facial growth development in subjects with skeletal open-bite and skeletal deep-bite faces on lateral cephalometric radiographs of 16 male and 16 female subject of age between 3 to 18 years with two divergent patterns divided into open and deep-bite faces. The posterior dimensions of the face did not discriminate between those two typological groups. The female open bite subjects were earliest in the timing growth spurt which was followed by deep-bite female subjects, then comes the open bite males before deep-bite male subjects.

P.A. Cook et al (1988)[53] Bjork's tracing method had some drawbacks in tracing of mandibular superimposition which was modified and investigated using multiple tracing of 50 lateral cephalometric radiographs. The horizontal error levels were much less than the vertical, midline structures more reliable than bilateral structures and the lower third molar tooth germ more reliable than the inferior dental canal.

Luc P.M. Tourne (1990)[54] suggested that altered muscular function had great influence on craniofacial morphology. The switch from a nasal to an oronasal breathing pattern induced functional adaptations that included total anterior facial height and vertical development of the lower anterior face.

Demetrios J. Halazonetis(1991)[55] Longitudinal data from lateral cephalograms of 55 white female and 39 white male subjects were used to check the quantitative data on the shape of the mandible at the period around the pubertal growth spurt and to test the hypothesis that early mandibular shape may influence the amount and direction of subsequent mandibular growth. The mandibular outline from articulare to gnathion was analysed into cosine curves, according to the Fourier equation. The resulting Fourier coefficients, representing mandibular outline shape, were analysed statistically in relation to age, sex, craniofacial pattern, and mandibular growth rotation. Statistically significant growth changes of the Fourier coefficients were observed, especially during the post pubertal period, indicating a decrease in the gonial angle with age. Sex-related differences in shape were observed at all ages, male subjects showing a more rounded shape of the mandible than female subjects. Mandibular shape, as represented by the Fourier coefficients, was correlated to cephalometric variables, indicating mandibular inclination, but only poorly to cephalometric variables, indicating anteroposterior jaw relation. Total rotation of the mandible during growth could not be predicted by mandibular shape.

Baumrind et al (1992)[56] did a study to evaluate the proportion of external chin in relation to symphyseal area in normal jaws and in those with diverse morphology. Subjects were selected on the basis of normal growth, horizontal and vertical growth. Lateral and frontal radiographs were taken to analyse the general mandibular form and to determine the percentage of external / total symphyseal area. The mean displacement of gonion was in an upward and backward direction at an angle of approximately 45° to the Frankfort plane. Mean displacements at menton and pogonion were in a downward and backward direction but were very small. Mean displacement at point B was somewhat greater than that of menton and gonion, oriented in an upward and backward direction.

Urban Hagg and Kerstin Attstrom(1992)[57] studied four cephalometric measurements on three lateral cephalograms of 21 subjects. The estimates made by three standard cephalometric approaches were compared with that made by a "scientific" method. The scientific method was based on the change in position of the cephalometric landmark condylion on cephalograms orientated on two metal implants inserted in the mandible. The other three investigated "standard" cephalometric methods were each based on estimating the difference in length between two cephalometric landmarks: (1) pogonion-condylion, (2) pogonion-articulare, and (3) maximum mandibular length. In general, the individual estimates of the amount of mandibular growth by the scientific method and that estimated by each of the standard cephalometric methods were not proportional. Some factors affected the estimates of mandibular growth. For example, (1) the growth direction of the condyle, (2) the change in position of pogonion on the mandible during the growth, and (3) the apposition of bone on the chin in some cases. The amount of mandibular growth, which is estimated by the standard cephalometric methods, and growth velocity curves, which is based on such estimates, are therefore not valid. Accordingly, conventional cephalometric analyses are not as reliable at traditionally envisaged.

Aki et al, (1994)[58] determined whether symphysis morphology could be used as a predictor of the direction of mandibular growth and to assess growth changes of the symphysis. Cross-sectional data included lateral cephalometric radiographs of 115 adults and a subset of 62 at four age groups. They found significant difference in the symphysis angle between extreme groups. Symphysis morphology was found to be associated with the direction of mandibular growth, especially in male subjects with symphysis ratio having the strongest relationship. A mandible with an anterior growth direction was associated with a small height, large depth, small ratio, and large angle of the symphysis. Conversely, a posterior growth direction was associated with a large height, small depth, large ratio, and small angle of the symphysis. Symphysis dimensions continued to change until adulthood with male subjects having a greater and later occurring change compared with female subjects.

Karlsen(1995)[59] studied that craniofacial growth was followed longitudinally in two groups of boys with low and high MP-SN angles. Group differences in dimensional changes were explained by a difference in matrix rotation of mandibular corpus, especially in the 6-12 year period. In the 12-15 year period, matrix rotation was similar in the two groups and so were dimensional changes. Morphologically, dimensional group differences in 6- 12 year period were theoretically compatible with the fact that mandibular rotation was clearly more forward in the low angle than in the high angle group.

Dibbets(1996)[60] studied morphology associated between the Angle classification and craniofacial form which was analysed with the aid of multiple linear regression analysis in a sample of 170 children, before orthodontic treatment had started. It was found that part of the differences between Class II, Class I, and Class III was accounted for by systematic variation in a coherent set of midface and cranial base dimensions. These variations were in harmony with each other: the cranial base angle Ba-S-N closed and the legs S-N and S-Ba shortened systematically from Class II, over Class I, to Class III. The juvenile mandible notably was not systematically different. Because the cranial base provides the framework for the maxilla to be built upon, it was concluded that in juveniles the midface above anything else creates the characteristic difference between the three Angle classes, not the mandible. The Angle classification of malocclusion, therefore, represents three arbitrary markers on a morphological continuum.

Lambrechts et al, (1996)[61]investigated that the depth of the notch was strongly correlated with the skeletal morphology . In the same study, shallow notch cases presented more horizontal mandibular planes, more prominent chins and shorter anterior heights than the deep notch cases.

Pancherz H, Zieber K, Hoyer (1997)[62] did a comparison of dentoskeletal morphology in 347 CLASS II division 1 and 156 CLASS II division 2 malocclusions was performed using lateral cephalometric radiographs. Skeletal CLASS II and CLASS III as well as hypo and hyperdivergent maxillary/mandibular jaw base relationships were seen in both malocclusion samples. The high frequency of cases with mandibular retrusion and a short lower face. In conclusion it can be said that, except for the position of the maxillary incisors, no basic difference in dentoskeletal morphology exists between CLASS II division 1 and CLASS II division 2 malocclusions.

Gail burke, Paul major et al(1998)[63] carried out the study to determine the correlation between the condylar characteristics measured from pre-orthodontic tomograms of preadolescents and their facial morphologic characteristics and found that vertical facial morphologic have angled condyles and anteriorly angled condyles were correlated to patients with a horizontal facial morphology. No significant correlations were found between the other condylar characteristics .

Masahita Tsunori(1998)[64] studied the relationship between mandibular body tooth inclination ,cortical bone thickness and facial types on 39 dry skulls, lateral cephalogram and 4 CT’s .Study concluded that long face patterns included narrow arches because of narrow mandible and width of arches were smaller than short face subjects.Buccal cortical bone thickness was greater in short faced subjects than long face.

Bresin et al(1999)[65] studied density and thickness of cortical bone of both maxilla and mandible and concluded that they adapt to masticatory forces and therefore results in different maxillomandibular morphology between the facial types.The forces generated by masticatory muscles affect the occlusion, dental arch forms and mandibular morphology.

Andrew Girardot (2001)[66] conducted a study to compare the condylar position in different facial skeletal types and the amount of condylar movement from the upward and forward position to the intercuspal position was measured. It was hypothesized that hyperdivergent group would exhibit greater condylar displacement than the hypodivergent group.

Ronald P. Kolodziej (2002)[67] conducted a study to test the hypothesis that the antegonial notch depth is a useful predictor of facial growth in untreated growing patients randomly chosen from a longitudinal sample. Lateral cephalometric radiographs were obtained from 20 males and 20 females at 3 times, approximating prepubescence (8.5 years), adolescence (12 years), and adulthood (17 years). Prepubescent and adolescent antegonial notch depths were correlated with vertical and horizontal growth changes of the jaws from the age of 8.5 years to adulthood. Correlation analysis revealed a statistically (but *not* clinically) significant negative relationship between adolescent antegonial notch depth and horizontal growth of the maxilla and the mandible from adolescence to adulthood. Previous investigators have proposed that antegonial notch depth, when extreme in magnitude, might be used to predict facial growth. They concluded that antegonial notch depth fails to provide sufficient indication of future facial growth to warrant its application as a growth predictor in a nonextreme population.

A.B.M Rabie (2002)[68] designated a study to identify series of factors regulating condylar growth. Study was conducted on 115 Sprague dawley rats, 35 days old. Immunostaining was used to identify those factors in protein level. Study concluded that Sox 9 factor which is expressed by cells in proliferative layer regulates condylar growth.

Julia von Bremen, Hans pancherz et al (2005)[69] conducted study to apply Bjorks structural signs of mandibular growth rotation to assess the hypodivergency or hyperdivergency of mandible. 135 lateral cephalograms of subjects were collected, out of which 95 subjects exhibited large and 40 subjects exhibited small mandibular plane angle. There was no association between the degree of hypo/ hyperdivergency or the age of the subject's .However, hypodivergency was recognized more easily than hyperdivergency.

Chan,Woods,Stella (2008)[70] indicated that there are biomechanics differences between vertical facial types which results in morphologic and functional differences.The size and orientation of masticatory muscles and the forces generated by them affect development of maxillofacial complex and facial divergence.

Aya Kurusu, Mariko Horiuchi et al (2009)[71]did a study to clarify the relationship between occlusal force and mandibular condyle morphology using clinical data. The subjects were 40 female patients with malocclusion. The mandibular condyle morphology was assessed by using limited cone-beam CT imaging. The maximum occlusal force was calculated by using pressure-sensitive films. Moreover, condylar length was significantly correlated with the occlusal plane angle to the FH, the mandibular plane angle to the FH, the ramus inclination, and the posterior facial height (S-Go). Low occlusal-force patients tend to have smaller mandibular condyles.

Sanjay suri et al(2010)[72] studied cranial base, maxillary and mandibular morphology in 25 patients with Down's syndrome and found significant hypoplasia in cranium and face.

Mangla et al,(2011)[73] assessed symphyseal morphology relation with different mandibular growth patterns (MGPs) using symphyseal parameters (height, depth, and ratio) of normal subjects compared with four groups with malocclusion (CLASS III vertical, CLASS II vertical, CLASS III horizontal, and CLASS II horizontal). These groups (15 samples each) were matched (for sex and cervical maturation stage [CVMS]) based on their cephalograms and patient charts. They found the symphyseal ratio to have a significant correlation with the MGP. The symphyseal ratio (Height/Depth) was small in a mandible with vertical growth pattern CLASS II or CLASS III. Conversely, a horizontal growth pattern of a CLASS II or CLASS III mandible was associated with a larger ratio of the symphysis in comparison with the normal group. The symphyseal ratio was also found to be greater in females.

Horner et al(2012)[74] conducted a CBCT study to evaluate facial types and mandibular morphology and focused mainly on the cortical bone thickness in the adults. They found statistically significant differences between the facial types in the buccal cortical bone between the premolar, first molar, and the second molar interradicular sites in the mandible. Also concluded that the hypo divergent group had thicker cortical bone and alveolar bone in the hypodivergent subjects.

Elcin Esenlik et al (2012)[75] investigated the alveolar and symphysis region morphology in hyperdivergent, hypodivergent, and normodivergent CLASS II division 1 anomalies using 111 young adult female patients with skeletal CLASS II division 1 anomalies were compared to those of 54 CLASS I normal subjects (control group). The heights and widths of the symphysis and alveolus and the depth of maxillary palate were measured on the lateral cephalograms and concluded that symphysis width is the main factor in the differential diagnosis of CLASS II division 1 anomaly rather than symphysis height and hypodivergent CLASS II division 1 anomaly is more suitable for mandibular incisors movements.

Al-Khateeb et al (2013)[76] assessed the morphology and dimensions of mandibular symphysis (MS) in different anteroposterior jaw relationships and to investigate whether craniofacial parameters have any correlation with its shape and/or dimensions. They studied lateral cephalograms of subjects with Class I, Class II, and Class III skeletal relationships and used mandibular symphysis parameters to found that larger angle of concavity of the chin, more inclination of the alveolar bone toward the mandibular plane, and larger Mandibular symphyseal dimensions and area were found with a Class III skeletal relationship compared to Class I and Class II relationship and concluded that mandibular symphysis dimensions were strongly correlated to anterior facial dimensions.

RS Gowda(2013)[77] stated that condylar head is more forwardly inclined in hyperdivergent patterns and backwardly inclined in hypodivergent pattern. And also noticed that hypodivergent pattern have a flat inferior border but in hyperdivergent pattern notching of inferior border is seen.

Jorge C. Coro et al(2016)[78] examined the relationship of the 3-dimensional posterior-occlusal plane and the mandibular 3D spatial position. The relationship of the POP to mandibular morphology was also investigated. The POP showed significant correlations with mandibular position in the sagittal, coronal, and axial planes. It also showed a significant correlation with mandibular morphology which suggested that there is a distinct and significant relationship between the 3D POP and the mandibular spatial position and its morphology.

Juliana Macedo de Mattos et al (2017)[79] purpose of this study was to observe the positions of the glenoid fossae and mandibular condyles are identical on the Class I and Class II sides of patients with Class II subdivision malocclusion. Patients with Class II malocclusion displayed a symmetric position of the glenoid fossae and condyles with no statistically significant differences between sides, whereas patients with Class II subdivision showed asymmetry in the distance between the glenoid fossae and anterior cranial base or Sella turcica, with distally and laterally positioned glenoid fossae on the Class II side. Also, male patients had greater distances between glenoid fossae and anterior cranial fossa.

Takashi S. Kajii et al (2018)[80] undertook a study to check the changes of the TMJ condyle which affect backward rotation of the mandibular ramus in Angle Class II orthodontic patients with idiopathic condylar resorption (ICR) on 20 Japanese women with Class II malocclusion with ICR (ICR group) and 24 women with Class II malocclusion without ICR (non-ICR group). The ICR group had a significantly smaller condylar ratio, greater backward rotation of the ramus, less labially inclined upper incisors, and a steeper occlusal plane. The increased backward rotation of the ramus in the ICR group was significantly associated with a smaller condylar ratio. Angle's Class II patients with ICR had shorter condylar height attributable to osseous changes of the TMJ condyle, and the shorter condylar height may affect subsequent backward rotation of the ramus.

Kim HJ et al (2019)[81] indicated that there are biochemical differences between vertical facial types which result in morphologic and functional differences. The size and the orientation of masticatory muscles and the forces that they generate affect the development of maxillofacial complex and facial divergence.

Min-Hee Oh and Jin-Hyoung Cho (2020)[82] evaluated whether the three-dimensional (3D) morphology of the mandibular condyle, glenoid fossa and mandible correlated with menton deviation in facial asymmetry on 30 adults with facial asymmetry. Linear, angular, and volumetric measurements of the 3D morphology of the mandibular condyle, glenoid fossa, and mandible were recorded using computed tomography (CT) images. They concluded that in facial asymmetry, the right/left differences in mandibular condyle and mandible have more impact on the menton deviation than the right/left differences in glenoid fossa.

MATERIALS AND INSTRUMENTS REQUIRED

1. Sample size of 90 subjects which were divided into three groups as Normodivergent, Hypodivergent and hyperdivergent groups according to SN/MP angle (30 subjects each). Each group is subdivided into two groups according to gender variation as Males and Females.
2. Digital panoramic and cephalometric system (KODAK 8000 C)
3. Digital printer (FUJI FILM DRY PIX SMART)
4. Radiographs – lateral cephalograms
5. Nemoceph software

METHOD

To obtain a standardized orientation of the head, referred to as the natural head position is possible by focusing at a distant point. The concept of natural head position was originally defined by Broca as being the position of the head when an individual stands with the visual axis in the horizontal plane and was introduced in orthodontics in the 1950's. The visual axis can be aligned with the horizontal plane by asking a relaxed subject to look at a distant reference point or by asking an individual to take a step forward. While taking a step forward an individual usually will attain a natural head position also known as ortho-position.

In the present study all the lateral cephalograms were taken in natural head position using the mirror position in which a long mirror was used to accommodate the different inclinations of the head in individuals while taking the radiographs. The radiographs were taken in a cephalostat with a film-to-focus distance of 180 cm and a film to- median plane distance of 10 cm. No correction was made for the constant linear enlargement of 5.6%. The cephalometric measurements were obtained from computerized tracing of direct digital radiographs using Nemoceph software, Version 6.0 Nemotec SRL and analysed, by measuring 9 angular and 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 were analysed.

INCLUSION CRITERIA

- Patients aged 18 -30 years
- Patients desiring orthodontic treatment.
- Beta angle :- 18˚ - 27 ˚
- Wits appraisal :- 3mm – 8mm
- ANB angle more than 3˚ - 8˚
- Mandibular plane angle (SN-MP)
    1. Normodivergent : 28˚-37˚
    2. Hyperdivergent : >37˚
    3. Hypodivergent : <28˚

EXCLUSION CRITERIA

- Patients with craniofacial anomalies
- Patients with facial asymmetries
- Patients with neuromuscular disorder
- Patients with any systemic disease
- Patients undergoing orthodontic treatment
- Pre-treated orthodontic cases
- History of any previous surgery.

LANDMARKS USED IN THIS STUDY

1. Sella(S): the point representing the midpoint of the pituitary fossa
2. Nasion(Na): the most anterior point of the frontonasal suture in the median plane
3. Gonion [Go]: a constructed point, the intersection of lines tangent to the posterior margin of the ascending ramus and the mandibular base.
4. Menton [Me]: is the most inferior point on the outline of the symphysis as seen on the lateral cephalogram.
5. Point B [Supramentale]: It is the most posterior point in the outer contour of the mandibular alveolar process.
6. Articulaire(Ar): The point of intersection of the posterior margin of the ascending ramus and the outer margin of the cranial base.
7. Dc: is the point in the center of the condyle neck along the Ba-N plane
8. Xi: geometric centre of the ramus
9. Pm: Point at which shape of symphysis mentalis changes from convex to concave
10. CF-The intersecting point of the FH plane and the PTV plane
11. Basion(Ba): the anterior margin of the foramen mangnum
12. Pogonion [Pog]: most anterior point on the bony chin as seen on the lateral cephalogram.
13. Condylion(Co): Most anterior point on the head of the condyle.

14. Gnathion(Gn): the midpoint between the Me and Pog on the contour of the chin on the mid-sagittal plane.

15. Infradentale: the highest point of the gingiva between the two central incisors of the lower jaw.

16. Anterior Nasal Spine [ANS] : point ANS is the tip of the bony anterior nasal spine as seen the lateral cephalogram.

17. Anterior convex point (ACP) - point of greatest convexity along the anterior-inferior border of mandible

18. Inferior gonion (IGo) – point of greatest convexity along the posterior – inferior border of the mandible

19. Orbitale [Or]: most inferior on the infra – orbital margin

20. Porion [Po]: ‘anatomic porion’ is the outer upper margin of the external auditory canal, Machine porion’’ is the upper most point on the outline of the metal rings on the ear rods of the cephalostat.

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. Chin tangent line (CTL) – line connects Pog and point B
5. PTV plane- a line perpendicular to the FH through the Pt point.
6. Ramal line(RL):A tangent to posterior border of mandible.

MANDIBULAR MORPHOLOGY VARIABLES

LINEAR VARIABLES

1. Ramus height-(RAM-H) - The distance from the cross-point of the FH plane and the posterior border line of the ramus to the cross-point of the posterior border line of the ramus and the mandibular plane.

2. Ramus width- smallest anterioposterior diameter of ramus.

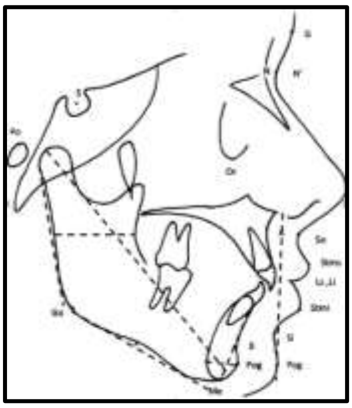
3. Mandibular depth-line between condylion to gnathion

4. Symphysis height- distance between infradentale and menton point.

5. Symphysis depth-horizontal distance between Pogonion and most posterior wall of symphysis.

6. Antegonial notch depth-This linear measurement was taken from greatest point of convexity in antegonial notch to line connecting anterior convexity point (ACP) with inferior gonion (IGo) as taken by Ronald .p.kolodzeij.

7. Lower anterior face height-ALFH was measured as the distance between anterior nasal spine (ANS), and Menton (Me)



ANGULAR VARIABLES

1. Mandibular plane angle -mandibular plane angle was measured between the SN (Sella –Nasion) plane and to the mandibular plane (Gonion – Menton) as taken by Schudy.

2. Symphysis angle -Symphysis angle: posteriosuperior angle formed by the line through Me and point B and the mandibular plane (Aki *et al*, 1994).

3. Upper gonial angle- angle formed by the points articulare, gonion and nasion

4. Lower gonial angle- the angle formed by the points nasion, gonion and menton.

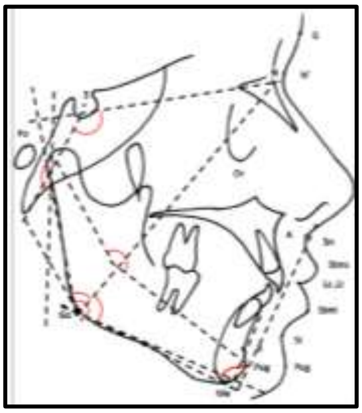
5. Mandibular arc angle-posterosuperior angle formed by the points Dc, Xi, Pm at Xi.

6. Inclination of symphysis-Angle between chin line and SN plane.

7. Inclination of condylar head-–Angle between lines represent anterior cant of the condylar head and line perpendicular to Frankfort horizontal plane.

8. Curvature of mandibular canal-angle between mental and mandibular canal

9. Gonial angle- angle between line from Articulaire to Gonion and Gonion to Pogonion



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

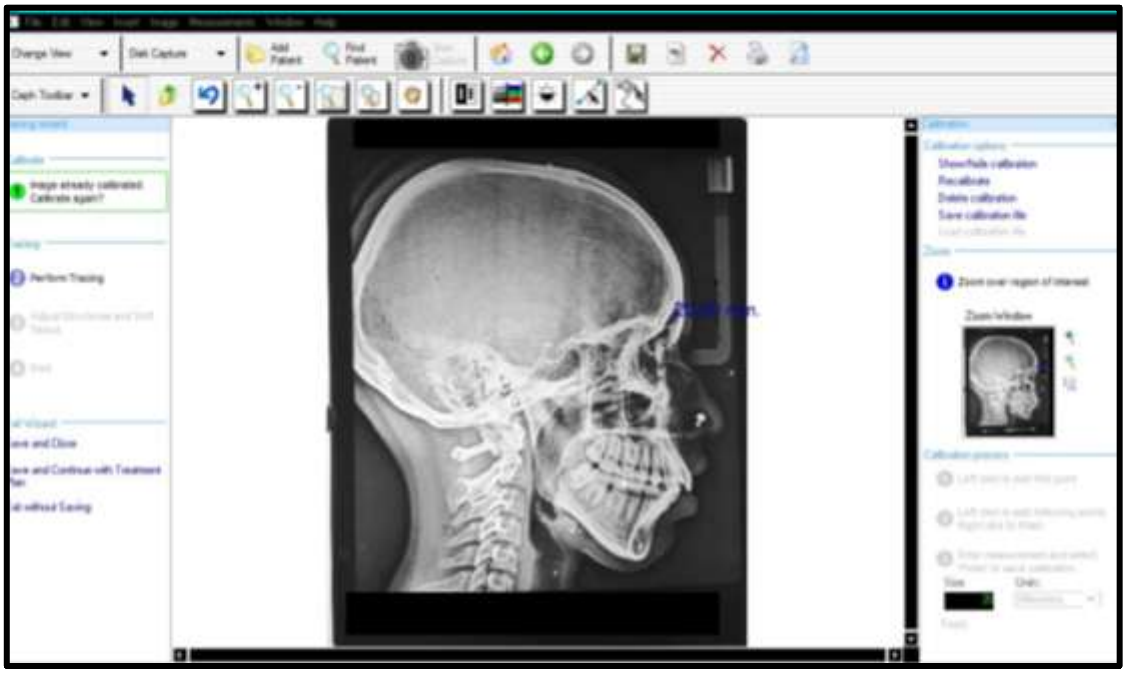


Fig 4. NEMOCEPH SOFTWARE, VERSION 6.0
NEMOTEC SRL (SPAIN)

COLOUR PLATE V

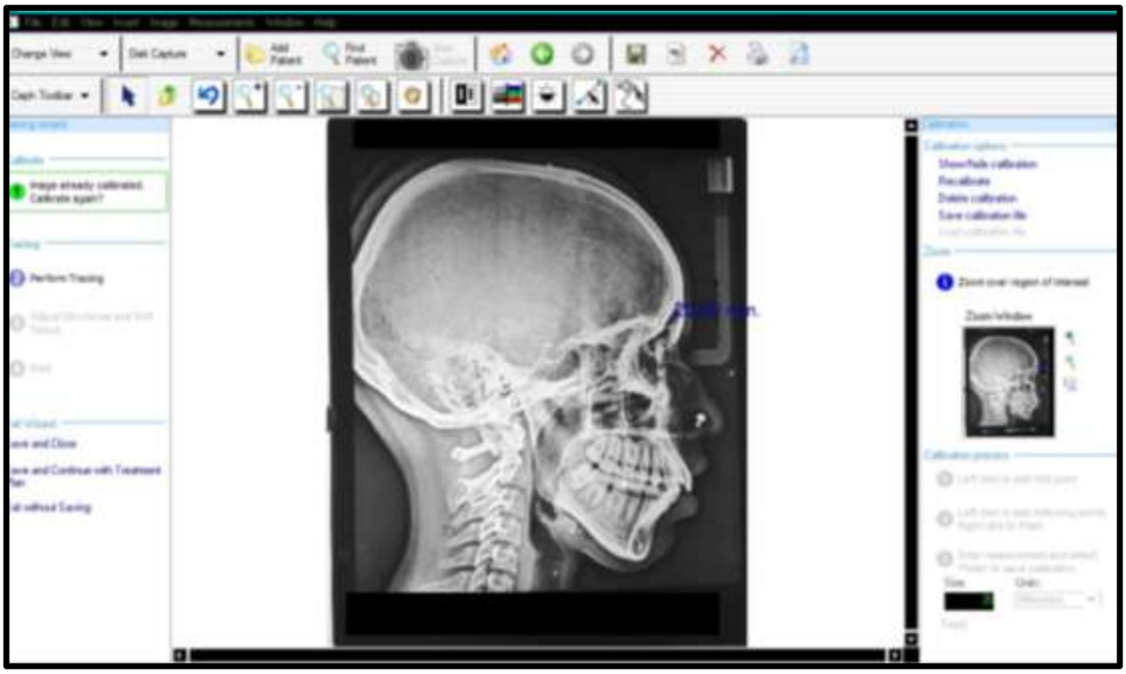


Fig 5. CALIBERATION ON NEMOCEPH SOFTWARE

COLOUR PLATE VI

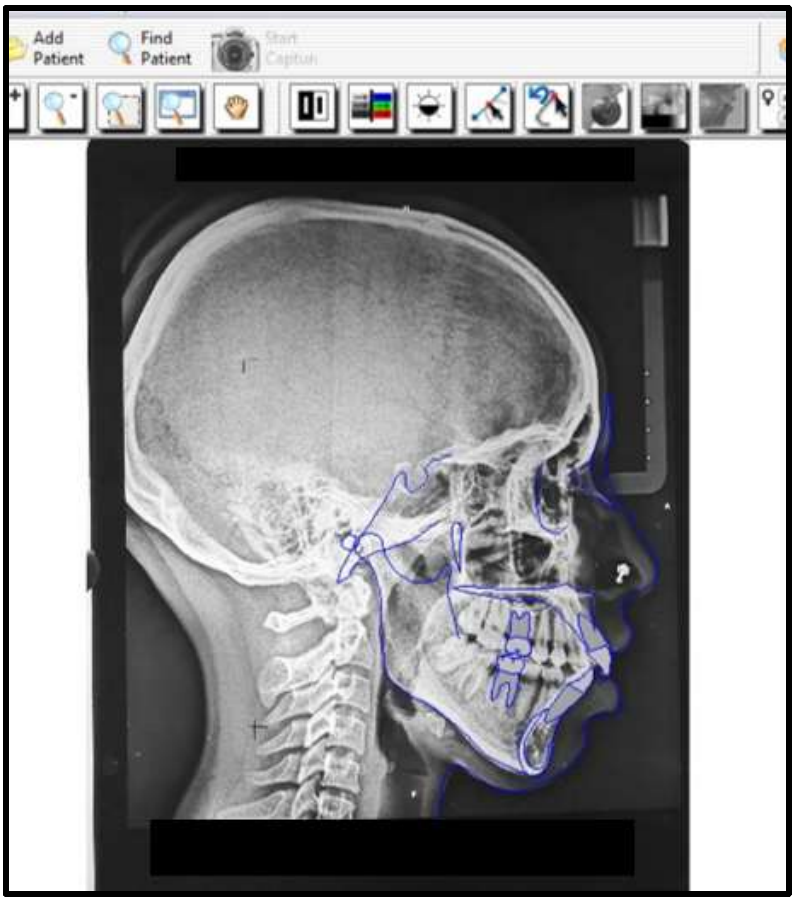


Fig. 6: Tracing of lateral cephalogram on Nemoceph

COLOUR PLATE VII

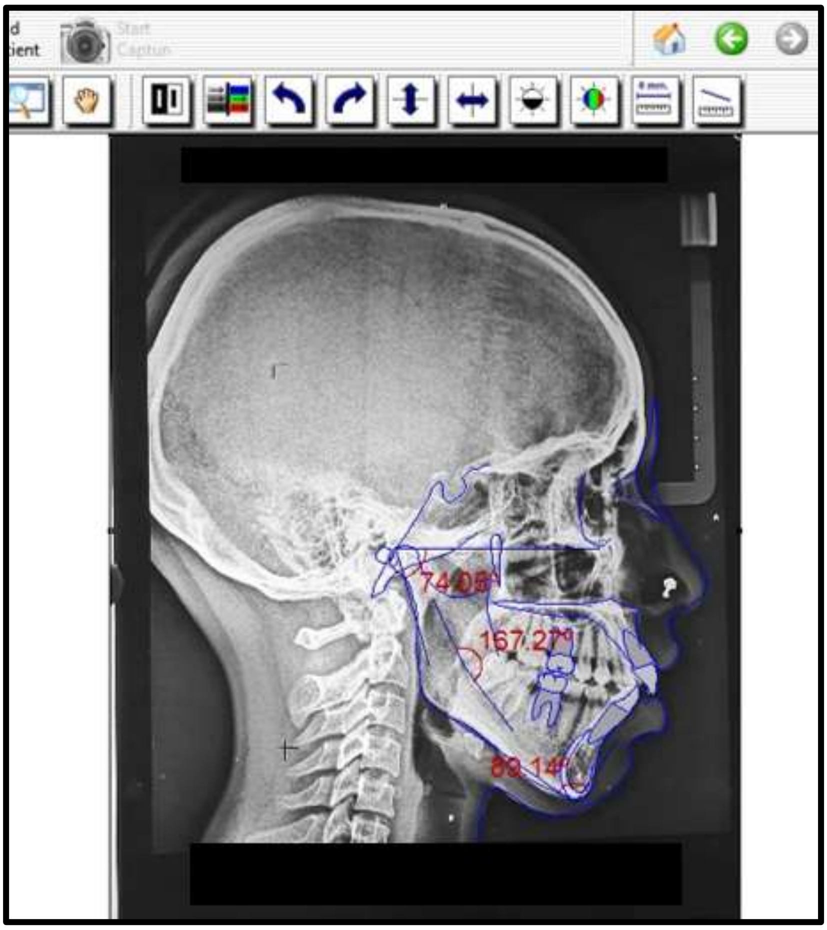


Fig. 7: Skeletal Pattern: Angular measurements

COLOUR PLATE VIII

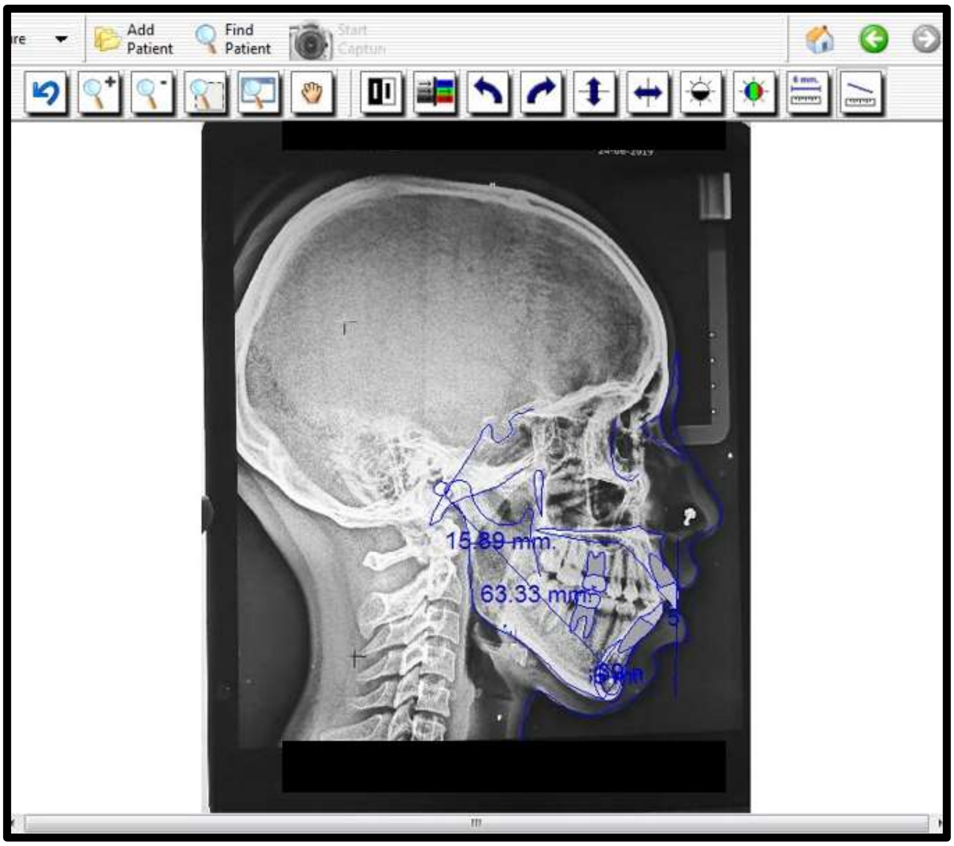


Fig. 8: Skeletal Pattern: Linear measurements

RESULTS

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

Group 1: Normodivergent pattern

Group 2: Hypodivergent pattern

Group 3: Hyperdivergent pattern

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 the one-way analysis of variance test and F test (ANOVA 'F') for comparison amongst the three groups followed by Tukey post hoc test for multiple comparisons. The independent t-test was used for comparisons amongst males and females in all the three groups. The “p” values were considered significant at or below 0.05.

LINEAR MEASUREMENTS:

Ramal height

The mean ramal height amongst Normodivergent, Hypodivergent and Hyperdivergent groups was 28.82 ± 2.21, 31.9 ± 3.3 and 26.05 ± 2.29 respectively. There existed highly statistically significant (p) difference amongst all the three groups as revealed by ANOVA ‘F’ test. Ramal height was highest amongst the Hypodivergent group followed by Normodivergent and least in Hyperdivergent group.

Inter-group comparison between Normodivergent versus Hypodivergent, Normodivergent versus Hyperdivergent and Hypodivergent versus Hyperdivergent revealed by Turkey’s post hoc test to find pairwise difference and shown highly a statistically significant (p0.05) difference amongst all the three groups.

There existed a highly statistically significant (p) difference amongst male participants of all the three groups as revealed by ANOVA ‘F’ test. The mean values of ramal height were highest amongst the Hypodivergent males followed by Normodivergent and Hyperdivergent males.

Although similar trend was observed amongst the female participants, the difference was statistically significant (p0.05).

Ramal width

The mean ramal width amongst Normodivergent, Hypodivergent and Hyperdivergent groups was 17.64 ± 1.22, 19.89 ± 1.93and 16.38 ± 1.59 respectively. There existed highly statistically significant (p) difference amongst all the three groups as revealed by ANOVA ‘F’ test. Ramal height was highest amongst the Hypodivergent group followed by Normodivergent and least in Hyperdivergent group.

Inter-group comparison between Normodivergent versus Hypodivergent, Normodivergent versus Hyperdivergent and Hypodivergent versus Hyperdivergent revealed by Turkey’s post hoc test to find pairwise difference and shown highly a statistically significant (p0.05) difference amongst all the three groups.

There existed a highly statistically significant (p) difference amongst male participants of all the three groups as revealed by ANOVA ‘F’ test. Statistically highly significant results observed between Normodivergent versus Hypodivergent and Hypodivergent versus Hyperdivergent when compared with each other.

Although Statistically highly significant (p) results observed between Normodivergent versus Hypodivergent and Hypodivergent versus Hyperdivergent when compared with each other.

Statistically highly significant (p) results observed between Normodivergent versus Hyperdivergent and Hypodivergent versus Hyperdivergent when compared with each other.

Mandibular depth

The mean mandibular depth amongst Normodivergent, Hypodivergent and Hyperdivergent groups was 60.68 ± 2.85, 63.73 ± 2.68 and 57.81 ± 3.72 respectively. There existed highly statistically significant (p) difference amongst all the three groups as revealed by ANOVA 'F' test. Ramal height was highest amongst the Hypodivergent group followed by Normodivergent and least in Hyperdivergent group.

Inter-group comparison between Normodivergent versus Hypodivergent, Normodivergent versus Hyperdivergent and Hypodivergent versus Hyperdivergent revealed by Turkey's post hoc test to find pairwise difference and shown highly a statistically significant (p0.05) difference between Hypodivergent versus Hyperdivergent comparison.

There existed a highly statistically significant (p) difference amongst male participants of all the three groups as revealed by ANOVA 'F' test. The mean values of ramal height were highest amongst the Hypodivergent males followed by Normodivergent and Hyperdivergent males. Highly significant (p) difference in only Hypodivergent versus Hyperdivergent comparison.

Although similar trend was observed amongst the female participants, the difference was highly statistically significant (p0.001).

Symphysis height

The mean symphysis height amongst Normodivergent, Hypodivergent and Hyperdivergent groups was 14.31 ± 0.59, 13.45 ± 1.15 and 16.16 ± 1.30 respectively.

There existed highly statistically significant (p) difference amongst all the three groups as revealed by ANOVA ‘F’ test. Ramal height was highest amongst the Hyperdivergent group followed by Normodivergent and least in Hypodivergent group.

Inter-group comparison between Normodivergent versus Hypodivergent, Normodivergent versus Hyperdivergent and Hypodivergent versus Hyperdivergent revealed by Turkey’s post hoc test to find pairwise difference and shown highly a statistically significant (p) difference amongst all the three groups.

There existed a highly statistically significant (p) difference amongst male participants of all the three groups as revealed by ANOVA ‘F’ test. The mean values of symphysis height were highest amongst the Hypodivergent males followed by Normodivergent and Hyperdivergent males. Statistically highly significant (p) difference present in Hypodivergent versus Hyperdivergent comparison.

Although similar trend was observed amongst the female participants, the difference was statistically significant (p).

Symphysis depth

The mean symphysis depth amongst Normodivergent, Hypodivergent and Hyperdivergent groups was 8.70 ± 1.15, 10.49 ± 0.65 and 7.81 ± 0.94 respectively. There existed highly statistically significant (p) difference amongst all the three groups as revealed by ANOVA ‘F’ test. Ramal height was highest amongst the Hypodivergent group followed by Normodivergent and least in Hyperdivergent group.

Inter-group comparison between Normodivergent versus Hypodivergent, Normodivergent versus Hyperdivergent and Hypodivergent versus Hyperdivergent revealed by Turkey's post hoc test to find pairwise difference and shown a statistically significant difference amongst all the three groups.

There existed a highly statistically significant (p) difference amongst male participants of all the three groups as revealed by ANOVA 'F' test. The mean values of symphysis depth were highest amongst the Hypodivergent males followed by Normodivergent and Hyperdivergent males.

Although similar trend was observed amongst the female participants, the difference was statistically significant (p0.001).

Antegonial notch depth

The mean antegonial notch depth amongst Normodivergent, Hypodivergent and Hyperdivergent groups was 1.05 ± 0.23, 0.87 ± 0.24 and 1.30 ± 0.42 respectively. There existed highly statistically significant (p) difference amongst all the three groups as revealed by ANOVA 'F' test. Ramal height was highest amongst the Hypodivergent group followed by Normodivergent and least in Hyperdivergent group.

Inter-group comparison between Normodivergent versus Hypodivergent, Normodivergent versus Hyperdivergent and Hypodivergent versus Hyperdivergent revealed by Turkey's post hoc test to find pairwise difference and shown highly a statistically significant (p0.05) difference amongst all the three groups.

There existed a statistically significant (p) difference amongst male participants of all the three groups as revealed by ANOVA ‘F’ test. The mean values of antigonial notch depth were highest amongst the Hypodivergent males followed by Normodivergent and Hyperdivergent males. Higher statistical significance found among hypodivergent versus hyperdivergent groups.

Although similar trend was observed amongst the female participants, the difference was statistically significant (p0.007).

Lower anterior face height

The mean lower anterior face height amongst Normodivergent, Hypodivergent and Hyperdivergent groups was 39.06±2.26, 35.55±2.85 and 41.28±1.43 respectively. There existed highly statistically significant (p) difference amongst all the three groups as revealed by ANOVA ‘F’ test. Ramal height was highest amongst the Hypodivergent group followed by Normodivergent and least in Hyperdivergent group.

Inter-group comparison between Normodivergent versus Hypodivergent, Normodivergent versus Hyperdivergent and Hypodivergent versus Hyperdivergent revealed by Turkey’s post hoc test to find pairwise difference and shown highly a statistically significant (p0.001) difference amongst all the three groups.

There existed a highly statistically significant (p) difference amongst male participants of all the three groups as revealed by ANOVA ‘F’ test. The mean values of lower anterior face height were highest amongst the Hypodivergent males followed by Normodivergent and Hyperdivergent males.

Although similar trend was observed amongst the female participants, the difference was statistically significant (p0.001).Also it is highly significant (p) when compared between all the groups.

ANGULAR MEASUREMENTS:

Mandibular plane angle

The mean values of mandibular plane angle amongst Normodivergent, Hypodivergent and Hyperdivergent groups were 30.47 ± 1.46, 22.98 ± 1.81 and 38.8 ± 1.16 respectively. . This difference was statistically significant (p) as revealed by ANOVA 'F' test. Inter-group comparison showed statistically highly significant ($p < 0.001$) difference between the groups revealed by Tukey's post hoc test to find pairwise comparison.

There existed a highly statistically significant difference ($p=0.001$) amongst the male participants from all the three groups as shown by ANOVA. The highest values were observed in the hyperdivergent group followed by Normodivergent and lowest in the ypodivergent group.

Similar trend was observed amongst the female participants from all the three groups.

Symphysis angle

The mean values of symphysis angle amongst Normodivergent, Hypodivergent and Hyperdivergent groups were 79.83 ± 3.34, 83.26 ± 5.65 and 77.08 ± 5.17 respectively. This difference was statistically highly significant (p) as revealed by ANOVA 'F' test. Inter-group comparison showed statistically highly significant (p< 0.001) difference in hypodivergent versus hyperdivergent group revealed by Tukey's post hoc test to find pairwise comparison.

There existed a statistically significant difference (p=0.021) amongst the male participants from all the three groups as shown by ANOVA. The highest values were observed in the Hypodivergent and Hyperdivergent , Normodivergent groups have similar values .

The difference in the mean values of symphysis angle was highly statistically significant (p<0.001) amongst the female participants in all the three groups. The highest values were seen in hypodivergent group whereas hypodivergent group have least value.

Upper gonial angle

The mean values of upper gonial angle amongst Normodivergent, Hypodivergent and Hyperdivergent groups were 51.41 ± 2.64, 51.75 ± 4.62 and 53.88 ± 5.57 respectively. This difference was statistically not significant as revealed by ANOVA 'F' test.

There was no statistically significant difference amongst the male participants from all the three groups as shown by ANOVA.

The difference in the mean values was statistically significant (p=0.011) amongst the female participants in all the three groups. Higher statistical significance found among Normodivergent versus Hyperdivergent and Hypodivergent versus hyperdivergent groups.

Lower gonial angle

The mean values of lower gonial angle amongst Normodivergent, Hypodivergent and Hyperdivergent groups were 72.62 ± 2.7, 66.26 ± 3.6 and 75.03 ± 4.71 respectively. This difference was statistically highly significant (p) as revealed by ANOVA 'F' test. Inter-group comparison showed statistically highly significant ($p < 0.001$) difference in between Normodivergent versus Hypodivergent and Hypodivergent versus Hyperdivergent groups revealed by Tukey's post hoc test to find pairwise comparison.

There existed a highly statistically significant difference ($p < 0.001$) amongst the male participants from all the three groups as shown by ANOVA. The highest values were observed in the Hyperdivergent then in Normodivergent and least in Hypodivergent group. Inter-group comparison showed statistically highly significant ($p < 0.001$) difference in between Normodivergent versus Hypodivergent and Hypodivergent versus Hyperdivergent groups revealed by Tukey's post hoc test to find pairwise comparison.

The difference in the mean values of symphysis angle was highly statistically significant ($p<0.001$) amongst the female participants in all the three groups.Intergroup comparison also showed similar trends among females.

Mandibular arc angle

The mean values of mandibular arc angle amongst Normodivergent, Hypodivergent and Hyperdivergent groups were 40.17 ± 4.46, 32.23 ± 4.13 and 43.46 ± 5.81 respectively. This difference was statistically highly significant (p) as revealed by ANOVA 'F' test. Inter-group comparison showed statistically highly significant (p< 0.001) difference in between Normodivergent versus Hypodivergent and Hypodivergent versus Hyperdivergent groups and statistically significant (p=0.028) among Normodivergent versus Hyperdivergent revealed by Tukey's post hoc test to find pairwise comparison.

There existed a highly statistically significant difference (p< 0.001) amongst the male participants from all the three groups as shown by ANOVA. The highest values were observed in the Hyperdivergent then in Normodivergent and least in Hyperdivergent group. Inter-group comparison showed statistically highly significant (p< 0.001) difference in between Normodivergent versus Hypodivergent and Hypodivergent versus Hyperdivergent groups revealed by Tukey's post hoc test to find pairwise comparison.

The difference in the mean values of mandibular arc angle showed similar trends among females.

Inclination of symphysis

The mean values of inclination of symphysis amongst Normodivergent, Hypodivergent and Hyperdivergent groups were 76.69 ± 4.1, 79.07 ± 4.26 and 71.07 ± 5.68 respectively. This difference was statistically highly significant (p) as revealed by ANOVA 'F' test. Inter-group comparison showed statistically highly significant (p< 0.001) difference in between Normodivergent versus Hyperdivergent and Hypodivergent versus Hyperdivergent groups revealed by Tukey's post hoc test to find pairwise comparison.

There existed a highly statistically significant difference ($p < 0.001$) amongst the male participants from all the three groups as shown by ANOVA. The highest values were observed in the Hypodivergent then in Normodivergent and least in Hyperdivergent group. Inter-group comparison showed statistically highly significant ($p < 0.001$) difference in between Hypodivergent versus Hyperdivergent groups revealed by Tukey's post hoc test to find pairwise comparison.

The difference in the mean values of mandibular arc angle angle showed similar trends among females.

Inclination of condylar head

The mean values of condylar head inclination amongst Normodivergent, Hypodivergent and Hyperdivergent groups were 89.45 ± 5.55, 96.81 ± 3.99 and 84.53 ± 6.87 respectively. This difference was statistically highly significant (p) as revealed by ANOVA 'F' test. Inter-group comparison showed statistically highly significant ($p < 0.001$) difference in between Normodivergent versus Hypodivergent and Hypodivergent versus Hyperdivergent groups revealed by Tukey's post hoc test to find pairwise comparison.

There existed a highly statistically significant difference ($p < 0.001$) amongst the male participants from all the three groups as shown by ANOVA. The highest values were observed in the Hypodivergent then in Normodivergent and least in Hyperdivergent group. Inter-group comparison showed statistically highly significant difference in between Normodivergent versus Hypodivergent ($p=0.001$) and Hypodivergent versus Hyperdivergent ($p < 0.001$) groups revealed by Tukey's post hoc test to find pairwise comparison.

The difference in the mean values of symphysis angle was highly statistically significant ($p<0.001$) amongst the female participants in all the three groups.Intergroup comparison showed statistically highly significant difference in between Normodivergent versus Hyperdivergent ($p<0.001$) and Hypodivergent versus Hyperdivergent ($p< 0.001$) groups revealed by Tukey's post hoc test to find pairwise comparison.

Curvature of mandibular canal

The mean values of curvature of mandibular canal amongst Normodivergent, Hypodivergent and Hyperdivergent groups were 148.81 ± 7.31, 144.72 ± 6.48 and 154.92 ± 6.58 respectively. This difference was statistically highly significant (p) as revealed by ANOVA 'F' test. Inter-group comparison showed statistically highly significant ($p< 0.001$) difference in Hypodivergent versus Hyperdivergent groups revealed by Tukey's post hoc test to find pairwise comparison.

There existed a highly statistically significant difference ($p< 0.001$) amongst the male participants from all the three groups as shown by ANOVA. The highest values were observed in the Hyperdivergent then in Normodivergent and least in Hypodivergent group. Inter-group comparison showed statistically highly significant difference in between Normodivergent versus Hyperdivergent ($p=0.005$) and Hypodivergent versus Hyperdivergent ($p= 0.001$) groups revealed by Tukey's post hoc test to find pairwise comparison.

The difference in the mean values of symphysis angle was highly statistically significant ($p<0.001$) amongst the female participants in all the three groups. Intergroup comparison showed statistically highly significant difference in between

Normodivergent versus Hyperdivergent (p=0.005) and Hypodivergent versus Hyperdivergent (p< 0.001) groups revealed by Tukey's post hoc test to find pairwise comparison.

Gonial angle

The mean values of gonial angle amongst Normodivergent, Hypodivergent and Hyperdivergent groups were 121.83 ± 3.34, 116.11 ± 8.14 and 132.65 ± 6.13 respectively. This difference was statistically highly significant (p) as revealed by ANOVA 'F' test. Inter-group comparison showed statistically highly significant (p< 0.001) difference in between Normodivergent versus Hypodivergent and Hypodivergent versus Hyperdivergent groups revealed by Tukey's post hoc test to find pairwise comparison.

There existed a highly statistically significant difference (p< 0.001) amongst the male participants from all the three groups as shown by ANOVA. The highest values were observed in the Hyperdivergent then in Normodivergent and least in Hypodivergent group. Inter-group comparison showed statistically highly significant difference in between Normodivergent versus Hyperdivergent (p=0.002) and Hypodivergent versus Hyperdivergent (p< 0.001) groups revealed by Tukey's post hoc test to find pairwise comparison.

The difference in the mean values of symphysis angle was highly statistically significant (p<0.001) amongst the female participants in all the three groups. Intergroup comparison showed statistically highly significant difference in between all comparative groups revealed by Tukey's post hoc test to find pairwise comparison.

TABLES

LINEAR PARAMETERS:

Table 1: Comparison of linear measurements between normodivergent, hypodivergent and hyperdivergent groups

OVERALL	Ramus Height Mean (SD)	Ramus Width Mean (SD)	Mandibular Depth Mean (SD)
Normodivergent	28.82 (2.21)	17.64 (1.22)	60.68 (2.85)
Hypodivergent	31.9 (3.3)	19.89 (1.93)	63.73 (2.68)
Hyperdivergent	26.05 (2.29)	16.38 (1.59)	57.81 (3.72)
One way Anova'F' test value	F = 36.436	F = 36.503	F = 26.923
p value, Significance	p < 0.001**	p < 0.001**	p < 0.001**
	Tukey's post-hoc test to find pairwise differences		
Normodivergent vs Hypodivergent	p < 0.001**	p < 0.001**	p = 0.001*
Normodivergent vs Hyperdivergent	p < 0.001**	p = 0.009*	p = 0.002*
Hypodivergent vs Hyperdivergent	p < 0.001**	p < 0.001**	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 2: Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups

OVERALL	Symphysis height Mean (SD)	Symphysis Depth Mean (SD)	Antigonial notch depth Mean (SD)	LAFH Mean (SD)
Normodivergent	14.31 (0.59)	8.70 (1.15)	1.05 (0.23)	39.06 (2.26)
Hypodivergent	13.45 (1.15)	10.49 (0.65)	0.87 (0.24)	35.55 (2.85)
Hyperdivergent	16.16 (1.30)	7.81 (0.94)	1.30 (0.42)	41.28 (1.43)
One way Anova'F' test value	F = 50.804	F = 63.198	F = 14.309	F = 48.891
p value, Significance	P < 0.001**	P < 0.001**	P < 0.001**	P < 0.001**
	Tukey's post-hoc test to find pairwise differences			
Normodivergent vs Hypodivergent	P = 0.007*	P < 0.001**	P = 0.065	P < 0.001**
Normodivergent vs Hyperdivergent	P < 0.001**	P = 0.001*	P = 0.008*	P = 0.001*
Hypodivergent vs Hyperdivergent	P < 0.001**	P < 0.001**	P < 0.001**	P < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 3: Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups in males.

MALES	Ramus Height Mean (SD)	Ramus Width Mean (SD)	Mandibular Depth Mean (SD)
Normodivergent	30.24 (1.27)	17.67 (1.34)	61.73 (1.83)
Hypodivergent	34.09 (2.96)	21.21 (1.04)	64.02 (2.79)
Hyperdivergent	26.18 (2.92)	17.19 (1.22)	57.88 (4.59)
One way Anova'F' test value	F = 37.147	F = 49.166	F = 13.407
p value, Significance	p < 0.001**	p < 0.001**	p < 0.001**
	Tukey's post-hoc test to find pairwise differences		
Normodivergent vs Hypodivergent	p < 0.001**	p < 0.001**	p = 0.148
Normodivergent vs Hyperdivergent	p < 0.001**	p = 0.528	p = 0.007*
Hypodivergent vs Hyperdivergent	p < 0.001**	p < 0.001**	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 4: Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups in males.

MALES	Symphysis height Mean (SD)	Symphysis Depth Mean (SD)	Antigonial notch depth Mean (SD)	LAFH Mean (SD)
Normodivergent	14.37 (0.59)	9.14 (1.11)	1.07 (0.23)	40.50 (1.51)
Hypodivergent	13.78 (1.17)	10.66 (0.71)	0.82 (0.22)	36.86 (3.11)
Hyperdivergent	15.63 (1.50)	7.95 (1.05)	1.36 (0.52)	41.56 (1.43)
One way Anova'F' test value	F = 10.171	F = 28.931	F = 8.647	F = 19.424
p value, Significance	p < 0.001**	p < 0.001**	p = 0.001*	p < 0.001**
	Tukey's post-hoc test to find pairwise differences			
Normodivergent vs Hypodivergent	P = 0.351	P < 0.001**	P = 0.145	P < 0.001**
Normodivergent vs Hyperdivergent	P = 0.012*	P = 0.005*	P = 0.078	P = 0.376
Hypodivergent vs Hyperdivergent	P < 0.001**	P < 0.001**	P < 0.001**	P < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 5: Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups in Females.

FEMALES	Ramus Height Mean (SD)	Ramus Width Mean (SD)	Mandibular Depth Mean (SD)
Normodivergent	27.40 (2.05)	17.61 (1.13)	59.62 (3.33)
Hypodivergent	29.71 (1.88)	18.57 (1.70)	63.43 (2.63)
Hyperdivergent	25.94 (1.51)	15.58 (1.52)	57.74 (2.76)
One way Anova'F' test value	F = 16.172	F = 16.000	F = 14.720
p value, Significance	p < 0.001**	p < 0.001**	p < 0.001**
	Tukey's post-hoc test to find pairwise differences		
Normodivergent vs Hypodivergent	p = 0.004*	p = 0.189	p = 0.003*
Normodivergent vs Hyperdivergent	p= 0.086*	p = 0.001*	p=0.196
Hypodivergent vs Hyperdivergent	p < 0.001**	p < 0.001**	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 6: Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups in Females.

FEMALES	Symphysis height Mean (SD)	Symphysis Depth Mean (SD)	Antigonial notch depth Mean (SD)	LAFH Mean (SD)
Normodivergent	14.26 (0.61)	8.27 (1.04)	1.03 (0.24)	37.63 (1.98)
Hypodivergent	13.13 (1.07)	10.32 (0.56)	0.91 (0.25)	34.24 (1.86)
Hyperdivergent	16.69 (0.83)	7.67 (0.83)	1.23 (0.30)	40.99 (1.41)
One way Anova'F' test value	F = 67.140	F = 41.143	F = 5.548	F = 54.168
p value, Significance	p < 0.001**	p < 0.001**	p = 0.007*	p < 0.001**
	Tukey's post-hoc test to find pairwise differences			
Normodivergent vs Hypodivergent	p = 0.002*	p < 0.001**	p = 0.460	p < 0.001**
Normodivergent vs Hyperdivergent	p < 0.001**	p = 0.139	p = 0.104	p < 0.001**
Hypodivergent vs Hyperdivergent	p < 0.001**	p < 0.001**	p = 0.006*	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

ANGULAR PARAMETERS:

Table 1: Comparison of angular measurements between normodivergent, hypodivergent and hyperdivergent groups

OVERALL	Mandibular Plane Mean (SD)	Upper Gonial angle Mean (SD)	Lower Gonial angle Mean (SD)
Normodivergent	30.47 (1.46)	51.41 (2.64)	72.62 (2.7)
Hypodivergent	22.98 (1.81)	51.75 (4.62)	66.26 (3.6)
Hyperdivergent	38.8 (1.16)	53.88 (5.57)	75.03 (4.71)
One way Anova'F' test value	F = 82.52	F = 2.713	F = 43.462
p value, Significance	p < 0.001**	p =0.072	p < 0.001**
	Tukey's post-hoc test to find pairwise differences		
Normodivergent vs Hypodivergent	p < 0.001**	p =0.953	p < 0.001**
Normodivergent vs Hyperdivergent	p < 0.001**	p = 0.086	p = 0.039*
Hypodivergent vs Hyperdivergent	p < 0.001**	p =0.159	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 2: Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups

OVERALL	**Symphysis angle Mean (SD)**	**Mandibular arc angle Mean (SD)**	**Inclination of symphysis Mean (SD)**
Normodivergent	79.83 (3.34)	40.17 (4.46)	76.69 (4.1)
Hypodivergent	83.26 (5.65)	32.23 (4.13)	79.07 (4.26)
Hyperdivergent	77.08 (5.17)	43.46 (5.81)	71.08 (5.68)
One way Anova'F' test value	F = 12.323	F = 42.364	F = 22.44
p value, Significance	P < 0.001**	P < 0.001**	P < 0.001**
	Tukey's post hoc test to find pairwise comparison		
Normodivergent vs Hypodivergent	p = 0.02*	p < 0.001**	p = 0.134
Normodivergent vs Hyperdivergent	p =0.076	p = 0.028*	p < 0.001**
Hypodivergent vs Hyperdivergent	p < 0.001**	p < 0.001**	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 3: Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups

OVERALL	Inclination of condylar head Mean (SD)	Curvature of canal Mean (SD)	Gonial angle Mean (SD)
Normodivergent	89.45 (5.55)	148.81 (7.31)	121.83 (3.34)
Hypodivergent	96.81 (3.99)	144.72 (6.48)	116.11 (8.14)
Hyperdivergent	84.53 (6.87)	154.92 (6.58)	132.65 (6.13)
One way Anova'F' test value	F = 36.52	F = 17.059	F = 55.140
p value, Significance	P < 0.001**	P < 0.001**	P < 0.001**
	Tukey's post hoc test to find pairwise comparison		
Normodivergent vs Hypodivergent	p <0.001**	p =0.047*	p = 0.002*
Normodivergent vs Hyperdivergent	p = 0.003*	p = 0.002*	p < 0.001**
Hypodivergent vs Hyperdivergent	p < 0.001**	p < 0.001**	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 4: Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in males

MALES	Mandibular Plane Mean (SD)	Upper Gonial angle Mean (SD)	Lower Gonial angle Mean (SD)
Normodivergent	31.13 (1.49)	51.84 (2.38)	73.71 (2.27)
Hypodivergent	23.07 (2.04)	52.52 (4.74)	67.76 (3.40)
Hyperdivergent	38.67 (1.59)	53.04 (7.06)	76.17 (3.19)
One way Anova'F' test value	F = 305.665	F = 0.211	F = 31.236
p value, Significance	p < 0.001**	p =0.811	p < 0.001**
	Tukey's post-hoc test to find pairwise differences		
Normodivergent vs Hypodivergent	p < 0.001**	p = 0.928	p < 0.001**
Normodivergent vs Hyperdivergent	p < 0.001**	p = 0.795	p = 0.075
Hypodivergent vs Hyperdivergent	p < 0.001**	p = 0.958	p < 0.001**

***p<0.05 – significant difference** **   **p<0.001 – highly significant difference**

Table 5: Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in males

Males	Symphysis angle Mean (SD)	Mandibular arc angle Mean (SD)	Inclination of symphysis Mean (SD)
Normodivergent	79.87 (4.19)	42.23 (2.77)	73.76 (2.33)
Hypodivergent	84.13 (5.92)	32.76 (4.65)	77.56 (4.55)
Hyperdivergent	79.91 (3.27)	44.98 (4.23)	71.42 (4.51)
One way Anova'F' test value	F = 4.245	F = 39.088	F = 9.290
p value, Significance	p =0.021*	p < 0.001**	p < 0.001**
	Tukey's post hoc test to find pairwise comparison		
Normodivergent vs Hypodivergent	p = 0.039*	p < 0.001**	p = 0.030*
Normodivergent vs Hyperdivergent	p = 1.00	p = 0.153	p = 0.245
Hypodivergent vs Hyperdivergent	p = 0.041*	p < 0.001**	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 6: Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in males

Males	Inclination of condylar head Mean (SD)	Curvature of canal Mean (SD)	Gonial angle Mean (SD)
Normodivergent	89.61 (5.72)	147.58 (5.35)	123.47 (3.02)
Hypodivergent	97.78 (3.60)	146.70 (4.87)	119.61 (9.01)
Hyperdivergent	87.69 (6.80)	154.87 (7.28)	132.67 (7.10)
One way Anova'F' test value	F = 14.013	F = 8.592	F = 14.379
p value, Significance	p < 0.001**	p = 0.001*	p < 0.001**
	Tukey's post hoc test to find pairwise comparison		
Normodivergent vs Hypodivergent	p = 0.001*	p = 0.914	p = 0.282
Normodivergent vs Hyperdivergent	p = 0.61	p = 0.005*	p = 0.002*
Hypodivergent vs Hyperdivergent	p < 0.001**	p = 0.001*	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 7: Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in females

Females	Mandibular Plane Mean (SD)	Upper Gonial angle Mean (SD)	Lower Gonial angle Mean (SD)
Normodivergent	29.81 (1.13)	50.99 (2.90)	71.53 (2.72)
Hypodivergent	22.89 (1.62)	50.98 (4.52)	64.76 (3.25)
Hyperdivergent	38.94 (0.51)	54.72 (3.53)	73.90 (5.74)
One way Anova'F' test value	F = 692.651	F = 5.038	F = 19.810
p value, Significance	p < 0.001**	p = 0.011*	p < 0.001**
	Tukey's post-hoc test to find pairwise differences		
Normodivergent vs Hypodivergent	p < 0.001**	p = 1.00	p < 0.001**
Normodivergent vs Hyperdivergent	p < 0.001**	p = 0.024*	p = 0.269
Hypodivergent vs Hyperdivergent	p < 0.001**	p =0.023*	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 8: Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in females

Females	Symphysis angle Mean (SD)	Mandibular arc angle Mean (SD)	Inclination of symphysis Mean (SD)
Normodivergent	79.79 (2.36)	38.12 (4.95)	79.62(3.31)
Hypodivergent	82.38 (5.42)	31.70 (3.62)	80.57 (3.47)
Hyperdivergent	74.25 (5.25)	41.95 (6.86)	70.75 (6.81)
One way Anova'F' test value	F = 12.410	F = 14.215	F = 19.009
p value, Significance	p < 0.001**	p < 0.001**	p < 0.001**
	Tukey's post hoc test to find pairwise comparison		
Normodivergent vs Hypodivergent	p = 0.276	p = 0.005*	p = 0.854
Normodivergent vs Hyperdivergent	p =0.005*	p = 0.131	p < 0.001**
Hypodivergent vs Hyperdivergent	p < 0.001**	p < 0.001**	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 9: Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in females

Females	**Inclination of condylar head Mean (SD)**	**Curvature of canal Mean (SD)**	**Gonial angle Mean (SD)**
Normodivergent	89.28 (5.56)	150.05 (8.88)	120.18 (2.86)
Hypodivergent	95.85 (4.25)	142.74 (7.41)	112.60 (5.46)
Hyperdivergent	81.37 (5.51)	154.97 (6.07)	132.63 (5.25)
One way Anova'F' test value	F = 29.727	F = 9.970	F = 70.048
p value, Significance	p < 0.001**	p < 0.001**	p < 0.001**
	Tukey's post hoc test to find pairwise comparison		
Normodivergent vs Hypodivergent	p = 0.003*	p = 0.030*	p < 0.001**
Normodivergent vs Hyperdivergent	p < 0.001**	p = 0.187	p < 0.001**
Hypodivergent vs Hyperdivergent	p < 0.001**	p < 0.001**	p < 0.001**

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

LINEAR PARAMETERS

Fig.1.a. : Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups .

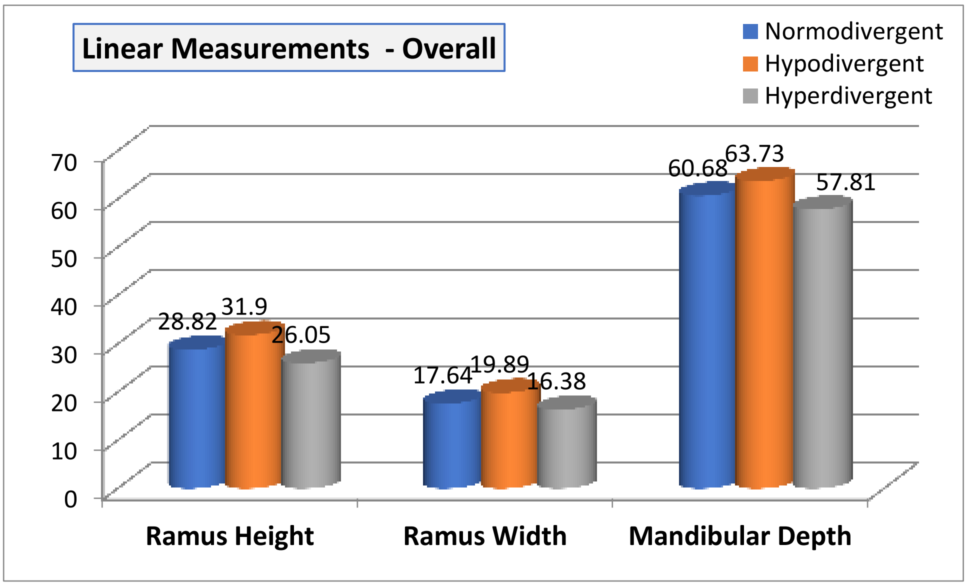


Fig.1.b. : Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups .

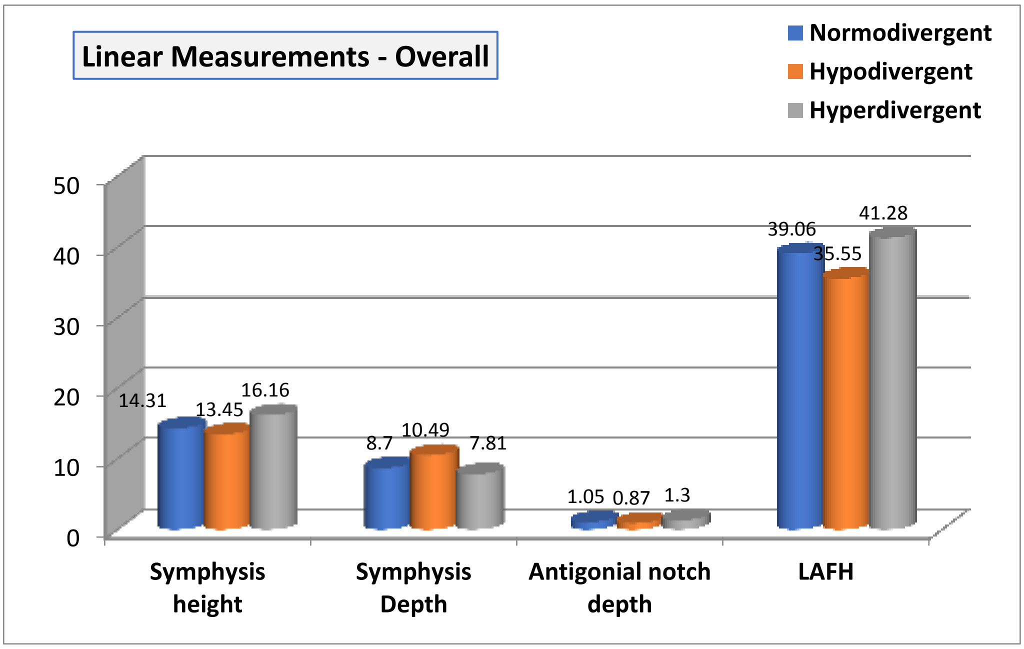


Fig.2.a. : Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups in males.

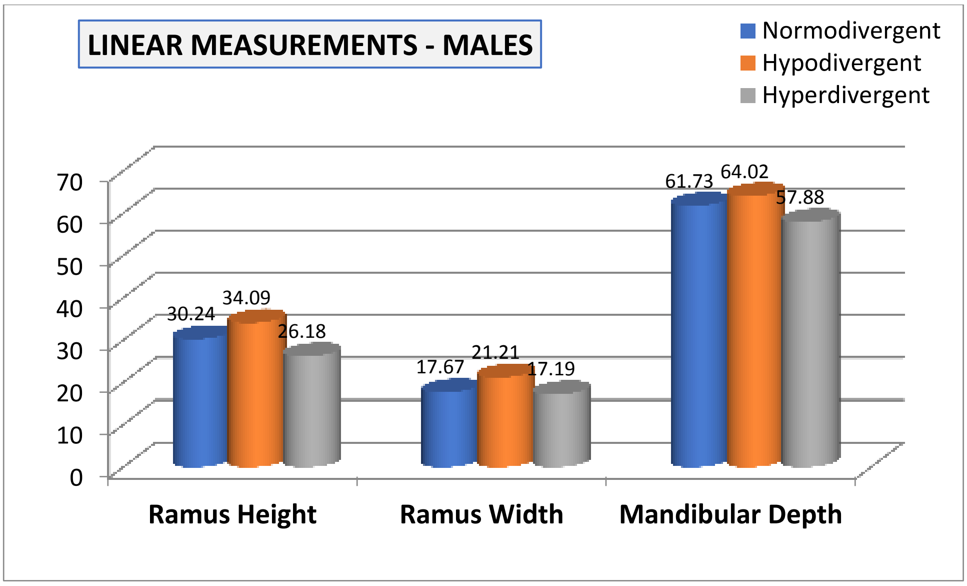


Fig.2.b. : Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups in males

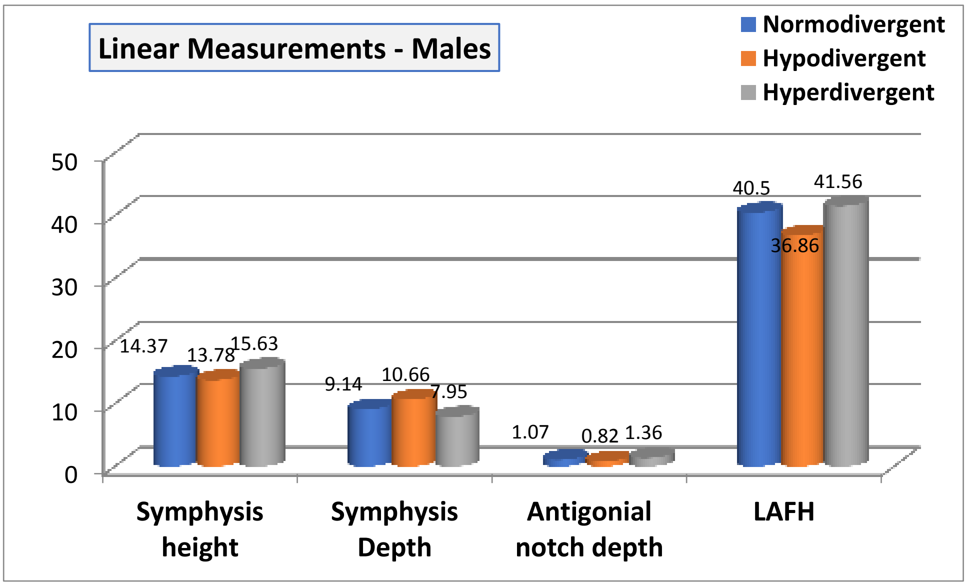


Fig.3.a. : Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups in females

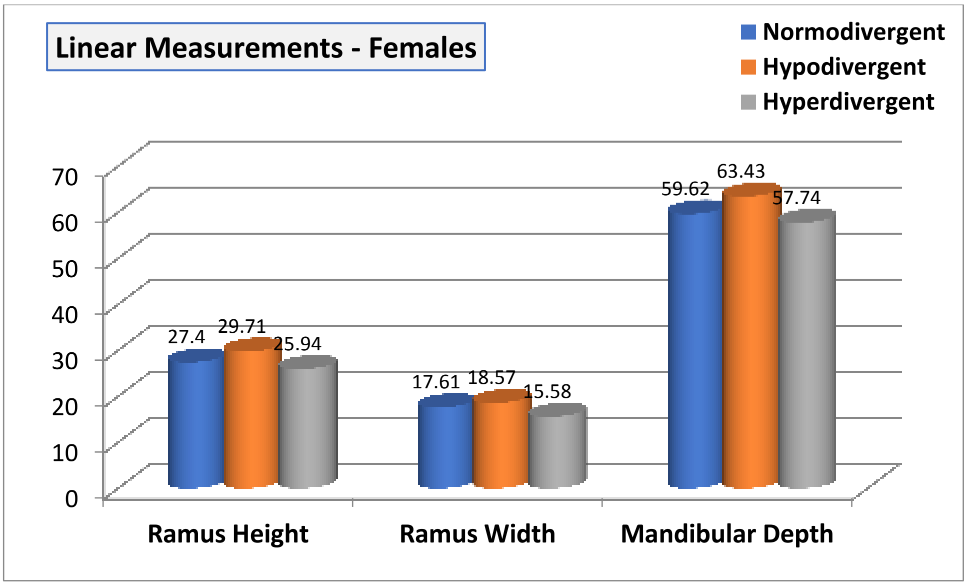
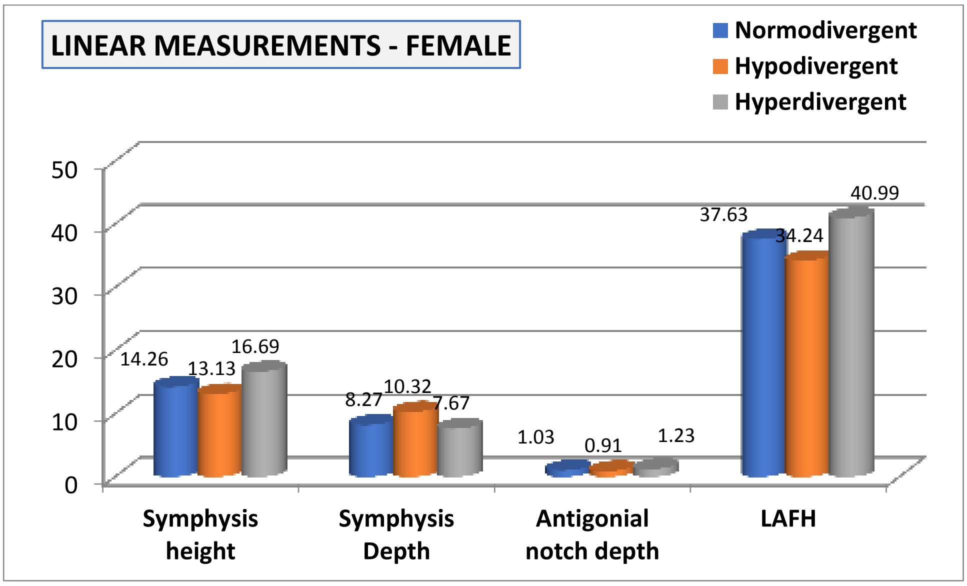


Fig.3.b. : Comparison of linear measurements between normodivergent , hypodivergent and hyperdivergent groups in females



GRAPHS ANGULAR

Fig. 1.a. : Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups .

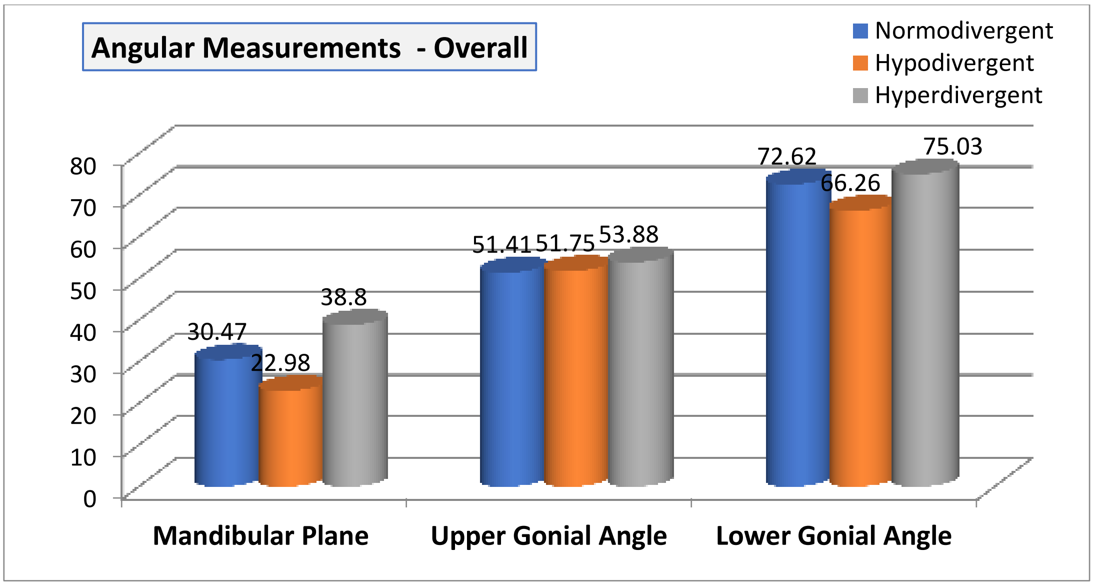


Fig. 1.b. : Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups .

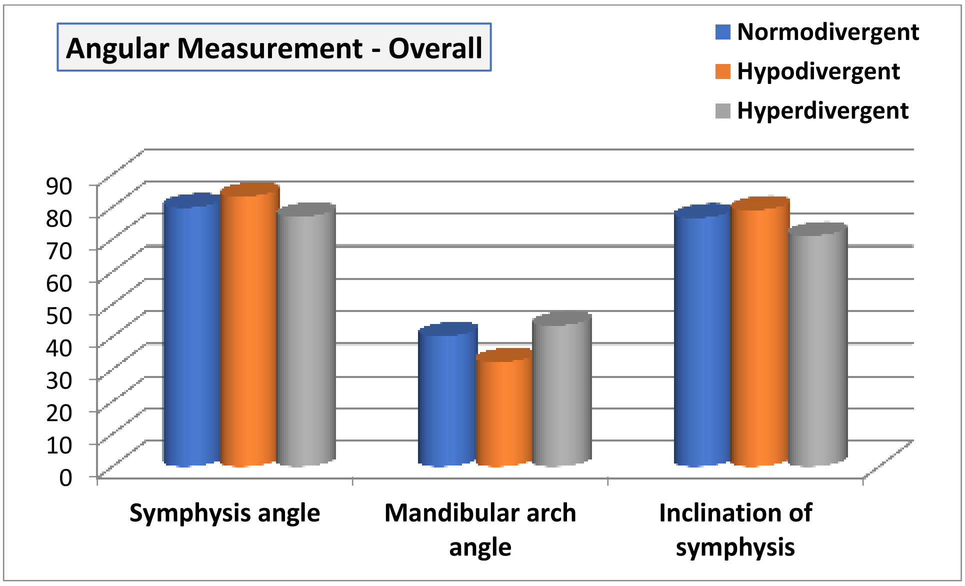


Fig.1.c. : Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups.

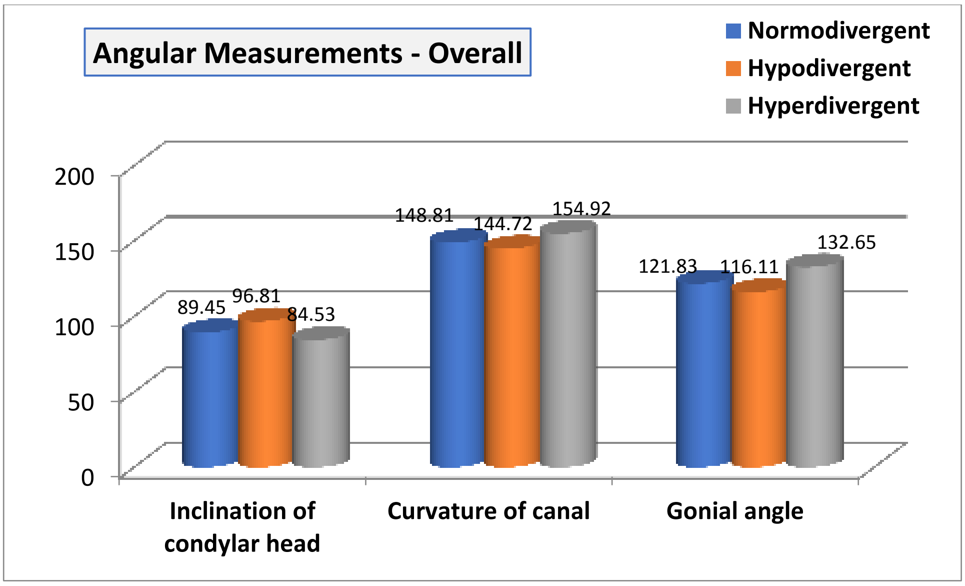


Fig.2.a. : Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in males.

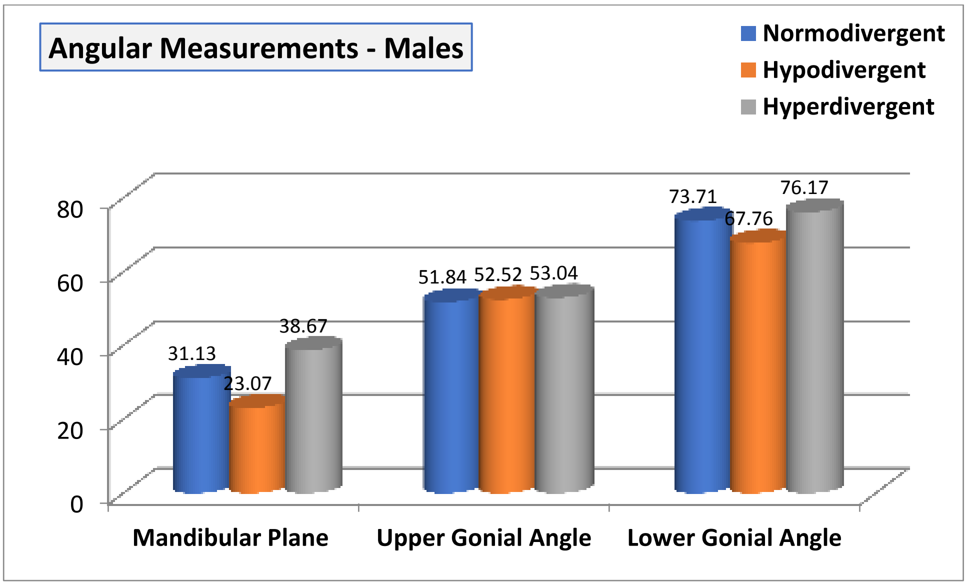


Fig.2.b. : Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in males.

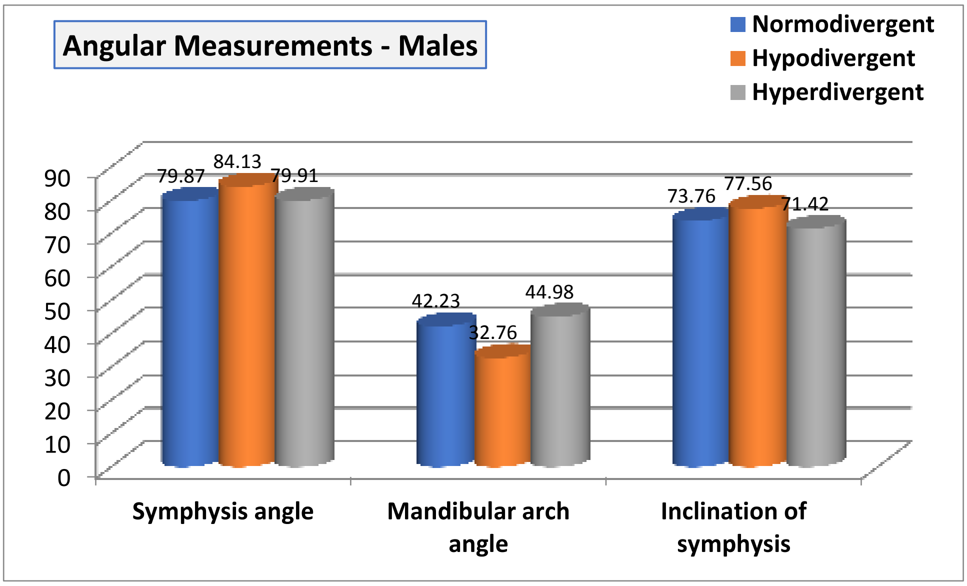


Fig.2.c. : Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in males.

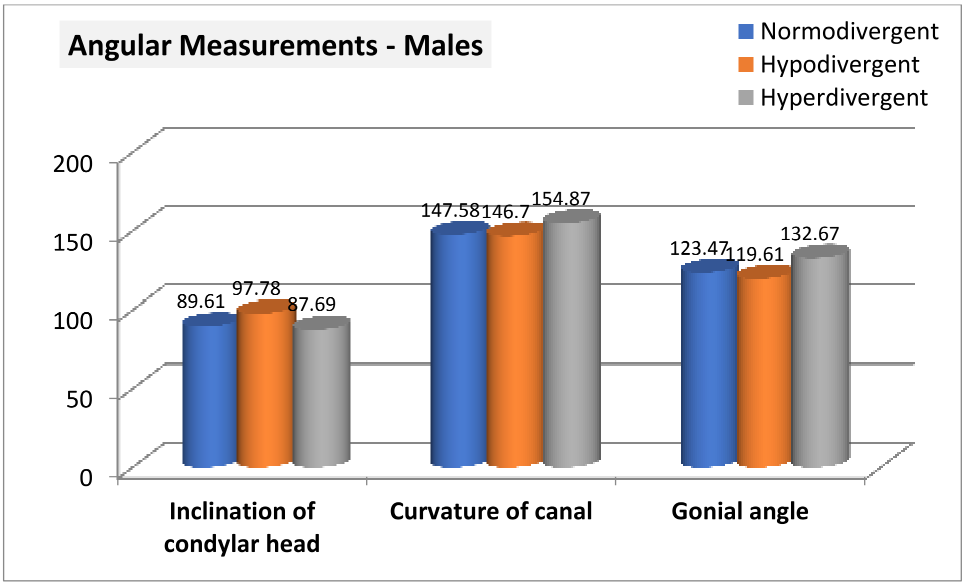


Fig.3.a. : Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in females.

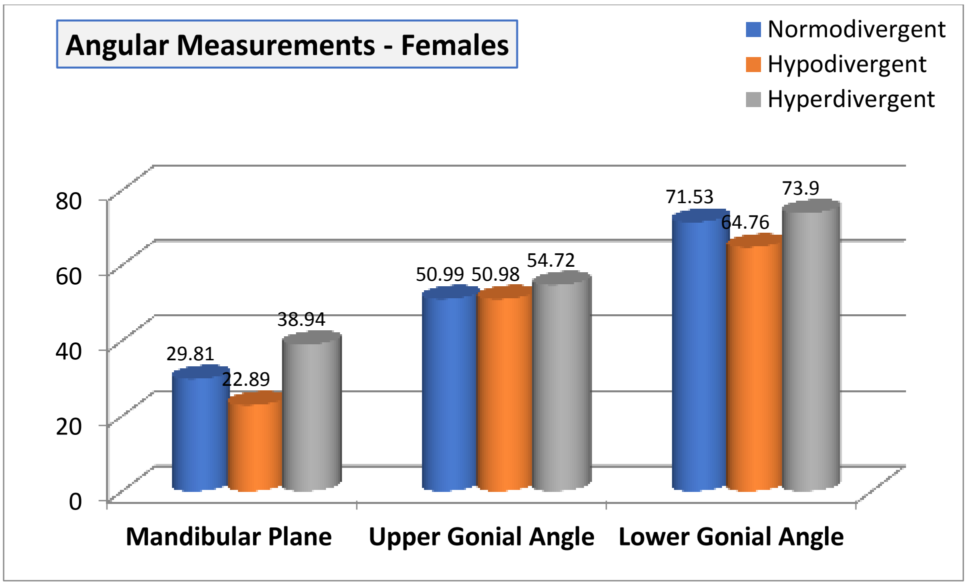


Fig.3.b. : Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in females.

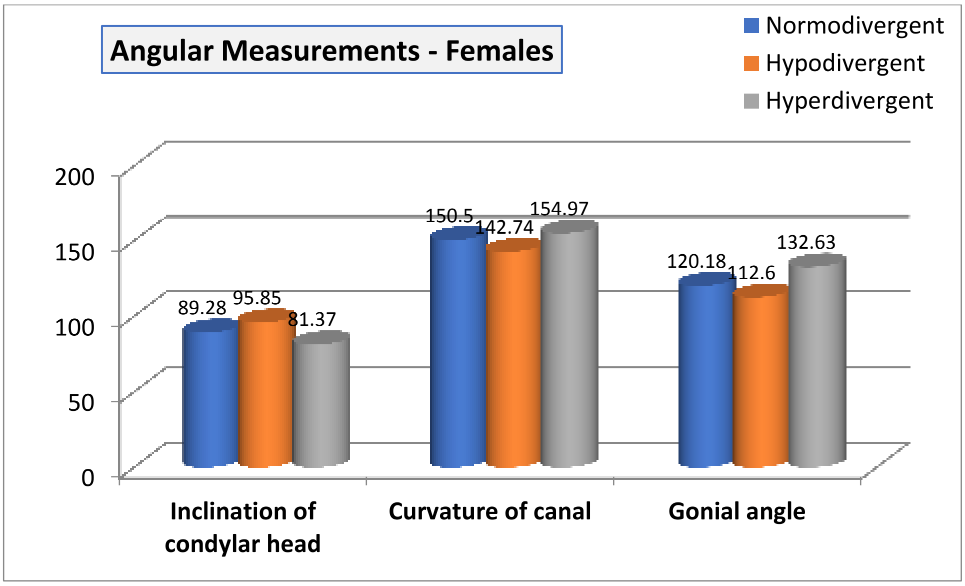
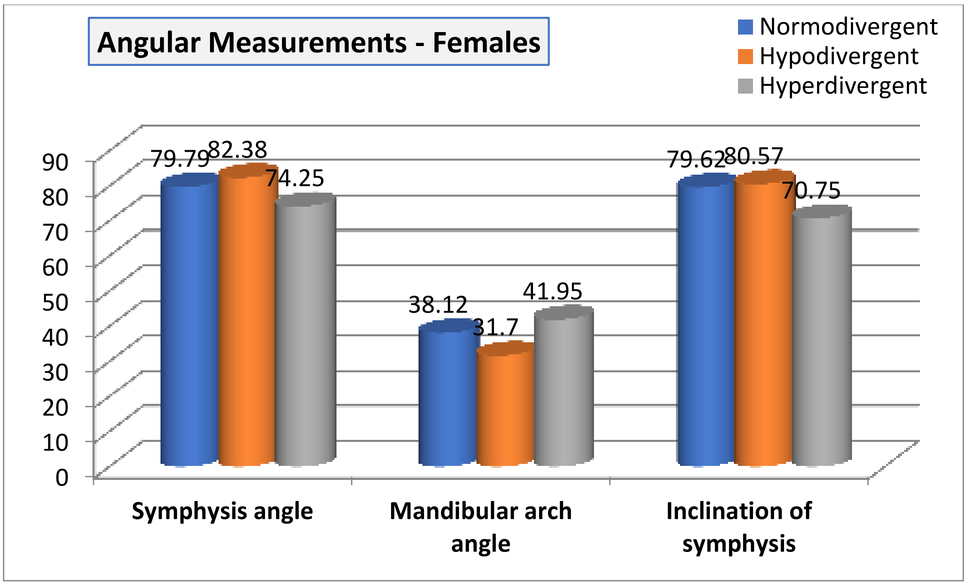


Fig.3.c. : Comparison of angular measurements between normodivergent , hypodivergent and hyperdivergent groups in females.



DISCUSSION

" Success is neither magical nor mysterious. Success is the natural consequence of consistently applying the basic fundamentals."

-Jim Rohn (American entrepreneur)

Orthodontic diagnosis and treatment planning have great emphasis on facial morphology and pattern of craniofacial growth. Thorough knowledge and basic understanding about different divergent patterns and their relation to each another is essential and directly influences the outcome of the treatment. Many studies have been done since long about growth of mandible. Bjork used metallic implants to evaluate changes occurred during growth.

Patients with Class II deformity are very common in day-to-day orthodontic practice. Also, the treatment plan for each patient with Class II malocclusion can be different based on different factors. The fundamental knowledge of mandibular morphology is essential in diagnosis and planning treatment objectives in both Orthodontic treatment and in Orthognathic surgical planning.

LINEAR PARAMETERS:

The *ramal morphology* is important to study specially when Orthognathic surgery need to be planned in skeletal Class II cases. It is of great importance in mandibular ramus osteotomy, as it decides the position of osteotomy cuts. Studies were done on evaluation of Ramal morphology in different growth pattern and best explained in Ricketts arcial growth pattern.

According to **Nanda**[52] Ramal height is a major contributor to posterior facial height and important in studying different divergent patterns. Present study showed that Ramus height and width is more in hypodivergent growth pattern have more ramus height than in normodivegent followed by Hyperdivergent pattern.

Similar results were observed in studies by **Hirota et al**[83]**, Isotupa et al**[84] **,Mangla et al**[73].

Symphyseal morphology plays very important role in orthodontic treatment planning as it is directly related to esthetics, which is the main concern of orthodontic patients. In Class II malocclusion esthetics is compromised mainly due to reduced chin prominence usually when mandible is at fault. So, it is important to consider the chin prominence during planning orthodontic treatment or orthognathic surgery. The rotation of mandible during growth in different divergences also affects symphyseal morphology.

The results suggest that Symphysis height in hyperdivergent group was greatest, which is followed by Normodivergent and least in hypodiveregent. Symphysis width in contrast is highest among hypodivergent growth and lowest in hyperdivergent group.

Studies done with correlated findings were **Haskell[40], Roy et al[85], Hylander[86]** which showed that the symphysis height increased and reduced chin prominence was seen in Vertical growers.

Past studies by **Kar and Agrawal[87]** showed that hyperdivergent group was significantly different only with the normodivergent group. In this study, the mean values of symphysis height were almost similar amongst the normodivergent and hyperdivergent groups followed by hypodivergent group.

Antigonial notch formation was explained by **Bjork** in his implant study that the change in direction of mandibular rotation causes, more remodelling at the inferior border of mandible in the area below angle of mandible which creates a Notch in inferior border of mandible.

Studies by **Ronald p kolodziej[67], Lambrechts[61], Singer[50], Enlow[88], Khoja[89]** proved that in a horizontally growing patient, the mandibular border is almost flat while in vertically growing patient, because of the backward rotation of mandible and the Masseter muscle pull, the antegonial notch gets deepened giving the lower border of mandible a notched appearance.

In this study, the mean values of antegonial notch depth was greater in hyperdivergent pattern and less in hypodivergent pattern. So, the study came in accordance with other studies mentioned earlier. Also, some studies showed that there is no significant difference among facial groups.

Lower anterior face height is the vertical distance between Anterior nasal spine to Mention point. This distance is affected by more increment or reduction through compensatory growth pattern. There is no gender variation found in studies by **Al Zubaidi(2005)[90],** while contradictory studies found significant variation given by **park(1989)[91].**

In the present study, LAFH was found to be increased in Hyperdivergent followed by Normodivergent and hypodivergent pattern respectively.

Mandibular depth shows the amount of retrognathism or prognathism of mandible. It is also important in studying growth and related studies**.** Mandibular depth was highest amongst the Hypodivergent pattern followed by Normodivergent and least in Hyperdivergent group. Females have less mandibular depth when compared with males in all divergent groups.

ANGULAR PARAMETERS:

Mandibular plane angle is used by Orthodontists for different purposes as Tweed used it in his Diagnostic triangle, **Schudy**[28] and **Issacson**[33] described facial morphology based on which certain mechanics is decided.

The difference in mean values of hypodivergent and hyperdivergent group as well as between Hypodivergent & Normodivergent group was found to be statistically significant. Similar results were also reported by **Dorthe betgenberger**[92]**, Gail. Burke**[63]**, and Clifford singer**[50].

In this study, The highest values were observed in the hyperdivergent group followed by normodivergent and lowest in the hypodivergent group. Similar trend was observed amongst the female participants from all the three groups.

Gonial angle is a valuable indicator in diagnosis of growth pattern and to determine rotation of mandible. It is a handy tool in age assessment in extreme situations like mass disaster, murderous mutilation, missing individual, etc. as reported by **Rubika et al**[93]**.**

Researchers revealed a great individual variation in gonial angle distortion and showed that the gonial angle differs with age and different types of malocclusion. gender did not have a considerable effect on the gonial angle.

In this study, lower gonial angle has highest value observed in the hyperdivergent group followed by normodivergent and lowest in hypodivergent group. The trend was similar amongst the female participants. The highest values were observed in the hyperdivergent group followed by normodivergent and lowest in hypodivergent group.

While upper gonial angle showed almost similar values in normodivergent and hyperdivergent groups followed by hypodivergent group. Similar trend was seen amongst the female participants from all the three groups.

The next variable studied was the *symphysis angle* and its effect on growth pattern. Symphysis in the hypodivergent group was found to be associated with a short height, large depth, small ratio (height/depth) and larger angle as compared with the hyperdivergent group in which the symphysis height was large, depth was small, ratio was larger, and symphysis angle was small. Similar findings were noted by **Ricketts(1960)**[94] and **Viazis(1992)**[95] who found a thick symphysis to be associated with an anterior growth direction.

According to this study, The highest values of symphysis angle were observed in the hypodivergent group followed by normodivergent and lowest in the hyperdivergent group.

And *Symphysis inclination* was studied by **Haskell**[40] suggested that with vertical development of the mandible, a smaller proportion of protruding chin is present. It could be interpreted that forward rotating patterns of growth allows pogonion to move in a relatively forward direction resulting in a prominent chin point. Backward rotating mandibles move pogonion backwards and downwards producing a less prominent chin.

In this study, the highest values were observed in the hypodivergent group followed by normodivergent and lowest in hyperdivergent group.

The highest values were observed in the hyperdivergent group followed by normodivergent and lowest in hypodivergent group. The trend was similar amongst the female participants.

Mandibular arc angle according to **Ricketts**[94]**, Bench**[96] and **Mangla**[73] significantly increased in hyperdivergent group when compared with hypodivergent and normodivergent groups.

The highest values were observed in the hyperdivergent group followed by normodivergent and lowest in hypodivergent group.

According to study by **Hazarey et al**[97], linear parameter was taken to check the *mandibular canal* and it was away from the mandibular plane in horizontal growers, whereas it was nearer to mandibular plane in vertical growers. In vertical growers the curvature of mandibular canal was more with average depth when compared to linear path in horizontal growers .

According to this study, mandibular canal angle was significantly increased in Hyperdivergent group and least among Hypodivergent group.

LIMITATIONS

- The evident limitation of the present study was small sample size.
- Lateral cephalogram being a two-dimensional representation of a three-dimensional structure, future studies are necessary with three dimensional radiographic aids.
- Since inclusion criteria were restricted to skeletal Class II discrepancy, further studies with other skeletal discrepancies can be carried out.
- Subjects were included on the basis of vertical facial patterns. However, the facial patterns in sagittal direction should also be taken into consideration.

SUMMARY AND CONCLUSION

The present study was done to assess and compare the mandibular morphology of Skeletal CLASS II malocclusion in three different facial types i.e. hyperdivergent, normodivergent and hypodivergent groups. 90 lateral cephalograms were taken which were divided into three groups (30 each) according to the SN-MP angle and all the linear and angular measurements were done. From the present study it can be concluded that,

- Ramus morphology showed ramal height and width is greater in Hypodivergent group and least in Hypodivergent group .

- Mandibular depth is highest in Hypodivergent group then in Normodivergent and least in Hyperdivergent group.
- Symphyseal height was increased in Hyperdivergent group and depth was increased in Hypodivergent group.
- Antigonial notch depth is more in hyperdivergent when compared with other two groups.
- Lower anterior face height is more in Hyperdivergent group and least in Hypodivergent group.
- Mandibular plane angle is more in Hyperdivergent group and least in Hypodivergent group.
- Symphysis angle is more in Hypodivergent group and least in Hyperdivergent group.
- Upper gonial angle is not significant and has no correlation between the groups.
- Lower gonial angle is more in Hyperdivergent group and least in Hypodivergent group.
- Mandibular arc angle is more in Hyperdivergent group and least in Hypodivergent group.
- Inclination of symphysis is more in Hypodivergent group and least in Hyperdivergent group.

- Inclination of condylar head is more in Hypodivergent group and least in Hyperdivergent group.
- Curvature of canal is more in Hyperdivergent group and least in Hypodivergent group.
- Gonial angle is more in Hyperdivergent group and least in Hypodivergent group.
- Study also showed that there is significant correlation in males of different facial divergent patterns and females showed similar trend in different facial types.

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(गोपनीय)

माहितीपूर्ण संमती फॉर्म

‘Evaluation of Mandibular Morphology of Skeletal Class II Malocclusions with different divergent patterns - A Software Study’

नाव: श्री/चि./श्रीमती/कु. .____

निवासी: ____ वय_________वर्ष.

माझ्या इच्छेच्या / निवडीचा कोणत्याही स्वरूपाचा कोणताही दबाव / प्रोत्साहन न लावता, याद्वारे

डॉ. ____________________________ ने प्रकल्पाचे आयोजन करण्याची माझी मंजुरी देतो/देते.

मी "रुग्णाच्या माहिती पत्रकाची" पावती स्वीकारत आहे आणि डॉक्टरांनी मला या संशोधन प्रकल्पाबद्दल योग्य आणि सूचनेबद्दल माहिती दिली आहे. मी माझ एक्स-रे आवश्यकते नुसार करण्यास सहमत आहे.

मी याप्रकल्पात भाग घेण्यास सहमती देतो आणि या चाचणीच्या काळात कोणतीही इतर योजना एकत्रित करणार नाही. मी डेन्टल हॉस्पिटलमध्ये किंवा इतर ठिकाणी दिलेल्या नियोजित तारखा आणि वेळांचे पालन करीन.

मी प्रमाणित करतो की मी या फॉर्मची माहीती वाचलेली आहे किंवा कोणाकडून वाचवून घेतली आहे.

____दिनांक______________

_______रुग्ण / कायदेशीर पणे अधिकृत प्रतिनिधी

स्वाक्षरी

(Confidential)

Informed Consent Form

'Evaluation of Mandibular Morphology of Skeletal Class II Malocclusions with different divergent patterns - A Software 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

LINEAR PARAMETERS

LINEAR MEASUREMENTS	RAM HGT			RAM WIDTH			MAND DPTH			SYM HGT			SYM DPTH			ANT NOT DPT			L ANT FAC HGT		
MALES	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper
	31.7	36.4	24	16.4	21.59	16.52	62.4	61.32	63.7	14.21	13.65	16.36	10.2	9.07	8.71	0.99	0.98	1.02	41.28	37	40.6
	30.4	35.4	24	16.94	20.48	18.55	59.52	65.33	63.7	13.87	12.5	16.36	9.75	10.05	8.71	1.05	0.87	1.21	43.09	34	40.6
	31.3	35	23.5	19.3	21.31	17.19	64.2	62.89	54.06	14.76	12.04	16.23	10.71	11.01	8.79	0.97	0.63	1.01	40.08	37.31	42.23
	29.1	32.8	21.6	18.12	20.23	16.3	59.24	68.35	46.71	15.29	14.75	13.16	8.94	10.09	7.91	1.25	0.76	2.79	39.27	38.68	40.73
	30.4	34.5	29.1	16.94	20.65	15.89	63.56	62.8	60.21	14.94	12.88	16.6	9.75	11.53	7.12	1.05	0.69	1.23	43.09	34.46	43.59
	29	35	28.2	19.99	20.56	17.77	61.3	62.42	54.06	15.03	12.43	14.78	7.61	10.82	6.97	0.98	1	1.95	38.5	34.27	42.58
	30.3	26.5	28.5	16.67	20.43	18.01	63.98	62.42	53.6	14.32	14.09	13.48	9.62	11.66	6.58	0.84	1.1	1.14	38.63	34.32	43.31
	28.1	37	29.8	15.38	22.64	19.33	61.81	67.88	58.55	14.35	13.13	15.48	7.4	10.62	6.27	1.67	1	1.12	40.48	36.28	44.1
	31.8	34.6	23.6	16.57	23.5	16.22	59.52	63.2	61.5	14.5	15.2	16.63	9.89	10.11	8.62	1	0.2	1.18	41.05	34.8	42.71
	30.4	29.3	28.4	16.82	22.64	18.73	60.13	61.34	56.94	13.85	14.6	18.03	7.52	10.3	8.23	1.27	0.64	1.01	38.37	35.9	40.06
	29	35.7	26.3	18.29	21.7	16.52	63.81	68.36	60.11	13.58	14.69	14.39	9.25	10.47	9.9	0.88	1.08	1.02	39.47	46.7	40.34
	31.7	37	28.7	20.03	20.8	18.52	60.2	67.2	60.41	14.88	15.9	14.46	9.1	10.7	8.92	0.98	0.94	1.99	41.09	37.54	41.61
	28.5	36.2	28.5	18.03	20.25	17.2	60.24	65.2	61.69	13.59	14.64	16.38	10.8	10.66	9.51	0.72	0.84	1.02	41.54	37.32	39.27
	30.1	31.4	21.1	18.2	21.5	15.83	63.74	61.23	61.52	14.91	13.8	15.12	8.63	11.83	8.03	1.23	0.83	1.02	41.65	36.26	40.9
	31.9	34.6	27.5	17.46	20	15.34	62.39	60.43	61.52	13.47	12.43	15.12	8	11.02	8.03	1.26	0.83	1.78	39.92	38.2	40.9
FEMALES	27.9	31.3	25.32	17.35	18.52	16.24	61.32	62.1	60.29	13.09	12.64	17.51	8.49	9.41	7.06	1.02	0.45	1.19	38.86	35.27	40
	28.5	28.1	23.5	17.74	20.9	17.32	60.76	60.86	55.24	15.2	12.23	16.77	9.18	10.15	6.89	0.98	0.64	1.25	36.08	34.58	41.13
	28.8	28.1	29	18.23	16.3	15.68	59.92	61.15	61.04	14.18	13.25	14.56	8.93	10.63	8.45	1.18	0.97	1.15	39.55	36.68	40.81
	29.7	32.4	25.3	16.68	18.75	15.86	55.42	64.94	58.5	13.6	12.36	14.63	8.4	10	7.79	0.63	0.75	1.51	36.61	33.43	40
	28.7	30.1	27.3	17.92	15.56	17.26	59.82	67.42	61.52	14.27	12.68	16.39	6.97	10.59	7.36	1.09	1	1.27	34.54	32.38	40.95
	26.3	29.3	27.5	17.23	19.77	14.69	56.42	64.5	60.59	14.62	14.49	17.04	6.62	10.44	9.74	1.21	0.92	1.87	39.24	32.96	42.4
	27.53	28.43	24.3	18.12	20.6	14.27	59.52	64.26	55.23	13.65	14.89	17.03	9.69	10.35	8.08	1.29	0.88	1.65	38.75	34.43	37.36
	30.4	26.4	26.4	18.33	18.46	18.79	58.2	60.42	52.53	14.84	12.95	17.74	10.5	9.81	9.53	1.43	1.2	1.31	38.39	31.34	41.33
	26.4	31.43	25.8	16.68	19.75	15.57	60	64.51	57.12	14.52	13.83	15.52	7.31	9.82	6.43	1.16	0.5	0.62	37.89	34.25	41.93
	28.2	27.6	28.3	20.53	20.98	16.37	61.42	61.71	55.04	15.07	14.71	16.75	7.92	10.73	7.55	1.02	1.4	1.44	36.77	36.96	41.98
	26.4	30.53	24.53	16.28	18.07	16.57	62.8	67.88	57.41	14.74	13.13	16.05	8	11.62	7.98	1.19	0.9	1.02	39.42	38.28	41.61
	28.4	31.7	25	18.09	17.42	12	65.86	67.52	59.46	14.25	12.67	16.7	8.02	10.88	7.34	0.54	0.99	1.26	36.67	33.33	39.91
	24.5	28.3	25.8	16.28	18.45	14.24	62.8	60.72	56.03	13.74	11.02	16.63	8	10.22	7.83	0.76	1	0.97	39.42	32.93	40.65
	27	29.5	25.6	18.46	19	15.44	52.09	62.53	60.65	14.59	13.99	17.27	7.25	10.67	6.71	0.97	1.19	0.95	32.99	33.34	41.17
	22.3	32.5	25.52	16.23	16.02	15.44	58.03	61.06	55.52	13.57	12.22	16.88	8.83	9.56	7.44	1.05	0.97	1.13	39.4	33.52	39.68

MASTER CHART
ANGULAR PARAMETRS

ANGULAR MEASUREMENTS	MAND PLAN ANG			SYM ANG			U GONIAL ANG			L GONIAL ANG			MAND ARC ANG			INCL SYMP			INCL CONDY HD			CUR OF CANAL			GONIAL ANG		
MALES	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper
	29	21.56	37.44	73.74	84.23	86.47	52.8	50.5	59.4	72.9	71.4	79.1	43.6	29.57	40.3	72.6	73.74	68.53	94.85	102.53	93.7	143.64	146.21	149.52	125.7	121.9	138.6
	32.64	20.35	37.48	81.42	88.3	73.24	52.1	45.6	59.4	72.4	65.1	79.1	42.3	28.7	41.5	74.67	86.54	62.32	94.85	98.47	86.16	146.99	150.56	149.52	124.5	110.7	138.6
	30.82	22.2	39.59	72.84	87.08	79.75	50.7	54.3	51.9	72.6	72.2	74.6	40.4	34.1	36.9	72.84	72.84	70.32	79.01	105.45	88.06	149.14	139.78	151.66	123.2	126.4	126.5
	31.52	21.54	39	74.59	88.52	83.56	49.6	49.3	58.1	70.5	64.3	72	39.8	37.1	45	78.2	74.59	74.32	91.65	101.79	99.65	146.16	145.41	152.81	120.2	113.6	119.1
	32.26	25.76	38	75.64	73.6	75.54	49.7	50	53.2	73.3	66	77.9	44.2	35.8	44.5	74.6	75.64	73.6	86.82	97.02	80.23	148.84	147.21	168.05	119	116.1	131.1
	30.5	24.46	38.38	82.88	86.73	80.22	51.5	45.4	47	73.2	68.8	80.8	42.3	34.8	46.6	74.5	82.88	71.32	80.72	92.05	98.16	145.34	145.53	155.11	124.7	144.2	127.8
	30	24.79	37.48	85.4	84.18	77.92	54.1	62.3	41.4	74	60.3	79.4	41.7	38.3	49.6	74.83	85.4	70.32	92.04	93.09	81.33	143	143.41	162.53	130	102.6	140.2
	32.48	22.62	40.73	83.32	82.3	81.71	50.2	54.3	57.3	73.5	72.2	74.3	41.6	30.8	36.9	72.31	72.84	76.5	80.57	98.39	88.06	148.27	149.78	139.82	125.5	126.4	131.6
	32.86	20.97	41.32	79.32	80.87	81.32	56.6	49.4	48.3	70.3	68.5	76.3	42.2	26.2	46.4	71.32	78.4	76.87	89.33	94.2	88.29	144.18	134.54	151.93	126.9	117.9	140.3
	31.85	23.29	35.84	78.45	88.52	81.77	50.2	52.4	47.1	73.5	65.8	72	39.6	37.1	48.5	75.92	81.45	70.32	91.65	98.39	86.38	148.27	146.64	152.81	123.7	118.2	138.3
	29.58	26.64	38.74	86.67	85.9	80.57	51.4	52.6	40.5	78	64.7	77.3	40.5	34.9	46	68.72	74.33	72.32	92.32	94.4	72.7	147.82	145.56	158.02	124.4	117.3	127.3
	28.49	20.28	39.72	80.43	89.32	79.89	56.6	50.3	60.5	77.7	71.3	75.5	40.5	28.8	49.4	76.06	79.43	78.02	92.12	96.56	83.63	142.06	152.54	166.54	122.4	121.6	135.9
	29.74	23.49	39.74	82.78	90	75.96	49.4	51.3	48.7	73.4	69.3	74	50.6	33.8	45.9	74.23	76	74.2	88.07	98.95	91.3	146.24	151.35	151.47	120.3	120.6	122.7
	32.85	25.87	40.27	81.35	68.94	79.68	53	51.4	62.6	77.1	67.3	79.7	40	23.1	48.5	71.09	74.78	68.94	91.16	98.39	89.73	165.14	149.54	152.48	122.4	118.7	142.3
	32.43	22.35	36.33	79.34	83.53	81.12	49.7	58.8	50.3	73.3	69.2	70.6	44.2	38.4	48.7	74.6	74.67	63.42	99.13	97.02	88	148.54	152.4	160.79	119.2	118	129.8
FEMALES	29.32	23.23	38.28	78.28	87.86	74.78	50.2	45.4	49.8	71.2	60.5	72.6	36	35.1	34.2	76.47	72.28	60.4	83.52	97.56	82.81	143.32	149.21	149.11	120.4	103.5	126.5
	29.32	20.18	39	81.68	88.49	74.67	58.2	51.2	56.1	77.9	66	76.4	30.3	29.1	41.7	73.24	81.68	60.09	89.52	97.71	74.72	148.34	131.12	155.332	121.4	105.1	130.7
	31.46	23.44	39	78.89	90.4	74.44	46.7	50.5	55.9	73.7	59.7	74.2	42	38.6	47.7	79.75	78.89	61.42	99.34	97.08	84.7	145.61	131.66	156.12	119.4	117	137.5
	30.23	22.78	39.13	85.48	88.49	78.2	49.5	55.9	56.7	70	61.7	78.3	43.2	25.8	48	83.56	85.48	70.52	97.48	94.07	74.72	142.04	145.37	156.42	120.4	110.2	138.4
	29.44	24.55	38.42	77.39	79.33	76.6	51.8	51.4	58.8	68.3	68	78.8	40.4	34.3	26.6	75.54	77.39	72.64	95.54	92.88	80.39	161.14	140.02	142.57	115	107.6	135
	30.48	25.89	39.52	77.44	79.63	74.5	51.3	47.9	59.7	71.6	68.9	79.9	41.5	33.3	47.1	80.22	77.44	68.85	95.89	102.98	87.56	162.17	142.93	151.86	120.1	119.5	130.6
	28.24	22.34	39.48	78.87	74.05	74.83	48.8	49.2	55.8	72.2	60.5	72.7	43.5	28	51.7	77.92	78.87	67.47	89.05	93.42	79.14	155.67	144.4	167.27	122.9	116.8	129.6
	30.42	22.45	39.47	80.43	79.24	75.92	52.4	54.3	51.5	71.3	64.8	71.7	37.4	29.9	43.1	81.71	83.49	71.54	82.42	97.98	81.1	153.22	144.54	152.73	121	109.6	138.5
	30	20.76	38.42	81.32	86.82	74.84	47.7	39	55.4	65.8	67.6	79.3	44.5	34.6	48	81.19	83.17	65.36	90.42	90.76	87.26	144.59	130.48	155.61	120.3	119.1	129.2
	29.38	23.54	38.47	82.76	76.62	75.92	54.2	52.1	53.7	74.4	68.9	74.2	39.7	32.9	38.8	81.77	82.76	71.36	82.26	87.8	86.35	148.6	146.71	161.29	113.5	106.6	130
	29.31	24.29	39.74	78.78	88.03	60.72	48.6	58,1	46.6	71.9	65.1	74.2	38.9	29.5	41.7	85.99	78.78	78.84	89.22	98.19	87.64	130.36	149.67	161.74	125.6	121	134.5
	29.73	24.45	38.27	79.6	79.91	73.65	49.8	51.8	51.9	70	62.8	72.7	28	27.6	31.6	79.89	79.6	79.91	83.92	103.03	71.28	164.41	139.42	155.42	120.5	113.2	120.8
	32.62	20.65	38.48	77.2	76.28	85.24	54	46.3	52	72.6	67.3	71.6	37.4	30	41.4	75.96	82	76.28	88.52	98.43	76.15	152.26	157.56	159.42	119.8	114.5	131.7
	28.31	21.38	39	81.3	78.12	67.09	50.6	50.3	54.7	71.5	62.4	55.8	37.5	21.6	46.2	84.11	85.32	78.12	87.18	92.44	88.07	153.41	144.65	149.52	120.3	113.6	136.1
	29	23.55	39.43	77.43	82.53	72.36	51.1	51.4	52.2	70.6	67.3	76.1	31.5	36.3	41.5	81.12	81.43	78.47	85	93.42	78.79	145.62	143.45	150.11	122.1	111.7	140.4