COMPARISON OF CONDYLAR AND RAMAL ASYMMETRY IN SUBJECTS WITH CLINICALLY NON-OBVIOUS AND OBVIOUS FACIAL ASYMMETRY - AN ORTHOPANTOMOGRAPHIC STUDY

DISSERTATION

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In

ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

By

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I hereby declare that this dissertation entitled "Comparison of condylar and ramal asymmetry in subjects with clinically Non-Obvious and Obvious facial asymmetry - An Orthopantomographic study" is a bonafide and genuine research work carried out by me under the guidance of *Dr. Kamna Srivastava*, Reader, Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

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S.NO	ABBREVIATED FORM	FULL FORM
1.	OPG	Orthopantomogram
2.	CH	Condylar height
3.	RH	Ramal height
4.	TH	Total height
5.	CAI	Condylar asymmetry index
6.	RAI	Ramal asymmetry index
7.	TAI	Total asymmetry index
8.	CRAI	Condylar ramal asymmetry index
9.	CBCT	Cone-beam computed tomography
10.	PA ceph	Posterioanterior Cephalogram
11.	Me	Menton
12.	TMD	Temporomandibular Disorder
13.	SMV	Submentovertex view

14.	R	Right
15.	L	Left
16.	UPC	Unilateral posterior crossbite
17.	SNGoGN	Angle between SN and Steiner's mandibular (Go-Gn) plane

ABSTRACT-

Introduction: Mandibular asymmetry is one of the primary causes of facial asymmetry that can be caused by variations in the height of the ramus or condyle. Hence it was decided to compare of condylar and ramal asymmetry on OPG in subjects with clinically non-obvious and obvious facial asymmetry**.**

Materials and Method: On the basis of clinical examination and confirm it by measuring menton offset on facial photographs, subject were divided into two groups i.e. Group I with clinically non- obvious facial asymmetry (Me offset <1mm, n=50, Mean age-18 ± 1 years) and Group II included subjects with obvious facial asymmetry (Me offset >1mm, n=50, Mean age-20± 1 years). The condylar and ramal measurements was measured on OPG using Digimizer software. Asymmetry indices were calculated by Habet et al method. Data was tabulated and statistically analysed by ANOVA and student’s t-test.

Results: The mean CH for both groups was significantly higher on left side than right side (L>R) (P<0.05). Only CAI showed statistically significant difference between Group I and Group II (P<0.05).

Conclusions: Mild form of condylar asymmetry in clinically non-obvious facial asymmetry group can be masked by soft tissue drape of the face upto certain extent while moderate to severe amount of condylar asymmetry may be the possible reason of clinically obvious facial asymmetry. So, timely diagnosis and treatment of condylar asymmetry is necessary to decrease it side-effects of causing temporomandibular disorders, muscle hyperactivity and functional problems.

Key-words: Condylar height, Ramal height, Condylar asymmetry index, Ramal asymmetry index, Digimizer software.

INTRODUCTION

Orthodontics is a dental specialty that includes both, the correction and prevention of dental irregularities as well as the assessment and correction of facial form. Assessment of the face is carried out in all three planes of space i.e. sagittal, vertical and transverse. The most important, but occasionally neglected aspect of facial form that can influence treatment decision and outcome is the presence of facial asymmetry.

Facial symmetry is derived from a Greek word “symmetries” which means of “like measure” where one half of the face is equivalent and same as another half, however true bilateral symmetry is never present naturally.[1] Asymmetry of the craniofacial complex was a common occurrence and sculptors of olden times reproduced this in their art. The debate on symmetry was not confined to the world of art. A German orthodontist, Simon (1924), stated “bilateral symmetry is a most common morphological characteristic of the body and especially the head.”[2]

According to Oxford dictionary (2010), asymmetry is a lack of equality of equivalence between parts or aspects of something; lack of symmetry”.[3] In relation to the face, symmetry and balance can be considered as correspondence in size shape and arrangement of the facial features on both sides of the mid sagittal plane. The bilateral symmetry is rare hence various studies evaluated the same. [(3,6-14)]

Few studies that evaluated bilateral asymmetry using composite photographs [(4,6-13)] found that images constructed of the original image and a reverse left or right side, when viewed by strangers, were not identified as belonging to the original image, whereas, the individuals from which the images were taken were able to recognize themselves from the image made of the left sides. This method allowed observation of mild asymmetries of an individual.

Mild facial asymmetry exists in every face that can be neglected and cannot be considered as abnormal condition unless it is clinically obvious. The clinically obvious facial asymmetry is a concern for individuals for which they seek treatment to enhance facial attractiveness. The perception of facial asymmetry differs between clinicians and individual subjects. The facial asymmetry as observed by individuals is asymmetry of overlying soft tissues that may completely or partially mask the underlying skeletal asymmetry of variable extent. [(13,14-15)]

Facial asymmetry results from congenital causes, environmental causes and functional factors. Congenital causes such as hypoplasia of the ramus and condyle can play a role in the development of mandibular asymmetry.[13]

Among environmental causes, pathological factors such as infections, tumors, osteoarthritis of the temporomandibular joint, rheumatoid arthritis, and myogenic problems such as Myospasm, chronic muscle shortening, muscle splinting, or occlusal interferences can also lead to mandibular asymmetry. Trauma during the growth period can result in condylar asymmetries by disturbing the downward and forward growth of the mandible.[16] Along with morphological asymmetry, functional and mechanical stresses may influence mandibular asymmetry. Mongini et al.[17] showed that the chewing forces during mastication indicate the magnitude of joint loading over time, which is related to condylar size. Few investigators found that a reduction in the height of the mandibular ramus was associated with a decrease in function (el Mofty).[18] The adaptive response of the mandible to deviations during function may cause remodeling of the condyle and glenoid fossa, which may lead to mandibular asymmetries.[19]

Mandibular asymmetry is one of the major cause of craniofacial asymmetry because of its direct effect on facial appearance and needs special attention during orthodontic diagnosis and treatment planning.[20] Mandibular asymmetry is of great interest for both orthodontists and prosthodontic specialists, not only for aesthetic considerations, but also because of its involvement in the stomatognathic system which may cause functional problems such as temporomandibular disorders along with psychological disturbances.

Various studies investigated the relationship between condylar asymmetries and temporomandibular disorders (TMD) and concluded that condylar asymmetry has been associated with TMD, emphasizing the importance of its evaluation in subjects with clinically obvious facial asymmetry. It is important to determine the etiological factor and to identify the site of the asymmetry in order to achieve a balanced and harmonious facial appearance following orthodontic or surgical treatment.

Mandibular asymmetry manifests as asymmetrical condylar and ramal height with morphological changes like rotated facial appearance with kinking at the mandibular symphysis, prominence of lower mandibular border and canting of occlusal plane. Condylar and ramal measurements are important to know where impairment of growth has occurred resulting in facial asymmetry. Treatment in early stage is less traumatic to patient and comparatively easier for clinician.

For assessment of craniofacial asymmetry various type of diagnostic aids can be used like frontal photograph, two-dimensional radiographs (Posteroanterior Ceph (PAceph), Orthopantomogram(OPG) and submentovertex view (SMV)) and 3D imaging techniques (lasers, stereophotogrammetry, CT, CBCT and MRI etc.).[1] Frontal facial photographs can be used to quantify soft tissue features but hard tissue can be analyzed only by radiographic methods. Among 2-D techniques, comparative assessment of facial asymmetry using PA ceph, SMV and OPG has been reported. Posteroanterior cephalometry has been used commonly to evaluate and measure facial asymmetry since decades. All horizontal lines connecting bilateral cranial landmarks and vertical lines perpendicular to these horizontal lines can adequately serve as reference lines in the analysis of vertical asymmetry from PA cephalograms. However, use of PA ceph warrants need of additional radiation exposure and landmark identification is difficult. Submentovertex (SMV radiograph) provides good visualization of the skull base, mandible and condyle and helps to identify transverse craniofacial asymmetries but it cannot detect asymmetries in the sagittal and coronal planes. This also needs additional radiation exposure of patient for assessment of craniofacial asymmetry. The assessment of condylar and ramal asymmetry on OPG which is routinely taken as preliminary record for patients undergoing fixed orthodontic treatment is an excellent alternative for preventing additional radiation exposure.

Though 3-dimensional image analysis is becoming a more popular and viable option for assessing the soft and hard tissues. The biggest disadvantage is high radiation exposure than conventional radiograph, associated high cost, including purchasing the equipment and necessary software, therefore limiting the number of clinicians able to offer such techniques.

Hence assessment of condylar and ramal measurement in present study was done by tracing concerned landmarks on OPG that is taken as essential diagnostic record for subjects undergoing fixed orthodontic treatment. Different author proposed various methods to assess mandibular asymmetry on OPG- Habet's method (1988)[21], Kjellberg method (1994)[22] and the Levandoski method (1995)[23] are used to commonly. All these methods compared the quotients from both sides, instead of a linear measurement to avoid magnification error hence expressing mandibular asymmetry as asymmetry indices.

Habets et al [21] (1988) diagnosed vertical asymmetries between the right (R) and left (L) on OPG by evaluating the difference in vertical height between the two sides expressing it as an asymmetry index ((R - L)/ (R + L) x 100%).

Kjellberg's modified Habet's et al method[21] by calculating CH from superior most point of condyle (CO) to sigmoid notch (MN), the mandibular height (MH) as the distance between MN and GO (gonion), and the ramal height (RH) as the distance that goes from CO to GO. They calculated condylar symmetry Index (SI) = (CH/ RH_A)/ (CH/ RH_B) X 100 Where RH_A was RH with lesser measurement that could be of right or left and RH_B was RH with higher measurement.

Levandoski had drawn lines perpendicular to a maxillary vertical midline at symphysis of the mandible (Go′), the tip of the condyle (Cd′) and the tip of the coronoid process (Kr′) that represented CH (Cd’-Kr’) and RH (Kr’-Go’) respectively.

As Habet’s technique is the oldest method of assessing asymmetry through OPG and was easier in terms of identifying the points and measurements. Hence it was used in present study.

Facial asymmetry had been assessed in subjects with different malocclusions or single malocclusion grou, in unilateral and bilateral crossbite using OPG.A study by Hirpara et al compared vertical facial asymmetry using posteroanterior cephalogram and orthopantomogram and concluded OPG can be effectively used to assess difference between right and left maxilla and posterior mandible based on asymmetry indices. Larheim et al concluded that vertical measurements on panoramic radiograph within limitations are more accurate than horizontal / transverse and angular measurements.

However, no study has been conducted to compare condylar and ramal asymmetry using OPG between subjects with clinically obvious facial asymmetry and non-obvious facial asymmetry. Clinical examination and facial photography were used to classify subjects in two groups i.e. those with clinically obvious facial asymmetry and non-obvious facial asymmetry, this was followed by assessing underlying facial asymmetry on OPG. Considering this, the aim of our study was to evaluate condylar and ramal vertical asymmetry on OPG in subjects with clinically obvious facial asymmetry and non-obvious asymmetry as assessed on frontal facial photographs.

AIM

To evaluate and compare condylar and ramal morphology in subjects with clinically obvious and non-obvious facial asymmetry using OPG.

OBJECTIVES

I. To evaluate condylar and ramal height for both right and left side in subjects with clinically non-obvious facial asymmetry.

II. To evaluate condylar and ramal height for both right and left side in subjects with clinically obvious facial asymmetry.

III. To evaluate various asymmetry indices in subjects with clinically non-obvious facial asymmetry.

IV. To evaluate various asymmetry indices in subjects with clinically obvious facial asymmetry.

V. To compare condylar and ramal height between right and left side for each group.

VI. To compare different asymmetry indices [2] between subjects with clinically obvious and non-obvious facial asymmetry.

REVIEW OF LITERATURE

1. **Eugene H. illiamson, and Michael D. Simmons (1979)**[24] conducted a study to assess the amount of mandibular asymmetry measured from submental-vertex and frontal radiographs of 53 subjects and to test for a correlation with muscle pain to palpation. The submental-vertex, measurements were made by marking the center of the right and left condyles and the midline on the most anterior point on mandibular symphysis. The distance from the points on the posterior surface of the condyles to pogonion was measured to the nearest 0.5 mm. and recorded. In frontal radiograph, the most superior portion of each condyle was identified and marked and point on the inferior surface of the mandibular symphysis inferior to the genial tubercles was selected. This point has been shown to coincide with menton on the sagittal headfilm. The distance from each condylar point to menton was then measured to the nearest 0.5 mm. and recorded.All subjects displayed malocclusions and were examined for sensitivity of the muscles of mastication to palpation. The technique of Solberg and Krough-Poulson was followed for muscle palpation, that is bilateral testing was done by the operator and the subject was asked to compare sides and then determine the degree of sensitivity. The No. 1 was assigned to mild, No. 2 was assigned to moderate, and No. 3 to severe. The numbers were then totalled for all the muscles of each patient and assigned as the patient's pain-dysfunction index. Amount of asymmetry and the patient's pain-dysfunction index was calculated. Correlation between amount of asymmetry from the submental-vertex film and amount of pain was calculated. No statistically significant correlation was shown between mandibular asymmetry and muscle sensitivity. There was no correlation between the amount of mandibular morphologic asymmetry and the amount of facial pain elicited from muscle palpation.

2.**Larheim TA and Svanaes DB(1986)**[25] conducted a study to evaluate the reproducibility of nine mandibular variables (vertical, horizontal and angular measurements) assessed from repeated panoramic exposures. Two separate exposures of three groups of patients were made under different radiographic conditions, each group representing one method. Acceptable reproducibility was observed for the vertical and angular variables, the method variance being mostly within 3% of the total variance. Horizontal variables were clearly more unreliable. No statistically significant differences were observed between the reproducibility of the right and left sides. A negative correlation was found between the angular variables within two groups. For most variables, only small differences among the methods were found. The highest reliability was obtained when the same radiographer recorded the reference number of the head positioner and made both exposures. An accuracy study on five dried skulls showed an image magnification of approximately 18% to 21% for the vertical variables, whereas the gonial angle assessed from a panoramic film was almost identical to that measured on the dried mandible.

3. **Habets LLMH, Bezuur JM, Naeiji M And Hansson TL (1988)**[21] conducted a study to compare the vertical dimensions of the condyles and the rami in the OPG images between two different groups of patients, with and without craniomandibular complaints, focusing their respective magnitude of vertical symmetry. Condylar asymmetries with more than 6% difference in vertical dimensions between the left and right sides are supposed to be noted in an OPG Orthopantomograms (n=152) was used to assess condylar and rami heights. The outlines of the condyle and the ascending ram us of both sides were traced on acetate paper. On the tracing paper a line (A) was drawn between the most lateral points (O_1) of the condylar image and of the ascending ramus image (O_2). To this line ('the ramus tangent'. A) from the most superior point of the condylar image a perpendicular line (B) was drawn. The vertical distance from this line on 'the ramus tangent' to the most lateral point of the condyle (O,) projected on the ramus tangent was measured. This distance was called the condylar height (CH). The distance beween the two originally marked most lateral points of the image (O_1 and O_2) was called the ramus height (RH) and measured. (R-L)/(R+L) X 1OO % was used to assess asymmetry index. These differences were always bigger in the CMD group than in the dental group. A statistically significant

difference was found between the patients of a routine dental group and the patients treated for craniomandibular disorders (CMD) for condylar height symmetry.

4. **Peck S, Peck L, Kataja M (1991)** [26] conducted a study on (n=52) white adult subject on PA ceph and photographs to evaluate skeletal asymmetry in aesthetically pleasing faces.PA ceph and photographic records were taken for each patients. A midskeltofacial line were constructed on each ceph by shore’s method. Skeletal asymmetry were computed from three bilateral landmark as described by Sassouni- 1) laterosuperior orbit,LO; 2) lateral zygoma Zyg; and (3) gonion Go. The difference between each pair of measurement was recorded as left minus right, in this way sidedness in facial asymmetry could be evaluated. Seperate computation were made to test for left and right side dominance. This study concluded that the laterosuperior orbit exhibited the least asymmetry and least variability and a slight tendency towards right side than left side was found but not statistically significant.

5.**Miller VJ (1992)**[20] A group of patients with a craniomandibular disorder of arthrogenous origin demonstrated an age-related variation of condylar asymmetry with age on panoramic x rays. This may reflect a greater depletion of the mesenchymal cell layer, which is responsible for adaptation of the articular surface as age increases. This would then result in greater deterioration of the articular surfaces and a consequent decrease in condylar asymmetry. The vertical condylar asymmetry index calculated by Habets et al method was found to decrease as the age of the patient increased. The mean asymmetry index (Al) for this group of patients, namely 18.76 % , was significantly higher than that reported by Habets et al. They reported a value of 7.3 % for patients with an arthrogenous origin of pain in a group of patients with craniomandibular disorders.There appears to be a negative correlation between age and asymmetry index. This could reflect a gradual loss of undifferentiated mesenchymal cells in the articular surface, and thus a decrease in asymmetry with the development of degenerative joint disease. No significant association appears to exist between left or right-handedness and the value of the asymmetry index. This appears to rule out an effect on asymmetry as a result of left- or right-hand dominance. Thus, when considering asymmetry indices in patients with an arthrogenous origin of pain, it is necessary to consider the patient's age.

6.**Ferrario VF, Sforza C, Pizzini G, Vogel G (1993)**[7] evaluated size and shape difference in males and females using Eucledian distance matrix analysis on photographs of 108 healthy young adults (57 men and 51 women). It was found that males face was larger than females and the face was longer in males than females. A global shape difference was demonstrated, the male face being more rectangular and the female face more square. Gender variations involved especially the lower third of the face and, in particular, the position of the pogonion relative to the other structures was seen.

7.**Ferrario VF, Sforza C, Miani A and Serrao G (1994)**[27] studied facial asymmetry (n= 80; men-40, women-40) using 3 dimensional coordinates of 16 standardized facial landmarks (trichion, nasion, pronasale, subnasale, B point, pogonion, eye lateral canthi, nasal alae, labial commissures, tragi, gonia) were measured by infrared photogrammetry by an automated instrument. The form of the right and left hemifaces was assessed by calculating all the possible linear distances between pairs of landmarks within side. Side differences were tested by using euclidean distance matrix analysis. He concluded that right side of the face was larger than left side. The mean faces of both groups were significantly asymmetric i.e. two side of the face showed significant difference in shape but no difference in size. 3-dimensional analysis of the human face provide better evaluation of the harmonic relationships among craniofacial structures, including the contribution of muscles and adipose tissue.

8. **Rose JM, Sadowsky C, Ellen A. BeGole and Moles R (1994)**[28] conducted a study to compare mandibular symmetry between the study group(n_1=28) exhibiting Class II subdivision malocclusions with full Class I molar relationship on one side and a Class II molar relationship on the opposite side and with control group of Class I malocclusions (n_2 30). On the sub-

mentovertex films, the outlines of the mandible were traced including the condyles, coronoid processes, gonial angles, first molars, and central incisors. Mandibular asymmetry was assessed at three levels through coordinate systems representing the cranial floor, the mandible, and the mandibular dentition. The first related both skeletal and dental components of the mandible to the cranial floor. Secondly, mandibular skeletal and dental asymmetry was assessed relative to the mandibular condyles. Lastly, the symmetry of the mandibular dentition was related to the lower molars. Thus, asymmetry of the mandible was determined through a hierarchy of asymmetry descriptions. Variables representing the anteroposterior difference between right and left mandibular molar positions showed a statistically significant difference between the groups. This study supports the findings of a relative anteroposterior difference in spatial positioning of mandibular molars in Class II subdivision malocclusions. In addition, this study has found that the mandible in Class II subdivision malocclusions exhibits no unusual skeletal positioning or skeletal asymmetry. Only the mandibular dentition was found to be asymmetric, resulting in a relative distal positioning of the lower first molar on the Class II side.

9. **O'Byrn B L, Sadowsky C, Schneider C and BeGole EA (1995)** [29] conducted a study on SMV radiographs to determine diiference in mandibular symmetry in adults with untreated unilateral posterior adults with untreated Class I malocclusions. Condylar position within the glenoid fossa was analysed with horizontally corrected tomograms. Tracings of the pretreatment SMV radiographs was done included the condylar heads, coronoid processes, first molars, central incisors, gonial angles, and lateral and medial borders of the mandibular body and ramus. Landmarks were identified and then digitized with a commercial computerized system (Orthodontic Logic Inc., Kansas City, Mo.). They concluded that the mandible in adults with unilateral posterior crossbite was "rotated" relatively posteriorly on the crossbite side as related to the cranial floor. Also, the molars were positioned relatively posterolaterally on the crossbite side. Because of a lack of demonstrable difference in both mandibular skeletal asymmetry and

condylar position within the fossa between the two groups, it was assumed that the glenoid fossa through remodelling was also located relatively posteriorly on the crossbite side, since the mandible was "rotated" relatively posteriorly in relation to the cranial floor. It is therefore suggested that unilateral posterior crossbites in adults in the absence of a functional shift of the mandible should probably not be corrected by orthodontic tooth movement alone.

10.**Severt and profit (1997)** [30] conducted a study in the University Clinic of North Carolina, where 1460 patients with dentofacial deformity were assessed with respect to facial asymmetry. It was found that 34% of the sample had a clinically detectable asymmetry. Asymmetries affecting the upper face occurred in only 5% of their sample,36% had the asymmetry of the midface and 74% had asymmetry of the mandible, thereby concluded that asymmetries commonly affect lower third grater than upper and middle third of face.

11. **R. Borrato, U. Gambardella, P. Micheletti, L. Pagliani, L. Preda, T.L Hansson (2002)** [31] conducted a study to evaluate the possibility to recognize a condylar-mandibular asymmetry through a panoramic radiograph. 100 skulls were studied and measured that showed the presence of asymmetry. Using the same skulls examined the possible correlation between morphological and radiological data. The condyle and ramus heights were measured by one examiner by put into the formula given by Habet et al on OPG. They concluded that all calculated asymmetries, anatomical or radiological, between +3% and 3% were not classified as true asymmetries, although asymmetry may exist. They did not find out any correlation's between the condylar asymmetry evaluated at the anatomical level and the radiological asymmetry . This is probably due to the different positioning of the jaws during the two different measuring processes.

12.**Goel S, Ambekar A, Darda M, Sonar S (2003)**[32] investigated the transverse facial asymmetry seen in different malocclusion using frontal asymmetry analysis suggested by Grummons using PA ceph of 120 subjects. They found asymmetries were seen in all types of malocclusion, mandibular region showed the asymmetries of higher magnitude and asymmetries decreased as they approached higher in craniofacial skeleton.

13-**A.M. Sahin Saglam (2003)[33]** did a study on lateral ceph and OPGs of 72 subjects aged 12-16 yrs. to assess condylar asymmetry measurements in different skeletal patterns. The lateral cephalometric radiographs were divided into three groups according to the ANB angle: ANB angles smaller than 1°, between 1 ° and 5 °, and larger than 5 °. Each group was also divided into two subgroups according to sex. The effects on the ANB angle and sex on the condylar asymmetry measurement were investigated on the panoramic radiographs by Habet et al method. They founded that change in condylar plus ramal index measurement was affected by change of ANB angle and no measurement was affected by the sex. Condylar asymmetry neither have been affected by the ANB angle nor by sex, the condylar plus ramal index measurement was affected by both of them. No statistically significant difference was found between the groups regarding age.

14. **Edler R, Wertheim D and Greenhill D (2003)** [34] conducted a study compared measurement of mandibular asymmetry by digitization of mandibular outlines from standardized facial photographs and posteroanterior cephalometric radiographs (n=28). Photographs were taken under standardized conditions with visual axes horizontal The photos were digitized using Visual C++ version 6 software. Mandibular outline digitization done, the lower part of the face was divided into right and left segments. The segments were then compared according to 4 ratios, area (relative size of right and left mandibular segments), perimeter or length of outlines, compactness (shape), and moment. A significant relationship was found for 3 of the ratios (area, compactness, and moment) between measurements from photographs and radiographs. The comparison showed that measurements from the radiographs correlated more closely with those from photographs when the mastoid processes were used as a baseline, rather than latero-orbitale. Digitization from standardized photographs is the preferred approach, the results indicated that posteroanterior cephalometric radiographs can be used similarly.

15. **Saglam A (2004)**[35] established the relationship between condylar asymmetry and handedness of the patients with temporomandibular disorders (TMD) and patients with no signs or symptoms of TMD (n=25,15-52 years). OPGs were taken to express the symmetry between the condyles and the rami, Habets et al. method was used. For TMD group, the mean of condylar asymmetry (11.11 $\pm$ 11.03%), mean of ramus asymmetry (3.07 ± 1.60%), and the mean of condylar plus ramus asymmetry (2.96 ± 1.87%) was found. For control group, the mean of condylar asymmetry (8.36 ± 6.27%), ramus asymmetry (3.08 ± 2.06%), and condylar plus ramus asymmetry (2.64 ± 1.88%) was found. No statistically significant differences were found between age, condylar asymmetry, ramus asymmetry, and condylar plus ramus asymmetry of the experimental and control groups ($p>0.05$). No statistically significant differences were found between condylar asymmetry index in patients with TMD according to myogenous problems and in patients with no signs or symptoms of TMD.

16.**Zaidel DW, Cohen JA (2005)** [36]evaluated facial asymmetry on the photograph of group I (n=27;15 females,12 males) and group II (n=21;14 females, 7 males). Group one rated the original views of the photographs and group two rated the mirror reversed view of these photographs by creating symmetrical left-left and right-right composites of the faces and asked a new group of subjects to choose the most attractive pair member. No differences between the left-left and right-right composites were revealed but significant differences were obtained between 'same' and the left-left or right-right. The result was found out that the beautiful faces can be functionally asymmetrical too.

17**. Kambylafkas P, Murdock E, Gilda E, Tallents R H, Kyrkanides S (2006)** [37] conducted study to evaluate the accuracy of panoramic radiographs for diagnosing vertical asymmetry of the posterior mandible. The first part of the study used a model to evaluate the reproducibility of this particular panoramic machine. The tube traverse did not significantly affect the linear measurements, but the side of the machine where the structure was located produced an average of 2.1% variation in the total height of the mandible. In the second part of the study, the left-right (%) differences were measured on the panoramic and the laminographs of five skulls with lead markers. These differences were compared with the percent difference measured directly on the skull and with each other and suggested that the laminograph could be used as the ''gold standard'' for measuring posterior vertical mandibular asymmetry. The sensitivity of the panoramic radiograph to diagnose asymmetry for the total height was determined to be 0.62 (high false negative) and the specificity 1.0 ((no false positive). This meant that none of the panoramic radiographs indicated greater than 6% asymmetry if the laminograph radiographs indicated less than 6% asymmetry. Patients with a less than 6% difference between the left and right sides might not be diagnosed with panoramic radiograph. The laminograph radiographs is the gold standard and the panoramic radiograph can be used for detecting asymmetries of total ramal height.

18- **Kilic N, Kiki A and Oktey H (2006)** [38] investigated condylar and ramal asymmetry in unilateral cross bite patients (n=81) as compared with subjects with normo-occlusion(n=75) on OPG by Habet et al method. They found that subjects with unilateral posterior cross bite had more asymmetric condyle than subjects with normal occlusion. Condylar (p value-0.039*), ramal (p value-0.043*), and condylar-plus-ramal heights(p value-0.02*) on the crossbite side were smaller than those on the non-crossbite side. There was no statistically significant difference between the CH (p value-0.664), RH (p value-0.154), and CH + RH (p value-0.152) measurements of the right and left sides in the control group. Condylar, ramal, and total (condylar plus ramal) asymmetry indexes were higher in the crossbite group than in the control group, but statistical significance was seen only in the condylar index (P <.001). The effect of sex on the asymmetry indexes was not statistically significant They concluded that subjects with functional unilateral posterior crossbite have asymmetrical condyles.

19. **Sezgin O S, Celenk P, Arici S (2007)** [16] investigated the effects of different occlusion types

on the mandibular asymmetry in young individuals. Mandibular asymmetry measurements were performed on the panoramic radiographs (n=189, females-104, males-85; age range 11–15 years) with different occlusion patterns. The subjects were divided into five groups according to the occlusion types, namely, Angle Class I (Cl I,n=39), Class II division 1 (Cl II/1;n=43), Class II division 2 (Cl II/2,n=39), Class III (Cl III;n=42), and normal occlusions(n=26).The condylar asymmetry, ramus asymmetry, and condyle-plus-ramus asymmetry in vertical heights were determined on OPG according to the method suggested by Habets et al. The results showed that condylar asymmetry index measurements were affected by the occlusion type (P = .004), there were no statistically significant differences between the groups for the ramus (P = .18) and condyle-plus ramus asymmetry indexes (P = .060). There was significant difference in condylar asymmetry index between the control and the Cl I and Cl II/1 experimental groups. There were no statistically significant differences between the control group and the Cl II/2 and Cl III experimental groups. The Cl II/1 experimental group also showed a higher asymmetry index value than did the Cl II/2 and CIII groups. They concluded that malocclusions have a marked effect on condylar height in comparison with ramal height.

20-**Uysal T, Sisman Y, Kurt G and Ramoglu S I (2007)** [39] evaluated the condylar, ramal and condylar plus ramal mandibular vertical asymmetry in a group of adolescent subjects with normal occlusion (n=40), unilateral (n=46) and bilateral posterior cross bite (n=40). Intraoral photographs and plaster models were used to classify the patients according to their malocclusions. Condylar, ramal, and condylar-plus-ramal height measurements was done on OPG according to Habets et al method. There was no statistically significant difference between the right and left sides in condylar, ramal, and condylar+plus-ramal height measurements of the bilateral posterior crossbite patients and normal occlusion sample. no statistically significant differences between the mean values of the male and female subjects in mandibular asymmetry indexes. Condylar asymmetry index values were significantly higher compared with the 3%

threshold value of Habets et al in each group, but comparisons between groups were not statistically significant. Asymmetry indexes (condylar, ramal, and condylar-plus-ramal) were similar, and no statistically significant differences were found among the unilateral and bilateral posterior crossbite groups and the normal occlusion sample.

21.**Haraguchi S, Lguchi Y and Takada K (2008)** [40] investigated the laterality of the normal asymmetry of the human face, and examined difference in laterality in relation to sex, growth stage and skeletal classification using photographs (n=1800). Sample were categorized according to sex, one of three growth stages, and one of three skeletal patterns. Conventional facial photos were taken and analyzed with a software program (Photoshop 5.5J; Adobe). Points err and erl were defined as points on the patient's right and left sides where a line connecting the centers of the ear rods intersects the outer contour of the face. The differences in the distance between err and erl to the facial midline were measured. The horizontal distance between me and the facial midline was also measured. The results showed that 79.7% of subjects with facial asymmetry had a wider right hemiface and that 79.3% of the subjects with chin deviation showed left-sided laterality. Laterality in the normal asymmetry of the face is consistently found in Japanese orthodontic patients. The right-sided dominance of the face was independent of sex, age, and skeletal jaw relationships. In this regard, the proportion of subjects with a wider right hemiface was larger at earlier ages than at later ages, while the proportion of subjects with a wider left hemiface was larger at later ages than earlier. They concluded that the laterality in the normal asymmetry of the face which is consistently found in human is likely to be a hereditary rather than an acquired trait within each sex.

22-**Lee M S, Chung D H, Lee J W and Cha K (2008)** [41] determined the soft tissue characteristics of patients perceived to have severe asymmetry requiring treatment. The observers selected 100 photographs of patients (50 patients with moderate asymmetry and 50 with severe asymmetry) out of 1000 photographs for further assessment. A panel of 9 orthodontists rated the facial asymmetry of the 100 patients on a 100-mm visual analog scale. Scoring was done from score 0 (most symmetric) to score of 100 (most asymmetric). The patients were classified into 3 groups according to the average assessment scores in the previously fixed regions. Group I patients had scores of 0 to 33.3(least facial asymmetry), group II patients had scores of 33.4 to 66.7(moderate facial asymmetry), and group III patients had scores of 66.8 to 100(severe facial asymmetry). The scale was divided into 3 equal regions. Region 1 included least facial asymmetry; according to the orthodontists, these patients did not require treatment. Region 2 included patients with moderate facial asymmetry who did not require treatment. Region 3 included patients with the most facial asymmetry who did require treatment. The soft-tissue characteristics of each group was analysed using different angular and linear measurements like eye canting, lip canting, gonial canting, nose deviation, ramus and body inclination difference and gonial angle difference etc. Lip canting, chin deviation and gonial angle had statically significant difference between 3 groups. Chin deviation and gonial angle difference affected the assessment of facial asymmetry and that help clinicians to make differential diagnoses and treatment plans for patients with facial asymmetry.

23.**Fong JHJ, Wu HT, Huang MC, Chou YU, Chi LY, Fong Y (2010)** [42] investigated the facial skeletal features associated with chin deviation (>2mm) (n=25). Fifteen skeletal landmarks including median and lateral points were located on posteroanterior cephalograms. The CG–ANS (crista-galli of the ethmoid–anterior nasal spine) line and the perpendicular line through the CG were used as references. The differences between the distances from paired lateral points to reference lines were examined to analyse the symmetry of facial skeletal tissue. There were no significant asymmetries of the gonial angle, ramus height, and vertical distances from other paired lateral points to the x-axis was found. The amount of chin deviation was associated with the absolute differences of the left and right ante-gonion to the y-axis and zygomaticofrontal suture to the x-axis. The direction of chin deviation was significantly associated with the difference in the effective length of bilateral mandibular halves. Hence, it was concluded that facial asymmetry exists in patients with chin deviation and this should be considered when planning treatment for both the nonsurgical and surgical-orthodontic cases with chin deviation, 68% show deviation to left side then on right side.

24. **Ramirez-Yañez GO, Stewar A, Franken E and Campos K (2010)**[43] conducted a study to determine the prevalence of mandibular asymmetries during the mixed dentition in growing children (8–12 years). In this study four linear measurements, mandibular ramus height, ramus width, corpus height, and corpus length, and two angles, mandibular gonial (Go) and mandibular condyle (Co), measurements were performed on the right and left sides of the mandible of panoramic radiographs (n=327;males: 169; females: 158) and the developmental stage of the permanent lower second molar were analysed. The stages of development of the permanent lower second molars on both sides of the mandible were also compared and classified into one of the 14 stages proposed by Moorrees (1967), where stage 1 corresponds to the initial cusp formation and stage 14 to complete root formation and apical closure. Asymmetry index (AI) were calculated by formula proposed by Saglam (Habit's technique). No significant differences were observed between the developmental stages of the permanent lower second molars when comparing both right and left mandible. The results showed no association between the presence of mandibular asymmetries with gender and age and that the presence of mandibular dimensional and angular asymmetries does not affect tooth development.

25. **Fuentes R, Engelke, W, Bustos, L, Oporto, G, Borie, E, Sandoval, P, Garay, I, Bizama, M & Borquez (2011)** [44] conducted a study determine reliability of two techniques (Habets and Kjellberg) for measuring condylar Asymmetry on panoramic x-rays (n=30). The x-ray method of measuring condylar asymmetries in orthopantomographies presents a minor tendency for error due to slight displacements of the head in the horizontal plane. Each subject underwent three panoramic x-rays in three different positions: orthoradial, and at 5º and 10º horizontal angles.

The Habets and Kjellberg measurements were taken. When comparing Habets' measurements in all the patients stratified by sex on the right and left side (right condylar height (RCH) and left condylar height (LCH)), no statistically significant differences were observed when the 0° and 5° angles were compared. By contrast, significant differences were found in all the patients at 0° and 10° only in RCH, the variation being greater at 10°; when stratifying by sex, the significant difference was in women, the variation being greater at 10°.In Kjellberg et al. method, linear measurements of the ramal height and condylar height with different head positions facing right, significant differences were found only in the men between the 0º and 5º angles of the ramal height on the left side and no significant differences were observed in the women. Habets' technique did not show any statistically significant differences in the x-rays at 5° and 10° horizontal angles compared to the 0º angle whereas Kjellberg's technique showed statistically significant differences only at the 10° angle compared to the 0º angle. The 10° changes produced linear and ratio variations, but the indices did not vary. This study concluded that both methods provide acceptable clinical information within the limitations of these techniques to obtain data on condylar symmetries or asymmetries of the mandibular body or ramus.

26. **Sievers M M, Larson B E, Gaillard PR, Wey A (2012)** [45] conducted asymmetry assessment using cone beam CT to estimate possible differences in skeletal asymmetry between patients with skeletal Class I and skeletal Class II relationships (n=70). ANB angles were measured on simulated lateral cephalometric images extracted from the CBCT radiographs and digitized using Dolphin 11.5 betabuild 15. The Class I group (n= 30) patients with ANB angle 2.5^0 to 3.4^0degrees, Class II group (n=30) with ANB angles of 4.5^0 and higher and third group (n=10) ANB angles between 3.4^0 and 4.4^0 degrees. DICOM files obtained from the CBCT scans and asymmetry was quantified using an asymmetry index developed by Katsumata et al. method. Pearson correlation coefficients measuring the linear relationship of ANB to asymmetry index score were calculated for each landmark across all patients. None of the coefficients were

statistically significant for a linear relationship between ANB and asymmetry index score for any landmark. There were no significant differences in asymmetry index scores relative to ANB angle. No significant differences in the mean asymmetry index values were found for any landmark. this study did not support a relationship between increasingly positive ANB angles and skeletal asymmetry.

27**. Biagi, Craparo A, Trovato F, Butti AC, Salvato A (2012)** [46] conducted a study to evaluate the use of the Levandoski Panoramic Analysis in the diagnosis of dental and mandibular asymmetries and its contribution to clinical patient's evaluation and treatment planning on panoramic radiographs (n=31) of children (7 to 14 year) were analysed using 10 linear measurements. All the panoramic films were traced on acetate paper using a standardised millimetre ruler and compass based on the Levandoski Panoramic Analysis. The maxillary vertical midline (line 1),tangent to the highest condyle (line 2), The ramal lines (line 3), line is drawn on lower border of mandible in each direction to the ramal line through the gonion (line 4). Etc. For each value, mean and standard deviation were computed separately for each side. Seven parameters (L2 to L8) showed no statistical difference; on the contrary L9, the right-side length of the maxilla was shorter ($p<0.05$) compared to left side. A dominance for the left side over the right side was observed. The percentage of frequency of longer coronoid and condyle was significant for the left side, where a longer coronoid was found on 52% and a longer condyle on 45% of the sample. The mean value for coronoid asymmetry was only 0.03 mm and for condyle asymmetry it was irrelevant. The data obtained were not statistically significant with the exception of maxillary length: the right-side length of the maxilla was shorter compared to the left side.

28**. Sodawala J, Shekar SE, Mathew S (2013)** [47] conducted a study to investigate vertical condylar asymmetry in post-adolescents with no clinical signs or symptoms of temporomandibular joint disorders using panoramic radiographs (total subjects=78). Subjects having different skeletal patterns was divided into three groups based on ANB angle i.e. Group 1: ANB=2 degree (n=26; Male-13, Female 13), Group 2=ANB > 2 degree (n=26 Male-13, Female 13), Group 3: ANB < 2 degree (n=26 Male-13, Female 13). Condylar height, ramus height and total ramus height on both the sides were measured by kjellberg method for each subject and asymmetry indexes were calculated. This study suggested that vertical condylar asymmetries (greater than 3% cutoff) exists among post-adolescents with no clinical signs and symptoms of temporomandibular joint disorders. No statistically significant difference was found between the groups (p>0.05). Vertical condylar, ramus and condylar plus ramus asymmetry indexes were not affected by the sex and ANB angle in these patients.

29. **Halicioglu K, Celikoglu M, Buyuk SK, Sekerci AE, Candirli C (2014)** [48] conducted a study to investigate the mandibular vertical asymmetry in a patient with early unilateral mandibular first molar extractions. Mandibular asymmetry index measurements (condylar, ramal and condylar-plus-ramal) were performed on the panoramic radiographs by Habet's method, Group I had patients with a unilateral mandibular first molar extracted before the age of 12 years (n= 51;mean age: 18.60 ± 1.11 years) and a Group II had subject with no extractions and had excellent Class I relationships(control group,n=51;mean age: 18.53 ± 1.29 years). They concluded that No group showed statistically significant sex-or side-specific differences for posterior vertical height measurements. No statistically significant difference was found for the condylar asymmetry index (CAI) and ramal asymmetry index (RAI) measurements between the study and control groups (P > 0.05), however values of both groups were more than 3% while condylar-plus-ramal asymmetry index (CRAI) measurements showed statistically different between the groups.

30**. Rajpara Y, Shyagali TR, Trivedi K, Kambalyal P, Sha T, Jain V (2014)** [49] studied the extent of facial asymmetry in individuals who had no visible facial asymmetry. Posterior-anterior cephalography (n=50) of aesthetically pleasing faces were taken and traced for the Grummon's facial asymmetry analysis. Parameters such as the horizontal planes, mandibular morphology, mandibular deviation and the transverse asymmetry were measured. Significant difference between the mandibular morphology measurements such as condylar-gonion distance, gonion-menton distance and the condylar-menton distance was found. The mandible showed the left side deviation. There was highly significant correlation between the zygomatic arch and the measurements like nasal cavity distance, condylar distance and the jugular process distance to the mid-sagittal plane. They concluded that Skeletal asymmetries are a common finding even in individuals who have normal facial features. Right sided dominance of the mandible was more and there was also tendency for the craniocaudal increase in the rate of the asymmetry. The Co-Go shows least and Go-Me shows highest rate of asymmetry of 2.23 mm and 3.96 mm respectively. In the sidedness, Go angle shows right sidedness. Both the Go-Me and Co-Me shows right sidedness, but Co-Go shows left sidedness which is statistically significant. They concluded that asymmetries are common finding in human beings, they decrease in magnitude as we approach higher in craniofacial regions and mandibular region shows the asymmetries of higher magnitude with right side dominance of mandibular asymmetry.

31**. Kasimoglu Y, Tuna E B, Rahimi B, Marsan G, Gencay K (2014)** [50] investigated the relationship between vertical asymmetries of the mandibular condyle with different occlusion types, including Angle Cl I, Cl II, Cl III malocclusions and unilateral posterior crossbite (UPC) in adolescent patients with no signs and symptoms of temporomandibular disorders. subjects were divided into Group I: normal occlusion, Group II: Angle Class II malocclusion, Group III: Angle Class III malocclusion and Group IV: UPC (n=30 in each group). Condylar height, Ramal height, total height and asymmetry index for each patient was measured on panoramic radiographs by using Habet et al formula. Condylar asymmetry indexes ranged between 3.50 to 9.49%. According to the occlusion type of the subjects, the difference of condylar asymmetry measurements between the groups was statistically significant (P,0.01). There was no statistically significant difference between Cl I, Cl II and Cl III (P.0.05). Condylar asymmetry levels in UPC were significantly higher ($P<0.05$, $P<0.01$) than Cl I (P=.005), Cl II (P=.001), and Cl III (P=.041). Gender-related difference (P.0.05) or an age difference (P.0.05) was not found. In UPC, condylar asymmetry levels between male and female patients showed statistically significant difference ($P>0.05$).This study concluded that no significant difference was detected between the condylar asymmetry values of Cl I, Cl II, and Cl III malocclusions. The patients with UPC had more asymmetric condyles when compared to other occlusion groups. These patients might be at risk for developing skeletal mandibular asymmetries in the future. Early correction of posterior crossbite can help to prevent skeletal asymmetries.

32. **Wen, Yn W, Yue Z, Ding Bo, Xiao Y and Chun-Ling W (2015)** [51] conducted a study to assess condylar asymmetry in Angle class III malocclusion with mandibular deviation in two groups i.e. the symmetry group (n=20) whose menton deviation (MD) were less than 2 mm and the asymmetry group (n=20) with MDs of more than 5 mm with skeletal class III (ANB<-4^{o}). The computed tomographic data obtained and three-dimensional model were built with SimPlant software. The distance, angle and the bone density were measured in the three-dimensional model with the SimPlant software. The differences between the separated side in each group were analysed. In the asymmetry group, some measurement projects of the bilateral condyles showed significant differences, such as the ramal height, condylar perpendicular height, the area of maximum cross section of condylar, condylar mediolateral diameter, length of posterior slope, and angle of posterior slope. When the asymmetry group was compared with the symmetry group, the condyles of the asymmetry group showed more asymmetrical variations in morphology, such as the ramal height, the condylar perpendicular height, the area of maximum cross section of condylar, the mediolateral diameter, the length of anterior slope, and angle of posterior slope. The bone mineral density of the condylar anterior and condylar medial point was higher in the non-deviated side, and the bone mineral density of the condylar posterior was

higher in the deviated side, and no statistically significant difference was found in the symmetry group. In class III malocclusion with mandibular deviation patients, the three-dimensional morphology and bone density of condylar on the deviated side differ from the non-deviated side, which indicates the association between asymmetrical jaw function and joint remodelling.

33. **Syeda AA, Roohi U (2015)** [33] investigated condylar asymmetry in a group of untreated Class II Div 1 malocclusion (n=100, 50males and 50 females) and compared them with a control group of normal Class I malocclusion (n=100, 50males and 50 females) using Habets et al technique to compute condylar, ramal, and condylar plus ramal asymmetry values for all subjects on orthopantomograms. Results had shown that Condylar asymmetry index (CAI) values was significantly higher in class II div I malocclusion. There were no statistically significant differences between the groups for Ramus asymmetry index (RAI) values (P = 0.189) and Condylar plus ramus asymmetry index (CRAI) values (P = 0.059). There is a significant difference in values of males between condylar height (right and left), ramus height (right and left), combined height (right and left) and condylar asymmetry ratio. Other asymmetrical ratios were insignificant. Similarly for females, condylar height, combined height and asymmetrical ratios were all insignificant. CAI value was significantly higher in Class II/1 malocclusion males when compared with normal Class I malocclusion. Thus, malocclusion could act as a predisposing factor for having asymmetric condyles if left untreated.

34.**Kang Young choi (2015)** [52] conducted a questionnaire survey among 434 medical student by evaluate photographs of Asian women to evaluate facial asymmetry and canting. Images with canting less than 3°–4° and a difference smaller than 3–4 mm were not recognized as asymmetric. It was recognized that difference was more than 3 mm or 3 degrees respectively was considered as asymmetric. The students were asked to evaluate the most attractive or symmetrical in three sets of modified photographs along with the original: (1) Mirror-ness: original, left mirror, and right mirror image, (2) Lip-chin canting: original image and 5 images with lip chin canting from1°to 5°, (3) Oral commissure level: original and 5 images with oral commissure elevated toward the medial canthus from 1 to 5 mm. The results showed that students favoured the original images with natural asymmetry.3°-lip chin canting and 3-mm oral commissure change were recognized as the most common asymmetrical pattern ($p<0.01$). Asymmetry can be assessed by using 5 steps in clinical setting. This is to assess in the order of macroesthetics, miniesthetics, and microesthetics. asymmetry should be accurately diagnosed in a constant outside-in pattern by using 2D and 3D photogrammetry, or radiometry.

35. **Hipara N, Jain S, Hipara V S and Punyani P R (2016)** [53] correlated the asymmetry indices in maxillary and mandibular regions derived from posteroanterior cephalogram and OPG (n=31) in subjects with gross facial asymmetry. This study also compared and correlate condylar index using Habet's and Kjellberg's formulae. Vertical measurement of condyles, coronoid processes, ramus, Co-Go distance and maxilla were recorded on both sides in orthopantomogram and PA cephalograms. Asymmetry index and condylar ratio were calculated from bilateral linear measurements. The condyle asymmetry index was the highest amongst all the observed variables (23.59 ± 5.92 for OPG and 20.67 ± 4.54 for PA cephalogram). No statistically significant differences in asymmetry indices were found between OPG and PA cephalogram. There was positive correlation between all indices measured from the PA cephalogram and OPG. Asymmetry indices for the condyle and Co-Go distance and condylar ratio (Kjellberg) derived from OPG were found to be statistically highly significantly correlated with those derived from PA cephalogram ($p<0.01$). s. Habet's and Kjellberg's indices correlated significantly negatively with each other. Condyle had highest asymmetry index while maxilla has lowest asymmetry index. This study concluded that digital OPG could be used to calculate the right left difference for both maxilla and posterior mandible, based on asymmetry indices derived from vertical parameters for preliminary diagnosis.

36 **Sundrani A, Kamble R H, Srivastav S, Alam F (2017)**[54] evaluated skeletal and dental

asymmetries in Angle's class II subdivision malocclusion in central India population (n=100). They were divided into 3 groups; Group I-50 class II subdivision, Group II- 50 class II and group III-50 class I. Habet's formula was used to calculate Asymmetry index. They concluded that condylar height of left side and ramal height of each side was statistically significant in class II subdivision group as compared to control group (Group I and Group II). The asymmetry indices for condylar height and ramal height was also found to be statistically significant. There was no significant dental asymmetry present in the subdivision group as compared to class I and class II as seen in study model.

37. **Bal B, Dikbas I, Malkondu O, Ora K(2017)** [55] conducted a study to estimate the prevalence of ramus asymmetries related to age and gender in a young population and the influence of growth spurt on ramus asymmetry. Panoramic radiographs (n=776; Age range 9-21yrs) were included. Sample were divided into two groups i.e. group I (n=168) and the group II (n=608) with respect of linear growth spurt as age 12 in females and age 14 in males. Bilateral ramus heights on each panoramic radiograph were measured, ratios were calculated using the formula described by Habets et al. This study revealed a high prevalence (10.8%) of ramus asymmetry in 9–21-year-old population with mean ramus asymmetry value 2.90% ± 2.58%, with females' predominance for ages between 14 and 21 but the difference was not statistically significant. Significant differences between the right and left ramus height ratios were observed ($p < 0.01$) for the entire study population on OPG which did not correlate with the age and gender of the patients.

38. **Bharti C, Jain S, Bharti H V (2018)** [1] conducted a study for assessment of facial asymmetry and establishment of threshold of sub-clinical asymmetry in Malwa population (n= 60) with Angle's Class I Molar relationship with minimum crowding. The photographs of patients were subjected to scrutiny to a panel comprising of a lay observer, an orthodontist and a

general practitioner for subjective evaluation of asymmetry scored ‘0’ and ‘1’ on the basis of prepared questionnaire. The subjects were further divided into ‘True symmetrical’ (score 0) n= 27 and ‘symmetrical’ (scored 1) n= 33. Patient’s OPGs were analysed and absolute value of asymmetry indices were calculated by using the formula proposed by Habets method. Comparison of absolute asymmetry index of different parameters between male and female subjects was performed. They concluded that there is no association of gender with predominance of facial asymmetry. On assessment of side predominance, right side dominance of asymmetry for corpus length, middle facial width, cheek length, lower facial width. On assessment of side predominance of asymmetry, it was concluded that the right-side dominance of asymmetry for corpus length, middle facial width, cheek length, lower facial width. A threshold value of 6% for sub-clinical asymmetry was established from this study except for condylar and coronoid.

39-**Taki, Ahmed M H, Hussain A. Ghani, Kaddah F A (2019)** [56] conducted a study to investigate the vertical mandibular asymmetry into four groups, class I (n=26), class II/I(n=30), class III(n=23) and control group with normal occlusion (n=23). OPG was used to measure condylar asymmetry index (CAI), ramal asymmetry index (RAI) and condylar plus ramal asymmetry index by Habets’ technique to assess mandibular asymmetry. CAI values ranged between 4.08% and 14.90% in all occlusal types, whereas both ramal asymmetry index (RAI) and condylar-plus-ramal asymmetry index (CRAI) values were below the 3% threshold. CAI values were significantly affected by the occlusal type (P = 0.000). there were no statistically significant differences between the groups for the RAI values (P = 0.745) and CRAI values (P = 0.155). As there were statistically significant differences for CAI values, there was no statistically significant difference between CG/Class III subjects (P = 0.928). Significant differences were found between CG/Class I subjects (P=0.01), and CG/Class II division I subjects (P = 0.000). Further comparison between Class II division I/Class I subjects revealed that there was still significantly higher CAI values for Class II subjects (P = 0.009). They concluded that both class II/I and class I malocclusion had significantly higher CAI values compared to CG and class III group. CAI value was significantly higher in class II/I malocclusion compared to Class I malocclusion. Both these malocclusions could act as a predisposing factor for having asymmetric condyles if left untreated.

40. **Sarika K, Ghosh P, Varma S, Ajith V, Anand L (2020)** [57] conducted a study to evaluate the vertical mandibular asymmetry in TMD patients (age range-18-35yr) TMD positive group (n=136, males-53, female-81) and TMD negative group (n=136, males-72, female-64) using orthopantomography. Condylar asymmetry, ramal asymmetry and total mandibular asymmetry (Condyle + ramus) in vertical plane were assessed by two investigators by using formula given by Habet et al. Comparison of study group based on gender shows that there was significant asymmetry of the condyle, ramus and total asymmetry (condyle + ramus) in females of both TMD positive and TMD negative groups but difference was statistically significant ($p<0.05$). Ramal asymmetry was present in males of both TMD positive and TMD negative group and the results was significant statistically ($p<0.05$). Evaluation of the condylar and total asymmetry (condyle + ramus) in males of TMD positive and TMD negative group was not statistically significant. Frequency of vertical mandibular asymmetry was more in TMD positive group than the TMD negative group but the results was not statistically significant. However, OPGs of female patients were showing significant asymmetry of the condyle, ramus, and total (condyle + ramus) and the results was statistically significant.

41. **Bolat E and Alkis H T (2021)** [58] conducted a study to evaluate condylar, ramal and condylar+ramal mandibular vertical asymmetry in a group of patients with different vertical skeletal patterns i.e. 35 hypodivergent, 34 normodivergent and 35 hyperdivergent patients. Mandibular condylar and ramal measurements were performed on panoramic radiographic images and asymmetry indices were obtained according to the Habets' formula. This study

concluded that condylar asymmetry values were found to be higher than a 3% threshold value in all groups, but no significant differences were observed between the groups. The mean ramal height measurements were significantly higher in the hypodivergent group. Condylar asymmetry index values were found to be higher than a 3% threshold value in all study groups. The condylar, ramal and total asymmetry index values were not statistically different between the vertical skeletal pattern groups.

42- **Srivastava A, Raghav P, Pradhan S (2022)**[59] conducted a review of literature to understanding of effectiveness of orthopantomography in vertical mandibular measurements.18 relevant articles were included. This study concluded that when using conventional or digital panoramic images to assess vertical measurements, the panoramic image was therefore affected by both magnification errors and displacement. The horizontal distances are particularly unreliable as a result of the nonlinear variation in the magnification at different object depths, whereas vertical distances are relatively reliable. Vertical measurements are usually more accurate than horizontal measurements and angular measurements, but they are not the true representation of the real objects.

43. Uppal A, Teja H P, Mittal S, Verma A, Aneja G, Gagain M (2023) [60] conducted a study to compare vertical mandibular asymmetry in different malocclusion groups including Angle's Class I malocclusion (n=30), Angle's Class II div 1 malocclusion (n=30), Angle's Class II div 2 malocclusion (n=30), Angle's Class II subdivision (n=30) and Unilateral posterior cross bite(n=30) with an age range of 18-24 year by Habet et al method. They concluded that condylar height was more on right side than left side (R>L) in all groups, ramal height is more on right side than left side (R>L) except Angle's Class II subdivision malocclusion (R<L) and condylar plus ramus heights were on right side than left side (R>L) in all groups. On comparing condylar asymmetry index(CAI), Angle's Class II subdivision malocclusion had the maximum CAI whereas Angle's Class II div 1 malocclusion had the minimum CAI with no statistically significant difference between all groups. On comparing ramus asymmetry index (R.A.I), Angle's Class II div 2 malocclusion had the maximum RAI whereas Angle's Class II div 1 malocclusion had the minimum RAI and no statistically significant differences were found between groups. On comparing Condylar and Ramus Asymmetry Index (C.R.A.I.) for different groups, maximum CRAI was seen in Angle's Class II subdivision malocclusion whereas minimum CRAI was seen in unilateral posterior cross bite and no statistically significant differences were found.

MATERIALS AND METHOD:

This study was conducted in the Department of Orthodontics, BBDCODS on patients coming to the department for fixed Orthodontic treatment with an aim to evaluate and compare condylar and ramal asymmetry in subjects with clinically obvious and non-obvious facial asymmetry. Facial asymmetry was evaluated initially on the basis of clinical examination and confirmed by measuring menton offset on facial photographs. The subjects were then divided into two groups i.e. Group I with clinically non- obvious facial asymmetry and Group II included subjects with obvious facial asymmetry. The underlying facial asymmetry of both groups was assessed on OPG using condylar and ramal measurements. The approval was taken from Ethical committee of Babu Banarsi Das College of Dental sciences, BBDU, Lucknow before conducting this study, and informed consent was taken from all the participants of the study.

Eligibility Criteria:

Inclusion criteria-

1.Patient in age range of 18-30 years.

2.No missing teeth excluding third molar.

3.No developmental or acquired craniofacial or neuromuscular deformity

4.No history of TMJ disorders.

5.No evidence of pathologies (cyst/tumor/abscess) involving in craniofacial region.

6.Patient who had not undergone fixed orthodontic treatment or Orthosurgical treatment.

Exclusion criteria

1. Patients already undergone treatment for asymmetry.

2. Patients having any type of mechanical or chemical injury on face.

3. Patient having chin deviation due to functional shift of mandible.

4.Patient not willing to participate.

Sample

After initial screening of 200 subjects,150 subjects were selected on the basis of assessment of asymmetry by clinical examination, followed by confirmation on evaluating the menton offset on digital photograph using Digimizer software. Mean values of menton offset were tabulated as follows for selection of final sample (Table 1).

Table 1-Criteria for selection of final sample

Menton offset	**Groups**
Less than 1mm	Non-obvious facial asymmetry (Included)
Between~1-2mm	Borderline Case (Excluded)
More than 2mm	Clinically obvious facial asymmetry (Included)

The final sample includes 100 subjects into two groups (n=50), Group I had 50 subjects with clinically non obvious facial asymmetry (Menton offset <1mm) and Group II had 50 subjects with clinically obvious facial asymmetry (Menton offset >2mm). OPGs of selected subjects were taken for assessment of condylar and ramal morphology.

Materials-

A)-Material used for clinical examination to evaluate Facial asymmetry (Figure 1)

(I) Diagnostic Instrument (Mouth mirror, Explorer)

(II) Scale

(III) Micropore

(IV) Marker

Figure 1: Material for clinical examination

B)-Material used for taking and evaluating photograph for assessment of facial asymmetry (Figure 2)

(I) Camera-Canon (LENS:18-55) 14 megapixel Digital single lens reflex (DLSR)

Camera 24.1 megapixel DX format sensor and 39 point AF system)

(II) Tripod stand

(III) Ruler for calibration of photograph

(IV) White board

(V) Computer system with loaded softwere

a) Adobe photoshop (Version 13.0.1X64)

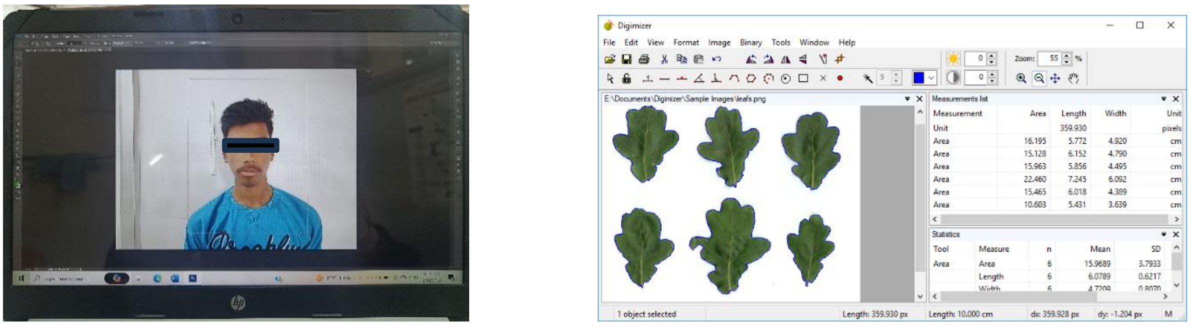
b) Digimizer softwere (Version 6.3.0)

I

I

II

I



V (a) V (b)

Figure 2: Material used for taking and evaluating photograph: I-Camera; II-Tripod stand; III-Ruler; IV-White board; V (a)-Adobe photoshop; V (b)- Digimizer software

C)-Material used for taking OPG (Figure 3)

(I) OPG-Cephalostat machine-(Planmeca Proline XC, Dimex 3 GUI software 1.4.3.0.R)

(II) Thermal Printer (AGFA Drystar DT 2B)

(III) Radiograph Sheet (AGFA Drystar 2B Film 11x 14inch

(IV) Bite Blocker

I II III

Figure 3: Material used for taking OPG: I-Cephalostat Machine; II- Thermal printer; III-Radiograph sheet used for taking OPG.

D)Material used for evaluation of mandibular asymmetry-

(I) LED board with calibration

(II) Computer with loaded Digimizer software

Method-

1)For clinical examination-

1) Patient was asked to sit relaxed on dental chair in upright position.

2) Extraoral direct clinical assessment was done by visual inspection of facial asymmetry.

2) For taking and analyzing Digital photograph-

A) Method of taking digital frontal facial photograph (Figure 4)-

1) The subjects were asked to stand in an upright position against the white board and vertical ruler was attached to the background for calibration of the photograph.

2) Frontal facial photographs of the subjects were taken in natural head position with maximum intercuspation and relaxed lip posture.

3)The natural head position was achieved by asking the subjects to stand still, look straight in a mirror placed infront of them.

4) DSLR camera was placed at a distance of 4 feet from the subjects faces and the camera was secured in a tripod stand at proper height so as to have uniformity in taking photographs following a standard protocol.

5) The frontal photographs were transferred into laptop and saved as JPEG (Joint Picture editing group) Format.

Figure 4: Method of taking digital frontal facial photograph

B) Method of analyzing photograph for sample selection (Figure 5)-

1) All saved digital photographs were imported into a commercially available photograph editing software (Adobe Photoshop, Windows 10, Adobe system) and for editing photos.

2) The photographs were cropped vertically 5mm above the head and 25 mm below the soft tissue chin and horizontally 10 mm lateral to both ears to a size of 5 X 3.5 inch.

3) The selected and cropped frontal photographs were transferred to Digimizer software for measurement of menton offset.

4) On Digimizer software, magnification error was eliminated by marking two points at the distance of 1 cm on the scale of photographs using calibration of softwere.

5)The image enhancement features of the software, like brightness, contrast, adjustment, magnification and other advanced tools were used for accurate identification of landmarks and adjustment of soft tissue structures.

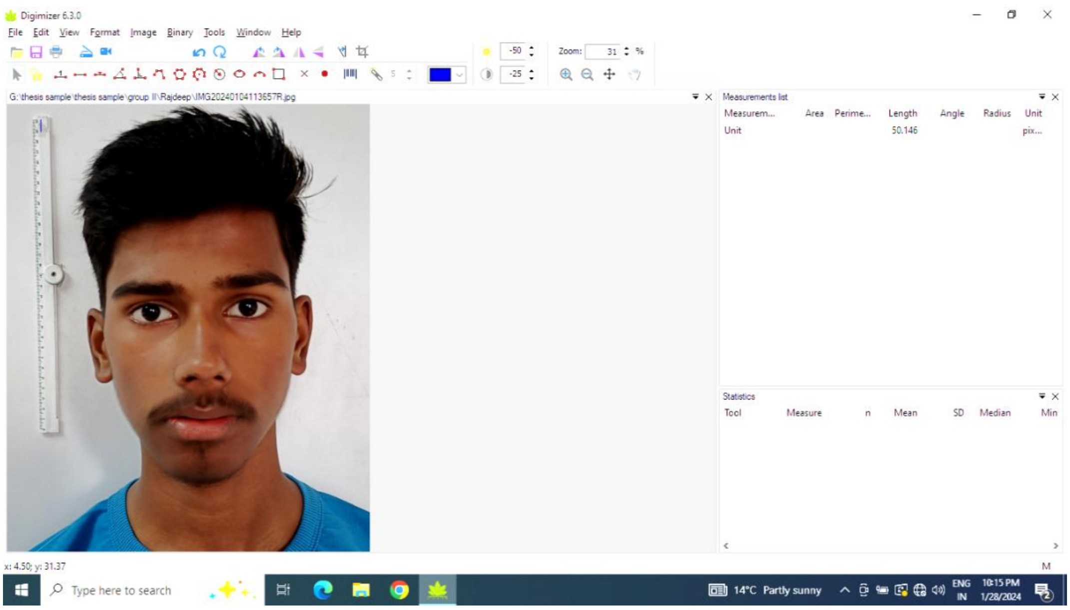


Figure 5: Transferring the frontal photograph of subjects to the computer loaded with Digimizer software.

6) Following landmarks and reference plane were identified on Digimizer software to measure menton offset:-

Landmarks (Figure 6):

1. Nasion (N'): The point in the middlle line located at the nasal root.
2. Right pupil (P'): The midpoint of the left eye pupil.
3. Left pupil (P): Midpoint of the left eye pupil.
4.Menton (Me’): The most lowest part of the chin on the mandible in the midline.

Reference plane (Figure 7):

1.Interpupillary line (PP'): A horizontal line from left pupil to right pupil.

2. Mid facial plane (Mfp): A line perpendicular to interpupillary line from nasion.

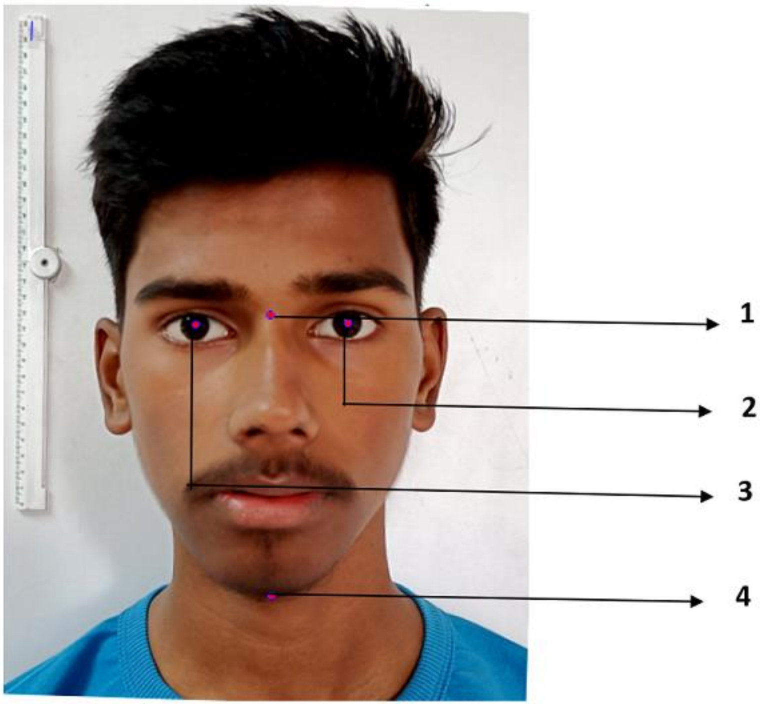


Figure 6: Landmarks identified to measure menton offset:1-Nasion, 2-Right pupil, 3-Left pupil and 4-menton.

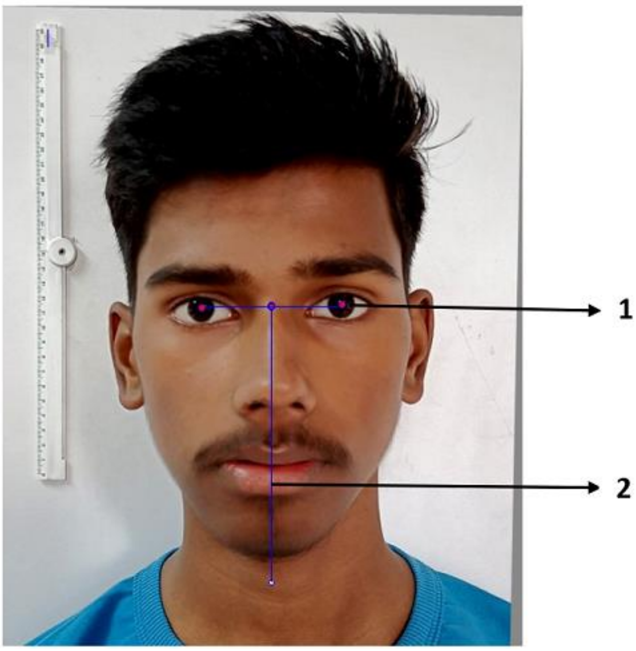


Figure 7: Reference plane:1-Interpupillary line (PP'); 2- Midfacial plane (Mfp).

After identification of landmarks and reference plane,menton offset was measured as linear distance between midfacial plane and menton.

Menton offset was measured for each photograph and sample was divided into groups based on its values as shown (table 2). The final sample included two groups (n=50), Group I had 50 subjects with clinically non obvious facial asymmetry that as served as control group (Menton offset<1mm) and group II had 50 subjects with clinically obvious facial asymmetry that served as experimental group (Menton offset >2mm).

Table 2: Distribution of sample with menton offset for both group

Groups	Number of sample	Age (Mean ± years)	Menton offset (Mean ± SD) In mm	Standard Error Mean
Group I	50	18.5 ±1.5	0.6748 ±.34845	.04928
Group II	50	19.5 ±1.5	3.7272 ±1.70265	.24079
P value				0.001*

OPGs of all the selected subjects of Group I and Group II were taken.

3) For taking and Analyzing OPG-

A) For Taking OPG

1)Planmeca proine XC was used to take OPG of selected patients. To prevent magnification in the vertical direction, the distance between the focal point of the X-ray tube and the film must always be the same.

2)The OPG was also taken in natural head position with lips relaxed and teeth in centric occlusion.

3) The ear posts were used to correct alignment of the patients head for undestroyed symmetrical image of the patient.

4) The exposure value was set at 70Kv,5mA at 12 sec.

B) For measurement on OPG (Figure 8)-

1)Printout of all digital OPGs was taken with a magnification of 100 %. OPG radiograph was placed on LED board.

2) Photograph of OPG with calibration as on LED board was taken and transferred to digimizer software on laptop.

Figure 8: Photograph of OPG with calibration as on LED board.

4) Following landmarks and reference plane were identified on OPG, for both right and left side according to method given by Habet et al.

Landmarks on OPG (Figure 9)-

L 1-It is the most lateral point of the condyle on OPG.

L 2- It is the most lateral point of the ascending ramus on OPG.

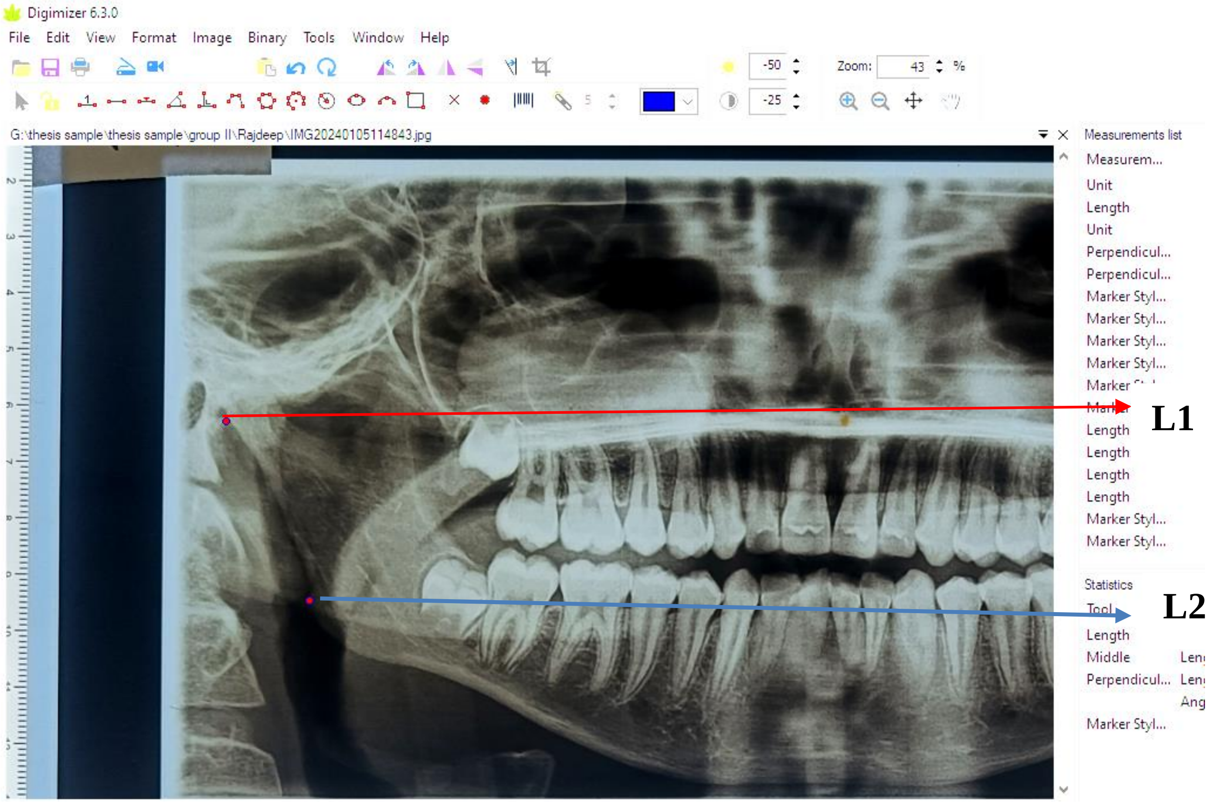


Figure 9: Landmarks on OPG: L 1-It is the most lateral point of the condyle on OPG; **L 2-** It is the most lateral point of the ascending ramus on OPG.

Reference Plane on OPG (Figure 10)-

Line A- A tangent line was drawn to the ramus that contact point L1 and L2.

Line B- A perpendicular is drawn to line A so that it passes through superior most part of condyle.

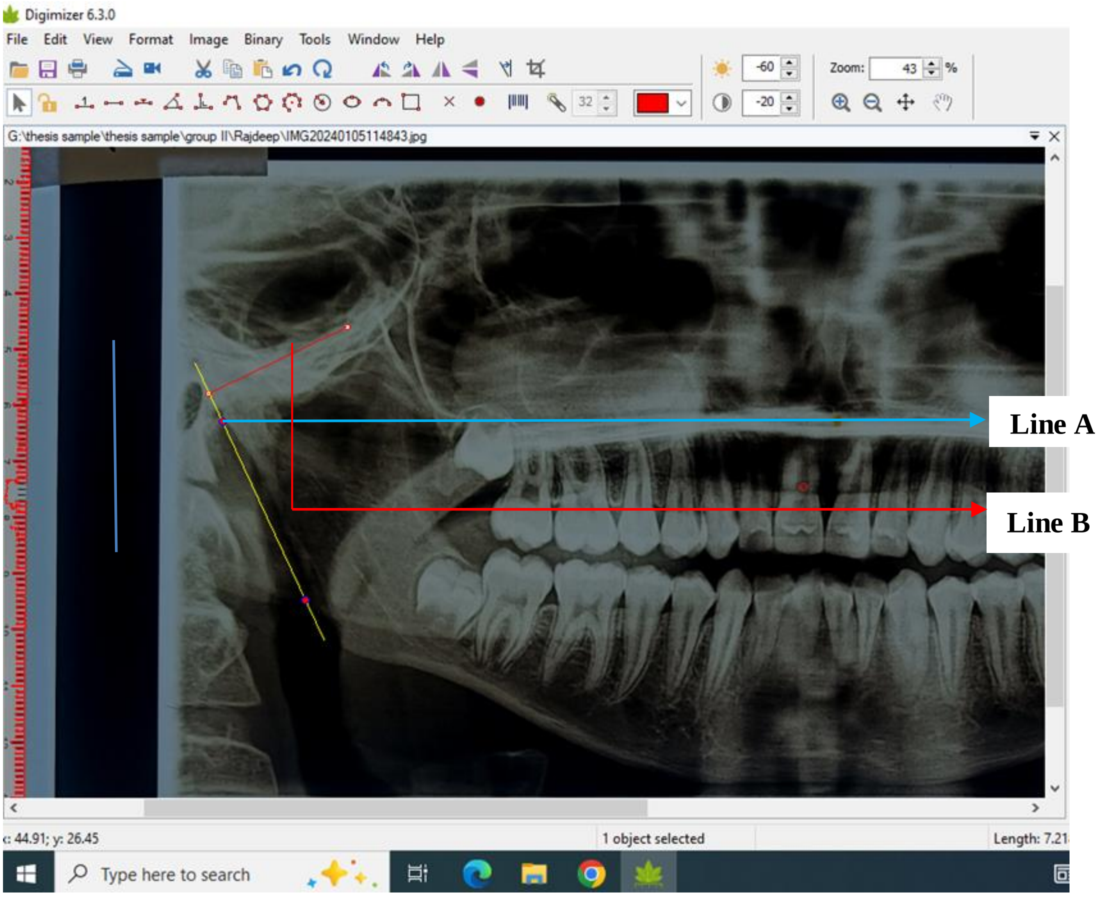


Figure 10-Reference plane on OPG: Line A- A tangent line was drawn to the ramus that contact point L1 and L2;**Line B-** A perpendicular is drawn to line A so that it passes through superior most part of condyle.

Parameters to measure condylar and ramal asymmetry [21](Figure 11) -

1. Condylar height (CH)-It was measured as the perpendicular distance between line B and line drawn parallel to Line B at L1.
2. Ramal height (RH)- It was measured as perpendicular distance between line drawn parallel to line B at L1 and L2.
3. Total height (TH)- The sum of measurement of CH (Condylar height) + RH (Ramal height) was taken as total height.

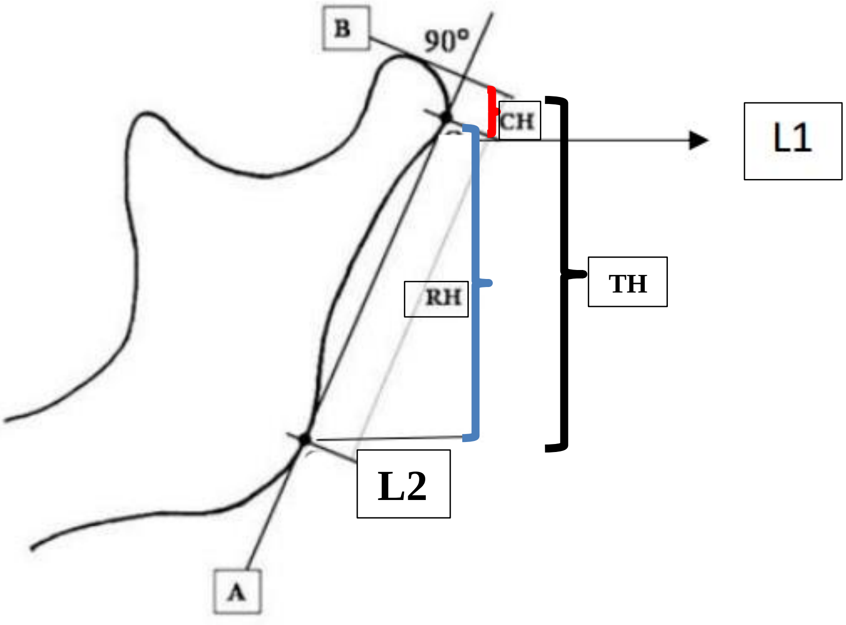


Figure 11: Representation of condylar height (CH),ramal height (RH) and total height (TH) on mandibular tracing.

4. Condylar Asymmetry Index (CAI) = $\frac{[\text{CH Right} - \text{CH Left}]}{[\text{CH Right} + \text{CH Left}]} \times 100$

5. Ramal Asymmetry Index (RAI) = $\frac{[\text{RH Right} - \text{RH Left}]}{[\text{RH Right} + \text{RH Left}]} \times 100$

6. Total Asymmetry Index (TAI) = $\frac{[(\text{CH+RH})\text{Right} - (\text{CH+RH}) \text{ Left}]}{[(\text{CH+RH}) \text{ Right} + (\text{CH+RH}) \text{ Left}]} \times 100$

All these measurements were done on right and left side for all the subjects of both groups and data was tabulated.

Measurement of reliability

For measurement of reliability,10 OPGs of 10 subjects were selected randomly from group I and group II. Condylar and ramal height was measured again on Digimizer software after a gap of 10 days .The first set of reading was compared with second set of reading using t test.

Table 3: Reliability analysis

Parameters		Paired Differences					t	df	P value
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
CH (In cm)	Mean difference in first and second reading	.00112	.00943	.00298	.00674	.00674	.000	9	1.000 NS
RH (In cm)	Mean difference in first and second reading - VAR00006	.00134	.01700	.00537	.01216	.01216	.000	9	1.000 NS

On comparison between first and second reading, it was observed that the mean difference between reading 1 and reading 2 was statistically not significant. Hence the measurement taken were considered to be reliable.

TOOLS FOR STATISTICAL ANALYSIS

Formula used for the analysis

A. The Arithmetic Mean

The most widely used measure of central tendency is arithmetic mean, usually referred to simply as the mean, calculated as

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

B. The Standard Deviation

The standard deviation (SD) is the positive square root of the variance, and calculated as

$$SD = \sqrt{\frac{\sum X_i^2 - \frac{(\sum X_i)^2}{n}}{n-1}}$$

where, n= no. of observations

and also denoted by subtracting minimum value from maximum value as below

C. Tests of significance

Test of significance are used to estimate the probability that the relationship observed in the data occurred purely by chance was there a relationship between the variables. They are used to test the hypothesis proposed at the start of the study.

In this study Parametric tests were used

a) **The data was normally distributed**
b) **The data was obtained from the sample which is randomly selected**
c) **The data was quantitative data**

I. T TEST.

T tests are based on the t distribution which is a symmetrical, bell-shaped curve like the normal distribution, but having different area and probability properties.

T distribution is a family of curves which are differentiated by their degrees of freedom.

With increasing sample sizes, the t distribution assumes the shape of the normal distribution. 2 A sample size of 100 is often chosen as the cut-off point for deciding when to apply For t or z.

TYPES OF T TESTS INDICATIONS.

a) Paired T Test

The paired t test is used to decide whether the differences between variables measured on the same or similarly matched individual are on average zero. As the data are matched there must be an equal number of observations in each sample.

Assumption. The paired t-test assumes that the differences in scores between pairs are approximately normally distributed, although the two sets of data under scrutiny do not need to be normally distributed.

b) Unpaired or two-sample t test (equal variance assumed)

The unpaired t test is used for comparing two independent groups of observations when no suitable pairing of the observations is possible.The samples do not need to be of equal sizes.

Assumptions. The test requires the populations to be normally distributed with equal variance, though the test is relatively robust to deviations from these assumptions. Unpaired t test or two-sample t test (unequal variance)

When the variances of the two groups differ and transformation does not produce equal variance, the calculation of the t test becomes more complex. Instead of using the pooled variance, estimates of the individual population variances are used

Formula:

$$t = \frac{M_x - M_y}{\sqrt{\frac{S_x^{\,2}}{n_x} + \frac{S_y^{\,2}}{n_y}}}$$

M =mean

n = number of scores per group

$$S^2 = \frac{\sum (x - M)^2}{n - 1}$$

x = individual scores

M = mean

n= number of scores in group

- *Define the problem*
- *State null hypthesis(H_0) & alternate hypothesis(H_1)*
- *Find t value, Find (X_1 - X_2)*
- **Calculate SE of difference between two means**

$$SE = \sigma\sqrt{1/n_1+1/n_2} \text{ or}$$

$$t = (X_1 - X_2) / SE$$

- *Calculate degree of freedom = $n_1 + n_2 - 2$*
- *Fix the level of significance (0.05)*
- *Compare calculated value with table value at corresponding degrees of freedom and significance level*
- *If observed t value is greater than theoritical t value, t is significant, reject null hypothesis and accept alternate hypothesis*

Statistical significance

Level of significance "p" is level of significance signifies as below:

$p > 0.05$	Not significant (ns)
$p < 0.05$	significant (*)

OBSERVATION AND RESULT-

The present study was conducted in the Department of Orthodontics & Dentofacial Orthopedics, Babu Banarasi Das college of Dental sciences, Lucknow to evaluate condylar and ramal asymmetry in 100 subjects with clinically non-obvious (Group I, n=50, mean age- 20.5± 1.5yrs) and obvious facial asymmetry (Group II, n=50, mean age-19.5 ± 1yrs) of North Indian population. The subjects were classified based on values of Me offset as measured on facial photograph. Group I had mean menton offset of 0.6748 ± 0.34845mm and group II had menton offset of 3.7272 ±1.70265mm with statistically significant difference between the groups. The result of the present study are tabulated as follows: -

Table 4: Descriptive statistics of the mean value of condylar height, ramal height and total height of right and left sides of Group I and Group II.

Table 5: Comparison of Condylar height, Ramal height and Total height between right and left sides for Group I as well as for group II using t-test.

Table 6: Descriptive statistics of condylar, ramal and total asymmetry index of Group I and Group II.

Table 7: Comparison of CAI, RAI and TAI between Group I and Group II using paired t test.

Table 4: Descriptive statistics of mean value of condylar height, ramal height and total height of Group I and Group II.

Parameters	Group I (N=50)						Group II (N=50)					
	Right			Left			Right			Left		
	Max	Min	Mean± SD	Max	Min	Mean± SD	Max	Min	Mean± SD	Max	Min	Mean± SD
Condylar height (CH) (in cm)	1.22	0.26	0.6886± 0.16731	1.05	0.26	0.7174± 0.15595	1.08	.33	0.6858± 0.15912	1.32	.33	0.7438± 0.17294
Ramal height (RH) (in cm)	5.62	3.13	4.1890± 0.50713	5.03	3.12	4.144± 0.46460	4.82	3.34	3.8998± 0.39426	4.97	3.02	3.9058± 0.43725
Total height (TH) (in cm)	6.84	3.76	4.8618± 0.56412	6.32	3.81	4.8894± 0.52906	6.27	3.92	4.6306± 0.47146	6.18	3.90	4.6496± 0.4752

$p<0.5$ not significant; $p<0.05$ just significant*; $p<0.01$ significant**; $p<0.001$ highly significant***

Table 4 shows descriptive statistics of mean value of condylar height, ramal height and total height of Group I and Group II.

The mean CH for group I was higher on left side (0.7174 ± 0.15595cm) then right side (0.6886±0.16731cm). Similarly for group II, CH was higher on left side (0.7438 ± 0.17294cm) than right side is (0.6858±0.15912cm).

The mean RH for group I was higher on right side (4.1890±0.50713cm) then left side (4.144± 0.46460 cm) whereas for group II, RH was higher on left side (3.9058±0.43725 cm) than right side is (3.8998± 0.39426 cm).

The mean TH for group I was higher on left side (4.8894±0.52906 cm) then right side

(4.8618±0.56412 cm). Similarly for group II, TH was higher on left side (4.6496± 0.4752 cm) than right side is (4.6496± 0.4752 cm).

Table 5- Comparison of Condylar height, Ramal height and Total height between right and left side for Group I and Group II.

Group	Parameter	Right Mean ± SD	Left Mean ± SD	Mean difference ± SD	P value
Group I	Condylar height (in cm)	0.6886 ±0.16732	0.7174 ± 0.15595	0.028±0.08	0.018*
	Ramal Height (in cm)	4.1890 ±0.50713	4.1442 ±0 .46460	0.044 ±0.29	0.281 NS
	Total height (in cm)	4.8618 ±0.56412	4.8894±0.52906	0.027±0.31	0.542, NS
Group II	Condylar height (in cm)	0.6858 ±0.15912	.7438 ±0.17294	0.058±0.13	0.004**
	Ramal Height (in cm)	3.8998 ±0.39426	3.9058±0.43725	0.006±0.28	0.883,NS
	Total height (in cm)	4.6306±0.47146	4.6496±0.47452	0.019±0.35	0.707, NS

Table 5 shows comparison of Condylar height, Ramal height and Total height between right and left side for Group I as well as for Group II.

On comparison between right and left side, only condylar height showed statistically significant difference both for Group I as well as Group II.

In Group I, mean difference of condylar height (CH) was of 0.028 ±0.08 cm between right and left side. Mean condylar height on left side was higher than right side (L>R) and showed statistically significant difference(P=0.018*).

The mean difference value of ramal height for Group I was 0.044 ±0.29 cm. Mean ramal height on right side was higher than left side (R>L) and showed statistically non-significant difference (P=0.281).

The mean difference of total height for Group I was 0.027±0.31 cm. Mean total height on left side was higher than right side (L>R) and showed statistically non-significant difference (P=0.542).

For Group II, mean difference of condylar height (CH) was 0.058±0.13cm. Mean condylar height was higher on left side than on right side (R<L) and showed statistically significant difference(P=0.004**).

The mean value of ramal height for Group II was 0.006 ±0.28 cm. Mean ramal height (RH) had higher values on left side then on right side (L>R) but showed statistically non-significant difference (P value=0.883).

The mean total height for Group II was 0.019±0.35 cm. Mean total height had higher values on left side then on right side (L>R) but showed statistically non-significant difference (P value=0.707).

Table 6: Descriptive statistics of Condylar (CAI), ramal (RAI) and total asymmetry index (TAI) OF Group I and Group II.

Asymmetry Indices	Group I			Group II		
	Min	Max	Mean + SD	Min	Max	Mean + SD
CAI	0.00	16.70	4.9310+ 3.52019	0.00	23.40	7.8438 + 5.88022
RAI	0.16	9.14	2.6112+ 2.31321	0.00	10.30	2.7766+ 2.36926
TAI	0.000	6.950	2.05266+1. 890282	0.110	13.600	2.64200+ 2.416151

TABLE 7-Comparison of CAI, RAI and TAI between Group I and Group II.

Group	CAI			RAI			TAI		
	Mean difference	Std. Error mean	P value	Mean difference	Std. Error mean	P value	Mean difference	Std. Error mean	P value
Group I Vs Group II	2.9±0.961	.49783 .83159	0.003*	0.16± 0.46	.32714 .33506	0.725, NS	0.58 ±0.43	.267326 .341695	0.177, NS

Table 6 and Table 7 shows condylar asymmetry index (CAI) was higher for Group II (7.8438 ± 5.88022cm) than Group I (4.9310±3.52019 cm) and their mean difference (2.9128 ± 7.640315 cm) showed statistically significant difference(p=0.003*).

Though ramal asymmetry index (RAI) was higher for group II (2.7766±2.36926 cm) than Group I (2.6112±2.31321 cm) but their mean difference (0.1654±3.525865 cm) showed statistically not significant difference(p=0.725).

Also, total asymmetry index (TAI) was also higher for Group II (2.64200±2.416151 cm) than Group I (2.05266±1.890282 cm) however their mean difference (0.58934±3.361292cm) showed statistically not significant difference(p=0.177).

DISCUSSION

Facial symmetry is derived from a Greek word “symmetries” which means of “like measure” where one half of the face is equivalent and same as another half, however true bilateral symmetry is never present naturally[1].

Mild facial asymmetry exists in every face that can be neglected and cannot be considered as abnormal condition unless it is clinically obvious for which individuals seek treatment to enhance facial attractiveness. The facial asymmetry as observed by individuals is asymmetry of overlying soft tissues that may completely or partially mask the underlying skeletal asymmetry of variable extent.[(11,17-18)]

Facial asymmetry results from congenital causes, environmental causes and functional factors. Congenital causes such as hypoplasia of the ramus and condyle can play a role in the development of mandibular asymmetry.[11]

Among environmental causes, pathological factors such as infections, tumors, osteoarthritis of the temporomandibular joint, rheumatoid arthritis, and myogenic problems such as myospasm, chronic muscle shortening, muscle splinting, or occlusal interferences can also lead to mandibular asymmetry. Trauma during the growth period can result in condylar asymmetries by disturbing the downward and forward growth of the mandible[39]. Along with morphological asymmetry, functional and mechanical stresses may influence mandibular asymmetry.

Mandibular asymmetry is one of the major cause of craniofacial asymmetry[20] because of its direct effect on facial appearance and needs special attention during orthodontic diagnosis and treatment planning. Mandibular asymmetry is of great interest for both orthodontists and prosthodontic specialists, not only for aesthetic considerations, but also because of its involvement in the stomatognathic system which may cause functional problems such as temporomandibular disorders along with psychological disturbances.[79] Mandibular asymmetry manifests as asymmetrical condylar and ramal height with morphological changes like rotated facial appearance with kinking at the mandibular symphysis, prominence of lower mandibular border and canting of occlusal plane. Condylar and ramal measurements are important to know where impairment of growth has occurred resulting in facial asymmetry. Considering this it was decided to evaluate condylar and ramal asymmetry in present study.

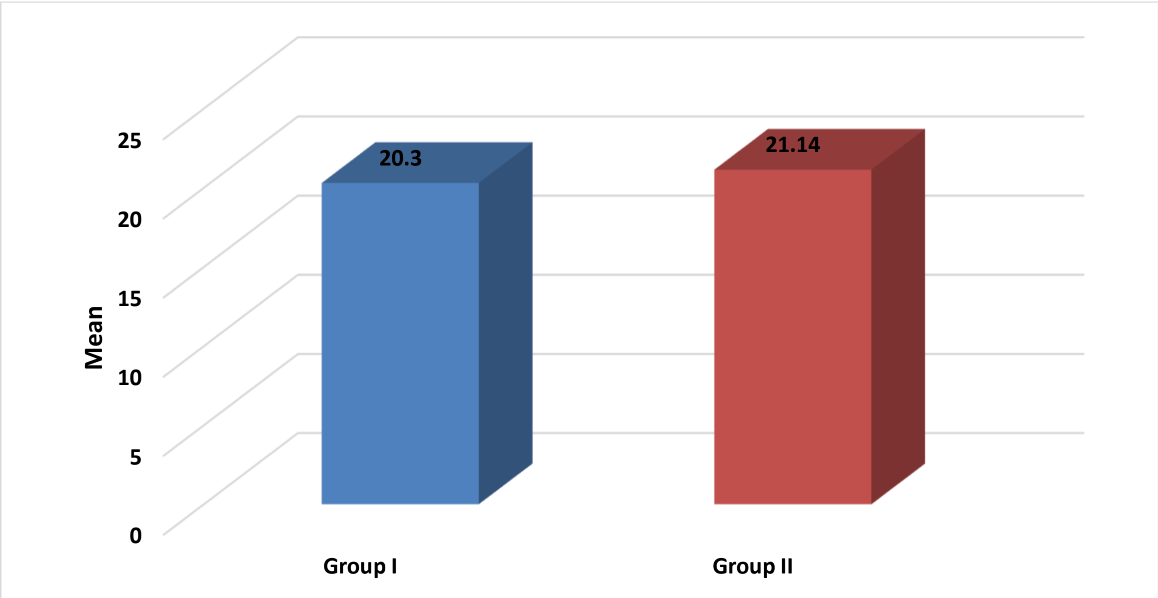
For assessment of craniofacial asymmetry various type of diagnostic aids can be used like frontal photograph, two-dimensional radiographs (Posterioanterior Ceph (PA ceph), Orthopantomogram (OPG) and submentovertex view (SMV)) and 3D imaging techniques (lasers, stereophotogrammetry, CT, CBCT and MRI etc). Frontal facial photographs can be used to quantify soft tissue features but hard tissue can be analysed only by radiographic methods. It was decided to use frontal photographs for assessing menton offset to know presence of clinically obvious facial asymmetry in the present study. Posteroanterior cephalometry has been used commonly to evaluate and measure facial asymmetry since decades.[50] However, use of PA ceph warrants need of additional radiation exposure and landmark identification is difficult. Submentovertex (SMV radiograph) provides good visualization of the skull base, mandible and condyle and helps to identify transverse craniofacial asymmetries but it cannot detect asymmetries in the sagittal and coronal planes.[62] OPG which is routinely taken as preliminary record for patients undergoing fixed orthodontic treatment is an excellent alternative for preventing additional radiation exposure. Though 3-dimensional image analysis is becoming a more popular and viable option for assessing the soft and hard tissues.[63] The biggest disadvantage is high radiation exposure than conventional radiograph, associated high cost, including purchasing the equipment and necessary software, therefore limiting the number of clinicians able to offer such techniques.

The extent of underlying hard tissue asymmetry of condyle and ramus in present study was done by tracing concerned landmarks on OPG that is taken as essential diagnostic record for subjects undergoing fixed orthodontic treatment. Different author proposed various methods to assess mandibular asymmetry on OPG- Habet's method (1988) [1,43,64-65], Kjellberg method (1994) [43,66,67] and the Levandoski method (1995) [46,68,69]. Among those, Habet's technique[21] an oldest method of assessing asymmetry through OPG was used in present study for its easy and accuracy in assessing condylar and ramal asymmetry. He diagnosed vertical asymmetries between the right (R) and left (L) on OPG by evaluating the difference in vertical height between the two sides expressing it as an asymmetry index

((R - L)/ (R + L) x 100%).

Considering this, the aim of our study was to evaluate condylar and ramal vertical asymmetry on OPG in subjects with clinically obvious facial asymmetry and non-obvious asymmetry as assessed on frontal facial photographs.

The present study was conducted in the Department of Orthodontics & Dentofacial Orthopaedics, Babu Banarasi Das college of Dental sciences, Lucknow to evaluate condylar and ramal asymmetry in 100 subjects with clinically non-obvious (Group I, n=50, mean age- 20.3± 1.5yrs) and obvious facial asymmetry (Group II, n=50, mean age-21.14 ± 1yrs) of North Indian population (Graph 1).



Graph 1-Representation of the mean age for Group I and Group II.

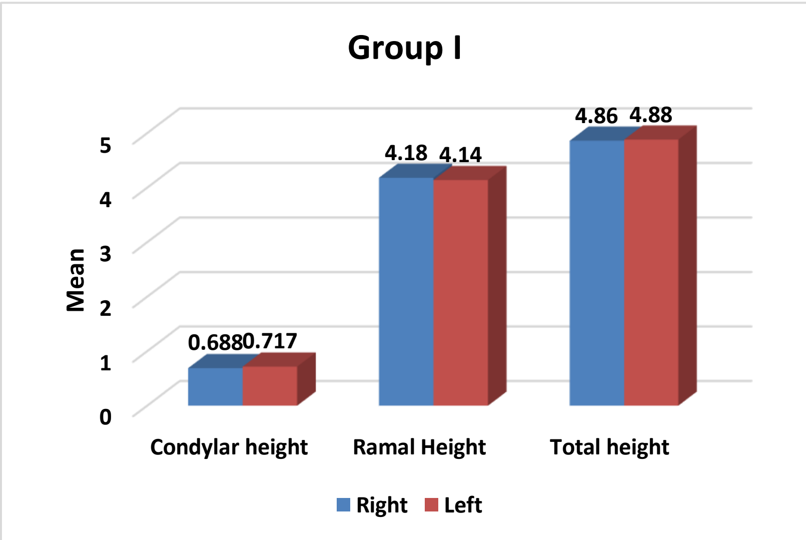
The sample was divided based on values of menton offset as measured on facial photograph of 150 subjects selected on the basis of clinical examination for facial asymmetry. The digital photographs of the subjects were made using digital SLR camera. The head of the subjects were positioned so that the Frankfort horizontal plane and the inter papillary line were parallel to the surface of the floor. The camera was fixed on a tripod which was kept at a distance of 6 feets from the face of the subject with vertical ruler attached to wall for calibration of the photographs. Digital photographs were cropped using Adobe Photoshop Cs, and then transferred to computer loaded with Digimizer software for the evaluation of facial asymmetry. The photographs were analysed for menton offset using Digimizer software after identification of required landmarks. Group I had mean menton offset value of 0.6748 ± 0.34845 mm (n=50; Me offset<1mm) and group II had mean menton offset value of 3.7272 ± 1.70265mm (n=50; Me offset >2mm) and the difference between the groups was statistically significant (P=0.001*). Subject who had menton offset value between 1-2mm were discarded from the groups.

For assessing underlying facial asymmetry of both groups, OPGs of selected subjects were taken. Condylar height, ramal height, total height on Digimizer software as per Habet et al method[21] were done on right and left side for all the subjects of both the groups. CAI, RAI and TAI were calculated using formula given by Habet's et al.[2] Data was tabulated and recorded on microsoft excel sheet and subjected to statistical analysis.

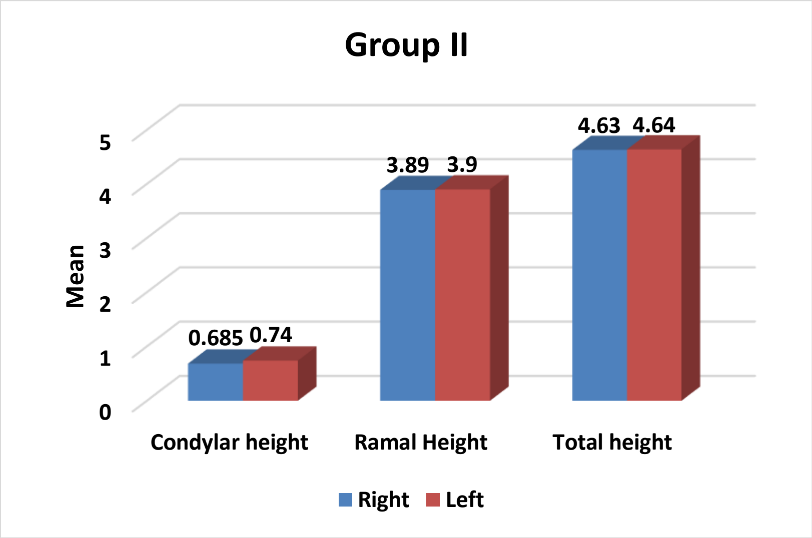
The result of present study suggested that CH differed significantly between right and left side for group I (P=0.018*) as well as for group II (P=0.004**) suggestive of the fact that bilateral symmetry is not present naturally.

The mean CH for Group I was higher on left side (0.7174 ± 0.15595cm) then right side (0.6886±0.16731cm) (L>R). Similarly for Group II, CH was higher on left side (0.7438 ± 0.17294cm) than right side is (0.6858±0.15912cm) (L>R).The mean RH for Group I was higher on right side (4.1890±0.50713cm) then left side (4.144± 0.46460 cm) (R>L) whereas for Group

II, RH was higher on left side (3.9058±0.43725 cm) than right side is (3.8998± 0.39426 cm) (L>R) but the difference was non-significant for Group I (P=0.281) as well as for Group II (P value=0.883). The mean TH for Group I was higher on left side (4.8894±0.52906 cm) then right side (4.8618±0.56412 cm) (L>R), similarly for Group II, TH was higher on left side (4.6496± 0.4752 cm) than right side is (4.6496± 0.4752 cm) (L>R) but the difference was non-significant for Group I (P =0.542) as well as for Group II (P =0.707) (Graph 2 and Graph 3).

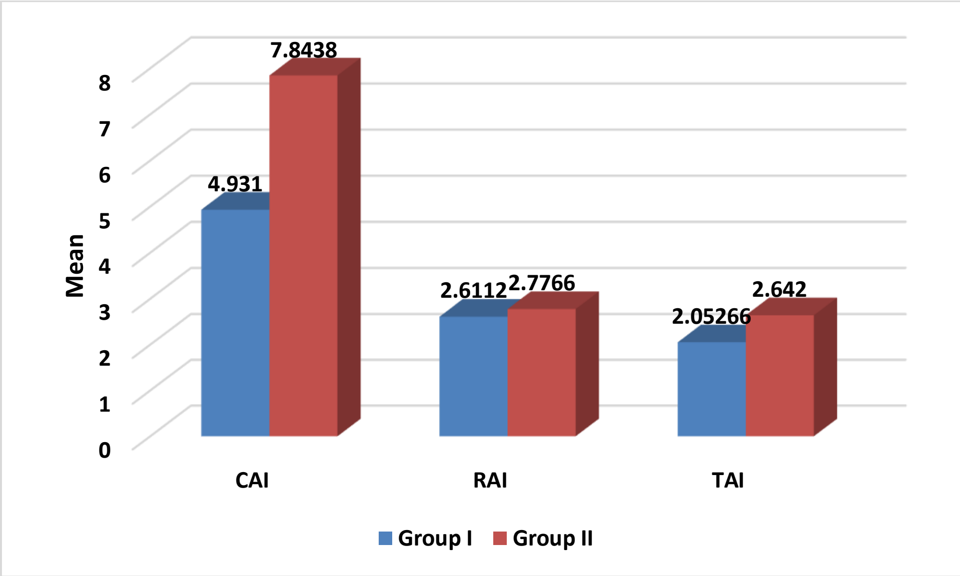


Graph 2: Comparison of mean value of condylar height, ramal height and total height of right and left side for Group I.



Graph 3: Comparison of mean value of condylar height, ramal height and total height of right and left side for Group II.

The mean values of condylar asymmetry index for both the groups were above threshold value of 3% as suggested by Habet et al for presence of posterior mandibular vertical asymmetry. However mean values of CAI were higher in Group II (7.8438 ±5.88022%) as compared to Group I (4.9310±3.52019%) and the difference was statistically significant (p=0.003**). Thus, it can be suggested that condylar asymmetry contributed to clinically obvious facial asymmetry as observed for soft tissue on photographs and evident by higher CAI values in Group II. Though, mean values of RAI and TAI were higher in Group II (RAI = 2.7766±2.36926%,TAI=2.64200±2.416151%) then Group I (RAI = 2.6112 ±2.31321 %; TAI = 2.05266 ±1.890282%) but difference was statistically not significant (P value for RAI=0.725;P value for TAI=0.177) suggestive of the fact that variation in ramal height did not contribute to facial asymmetry (Graph 4).



Graph 4: Comparison of CAI, RAI and TAI between Group I and Group II.

No study had been done to evaluate condylar and ramal asymmetry in subjects with clinically obvious and non-obvious facial asymmetry, hence direct comparison will not be possible. However, various studies that evaluated condylar, ramal and total asymmetries in subjects with sagittal discrepancies (class I, class II and class III) [33,54,56,60,65,70], temporomandibular disorders (TMD)[35,57,71], crossbites (unilateral and bilateral)[38,39,50] and various growth patterns[72] (hypodivergent, normodivergent and hyperdivergent would be discussed with respect to result of present study.

Studies by Al Taki et al (2015)[60], Sievers et al (2012)[45], Sezgin et al (2007)[39], Miller and Bodner (1997)[73], Miller and Smith (1996)[38], A M Saglam (2003)[33], J Sodawala et al (2013)[54], G. Kurt et al (2008)[39], A Sundrani et al (2015) [54] and A Uppal et al (2023)[74] evaluated condylar, ramal and total asymmetries in subjects with sagittal discrepancies (class I, class II and class III).

A study by **Al Taki et al (2015)[60]**, compared the vertical mandibular asymmetry of four groups divided on the basis of malocclusion types- class I, class II division 1, class III and control group with normal occlusion. In this study, CAI was above threshold value of 3% in all groups with values as 4.08 %, 9.13, 14.90, and 4.55 in Control group, Class I, Class II, and Class III patients respectively and the difference was statistically significant (p=0.000). They found subjects with class II div I and class I malocclusion had significantly higher CAI values compared to CG and class III group. As per authors, both these malocclusions could act as a predisposing factor for having asymmetric condyles if left untreated. As CAI varied with malocclusion types in their study, CAI varied significantly between subjects with clinically non- obvious (group I) and clinically obvious facial asymmetry (group II) in the present study with higher values in group II. On the other hand, RAI and CRAI measurements were below the 3% threshold value in all the groups in both studies. However, **Sievers et al (2012)**[45] assessed possible differences in skeletal asymmetry between patients with skeletal Classes I and II relationships and concluded that the discrepant jaw growth resulting in a Class II skeletal pattern results in no more skeletal asymmetry than Class I skeletal patterns. This study showed contrast result to the study by Al Taki et al.

A study by **Sezgin et al (2007)**[39] evaluated mandibular asymmetry in subjects with different occlusion patterns (class I, class II division 1, class II division 2, class III malocclusion group) and normal occlusion as control group. This study concluded that malocclusions had a marked effect on condylar height in comparison with ramal height The result of this study revealed that there was a significant difference of CAI between control group and the Class I and Class II division 1 malocclusion experimental groups. The Class II division 1 malocclusion experimental group also showed a higher asymmetry index value than the Class II division 2 and Class III malocclusion groups. The values of CAI as seen in control group was nearly similar to values obtained in our control group of our study.

Miller and Bodner (1997) [73] investigated the differences in CAI between control group and Class III malocclusion group, and concluded that there was no statistically significant difference between the groups. When condylar asymmetry/age relationships were plotted for the group with an Angle's Class III malocclusion no correlation was found. Also, they found that class II malocclusion, too, is not a major factor in the development of TMD disorders.

A study by **Miller and Smith (1996)**[38] compared condylar asymmetry index in subjects with Class I occlusion (11–18 years) and Class II division 2 malocclusion with deep overbite and found no statistically significant difference between groups.

Another study by A M **Saglam (2003)**[33] compared condylar asymmetry in different skeletal pattern on the basis of ANB angle as calculated on lateral cephalogram - ANB angles smaller than 1^{o}, between 1 ^{o} and 5 ^{o}, and larger than 5 ^{o} .Right vs left CAI value were highest for group with ANB < 1 (13.23%) followed by ANB > 5 (11.73 %) then 1 < ANB < 5(7.96%). Though values were higher than threshold values of 3% in all group but the difference was statistically insignificant. The CH+RH asymmetry index was affected by ANB angle while other measurements eg. CH and RH were not affected by the ANB angle and sex.

Another study by **J Sodawala et al (2013)**[54] evaluated condylar asymmetry in different skeletal patterns in post-adolescents' subjects on the basis of ANB angle - group 1: ANB = 2°, group 2: ANB > 2° and group 3: ANB < 2°. The mean condylar asymmetry index values in all groups were higher than threshold value of 3% but the difference was statistically insignificant. The mean ramus asymmetry index of group 2 was greater than the 3% cutoff rest other have less than 3% cutoff and the difference was statistically insignificant between groups. This study suggested that vertical condylar asymmetries (greater than 3% cutoff) exists among post-adolescents and vertical condylar, ramus and condylar plus ramus asymmetry indexes were not affected by the sex and ANB angle in these patients.

G. Kurt et al (2008)[39] evaluated and compared the condylar and ramal mandibular asymmetry in study group consisted of Class II subdivision subjects and normal occlusion subjects. During intragroup comparison of left and right side of CH, RH and CH+RH in both groups, no statistically significant differences were seen. On intergroup comparison, this is in contrast to result of present study where right verses left difference exist for CH. CAI, RAI and CH + RH index was statistically insignificant between groups.

Another study by **A Sundrani et al (2015)[54]** evaluated skeletal and dental asymmetries in Angle's Class II subdivision malocclusion with class II and class I malocclusion. They concluded that condylar height of left side of class II subdivision group was statistically significant compared to left side of the control groups (class I and class II) while Ramal height of both sides was found to be statistically significant in class II subdivision group as compared to the control groups (class I and class II). CAI and RAI were statistically significant between groups ($p<0.01$) and there was no significant dental asymmetry present in the subdivision group as compared to the control groups (class I and class II).

A study by **A Uppal et al (2023)[74]** evaluated vertical mandibular asymmetry in different malocclusions group (Angle’s Class I malocclusion, Angle’s Class II divison 1 malocclusion, Angle’s Class II division 2 malocclusion, Angle’s Class II subdivision) and group with subjects presenting unilateral posterior cross bite. The mean values of condylar height, ramal height and condylar plus ramal height was more on right side then left side but the difference was statistically insignificant. Result were in contrast to present study for CH as CH was significantly more on left side than right side in both groups in present study. However, result of their study for RH and TH were similar to our study. CAI was maximum in Angle’s class II subdivision group ((13.07 ±12.43mm) followed by Angle’s class I malocclusion (10.87± 9.23%) and class II divison 1 group (7.89 ±8.71%) had minimum CAI value but the difference was statistically insignificant. This is in contrast to present study where CAI differed significantly between groups.

The overall conclusion drawn from above mentioned studies is that CAI differed with malocclusion group in most of the studies except by Saglam et al who found CH+RH varied significantly between groups with variable ANB angle and a study by Uppal et al where CAI, RAI and TAI did not differ with malocclusion groups including a group with unilateral posterior crossbite (UPC). Also, Sundrani et al (2015) found RAI and TAI showed statistically significant difference in malocclusion groups. The subjects with class II division 1 malocclusion, class I malocclusions and class II subdivision malocclusion subjects had significantly higher CAI values compared to normal occlusion and Class III malocclusion group. These malocclusions groups could act as a predisposing factor for having asymmetric condyles if left untreated. All studies showed asymmetry value >3% in all groups that can be attributed to shape, angular and positional differences between right and left condyles or systematic measurement errors because of the small dimension of the condyle. The possible explanation for variation in condylar height with malocclusion was related to overloading of the articular surfaces of the temporomandibular joint (TMJ), that it affects the soft and hard tissue component of this surface, particularly the undifferentiated mesenchymal cell layer. The articular surface of the joint may be overloaded as a result of muscle hyperactivity This process can continue until the adaptive capacity of the surface is exhausted. This would express as condylar asymmetry or may lead to development of TMD. Syeda et al[40] suggested that certain malocclusion groups that can predispose to asymmetric condyle have symmetrical ramal height because of muscular compensation mechanism. **Maglione et al (2013)[62]** found that articular disc displacement was a significantly frequent symptom in patients presenting with condylar asymmetry.

Other studies by Sfondrini et al (2021)[71], Sarika k et al (2020)[57], Saglam et al (2004)[35], L Khojastepour et al (2019) [75] and V J Miller al (1997)[70] assessed vertical skeletal patterns in subjects with TMD.

A study by **Sfondrini et al (2021)[71]** compared the association between vertical skeletal patterns, condylar height symmetry, and temporomandibular disorders. The mean value for condylar asymmetry index was higher in TMD group (10.13±5.88%) then control group (4.69 ±3.67 %). They also found TMD group had significantly higher facial divergence as evident by higher mean value of SnGoGn as 25.61^0 in TMD and 22.54^0 in control group. They found TMD group had higher percentage of asymmetric condyles ($p < 0:0001$). Similarly we had higher percentage of asymmetric condyle in subjects with clinically obvious facial asymmetry (group II;p=0.003*).

A study by **Sarika k et al (2020)**[57] compared vertical mandibular asymmetry between TMD positive group and TMD negative group. In TMD negative group,

mean CAI value (Male-2.65+ 2.34%; Female-2.29 +2.63%), RAI value (Male-0.75+0.91%; Female-0.57 +0.74%) and TAI value (Male-0.86±0.75%;Female-0.72±0.64%) were lesser than values of TMD positive group, mean CAI value (Male-3.19 ± 2.33%; Female-3.29 +2.30%), RAI value (Male-1.62 ±1.69 %; Female-1.82 ±1.64%) and TAI value (Male-1.42 ±1.48 %;Female-1.61±1.45 %). The result are in contrast to present study where values of CAI were more than 3% threshold in both the groups (group I-4.931± 3.520%, group II-7.843± 5.880%) but there study had value below 3% in TMD negative group and just more than 3% in TMD positive group. This may be due to difference in selection criteria of study and experimental group in both the study. In our study sample were selected on the basis of clinically obvious and non-obvious facial asymmetry not on TMD positive and negative symptoms.

The study by **Saglam et al (2004)**[35] and **L Khojastepour et al (2019)**[75] investigated on the possible corelation between the condylar asymmetry and temporomandibular disorder and found higher CAI values in TMD subjects but no statistically significant differences was seen in patients with TMD and in patients without TMD.

V J Miller al (1997)[70] evaluated condylar asymmetry and handedness in patients with temporomandibular disorders and found there was no difference between sign and handedness (P > 0.05). This suggests that handedness did not affect the asymmetry index in this group of patients.

The other studies by Nihat kilic et al (2008)[38], T Uysal et al (2007)[39], Y Kasimoglu et al (2014)[50], by C Bharti et al (2018)[1] evaluated condylar, ramal and total asymmetry in crossbites groups (unilateral and bilateral).

A **Nihat kilic et al**[38] compared condylar asymmetry between experimental groups (subjects with unilateral posterior crossbite; n=81) and control group (subjects with normal occlusion; n=75) using Habet et al method. In experimental group they found condylar height was significantly smaller on the crossbite side (7.66 ±1.64 mm) than the non-crossbite side (7.97 ± 1.87mm). Similarly, RH was also significantly smaller on crossbite side(50.24±5.71mm) than the non-crossbite side (51.14± 5.35mm). Also, TH was also significantly smaller on crossbite side (57.89± 6.04) than the non-crossbite side (59.11± 5.59mm) but did not show significant difference between right and left. Their result showed that there was no statistically significant difference between the CH (p=0.664), RH(p=0.154), and CH + RH (p=0.152) measurements of the right and left sides in the control group.The mean value of total CAI of control group and experimental group were 3.81 ± 2.90 % and 7.13 ±4.80 % respectively RAI had a mean value of 1.80± 1.35 % and 2.14 ± 1.55% for control and experimental group respectively and TAI had mean value of 1.69± 1.13% and 1.87 ±1.48% for control and experimental group respectively. Condylar, ramal, and total (condylar plus ramal) asymmetry indexes were significantly higher in the crossbite group than in the control group, but statistical significance was seen only in the condylar index (P < 0.001). This result is similar to present study where only CAI differs significantly between groups.

A study by **T Uysal et al (2007)**[39] compared the condylar, ramal, and condylar-plus-ramal mandibular vertical asymmetry in a group of adolescent subjects (13.06 6 3.52 years) with normal occlusion (n=40), unilateral (n=46) and bilateral posterior crossbite (n=40) malocclusions by Habet et al method. In this study CH did not show any significant difference in normal occlusion group between right and left side (R=5.16± 1.27mm,L= 4.99 ±1.21mm;R>L),unilateral crossbite group(normal side=4.83± 1.43mm,crossbite side= 4.78± 1.49mm;Normal side >crossbite side) and bilateral crossbite group (R=5.10± 1.49mm,L= 4.94± 1.99mmR>L).Similarly for RH and CH+RH, statistically significant difference between sides was not seen in all three groups. CAI values were highest in unilateral crossbite group (11.04% ±

8.17%) followed by bilateral crossbite group(10.02% ± 12.52%) and least in normal occlusion group(7.57% ± 8.39%) and the difference was statistically insignificant between the groups (p>0.05).Also RAI and CRAI also showed statistically insignificant difference between these three groups in their study. The result was in contrast to present study where CAI differed between the groups. However, similarity was noted for CAI values more than 3 % in both the studies.

A study by Y **Kasimoglu et al** (2014)[50] found CAI values in Class I (6.51± 5.39%), Class II (6.23± 7.19%), Class III (7.77± 6.51%), and UPC (11.48± 7.29%) groups which differs significantly within groups with highest CAI values for UPC group. As CAI values were above 3% indicating condylar asymmetry in all groups. On intergroup comparison, CAI of UPC differed significantly with each malocclusion group (class I, class II and class III) suggestive of presence of vertical skeletal asymmetry in subjects with UPC.

Another study **by C Bharti et al**[1] in 2018 assessed facial asymmetry in subjects presented with aesthetically pleasing faces as selected by rating by panel of judge and established threshold of sub-clinical asymmetry in Malwa population. Mean condylar height did not show statistically significant difference between right side and left side (Right= 8.55±2.66mm, Left= 9.00± 2.44mm). Also mean total ramal height did not differed significantly between right side and left side.

The overall conclusion drawn from above mentioned studies is that TMD subjects had significantly more CAI values than non-TMD group in most of the studies except Saglam et al (2004)[35] and L Khojastepour et al[75] (2019). Also subjects with UPC had significantly more CAI in most of the studies [38,39,76] except in a study by Uppal et al[74]. It was observed that UPC patients have skeletal asymmetries. During the growth period, continuous condylar displacement in the glenoid fossa, resulting from occlusal problems, induces differential growth of the condyles[50]. The fact that the condyles on the crossbite side were relatively shorter is consistent with clinical and experimental studies that evaluated condylar heights in laterally shifted mandibles. Therefore, a posterior crossbite may be a potential factor in the development of condylar asymmetry. Early correction of posterior crossbite to prevent future skeletal asymmetries is of major importance.

Another study by **Esra Bolat et al (2021)[58]** compared vertical mandibular asymmetry in subjects with different vertical skeletal patterns. -Group 1: Hypodivergent group (SNGoGN ≤ 28), Group 2: Normodivergent group (28 ≤ SNGoGN ≤ 36) and Group 3: Hyperdivergent group (36 ≤ SNGoGN). Condylar height showed statistically significant difference between right and left side (p value=0.001) regardless of vertical skeletal pattern. When vertical skeletal pattern was considered, Group I, Group II and Group III had mean condylar height more on left side then right side(L>R) but the difference between right and left side was statistically not significant for all group. This is in contrast to result of present study where CH differed significantly between right and left side for Group I (P value=0.018*) and for Group II (p value =0.004*). Similarly, the mean ramal height for Group I was (L>R), Group II (R>L), Group III (R>L). RH was statistically significant only for hypodivergent group while TH was statistically insignificant for all groups. CAI, RAI and TAI values were statistically insignificant between groups. Hence, they concluded that the effect of the vertical skeletal pattern on vertical mandibular asymmetry was insignificant. Left side dominance for condylar height as observed in present study was also seen in studies by Ahmed et al[77], Vig and Hewitt et al[78], T Usyal et al[39]and Uppal et al[74].

Smith"[79] in tried to explain variability between right and left side in their article. The facial hemi- sides, as with the cerebral hemispheres, are functionally asymmetric, which is not surprising given the morphogenetic link between the brain and craniofacial appearance. Differential activity of the two hemifaces in relation to the contralateral hemispheres was thought to result in differential muscular development of the two hemifaces, hence, facial asymmetry was evident (Smith, 2000)"[79]. This relationship between the two kinds of asymmetry depends on the nature of neurological control of the two sides of the face by the two hemispheres. This control is contralateral; the left hemisphere controls the right side of the face (below the eyes), and the right hemisphere controls the left side of the face (below the eyes) as suggested by Thompson (1982)[80]. So, when hemimandibular dimensions were compared, left side had greater values than right side for various anatomical structure.

Within the limitation of present study, it can be suggested that mandibular asymmetry as evident by Me offset had major contribution for variation in condylar height and not ramal or total height. CAI values were above 3% in both the groups. It had been stated that error in head position could be responsible for condylar asymmetry.

Considering this, to prevent magnification in the vertical direction, when OPG is taken the distance between the focal point of the x ray tube and the film was kept always be the same and symmetric positioning of the head of subject in the panoramic machine was ensured by the same operator.

The main clinical implication of the present study would be ensure correction of asymmetric condylar position as early as it was visible especially in subjects with developing facial asymmetry or unilateral posterior crossbite. When diagnosis is done during active growth, modification of anatomy of mandibular condyle can be changed under influence of endochondral growth and if left untreated it will progress into clinically obvious facial asymmetry. Various growth modification procedures or expansion must be done as per individual case requirement to correct condylar asymmetry.

Future scope of study includes conducting a study with large sample size validate the results of present study. Subjects were divided on the basis of gender and age, comparing different malocclusion groups with clinically obvious and non-obvious facial asymmetry groups in different population groups. Use of 3-D techniques like CBCT to assess condylar asymmetry. The photogrammetric method of assessment of soft tissue asymmetry can be compared with asymmetries of underlying hard tissues using Posteroanterior cephalogram, CBCT and MRI etc. Also, comparison of condylar asymmetry can be made between growing and non-growing subjects.

CONCLUSION

The following conclusions may be drawn from the present study conducted to evaluate condylar and ramal asymmetry in subjects with clinically non-obvious and clinically obvious facial asymmetry in subjects of North Indian Population using Digimizer softwere:

1.Bilateral condylar asymmetry (CH=L>R) was evident in both groups. However, Ramal height and Total height did not show significant difference between right and left side in both the groups.

2.Condylar asymmetry index showed statistically significant difference between Group I and Group II (Group II >Group I).

3.Ramal asymmetry index and Total asymmetry index did not show statistically insignificant difference between Group I and Group II (Group II >Group I).

4.Clinically obvious facial asymmetry is mostly attributed to difference in condylar height.

Overall, it can be concluded that mild form of condylar asymmetry in clinically non-obvious facial asymmetry group can be masked by soft tissue drape of the face upto certain extent while moderate to severe amount of condylar asymmetry may be the possible reason of clinically obvious asymmetry[89]. So timely diagnosis and treatment of condylar asymmetry is necessary.

SUMMARY

Facial symmetry is derived from a Greek word "symmetries" which means of "like measure" where one half of the face is equivalent and same as another half, however true bilateral symmetry is never present naturally [1]. In relation to the face, symmetry and balance can be considered as correspondence in size shape and arrangement of the facial features on both sides of the mid sagittal plane[5]. Mild facial asymmetry exists in every face that can be neglected and cannot be considered as abnormal condition unless it is clinically obvious. Facial asymmetry results from congenital causes, environmental causes and functional factors[11]. Since condylar asymmetry has been associated with TMD[22], emphasizing the importance of its evaluation in subjects with clinically obvious facial asymmetry. Treatment in early stage is less traumatic to patient and comparatively easier for clinician. For assessment of craniofacial asymmetry various type of diagnostic aids can be used like frontal photograph, two-dimensional radiographs (Posteroanterior Ceph (PAceph), Orthopantomogram (OPG) and submentovertex view (SMV)) and 3D imaging techniques (lasers, stereophotogrammetry, CT, CBCT and MRI etc). The assessment of condylar and ramal asymmetry on OPG which is routinely taken as preliminary record for patients undergoing fixed orthodontic treatment is an excellent alternative for preventing additional radiation exposure. Hence assessment of condylar and ramal measurement in present study was done by tracing concerned landmarks on OPG by Habet et al method (1988)[21].He diagnosed vertical asymmetries between the right (R) and left (L) on OPG by evaluating the difference in vertical height between the two sides expressing it as an asymmetry index ((R - L)/(R + L) x 100%).He suggested that vertical mandibular asymmetry greater than 6% can be considered as true vertical asymmetry, as difference less than 6% might be a result of technical error during measurement on panoramic radiograph[17].Hence it was decided to evaluate condylar and ramal vertical asymmetry on OPG in subjects with clinically obvious facial asymmetry and non-obvious asymmetry as assessed on frontal facial photographs from North

Indian population.

This study was conducted in the Department of Orthodontics, BBDCODS on patients coming to the department for fixed Orthodontic treatment. Facial asymmetry was evaluated initially on the basis of clinical examination and confirmed by measuring menton offset on facial photographs. The subjects were then divided into two groups i.e. Group I with clinically non- obvious facial asymmetry (me offset <1mm, n=50, mean age-18 $\pm$ 1 years) and Group II included subjects with obvious facial asymmetry (me offset >1mm, n=50, mean age-20$\pm$ 1 years). The underlying facial asymmetry of both groups was assessed on OPG using condylar and ramal measurements. Evaluation of parameters of right and left side were done and asymmetry indices were calculated by Habet et al method[21]. The digital photographs of the subjects were made using digital SLR camera. The head of the subjects were positioned so that the Frankfort horizontal plane and the inter papillary line were parallel to the surface of the floor. The camera was fixed on a tripod which was kept at a distance of 6 feets from the face of the subject with vertical ruler attached to wall for calibration of the photographs. Digital photographs were cropped using Adobe Photoshop Cs. Cropped photographs was transferred to computer loaded with Digimizer software for the evaluation of facial asymmetry. The photographs from both groups were analyzed for menton offset using Digimizer software after identification of required landmarks. Mid facial Plane (Mfp) was used as refrence plane to measure menton offset as it was a perpendicular line to interpupillary line, passing through nasion. Menton offset was measured for each photograph and sample was divided into groups based on its values. The final sample included two groups (n=50), Group I had 50 subjects with clinically non -obvious facial asymmetry that as served as control group (Menton offset<1mm) and Group II had 50 subjects with clinically obvious facial asymmetry that served as experimental group (Menton offset >2mm). Photograph of OPG with calibration as on LED board was taken and transferred to digimizer software on laptop. landmarks and reference planes were identified on Digimizer software, for both right and left side. CH, RH and TH measurements were done on right and left side and asymmetry indices were calculated for all the subjects of both groups by Habet et al method and data was tabulated and recorded on Microsoft excel sheet and subjected to statistical analysis.

The following conclusions may be drawn from the present study:

1.Bilateral condylar asymmetry (CH=L>R) was evident in both groups. However, Ramal height and Total height did not show significant difference between right and left side in both the Groups.

2.Condylar asymmetry index showed statistically significant difference between Group I and Group II (Group II >Group I).

3.Ramal asymmetry index and Total asymmetry index did not show statistically insignificant difference between Group I and Group II (Group II >Group I).

4.Clinically obvious facial asymmetry is mostly attributed to difference in condylar height.

Overall, it can be concluded that mild form of condylar asymmetry in clinically non-obvious facial asymmetry group can be masked by soft tissue drape of the face upto certain extent while moderate to severe amount of condylar asymmetry may be the possible reason of clinically obvious asymmetry. So timely diagnosis and treatment of condylar asymmetry is necessary.

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ANNEXURE-I

BABU BANARASI DAS UNIVERSITY

BBD COLLEGE OF DENTAL SCIENCES, LUCKNOW

BBD UNIVERSITY

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

The project titled **"Comparison Of Condylar And Ramal Asymmetry In Subjects With Clinically Obvious And Non-Obvious Facial Asymmetry – A Orthopantomographic Study"** submitted by **Dr Shireen** Postgraduate student in the **Department of Orthodontics & Dentofacial Orthopaedics** for the Thesis Dissertation as part of MDS Curriculum for the academic year 2021-2024 with the accompanying proforma was reviewed by the Institutional Research Committee in its meeting held on **14th September, 2022** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.

Prof. Dr. Puneet Ahuja
Chairperson

Dr. Mona Sharma
Co-Chairperson

ANNEXURE II

BABU BANARASI DAS UNIVERSITY
BBD COLLEGE OF DENTAL SCIENCES, LUCKNOW

BBD UNIVERSITY

BBDCODS/IEC/09/2022 Dated: 16th September, 2022

Communication of the Decision of the Xth Institutional Ethics Sub-Committee Meeting

IEC Code: 16

Title of the Project: Comparison Of Condylar And Ramal Asymmetry In Subjects With Clinically Obvious And Non-Obvious Facial Asymmetry – A Orthopantomographic Study.

Principal Investigator: Dr Shireen **Department:** Orthodontics & Dentofacial Orthopaedics

Name and Address of the Institution: BBD College of Dental Sciences Lucknow.

Type of Submission: New, MDS Project Protocol

Dear Dr Shireen,

The Institutional Ethics Sub-Committee meeting comprising following members was held on 15th September, 2022.

1.	Dr. Lakshmi Bala Member Secretary	Prof. and Head, Department of Biochemistry
2.	Dr. Praveen Singh Samant Member	Prof. & Head, Department of Conservative Dentistry & Endodontics
3.	Dr. Jiji George Member	Prof. & Head, Department of Oral Pathology & Microbilogy
4.	Dr. Amrit Tandan Member	Professor, Department of Prosthodontics and Crown & Bridge
5.	Dr. Rana Pratap Maurya Member	Reader, Department of Orthodontics & Dentofacial Orthopaedics

The committee reviewed and discussed your submitted documents of the current MDS Project Protocol in the meeting.
The comments were communicated to PI, thereafter it was revised.

Decisions: The committee approved the above protocol from ethics point of view.

Forwarded by:

16/9

Prof. Dr. Puneet Ahuja
Principal
BBD College of Dental Sciences
BBD University, Lucknow

PRINCIPAL
Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow-226028

Lakshmi Bala
16/09/22

Dr. Lakshmi Bala
Member-Secretary
Institutional Ethics Sub-Committee (IEC)
BBD College of Dental Sciences
BBD University, Lucknow

Member-Secretary
Institutional Ethic Committee
BBD College of Dental Sciences
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ANNEXURE -III

Babu Banarasi Das College of Dental Sciences

(Babu Banarasi Das University)

BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

Guidelines for Devising a Participant / Legally Acceptable Representative InformationDocument (PID) in English

1. *Study Title*

Comparison of Condylar and Ramal Asymmetry in Subjects with Clinically Non-Obvious And Obvious Facial Asymmetry – An Orthopantomographic Study

2. Invitation Paragraph

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research/study is being done and what it will involve. Please take time to read the following information carefully and discuss it with friends, relatives and your treating physician/family doctor if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

3. *What is the purpose of the study?*

The purpose of the study is to compare and evaluate Condylar and Ramal Asymmetry in Subjects with Clinically Non-Obvious and Obvious Facial Asymmetry

4. Why have I been chosen?

You have been chosen for this study as you are fulfilling the required criteria for this study.

5. Do I have to take part?

Your participation in the research is entirely voluntary. If you do, you will be given this information sheet to keep and will be asked to sign a consent form. During the study you still are free to withdraw at any time and without giving a reason.

6.What will happen to me if I take part?

For my study you will be involved for the time required to take a photograph of your face and after that you will not be recalled. The subject will be asked to hold their head in natural head position with a vertical ruler. The subject is asked to lick the lip and then Swallow, so as to obtain the relaxed lip position. Photographs will be taken of the subjects using DLSR camera.

7.What do I have to do?

You do not have to change your regular lifestyle for the invitation of the study.

8.What is the procedure that is being tested?
The photograph obtained will be streamed and edited to obtain a posed frontal photograph. Evaluation and comparison will be made on your previous x ray.

9.What are the interventions for the study?
No intervention will be done.

10.What are the side effects of taking part?

There are no side effects on patients of this study.

11.What are the possible disadvantages and risks of taking part?
There is no risk involved in this study.

12.What are the possible benefits of taking part?

Using frontal photographs you will help in assessing the parameters of facial asymmetry in North Indian Population which an orthodontist must consider. If you have asymmetry then you can get it orthodontically corrected.

13.What if new information becomes available?
Sometimes during the course of a research project, new information becomes available about the research being studied. If this happens, your researcher will tell you about it and discuss with you whether you want to continue in the study. If you decide to withdraw, your researcher/investigator will make arrangements for your withdrawal. If you decide to continue in the study, you may be asked to sign an updated consent form.

14.What happens when the research study stops?
If the study stops/finishes before the stipulated time, this will be explained to the patient/volunteer.

15.What if something goes wrong?
If any severe adverse event occurs, or something goes wrong during the study, the complaints will be handled by reporting to the institution (s), and Institutional ethical community.

16.Will my taking part in this study be kept confidential?

Yes it will be kept confidential.

17.What will happen to the results of the research study?
The results of the study may be used to provide knowledge/Idea about the asymmetry and help to compare the prevalence and laterality of facial asymmetry among North Indian Population in males and females. Your identity will be kept confidential in case of any report/publications.

18.Who is organizing the research?

This research study is organized by the academic institution (BBDCODS).

19.Will the results of the study be made available after study is over?

Yes

20.Who has reviewed the study?

The study has been reviewed and approved by the Head of the Dept, and the IEC/IRC of the institution.

21.Contact for further information

Dr. Shireen Siddiqui

Department of Orthodontics and Dentofacial Orthopaedics

Babu Banarasi College of Dental Sciences.

Lucknow-227105

Mob- 7706093131

Dr. Kamna Srivastava (Reader)

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Dr. Rohit Khanna (HOD)

Department of Orthodontics and Dentofacial Orthopaedics

Babu Banarasi College of Dental Sciences.

Lucknow-227105

Mob-9415037011

Signature of PI………………………………

Name………………………………………..

Date…………………………………………

परिशिष्ट-III

बाबू बनारसी दास कॉलेज ऑफ डेंटल साइंसेज
(बाबू बनारसी दास विश्वविद्यालय)
बीबीडी सिटी, फैजाबाद रोड, लखनऊ - 227105 (भारत)

अंग्रेजी में एक प्रतिभागी/कानूनी रूप से स्वीकार्य प्रतिनिधि सूचना दस्तावेज़ (पीआईडी) तैयार करने के लिए दिशानिर्देश

1. अध्ययन शीर्षक
चिकित्सकीय रूप से गैर-स्पष्ट और स्पष्ट चेहरे की विषमता वाले विषयों में कॉन्डिलर और रामल असममिति की तुलना - एक ऑर्थोपेंटोमोग्राफिक अध्ययन

2. निमंत्रण अनुच्छेद
आपको एक शोध अध्ययन में भाग लेने के लिए आमंत्रित किया जा रहा है। निर्णय लेने से पहले आपके लिए यह समझना महत्वपूर्ण है कि शोध/अध्ययन क्यों किया जा रहा है और इसमें क्या शामिल होगा। कृपया निम्नलिखित जानकारी को ध्यान से पढ़ने के लिए समय निकालें और यदि आप चाहें तो दोस्तों, रिश्तेदारों और अपने इलाज करने वाले चिकित्सक/पारिवारिक डॉक्टर के साथ इस पर चर्चा करें। हमसे पूछें कि क्या ऐसा कुछ है जो स्पष्ट नहीं है या यदि आप अधिक जानकारी चाहते हैं। यह तय करने के लिए समय लें कि आप भाग लेना चाहते हैं या नहीं।

3. अध्ययन का उद्देश्य क्या है?
अध्ययन का उद्देश्य चिकित्सीय रूप से गैर-स्पष्ट और स्पष्ट चेहरे की विषमता वाले विषयों में कॉन्डिलर और रामल असममिति की तुलना और मूल्यांकन करना है।

4. मुझे क्यों चुना गया है?
आपको इस अध्ययन के लिए चुना गया है क्योंकि आप इस अध्ययन के लिए आवश्यक मानदंडों को पूरा कर रहे हैं।

5.क्या मुझे भाग लेना होगा?
शोध में आपकी भागीदारी पूर्णतः स्वैच्छिक है। यदि आप ऐसा करते हैं, तो आपको यह सूचना पत्रक रखने के लिए दिया जाएगा और एक सहमति प्रपत्र पर हस्ताक्षर करने के लिए कहा जाएगा। अध्ययन के दौरान आप अभी भी किसी भी समय बिना कोई कारण बताए अपना नाम वापस लेने के लिए स्वतंत्र हैं।

6.यदि मैं भाग लूंगा तो मेरा क्या होगा?
मेरे अध्ययन के लिए आपके चेहरे की तस्वीर लेने के लिए आवश्यक समय तक आपको शामिल किया जाएगा और उसके बाद आपको वापस नहीं बुलाया जाएगा। विषय को एक ऊर्ध्वाधर शासक के साथ अपने सिर को प्राकृतिक सिर की स्थिति में रखने के लिए कहा जाएगा। विषय को होठों को चाटने और फिर निगलने के लिए कहा जाता है, ताकि होठों की आरामदायक स्थिति प्राप्त हो सके। डीएलएसआर कैमरे का उपयोग करके विषयों की तस्वीरें ली जाएंगी।

7.मुझे क्या करना होगा?
अध्ययन के निमंत्रण के लिए आपको अपनी नियमित जीवनशैली में बदलाव करने की आवश्यकता नहीं है।

8.वह कौन सी प्रक्रिया है जिसका परीक्षण किया जा रहा है?

प्राप्त तस्वीर को सामने की ओर खींची गई तस्वीर प्राप्त करने के लिए स्ट्रीम और संपादित किया जाएगा। मूल्यांकन और तुलना आपके पिछले एक्स रे पर की जाएगी।

9.अध्ययन के लिए क्या हस्तक्षेप हैं?
कोई हस्तक्षेप नहीं किया जाएगा.

10.भाग लेने के दुष्प्रभाव क्या हैं?
इस अध्ययन का मरीजों पर कोई दुष्प्रभाव नहीं है।

11.भाग लेने के संभावित नुकसान और जोखिम क्या हैं?
इस अध्ययन में कोई जोखिम शामिल नहीं है।

12.भाग लेने के संभावित लाभ क्या हैं?
सामने की तस्वीरों का उपयोग करके आपको उत्तर भारतीय आबादी में चेहरे की विषमता के मापदंडों का आकलन करने में मदद मिलेगी, जिस पर एक ऑर्थोडॉन्टिस्ट को विचार करना चाहिए। यदि आपके पास विषमता है तो आप इसे ऑर्थोडॉन्टिक रूप से ठीक करवा सकते हैं।

13.यदि नई जानकारी उपलब्ध हो जाए तो क्या होगा?
कभी-कभी किसी शोध परियोजना के दौरान, अध्ययन किए जा रहे शोध के बारे में नई जानकारी उपलब्ध हो जाती है। यदि ऐसा होता है, तो आपका शोधकर्ता आपको इसके बारे में बताएगा और आपसे चर्चा करेगा कि क्या आप अध्ययन जारी रखना चाहते हैं। यदि आप वापस लेने का निर्णय लेते हैं, तो आपका शोधकर्ता/अन्वेषक आपकी वापसी की व्यवस्था करेगा। यदि आप अध्ययन जारी रखने का निर्णय लेते हैं, तो आपसे एक अद्यतन सहमति प्रपत्र पर हस्ताक्षर करने के लिए कहा जा सकता है।

14.जब शोध अध्ययन बंद हो जाता है तो क्या होता है?
यदि अध्ययन निर्धारित समय से पहले रुकता/समाप्त होता है, तो यह रोगी/स्वयंसेवक को समझाया जाएगा।

15.अगर कुछ गलत हो गया तो क्या होगा?
यदि कोई गंभीर प्रतिकूल घटना घटती है, या अध्ययन के दौरान कुछ गलत होता है, तो शिकायतों को संस्थान (संस्थाओं) और संस्थागत नैतिक समुदाय को रिपोर्ट करके नियंत्रित किया जाएगा।

16.क्या इस अध्ययन में मेरी भागीदारी गोपनीय रखी जायेगी?
हां इसे गोपनीय रखा जाएगा.

17.शोध अध्ययन के परिणामों का क्या होगा?
अध्ययन के परिणामों का उपयोग विषमता के बारे में ज्ञान/विचार प्रदान करने और उत्तर भारतीय आबादी के पुरुषों और महिलाओं में चेहरे की विषमता की व्यापकता और पार्श्वता की तुलना करने में मदद करने के लिए किया जा सकता है। किसी भी रिपोर्ट/प्रकाशन के मामले में आपकी पहचान गोपनीय रखी जाएगी।

18.अनुसंधान का आयोजन कौन कर रहा है?

यह शोध अध्ययन शैक्षणिक संस्थान (बीबीडीसीओडीएस) द्वारा आयोजित किया जाता है।

19.क्या अध्ययन के परिणाम अध्ययन समाप्त होने के बाद उपलब्ध कराए जाएंगे?
हाँ

20.अध्ययन की समीक्षा किसने की है?
अध्ययन की समीक्षा और अनुमोदन विभाग के प्रमुख और संस्थान के आईईसी/आईआरसी द्वारा किया गया है।

21.अधिक जानकारी के लिए संपर्क करें

डॉ. शिरीन सिद्दीकी
ऑर्थोडॉन्टिक्स और डेंटोफेशियल ऑर्थोपेडिक्स विभाग
बाबू बनारसी कॉलेज ऑफ डेंटल साइंसेज।
लखनऊ-227105
मोब- 7706093131

डॉ. कामना श्रीवास्तव (पाठक)
ऑर्थोडॉन्टिक्स और डेंटोफेशियल ऑर्थोपेडिक्स विभाग
बाबू बनारसी कॉलेज ऑफ डेंटल साइंसेज।
लखनऊ-227105
Mob-9956099502

डॉ. रोहित खन्ना (एचओडी)
ऑर्थोडॉन्टिक्स और डेंटोफेशियल ऑर्थोपेडिक्स विभाग
बाबू बनारसी कॉलेज ऑफ डेंटल साइंसेज।
लखनऊ-227105
मोब-9415037011

पीआई के हस्ताक्षर–…………………………………

नाम–……………………………………………….

दिनाँक– ……………………………………………

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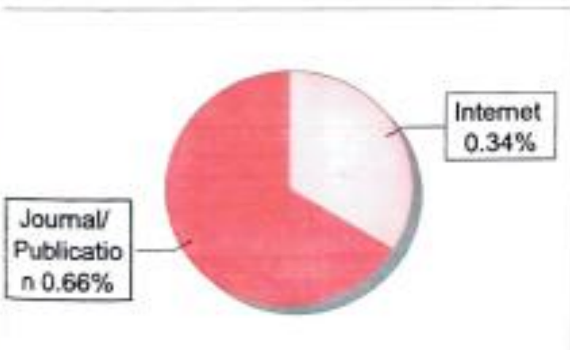

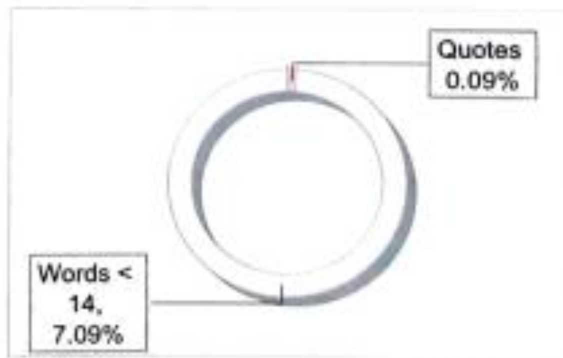

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Consent Form (English)

Phone no. and e-mail address.............

1. I confirm that I have read and understood the Participant Information Document dated

......for the above study and have had the opportunity to ask questions, OR I have been explained the nature of the study by the Investigator and had the opportunity to ask questions.

2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason and without my medical care or legal rights being affected.
3. I understand that the sponsor of the project, others working on the Sponsor's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. However, I understand that my Identity will not be revealed in any information released to third parties or published.
4. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s). 5. I permit the use of stored sample (tooth/tissue/blood) for future research. Yes | No[ ]
Not Applicable [ ]

6. I agree to participate in the above study. I have been explained about the complications and side effects, if any, and have fully understood them. I have also read and understood the participant/volunteer's Information document given to me.

Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:

Signatory…………… Name……………………..

Date……………….

Signature of the Investigator…………………. Investigator Name……………………

Date...........................

Signature of the witness.............................. Name of the witness……………………..
Date………………….

Received a signed copy of the PID and consent form

Signature/thumb impression of the subject or legally Date.............
Acceptable representative

सहमति फॉर्म (हिंदी)

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1 [illegible] ……[illegible]

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3. [illegible], [illegible], [illegible], [illegible]

4. [illegible] ([illegible]) [illegible]

6. [illegible], [illegible], [illegible]

[illegible] ([illegible])

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SN	Patient name	Age	Me offset (mm)	Condyler ht(cm)		Ramal ht(cm)		Total ht(cm)		CAI%	RAI%	TAI%
				R(cm)	L(cm)	R	L	R	L			
1	Abhishek	19	0.94	0.59	0.54	4.37	4.53	4.96	5.07	4.42	1.79	1.09
2	Abhishek singh	18	0.92	0.77	0.86	4.61	4.68	5.38	5.54	5.52	0.75	1.46
3	Abhishek Prajapati	21	0.8	0.62	0.61	4.11	3.89	4.73	4.5	0.81	2.75	1.08
4	Aaditeya Kr	18	0.87	0.65	0.72	5.12	4.8	5.77	5.52	5.1	2.21	1.07
5	Adnan	21	0.96	0.76	0.78	4.71	4.21	5.47	4.99	1.2	5.6	4.58
6	Adya	17	0.88	0.59	0.62	4.14	4.03	4.73	4.65	2.47	1.36	0.85
7	Akanshka Prajapati	19	0.8	0.42	0.47	3.75	3.36	4.17	3.83	5.61	5.48	4.25
8	Akash diveidi	22	0.9	0.89	0.82	4.41	4.58	5.3	5.4	4.09	1.89	0.93
9	Alka	25	0.99	0.63	0.66	3.48	3.71	4.11	4.37	2.32	3.19	3.06
10	Aman	26	0.99	1.22	1.02	5.62	4.93	6.84	5.95	8.9	6.54	6.95
11	Aman Singh	28	0.07	0.63	0.69	3.13	3.12	3.76	3.81	4.54	0.16	0.66
12	Amiy Anu	17	0.1	0.48	0.58	3.37	3.5	3.85	4.08	9.4	1.89	2.9
13	Amrita Soni	32	0.96	0.82	0.75	4.46	4.51	5.28	5.26	4.4	0.55	0.18
33	Piyush Pandit	17	0.96	0.63	0.65	3.69	4.3	3.99	4.95	1.56	7.63	3.73
34	Monika	18	0.7	0.56	0.65	4.05	3.79	4.61	4.44	7.43	3.31	1.87
35	Raunak	17	0.73	0.67	0.81	4.22	4.37	4.89	5.18	9.45	1.74	2.87
36	Rita	16	0.98	0.69	0.79	4.66	4.57	5.35	5.36	6.75	0.97	0.093
37	Ruby Panday	18	0.96	0.71	0.78	4.07	4.01	4.78	4.79	4.69	0.74	0.1
38	Sakshi	19	0.91	0.8	0.7	4.78	4.92	5.58	6.32	6.66	1.44	6.21
39	Saliq	19	0.7	0.79	0.78	4.38	3.98	5.14	4.76	0.63	4.78	3.83
40	Sarita	23	0.96	0.83	0.83	3.36	3.68	4.19	4.51	0	4.54	3.67
41	Sarita Pal	17	0.94	0.7	0.74	4.36	4.26	5.06	5	2.77	1.16	0.59
42	Shikha	16	0.7	0.81	0.72	4.59	4.65	5.4	5.37	5.88	0.64	0.27
43	Shreya Jamal	18	0.4	0.67	0.82	3.54	3.51	4.21	4.33	10.06	0.42	1.4
44	Vineeta	19	0.9	0.57	0.8	4.4	4.17	4.97	4.97	16.7	2.68	0
45	Urmila	25	0.97	0.42	0.51	4.01	3.84	4.43	4.35	9.67	2.16	0.91
46	Tushar	18	0.99	0.82	0.69	3.13	3.76	3.95	4.45	8.6	9.14	5.95
47	Swati Mishra	18	0.4	0.85	0.78	3.72	3.86	4.57	4.64	4.29	1.84	0.76
48	Tanu	18	0.2	0.58	0.64	3.53	3.76	4.11	4.4	4.91	3.15	3.4
49	vaishnavi	19	0.99	0.63	0.72	4.07	3.78	4.7	4.5	6.66	3.69	2.17
50	urvashi	23	0.8	0.59	0.69	4	3.8	4.59	4.49	7.81	2.56	1.1

Group II

SN	Patient name	Age	Me point (mm)	Condylar ht (cm) R	Condylar ht (cm) L	Ramal ht(cm) R	Ramal ht(cm) L	Total ht (cm) R	Total ht (cm) L	CAI	RAI	TAI
1	Adya	16	3.55	0.47	0.65	3.98	3.95	4.45	4.6	16.07	0.37	1.65
2	Aditi Singh	18	3.9	0.5	0.75	4.37	4.63	4.87	5.38	0.2	2.8	4.97
3	Ankita	17	3.49	1.08	1.31	4.47	4.87	5.55	6.18	9.62	2.6	5.37
4	Avantika	19	2.4	0.55	0.55	4.18	4.03	4.73	4.58	0	1.82	1.61
5	Bushra	20	3.3	0.66	0.7	4.03	3.81	4.69	4.51	2.94	2.8	1.95
6	Divyansh	21	6	0.6	0.74	3.91	3.94	4.51	4.68	10.44	0.38	1.84
7	Divyansh Singh	17	7	0.33	0.33	4.82	4.97	5.15	5.3	0	1.77	1.43
8	Joshua	19	3.8	0.5	0.57	4.72	4.68	5.22	5.25	6.54	0.4	0.28
9	Juhi	17	4	0.76	0.61	3.71	3.85	4.47	4.46	10.9	1.85	0.11
10	Kajal	20	4.3	0.45	0.68	3.52	3.92	3.97	4.6	20.3	5.37	7.35
11	Kusum	18	8	0.87	0.79	4.67	4.59	5.54	5.38	4.81	0.86	1.46
12	Mansi	21	3.11	0.63	0.58	3.85	3.56	4.48	4.14	4.13	3.9	3.94
13	Meena Kumari	21	2.22	0.54	0.66	4.01	4.38	4.55	5.04	10	4.41	5.1
14	Mohd.Arsh Iqbal	18	3.34	0.9	0.91	3.95	4.05	4.85	4.96	0.55	1.25	1.12
15	Mujahid	23	4.12	1.01	1.18	4.5	4.17	5.51	5.35	7.76	3.8	1.47
16	Muskan Mathur	24	3.33	0.88	0.75	3.43	3.7	4.31	4.45	7.97	3.78	1.59
17	Nandani	18	10	0.77	0.77	3.51	3.61	4.28	4.38	0	1.4	1.15
18	Neha	18	2.2	0.61	0.74	4.29	4.29	4.9	5.03	9.62	0	1.3
19	Nilakshi	24	2.22	0.84	0.8	3.34	3.59	4.18	4.39	2.43	3.6	2.45
20	Seekam Verma	22	2.04	0.7	0.85	3.62	3.26	4.32	4.11	9.67	5.23	2.49
21	Shalini	21	2.25	0.91	0.76	3.77	4.21	4.68	4.97	8.98	5.51	3
22	Shilpi	20	2.89	0.45	0.61	3.47	3.33	3.92	3.94	15.09	2.05	0.25
23	Shivang	19	2.22	0.64	0.69	4.3	4.46	4.94	5.15	3.75	1.82	2.08
24	Rajdeep	18	6.3	0.62	0.98	3.8	3.75	4.42	4.73	22.5	0.66	3.38
25	Jyoti Sharma	16	4.78	0.59	0.5	3.45	3.59	4.04	4.09	8.25	1.98	0.61
26	Ranjha	17	2.22	0.54	0.67	3.71	3.32	4.25	3.99	10.74	5.54	3.15
27	Amit Kumar	20	2.28	0.68	0.64	4.25	4.18	4.93	4.82	3.03	0.83	1.12
28	Rajini	20	5.6	0.9	1.06	4.08	4	4.98	5.06	8.16	0.99	0.79
29	Rishabh	24	4.19	0.69	0.51	3.44	3.53	4.13	4.04	15	1.29	1.1
30	Riya Singh	28	3.8	0.55	0.61	4.1	4.53	4.65	5.14	5.17	4.98	5
31	Ruby	30	3.62	0.74	0.88	3.34	3.02	4.08	3.9	8.64	5.03	2.25
32	Saksham	24	3.49	0.68	0.81	3.62	3.51	4.56	4.32	8.72	1.54	2.7
33	Shivangi	22	4.44	0.54	0.87	4.28	3.48	4.82	4.35	23.4	10.3	5.12
34	Shivani	21	3.78	0.66	0.73	3.9	3.93	4.56	4.66	5.03	0.38	1.08
35	Sreyansh	23	2.09	0.57	0.53	4.24	4.36	4.81	4.89	3.63	1.39	0.82
36	Vineeta	17	2.74	0.75	0.63	3.76	3.82	4.51	4.45	8.69	0.79	0.66
37	Shiddhi	16	2.04	0.7	0.56	3.4	3.4	4.1	3.96	11.11	0	1.73
38	Siddhu pandit	17	2.22	0.49	0.63	3.54	3.6	4.03	4.23	12.5	0.84	2.42
39	Vanya	17	3.18	0.72	0.96	4.58	4.12	5.3	5.08	14.28	5.28	2.11
40	Pooja	22	6.67	0.82	0.82	3.57	3.96	4.39	4.78	0	5.17	4.25
41	Pratima	23	2.24	0.66	0.72	3.52	3.36	4.18	4.08	4.34	2.32	1.21
42	Priya	24	3.13	0.91	0.87	3.94	4.13	4.85	5	2.24	2.35	1.52
43	Divyanshi Shing	28	2.04	0.67	0.83	3.67	4.05	4.34	4.88	10.6	4.9	5.85
44	Aditi	24	6.36	0.85	0.8	3.39	3.62	4.15	4.42	4.84	3.28	3.15
45	priya Kumari	26	2.67	0.64	0.84	3.63	3.92	6.27	4.76	0.01	3.84	13.6
46	Priya	25	4.32	0.73	0.76	4.09	3.33	4.82	4.09	2.01	10.2	8.19
47	Tanya	25	3.12	0.58	0.83	4.15	3.7	4.81	4.53	17.73	5.71	2.99
48	Saif	30	3.78	0.69	0.74	3.71	3.77	4.4	4.51	3.49	0.8	1.23
49	vandana	28	3.18	0.95	0.85	3.72	3.72	4.67	4.57	5.55	0	1.08
50	Urvashi	21	2.4	0.72	0.58	3.69	3.74	4.41	4.32	10.76	0.67	1.03