EVALUATION OF FACIAL ASYMMETRY IN NORTH INDIAN POPULATION-A PHOTOGRAPHIC STUDY

Dissertation

Submitted to

BABU BANARASI DAS UNIVERSITY, LUCKNOW, UTTAR PRADESH

In the partial fulfilment of the requirements for the degree

Of

MASTER OF DENTAL SURGERY

In

ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

By

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled ***"EVALUATION OF FACIAL ASYMMETRY IN NORTH INDIAN POPULATION- A PHOTOGRAPHIC STUDY"*** is a bonafide and genuine research work carried out by me under the guidance of **Dr. Rana Pratap Maurya** , 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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The satisfaction and euphoria that accompany the successful completion of a task could be incomplete without the mention of the people who made it possible. I owe my immense respects to almighty god for living in my heart, inspiring me for noble values in life and for his divine blessings

It is my privilege and honour to express my profound gratitude and heartfelt thanks to my Guide, ***Dr. Rana Pratap Maurya,*** *MDS, Reader , Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow. This work would not have been possible without his guidance, support and encouragement. Under his guidance, I successfully overcame many difficulties and learned a lot. His unflinching courage and conviction will always inspire me, and I hope to continue to work with his noble thoughts. I can only say a proper thanks to him through my future work. It is to him that I dedicate this work.*

I am also equally indebted to my co-guide, ***Dr. Tripti Tikku****, MDS, Professor and Head, Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow., for her valuable advice, constructive criticism, co-operation and continuous help rendered during the preparation of this dissertation.*

I gratefully acknowledge my co-guide ***Dr. Kamna Srivastava*** *MDS, Reader, Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow. Without her support nothing would have been possible for me. It was her understanding,*

encouragement, valuable suggestions, unstinted help and personal attention that have provided good and smooth basis for this work.

I am also thankful to ***Dr. Rohit Khanna****, MDS, Proffesor,* ***Dr.Snehlata Verma,*** *MDS, Reader,* ***Dr. Anshul Srivastava****, MDS Senior Lecturer and* ***Dr. Sangeetha Sharma,*** *BDS, Lecturer Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow, for their valuable suggestions, time to time guidance, encouragement and constant moral support during the period of my study.*

Special thanks to ***Mr. Manoj Pandey*** *for statistical analysis of my results and helping me in my thesis printing and formatting.*

I have to thank my parents for their love and support throughout my life. I would also like to express my gratitude to all my colleagues ***Anjana Singh****,* ***Rashid Khan, Sajal Maurya, Samreen Khatoon*** *and all my juniors with special thanks to* ***Rahul K. Anand, Aayush Garg, Harmeet Kaur*** *who helped me directly or indirectly in bringing the dissertation to completion.*

I also acknowledge the assistance rendered by the paradental staff in the department – ***Mrs Nirmala*** *and* ***Mr. Parshuram****. Besides this, several people have helped me knowingly and unknowingly in the successful completion of this project. I would like to thank each and everyone....*

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AIM: To evaluate and compare the facial asymmetry and laterality of facial asymmetry in males and females of North Indian population with class I molar relation using frontal photographs.

Materials and methods: The frontal photographs of 700 subjects of North Indian population were selected and divided into two Groups- Group I had 350 males and Group II had 350 females. Both groups were further subdivided into subgroup a and b for evaluation of parameters of right and left side respectively. The photographs were cropped in Adobe Photoshop. Twenty-two horizontal, six vertical and ten index and three midline parameters were measured using Digimizer Software for evaluation of facial asymmetry. The data obtained were analyzed statistically using SPSS (version 16).

Results: When comparison of various parameters between subgroup of Group I and Group II was done, Mid facial plane (Mfp) to Endocanthus (En), Exocanthus (Ex), Mid of the pupil (P'), Ala of the nose (Al), Subaurale (Sa), Chelion (Ch) and Gonion (Go) had significantly higher mean value in Group Ia (males) whereas the parameters Mfp to Palpabrale superious (Ps), Palpabrale inferious (Pi), P', Sa, Go and Zygion (Zy) had significantly higher mean value in Group IIb (females). Amongst vertical parameter, Chelion to Interpupillary line (Ch-PP') and Gonion to Interpupillary line (Go-PP') had significantly higher mean value on left side in both Group Ia (males) and Group IIa (females) and Exocanthus to Menton (Ex-Me') had significantly higher mean value on left side only in Group IIa (females), Landmarks away from midline like Sa, Zy, Go showed greater variation than the landmarks closer to the midline in both the groups. The midline landmarks deviated toward the left side in both Group I and Group II. When comparison was done between Group I and Group II, horizontal parameters - Mfp to Ex,

En, P and Sa had higher mean values in Group I (males) and Mfp to Ps, Pi, Cp and Zy had higher mean value in Group II (females). Significant difference was seen for Nose and Face index in Group I and Group II. No significant difference was found for vertical parameters in Group I and Group II. The midline landmark (pronasale (Prn), labiale superious (Ls) and Menton (Me')) of facial asymmetry showed significantly higher values in Group I (males) than Group II (females).

Conclusions: Wider (horizontal) hemiface on right side in males and on left side in female was found. Left side was longer vertically in both male and females. Facial asymmetry increases as we go away from midline. Laterality of facial asymmetry was evident with deviation towards left side of midline landmarks. Sexual dimorphism was also observed in various parameters used to assess facial asymmetry.

Key-words: Facial asymmetry, photographs , North Indian population, Digimizer, laterality.

Beauty is subjective, as once the famous Greek philosopher Plato said "Beauty lies in the eyes of beholder". Esthetic consideration for a face is greatly affected by cultural and ethnic factors, but whatever the culture, a disproportionate face becomes a psychosocial problem.[1] Harmonious facial features are more symmetrical closer to the facial midline and become asymmetrical as we move away from the facial midline[2].

According to Angle 'the study of Orthodontia is inseparably connected with that of art as related to the human face. The mouth is a most potent factor in making or marring the beauty and character of the face'.[3] Tweed defined the normal facial contour as being "balance and harmony of proportion" considered by the majority of us as most pleasing in the human face' though the importance of a well proportioned human face cannot be underestimated. Evaluation of facial esthetics is at best objective, because balance and harmony of facial components do not necessarily mean an attractive face. Despite the fact, that improvement of facial aesthetics is the cornerstone of any orthodontic treatment; our diagnostic considerations were initially based on Angle's paradigm which was based on the assumption that an ideal hard tissue proportions produce an ideal soft tissue proportions of profile. In early 21st century, an emphasis shifted on consideration of the oral and facial soft tissues[4].

Many human body parts undergo development with bilateral symmetry. This implies that the right and left sides can be divided into identical mirror images. However, due to biological factors inherent to processes of development as well as environmental disturbances, perfect bilateral symmetry is rarely found.[5]

The face often presents with a mild degree of asymmetry. Nevertheless, slight asymmetry, also known as relative symmetry, subclinical asymmetry or normal asymmetry, ends up being unperceived by its carriers and everyone around them.

The etiology of subclinical asymmetry remains controversial. It could derive from the fact that the lower and midface develop from the medial and lateral nasal processes as well as maxillary and mandibular processes, and despite being intrinsically coordinated, these structures might imply time lag between growth of right and left analoge of such embryonic processes.[6] Another reason could be dominance of opposite cerebral hemisphere in right or left sided individuals resulting in overdevlopment of dominant side. The literature also reports habitual mastication on one side ,constant facial pressure during sleep exclusively on one side, deleterious oral habits etc as being of the causes of normal asymmetry.[7]

Stedman's medical dictionary defines symmetry as equality or correspondence in form of parts distributed around the center or an axis at the two extremes or poles or on the two opposite sides of the body.[8] Clinically, symmetry means balance while significant asymmetry means imbalance. According to Bishara[9], perfectly bilateral face and body symmetry is largely a theoretical concept that seldom exists in living organisms. He also stated that, the slight facial asymmetry can be found in normal individuals, even in those with aesthetically attractive faces.

The minor facial asymmetry is common, usually cannot be seen and does not require any treatment. The point at which normal asymmetry becomes abnormal cannot be easily defined and is often determined by the clinician's sense of balance and the patient's sense of imbalance[9]. Clinical facial asymmetry in the craniofacial complex ranges from the barely detectable to gross discrepancies between the right and left halves of the face.

In the literature, a number of causal factors have been highlighted in the development of facial asymmetries. Chia et al[1O] suggested that asymmetries could have

pathological, traumatic, functional or develop-mental causal factors. Haraguchi et al[11] claimed that the etiology of facial asymmetry can be grouped into hereditary factors of prenatal origin and acquired factors of postnatal origin. Conversely, Cheong and Lo[6] reported that the causes of facial asymmetry can be grouped into three main categories: (I) congenital, of prenatal origin; (II) acquired, resulting from injury or disease; and (III) developmental, arising during development and of unknown etiology .

Facial asymmetry may be associated with Class I occlusion, but is more frequently associated with Class II and III occlusions. The laterality in the normal asymmetry of the face tends to have a greater preponderance in skeletal Class III cases. The normal asymmetry which usually results from a small size difference between the two sides should be distinguished from a chin or nose that deviates to one side, which can produce severe disproportion and esthetic problems.

By editing the photographs of a pleasant face in frontal view, with its respective mirror image, three images are obtained: the original one, both right sides and both left sides. Assessment of these images evinces the existing bilateral discrepancies.

The studies conducted on Turkish[11], Korean[2], Japanese[12], Brazilian[13] and Chinese[14] population have shown population difference in laterality of facial asymmetry with right side of the face being larger than left side. On contrast no difference between the two sides in the study of Vig et al[15] and left hemiface was larger than right in other studies.[12,16] The study conducted by Severt and Proffit[17] reported maximum facial laterality in lower third of face (74%) in comparison to the upper and middle third (5% and 36% respectively) of the face among the population

at the University of North Carolina. Similar results were seen in studies by Ferrario[18] (1994) and Haraguchi[12]. In the study conducted among Asian population by Chew et al [14], asymmetry was seen in 35.8% of 212 patients with dentofacial deformities. In a study by Carvalho et al [13] subjective perception of asymmetry was there in both the control group (54%) and the group requiring rhinoplasty (59%) whereas objective measurement on photographs revealed higher percentage of facial asymmetry in both the groups.

As population differences were seen in laterality of facial asymmetry, various studies have been conducted on Indian population as well to evaluate facial asymmetry using posteroanterior cephalometric radiographs. In the study conducted on South Indian population by Taneja et al[19], the total facial structures were significantly larger on the left side than the right. According to the study conducted by Shah et al[2O] in the Ahmadabad population and by Rajpara et al[21] in Udaipur population, facial asymmetry was noted in normal subjects but the right side was being larger than the left side. Similarly in the study conducted by Goel et al[22] in Karnataka population significant difference was noted in Class I, II and III malocclusion for various parameters used to assess facial asymmetry. They also found that asymmetry decreased in magnitude as we approach craniofacial regions. Similarly Rajpara et al[21] described that mandibular region showed greater asymmetries than the upper facial region. As no study has been conducted on the North Indian population hence it is decided to assess facial asymmetry in the normal subjects with class I molar relation of Lucknow of North Indian origin.

Patients with facial asymmetry can be evaluated through clinical assessment, photographs[12,23], posteroanterior cephalograms[14,19-22,24], and occasionally 3D-

computed tomography[2]. Clinical examination reveals asymmetry in the sagittal, coronal and vertical dimensions[6]. According to the study conducted by Dayalan M etal[25], for the planning of dental aesthetic treatment use of digital photographs of the face has become a part of the usual procedure. Digital photographs have been considered as a reliable method to evaluate the facial and dental symmetry. Photographs create a more comprehensive virtual model of the patient. It remains the most important diagnostic tool in the evaluation of facial asymmetry. The photographic assessment besides being a great diagnostic tool, for epidemiologic studies it is cost effective and does not expose the patient to potentially harmful radiation.[26,27]

Soft tissue measurements useful for characterizing facial morphology can be reliably measured from facial photographs hence it is decided to evaluate facial asymmetry using photographs in the present study.

The purpose of this study is to investigate the prevalence of facial asymmetry and laterality of the normal asymmetry on digital photographs taken of normal subjects with class I molar relation from North Indian population.

Aim of the study:

Evaluation and comparison of prevalence and laterality of facial asymmetry in males and females with normal occlusion of North Indian population.

Objectives of study:

1. To evaluate the facial asymmetry in males and females of North Indian population with class I molar relation using frontal photographs.

2. To evaluate the laterality of facial asymmetry in males and females of North Indian population with class I molar relation.

3. To compare the prevalence of facial asymmetry and its laterality in males and females of North Indian population.

Vig PS , Hewitt AB (1975)[15] evaluated 63 postero-anterior cephalogram of "normal" children of 9-18 years of age with an aim to assess facial asymmetry. In their study, the axis representing the middle third of the face was found to be deviating to the left of the axis representing the lower third of the face in the 67% of subjects. An overall asymmetry was found in most of the children with the left side being larger. The dento-alveolar region exhibited the greatest degree of symmetry. They concluded that compensatory changes seem to operate in the development of the dento- alveolar structures.

Shah SM, Joshi MR (1978)[2O] conducted a study on posteroanterior cephalometric radiographs of 43 subjects to evaluate the degree of facial asymmetry having clinically symmetrical and pleasing facial features with normal occlusion . The total facial structures were significantly larger on the right side than on the left side. The lateral maxillary region exhibited greater degree of asymmetry than other components of the face.

Chebib FS, Chamma AM (1981)[16] conducted a study on 64 subjects(32 male and 32 female) of Canadian population using PA ceph. They measured indices to assess craniofacial asymmetry using mid sagittal axis and lateral axis on PA ceph. All the midline structure would fall on the Maxis (Mid sagittal axis), a larger left side of the face was seen compared to the right.The specific indices of the bilateral craniofacial structure showed no significant asymmetry in the orbital region.

Farkas LG, and Cheung G (1981)[28] conducted a study on 308 (154 boys and 154 girls) of North American population using Anthropometry yo evaluate a degree of subtle asymmetry that can be expected in all of us. They found asymmetry was found to be very common, but average difference right and left measurements were mild (3

mm or 3%), with right side usually the largest and in the upper third of the face (69.2%)and the right side was more longer than the left.Sex and age did not influence the prevalence of asymmetries significantly.

Peck S, Peck L (1990)[29]consisted of 52 white adult subject (49 female and 3 male) on PA ceph and photographs to evaluate skeletal asymmetry in esthetically pleasing faces. Each subject was positioned in a Margolis cephalostat for standerized x-ray and photographic records. 3 frontal facial line were constructed using bilateral skeletal landmarks first latero superior object second lateral zygoma and gonion. A slight tendency towards right side than left side and was not statistically significant.

Ferrario VF, Sforza C, Pizzini G, Vogel G (1993)[26] evaluated size and shape difference in males and females using Eucledian distance matrix analysis on photographs of 1o8 healthy young adults (57 men and 51 women) were taken.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.

Ferrario VF, Sforza C, Miani A and Serrao G (1994)[18] studied facial asymmetry in 8O young healthy adults (4o men and 4o women) using 3 dimensional coordinates of 16 standardized facial landmarks as measured by infrared photogrametry.He concluded that right side of the face was larger than left side. The mean faces of both groups were significantly asymmetric ie two side of the face showed significant difference in shape but no difference in size.

Skinazi GLS, Lindauer S, Isaacson RJ(1994)[30] evaluated normal chin, nose, and lips ratios in young men and women. They used surface landmarks only to define an area, and soft tissue profile are analyzed in terms of the surface area of each component part present within this area. The profiles of 66 young adults were measured , and the mean total profile area and all of the component parts except the nose were statistically larger in men than in the women. The mean female nose was larger, but this difference was not significant. On the basis of percentage contributions, the mean female nose contributed significantly more to the total mean, female profile than the mean male nose did to the mean male total profile.

Severt and Proffit (1997)[17]conducted a retrospective study of a referred population 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 that had been identified and recorded in their patient notes prior to treatment. Asymmetries affecting the upper face occurred in only 5% of their sample, 36% had asymmetry of the mid-face and 74% had asymmetry of the mandible. Furthermore it was concluded that individuals with a class II skeletal base were least likely to have facial asymmetry.

Borod JC, Koff E, Yecker S, Santschi C, Schmidt JM. (1998)[31] conducted a study to examine 49 extant experiments of facial asymmetry during emotional expression in normal adult males and females in regard to gender, valence, and measurement technique. When they facial asymmetry was evaluated by trained judges or muscle quantification, facial expressions were left-sided, a finding implicating the right cerebral hemisphere in emotional expression. However, when self-report experiential methods were utilized, the valence hypothesis received some support. Although there was some indication in single-gender studies of greater facial lateralization for males

than for females, studies involving both males and females yielded no systematic asymmetry patterns as a function of gender.

Shaner DJ, Peterson AE, Beattie OB, Bamforth JS.(2000)[32] determined if facial asymmetry was greater in syndrome-affected individuals than in normal individuals and, if true, to distinguish those measurements that could be used in routine screening to identify the presence of syndromes in uncertain patients and to investigate the causes of measurement asymmetry at the level of the landmarks. They investigated soft tissue facial asymmetry in normal and syndrome-affected individuals ranging in age from 1 year to adulthood used a stereophotogrammetric method with which the three-dimensional (3D) landmark positions. In the statistically significantly different measurements, those from the right side were dominant, with one exception in each group, except normal males. They noted statistical differences in measurements did not infer significant differences in the positions of the landmarks between the right and left sides of the face.

Smith WM (2000)[33] assessed hemispheric facial asymmetry in 90 subjects (45 males and 45 females) of Dartmouth undergraduates on photographs using CANVAS software. This program calculated the areal, linear, perimetric and angular measurements, once appropriate markers were placed on an image. He calculated area of right and left hemiface below interpupillay line. He found that the left hemiface was larger than that for the right hemiface in males, the difference being .13 sq. cm. (3.8%) and the variation among males in this respect was from .3 to 14.2%. For the females the right hemiface mean was larger by .o9 sq.cm.(2.7%) and the variation among females in this respect was .6-12.8%.

Ferrario VF, Sforza C, Ciusa AV, Dellavia C, Tartaglia GM (2001)[34] assessed the effects of sex and age on 3-D soft tissue facial asymmetry in 4o males and 33 females in age range of 12 to 15years; 73 females and 89 males young adults in age rangeof 18 to 3o years and 41 male and 38 female in age range of 31 to 56 years using an electromagnetic instrument. The midline landmarks used in this study were pronasale and menton and paired landmarks used were exocanthus , endocanthus, orbitale superious, zygion, tragion, nasal alar crest, chelion and Gonion. All the parameters used were more in males except ala of the nose which was more in females in the adolescent period. The maximum normal asymmetry was slightly greater in females than in malesof corresponding age, within each sex, the largest values were found in the adolescent group. Tragion, gonion, and zygion were the most asymmetric landmarks in all the groups, whereas the least asymmetric was endocanthion.

Haraguchi S, Takada K and Yasuda Y (2002)[12] investigated the frequency, site, amount, and direction of facial asymmetry in 220 Japanese adults having class III malocclusion. The sample was divided into two groups: group I included children who had received chin cap for protraction headgear before came to hospital and group II included patient who had not received any orthopedic treatment for class III correction. Subjects with a deviation of more than 2mm from the facial midline associated with any of the 4 landmarks- ANS, U1, L1 and Me were classified as asymmetric and the asymmetry was measured on a postero- anterior cephalogram. The proportions of asymmetry for each landmark and between the landmarks, with a particular focus on the direction of laterality, were compared between the 2 groups. They found an obvious tendency towards left- sided facial laterality and this was more obvious in the lower part of the face. Group I showed a higher proportion of subjects with lateral deviation toward the right side and a greater amount of chin deviation.

Mcintyre GT and Mossey PA (2002)[35] evaluated size related right:left asymmetry in parents of children with orofacial clefts using PA ceph and Conventional cephalometric asymmetry analysis and morphometric asymmetry analysis were done. Wider hemiface on left side and shorter vertical dimension on right side were seen both in parents and children suggestive of heritable directional craniofacial skeletal asymmetry.

Goel S, Ambekar A, Darda M, Sonar S (2003)[22]investigated the transverse frontal facial asymmetry seen in different malocclusion using frontal asymmetry analysis suggested of Grummons using postero anterior cephalogram of 120 subjects. In their study they found asymmetries were seen in all types of malocclusion ,mandibular region showed the asymmetries of highest magnitude and asymmetries decreased as they approach higher in craniofacial skeleton.

Nicholls ME, Ellis BE, Clement JG, Yoshino M (2004)[36] examined the veracity of the right hemisphere and valence models by measuring asymmetries in: (i) movement of the face; and (ii) observer's rating of emotionality useing precise three-dimensional (3D) imaging technique. Models with happy, sad and neutral expressions were digitally captured and manipulated. Comparison of the neutral and happy or sad images revealed greater movement of the left hemiface, regardless of the valence of the emotion, supporting the right hemisphere model. There was a trend, however, for left-sided movement to be more pronounced for negative than positive emotions. Participants reported that portraits rotated so that the left hemiface was featured that were more expressive of negative emotions whereas right hemiface portraits were more expressive for positive emotions, supporting the valence model. The effect of valence was moderated when the images were mirror-reversed.

Zaidel DW, Cohen JA. (2005)[37] evaluated facial asymmetry in beautiful faces on photographs of "beautiful" faces from the collections of professional modeling agencies.The relationship between bilateral facial symmetry and beauty remains to be clarified. were selected. First, beauty ratings were obtained for these faces. Then, they created symmetrical left-left and right-right composites of the beautiful faces and asked a new group of subjects to choose the most attractive pair member. "Same" responses were allowed. No difference between the left-left and right-right composites was revealed but significant differences were obtained between "same" and the left-left or right-right. These results show that subjects detected asymmetry in beauty and suggest that very beautiful faces can be functionally asymmetrical.

Ercan I, Ozdemir S T, Etoz A, Sigirli D, Tubbs S, Loukas M, Guney I (2008)[23] tried to identify normal facial asymmetry between the right and left sides of the face using Eucledian distance matrix analysis. Facial landmark data were collected from two dimensional digital images of 321 young healthy subjects (150 males and 171 females). They found that the left side of the face was larger in both males and females. The number of significantly asymmetric linear distances between the two halves of the face were found and differences ware greater in females than in males.

Haraguchi S, Lguchi Y and Takada K (2008)[11] 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. They found that out of 1800 Japanese subjects (651 males and 1149 females) with facial asymmetry, 79.7 % had a wider right hemiface whereas 79.3 % of those with chin deviation had left sided laterality. These tendencies were independent of sex, age or skeletal jaw relationships. 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.

Fong JHJ, Wu HT, Huang MC, Chou YU, Chi LY, Fong Y et al (2010)[38] investigated the facial skeletal features associated with chin deviation (>2 mm) on 25 subjects (14 male and 11 female) over the age of 15 years. 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 direction of chin deviation was significantly associated with the difference in the effective length of bilateral mandibular halves. Hence, it was concluded that facial skeletal asymmetry exists in patients with chin deviation and this should be considered when planning treatment for both the nonsurgical and surgico-orthodontic cases with chin deviation. 68% show deviation to left side than right side. For every 1mm of chin deviation, the left mandibular effective length was longer than that of right side.

Mizumoto Y, Sr TD ,Fong KWC (2009)[39] assessed facial proportions by examining photographs of 3 groups of Asian women: group 1, 30 young adult patients with a skeletal Class 1 occlusion; group 2, 30 models; and group 3, 14 popular actresses. Photographic prints or slides were digitized for image analysis. Group 1 subjects had standardized photos taken as part of their treatment. Photos of the subjects in groups 2 and 3 were collected from magazines and other sources and were of varying sizes; therefore, the output image size was not considered. The range of measurement errors was 0.17% to 1.16%. ANOVA was selected because the data set was normally distributed with homogeneous variances. The subjects in the 3 groups showed good total facial proportions. The proportions of the face-height components in group 1

were similar to the golden proportion, which indicated a longer, lower facial height and shorter nose. Group 2 differed from the golden proportion, with a short, lower facial height. Group 3 had golden proportions in all 7 measurements. The proportion of the face width deviated from the golden proportion, indicating a small mouth or wide-set eyes in groups 1 and 2. The null hypothesis was verified in the group 3 actresses in the facial height components. Some measurements in groups 1 and 2 showed different facial proportions that deviated from the golden proportion (ratio).

Cheong YW, Lo LJ (2011)[6] discussed subclinical asymmetry, its etiology, assessment of soft tissue, dental and skeletal components contribution, and management of facial asymmetry. They stressed that patients perception of facial asymmetry and real exceptions from treatments must be assessed before finalizing the treatment plan.

Kim YM, Rha KS,Weissman JD,Most SP (2011)[4O] compared the external and internal parameters of the face and whether their developmental differences are associated with nontraumatic DNS. Five parameters (angle of septal deviation [ASD], angle of nasal floor [ANF], angle of lateral nasal wall [ALW], angle of inferior turbinate [AIT], and width of IT [WIT]) were measured. Preoperative frontal views of the patients were analyzed by comparing the distances between the following points on both sides of the faces: midsagittal plane to Zygion (MSP-Zy), Glabella to Exocanthion (G-Ex), Exocanthion to Cheilion (Ex-Ch), and Zygion to Cheilion (Zy-Ch).The differences between the right and left MSP-Zy, G-Ex, and Ch-Zy distance were significantly associated with the direction of septal deviation.

Carvalho B, Ballin AC, Becker RV, Berger CAS, Hurtado JGGM, Mocellin M(2012)[13] conducted a study for anthropometric evaluation of facial asymmetry in patients with preoperative history of rhinoplasty using photographs and comparing the

results to normal volunteers. They found high prevalence of asymmetry among both the pre rhinoplasty patients (100) and the volunteer subjects(101) . Subjectively 59% of patients were perceived as asymmetric, against 54% of volunteers and objectively more than 89% of respondents had asymmetrical measurements.

Hwang HS, Yuon D, Jeong H, Uhm GS, Cho JH, Yoon SJ (2012)[2] conducted a study with an aim of identifying the right and left difference in the facial soft tissue landmarks seen on computed tomography scans of 48 subjects (24 men, 24 women) with normal occlusion. In this study 27 soft tissue landmarks were identified in 3D coordinate system and their right and left difference were determined. The right and left difference values showed a tendency to increase as we proceed towards lower part of face or move laterally from the midline. Overall differences were determined not only in transverse plane but also in sagittal and vertical plane, indicating that 3D evaluation would be essential in the facial soft tissue analysis.

Taneja VK, Kumar GA, Farishta S, Minocha RC, Baiju G, Gopal D (2012)[19] assessed the skeletal craniofacial asymmetry in South Indian population using postero anterior radiographs of 60 subjects(30 males and 30 females). They found that the total facial structures were larger on the left side. Also the cranial base structure was exhibited greater degree of asymmetry. Same as females the cranial base region and maxillary region were found to be larger on left side whereas upper maxillary region was found to be larger on the right side.

Huang CS, Liu QW, Chen YR(2013)[41] conducted a study to differentiate a symmetric face from an asymmetric face by analyzing a three-dimensional (3D) facial image and plotting the asymmetry index (AI) on a facial symmetry diagram and sixty healthy Chinese adults (30 men and 30 women, mean age: 27.7 + 4.9 years old)

without any craniofacial deformity were recruited on a voluntary basis from a medical center. The 3D facial asymmetry can be documented with AI. The landmarks located on the upper face had a smaller AI than the landmarks located on the lower face. The facial symmetry diagram can identify efficiently the location of asymmetry on a face.

Kumar SS, Subrahmanya RM (2014)[42] designed a study with aim and objective of assessing the facial asymmetry in transverse plane in 90 subjects (45 males and 45 females) of Karnataka population having as skeletal class II jaw discrepancy using frontal ceph.The sample was divided into Group I(Class I malocclusion) , Group II (skeletal class II with maxillary excess) , Group III (skeletal class II with mandibular deficiency). The facial asymmetry of skeletal class II individuals were compared using Grummon's analysis in frontal cephalograms. Significant differences were observed between right side and left side values in relation to Ag-Me in males and Co-Ag-Me in females in group III individuals. Significant differences were also observed between right side and left side values in relation to J-MSR in males in Group II individuals. Significant differences were observed between right side and left side values in relation to Me-MSR in males in Group II individuals. Hence, it had been revealed that facial asymmetry exists between right and left sides in class II individuals. Maxilla is more asymmetrical than mandible in patients with maxillary excess. Asymmetry showed male dominance in individuals with maxillary excess and mandibular deficiency.

Tseng YC, Yang YH, Pan CY, Chang HP(2014)[43] employed PA cephalometric analysis to identify characteristics and differences in skeletal structure between patients who required surgical treatment (n=30) and those who needed Orthodontic treatment (n=30) only for management of facial asymmetries using the receiver operating characteristics (ROC) curve .The variable with the higher ROC curve was

considered a better indicator for the surgery group. This study identified six cephalometric variables as the minimum number of discriminators required to obtain the optimal discriminant effectiveness of diagnosis between orthognathic surgical and nonsurgical orthodontic treatment of facial asymmetry. The six criteria were mandibular shift angle ≥ 4.1˚ , Ramus –Menton -ANS ≥3.40˚ , Zygion-Menton-ANS≥5.30˚ , GWSO (greater wing of superior orbit)- Menton-ANS≥4.90˚, Jugal-Menton-ANS≥2.10˚ ,and Gonion-M-ANS ratio≥1.11.

Rajpara Y, Shyagali T R, Trivedi K, Kambalyal P, Sha T, Jain V (2014)[21] assessed the extent of facial asymmetry or as in individuals who had no visible facial asymmetry. This study was conducted on a sample of 50 adult subjects (25 male and 25 female) using posteroanterior cephalogram. Skeletal asymmetries were common finding even in individuals who had normal facial features. Right sided dominance of the mandible was more. Moreover the mandible showed the left side deviation.

Smith WM (2014)[44] conducted a study by of 9O subjects (45 males and 45 females) of Dartmouth undergraduates on photographs using CANVAS software. This program calculated areal, linear, perimetric and angular measures once appropriate markers are placed on an image. He calculated area of right and left hemiface below interpupillay line, he found that the left hemiface was larger than that for the right hemiface in males, the difference being .13 sq. cm. (3.8%) and the variation among males in this respect was from .3 to 14.2%. and for the females the right hemiface mean was larger by .o9 sq.cm.(2.7%) and the variation among females in this respect was .6-12.8%.

Amer ME; Labib A ; Hassan A(2015)[45] conducted a study to find correlations between lateral cephalometric measurements and photographic measurements of facial attractiveness in a group of Egyptian adolescents. Sixty adolescent laypersons judges (30 males – 30 females) participated in the evaluation of the pre-treatment

photographs of 60 adolescent subjects (30 females – 30 males) for facial attractiveness. From the 19 cephalometric measurements; ANB, wits appraisal, MMA, lower incisor / mandibular plane angle, profile angle, E-line to lower lip, lower lip thickness and upper lip length were the variables showed significant correlation with photo attractiveness for women and ANB, facial angle, upper incisor / palatine plane angle, Z-angle, Upper lip thickness and upper lip length were the variables showed significant correlation with photo attractiveness for man.

Moshkelgosha V, Fathinejad S, Pakizeh Z, Shamsa M (2015)[46] established angular and linear photogrammetric norms for aesthetic treatment goals in 24o subjects (11o females and 13o males) aged 16-18 years of Persian population. The photographic records were analysed using a aesthetic analyser software program. 43 facial indices were calculated digitally by computer software. Mouth width and nasal base width were significantly higher in males. The labial , nasal and chin area showed sexual dimorphism in most of the parameters used in this study. They found that all participants showed Right side laterality, in frontal measurements. It was observed that the boys had larger facial dimensions, greater facial heights, longer nasal,labial and chin lengths and greater nasal, labial and chin prominance than females.

Adamyu LH, Ojo SA, Danborno B, Adebisi SS,Taura MG(2016)[47] investigate the sex difference in 3 asymmetry indices and also determined the side dominance and type of asymmetry in 283 individuals comprising of 147 males and 136 females using facial photographs. Females had higher mean values for all parameters as compared to males. In this study females had statistically significantly higher mean value of orbital width on right side and Zygion to Gnathion facial distance was higher on left side in males. In this study males tend to have leftward Signed Asymmetry in orbital width and Zygion to Gnathion distance.

Duggal S, Kapoor DN, Verma S, Sagar M, Lee YS, Moon H et al (2016)[48] assesses the attractive facial features of Indian population on frontal photographs of of an equal number of males and females. Subjects were divided in two groups, Group I(unattractive) and group II (attractive). In order to analyse the face objectively, an experimental photogrametric facial analysis BAPA program was utilized. Comparing Group I and Group II of both males and females, difference between the upper face index and the mandible index was highly significant. In contrast, no significant differences (.15-4.63) were found between the groups in term of the lower face index, interpupillary index, eye height index, eye width index, nasal index and the lip index. For female faces, the facial index as well as the indices reflecing the upper face, mandible, left and right mandible angle, and left and right lateral gonial angle were significantly higher in group 2 than in group 1.

Hirpara N, Jain S, Hirpara VH and Punyani PH(2016)[49] assessed and correlated the asymmetry indices in maxillary and mandibular degree using posteroanterior cephalogram and standardized digital orthopantomogram. Vertical measurement of condyles, coronoid processes, ramus, Co-Go distance and maxilla were recorded on both sides in orthopantomogram and PA cephalograms. The schematic representations of measurements were drawn as described by Habet's and Kjellberg. At the same time asymmetry index and condylar ratio were evaluated vertical measurents of condyle, ramus, Co-Go distance, and maxilla asymmetryindices and condylar ratio correlated significantly between OPG and PA cephalogram. Habet's asymmetry index and Kjellberg's condylar ratio showed significant negative correlation amongst them. Thus, it has been concluded that asymmetry indices in vertical dimension can be calculated from OPG for mandibular posterior regions.

Kornreich D, Mitchel AAl, Webb BD, Cristian I, Jabs EW (2016)[50] compared global versus landmark analyses of facial asymmetry using three dimensional photogrammetry to establish a precise method for evaluating facial asymmetry. The landmark-based approach utilized anthropometric data points, their global approach involved registration of mirror images, independent of a midplane, to calculate a root mean square (RMS) value. They found that the global method has better precision and repeatability with a significantly lower error rate than the landmark-based method. In adults, the average RMS was 0.6253 mm with a standard deviation of 0.16. Their facial asymmetry measurement is more accurate than landmark-based measurements. This method is quick, reliable, and results in generation of a RMS score and a corresponding color-coded facial map that highlights regions of higher and lower asymmetry. This method may be used as a screening tool for asymmetry in both the clinical and research settings.

Reddy MR, Bogavilli SR, Raghavendra V, Polina VS, Basha SZ, Preetham R (2016)[51] evaluated the prevalence of skeletal facial asymmetry in Tirupati population using both photographs and Posteroanterior ceph of 100 subjects (50 males and 50 females). Parameters MSR to Go distance higher in right side than left side in males whereas it was higher in left side than right side in females but the difference was statistically insignificant. The MSR to Go distance was more in males than females. All participants showed mild asymmetry with right side laterality both in Photographs and Posteroanterior ceph. The difference between right and left were insignificant. Male had more laterality than female which was statistically non significant. Both male and female had left side laterality of chin and male had higher mean value as compared to female which was statistically significant.

This study was conducted to evaluate and compare the facial asymmetry of 700 (350 females and 350 males) subjects with normal occlusion in North Indian Population on digital photographs using Digimizer software. Approval was taken from Ethical Committee of Babu Banarasi Das College Of Dental Sciences , Babu Banarasi Das University, Lucknow before conducting of this study. A informed consent was taken from all the participants of the study.

Materials:

Sample:

The sample for this study comprised of frontal photographs in normal occlusion of 700(350 males and 350 females) subjects of North Indian population in the age range of 18-25 yrs. This sample was collected from the students of Babu Banarasi Das College of Dental Sciences and other colleges under Babu Banarasi Das University, Lucknow.

Sample selection Criteria:

The subjects were selected according to the following criteria:-

Inclusion criteria:

- Subjects whose atleast two generations were of North Indian origin.
- Age of the patients between 18-25 yrs.
- Subjects with class I molar relation, minimal crowding or spacing if any.
- All teeth were present till second molars.

- No history of any systemic illness.

Exclusion criteria:

- History of previous orthodontic intervention.
- Any relevant medical and dental history.
- Congenital anomalies of craniofacial regions and any subjects with obvious facial asymmetry.
- History of craniofacial trauma and surgery.
- Tempromandibualr joint disorders or deviation of mandible on opening and closing.
- Subjects with squint.

Materials-

- **Diagnostic instruments to check class I molar relationship-**
    - Mouth mirror
    - Explorer
- **Camera-**
    - Canon (LENS:18-55) 14 megapixel Digital single lens reflex (DSLR) camera(24.1 megapixel DX-format sensor, and 39-point AF system)
    - White background

Fig. 1. Nikon D-5200 Digital Camera

Fig. 2. Tripod Stand

- **Ruler for calibration of photographs:**

  Vertical ruler for the calibration of the photographs.

D. Computer and Softwares:

PC with Windows XP, windows 7, 1 GB RAM, about 8 Megabyte free space on the hard-disk with installed softwares:-

- Adobe Photoshop
- Digimizer software

Methodology

- **Clinical examination:**

Clinical examination was carried out for 800 subjects to assess the requirement of criteria for sample selection.Total 700 subjects who could satisfy the inclusion and exclusion criteria were selected from this.

- **Sample Division:**

700 subjects of North Indian population divided in two Groups –Group I and II, Group I had 350 males with mean age of 21.5± 1.5yrs and Group II had 350 females with mean age 20.5± 1.5yrs .The Group I was further subdivided into Group Ia and I b for parameter of right and left side respectively. Similarly Group II was divided into Group II a and IIb for parameter of right and left side respectively

GROUP I: 350 males.

GROUP II: 350 females.

Groups	Subgroups	Number of sample	Age (mean±years)
Group I (Males)	Group Ia	350	21.5+-1.5
	Group Ib		
Group II (Females)	Group IIa	350	2O.5+-1.5
	Group IIb		

Table 1: Sample Distribution in various groups

- **Method of taking digital frontal facial photograph:**

The subjects were made to stand in an upright position against the white background and vertical ruler was attached to the background for calibration of the photograph. Frontal facial photographs of the subjects was taken in natural head position with maximum intercuspation and relaxed lip posture using DSLR camera. The natural head position was achieved by asking the subjects to stand still , look straight in a mirror placed infront of them. The frontal facial photographs of all the subjects were taken using DSLR camera placed at a distance of 4 feet from the subjects faces and the camera was secured in a tripod stand.

The frontal photographs were transferred into PC. All digital photographs were imported into a commercially available photograph editing software (Adobe Photoshop, Windows

7, Adobe System) and prepared for editing. All photographs were cropped in size of 5× 3.5 inches. 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. Each image was saved as JPEG(Joint Picture Editing Group) file that was identical in size and resolution. The selected and cropped frontal photographs were transferred to Digimizer software for evaluation of photographs.

- **Method of measurement**

After transferring the frontal photographs to the computer loaded with Digimizer software. Magnification error was eliminated by marking two points at the distance of 6 cm on the scale of photographs using cursor. 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. Photographic landmarks were identified and marked and then adjustments were done as per definition discussed below. The analysis was done with the help of Digimizer software.

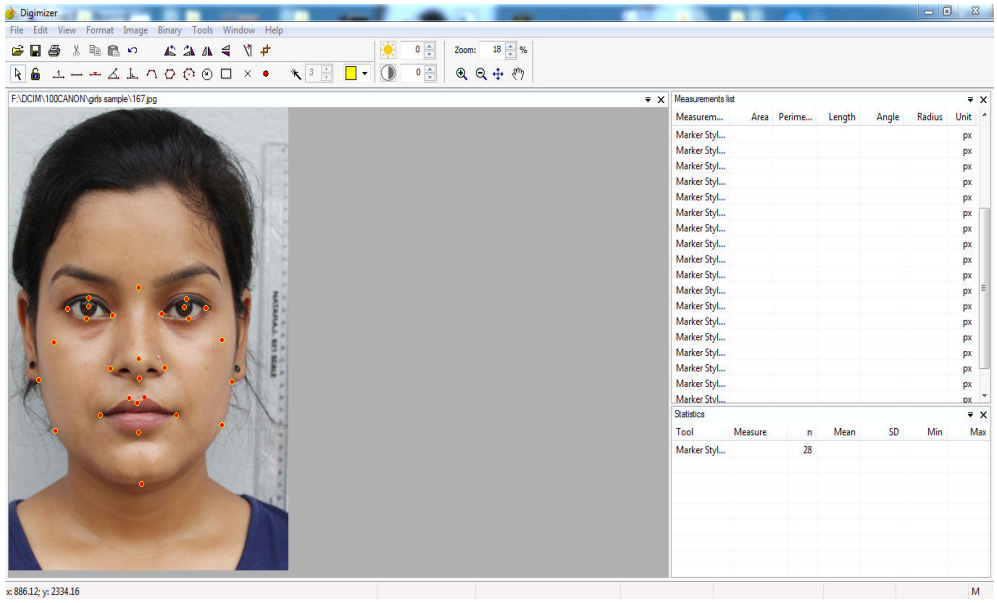


Fig. 3. Transferring the frontal photographs of subjects to the computer loaded with Digimizer software.

Landmarks on Frontal Facial photograph

Before making measurements for analysis following points and landmarks were marked on the photographs.

1. Trichion (Tr): The midpoint of the forehead that borders the hairline.

2. Nasion (N') : The point in the midlle line located at the nasal root.

3. Left pupil (P): Midpoint of the left eye pupil.

4. Right pupil (P'): The midpoint of the left eye pupil.

5. Left exocanthus(Exl) : The point at the left outer commisure of the eye fissure.

6..Right exocanthus(Exr): The point at the right outer commisure of the eye fissure.

7..Left endocanthus(Enl): The point at the left inner commisure of the eye fissure.

8.Right endocanthus(Enr) : The point at the right inner commisure of the eye fissure.

9. Left palpabrale superius(Psl): The mid point at the left upper eyelid.

10. Right palpabrale superious(Psr):The mid point at the right upper eyelid.

11. Left palpabrale inferious(Pil): The mid point at the left lower eyelid.

12. Right palpabrale inferious(Pir): The mid point at the right lower eyelid.

13.Left zygion(Zyl): The most lateral point on the left cheek bone.

14:Right zygion (Zyr): The most lateral point on the right cheek bone.

15. subnasale(Sn): The middle point where the upper lip joins the columella.

16.Left Ala of the nose(All) : The most lateral point on left alar contour.

17.Right ala of the nose(Alr): The most lateral point on right alar contour.

18.Left subaurale(Sal) : Lowest point of left earlobe.

19.Right subaurale(Sar): Lowest point of right ear lobe.

20. Labiale superius(Ls): The mid point of the vermilion border of thr upper lip.

21. Left crista philter(Cpl): The point on the crest of the philtrum on left side, the vertical groove in the median portion of upper lip ,just above the vermilion border.

22.Right crista philter(Cpr): The point on the crest of the philtrum on right side, the vertical groove in the median portion of upper lip ,just above the vermilion border.

23.Left Chelion(Chl) : The lateral point to the angle of the mouth on left side.

24.Right Chelion(Chr): The lateral point to the angle of the mouth on left side.

25. Labiale inferius(Li): The mid point of the vermilion border of thr lower lip.

26. Left gonion(Gol): The most lateral point at the left angle of the mandible.

27. Right gonion(Gor): The most lateral point at the right angle of the mandible.

28. Menton (Me): The most lowest part of the chin on the mandible in the midline.

29. Pronasale (Prn): The most prominent part of the nose.

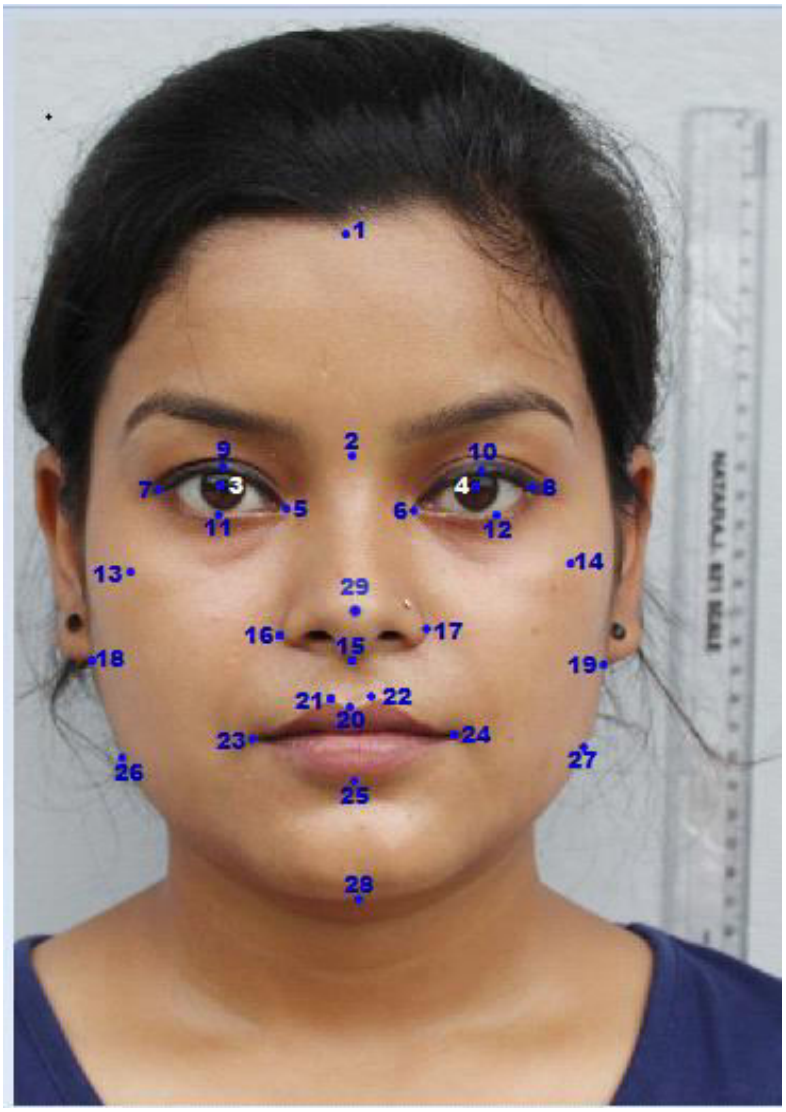


Fig.4. Points and landmarks. 1. Trichion(Tr) , 2. Nasion (N') , 3. Left pupil (P) , 4. Right pupil (P') , 5. Left exocanthus(Exl) , 6..Right exocanthus(Exr) , 7.Left endocanthus(Enl) , 8.Right endocanthus(Enr) , 9. Left palpabrale superius(Psl) , 10. Right palpabrale superious(Psr) , 11. Left palpabrale inferious(Pil) , 12. Right palpabrale inferious(Pir) , 13.Left zygion(Zyl) , 14:Right zygion (Zyr) , 15. subnasale(Sn) , 16.Left Ala of the nose(All) , 17.Right ala of the nose(Alr) , 18.Left subaurale(Sal) , 19.Right subaurale(Sar) , 20. Labiale superius(Ls) , 21. Left crista philter(Cpl), 22.Right crista philter(Cpr) , 23.Left Chelion(Chl) , 24.Right Chelion (Chr) , 25. Labiale inferius(Li) , 26. Left gonion(Gol) , 27. Right gonion(Gor) , 28. Menton (Me'). 29. Pronasale (Prn).

Reference plane:

- Interpupillary line (PP'): A horizontal line from left pupil to right pupil.
- Mid facial plane (Mfp): A line perpendicular to interpupillary line from nasion.

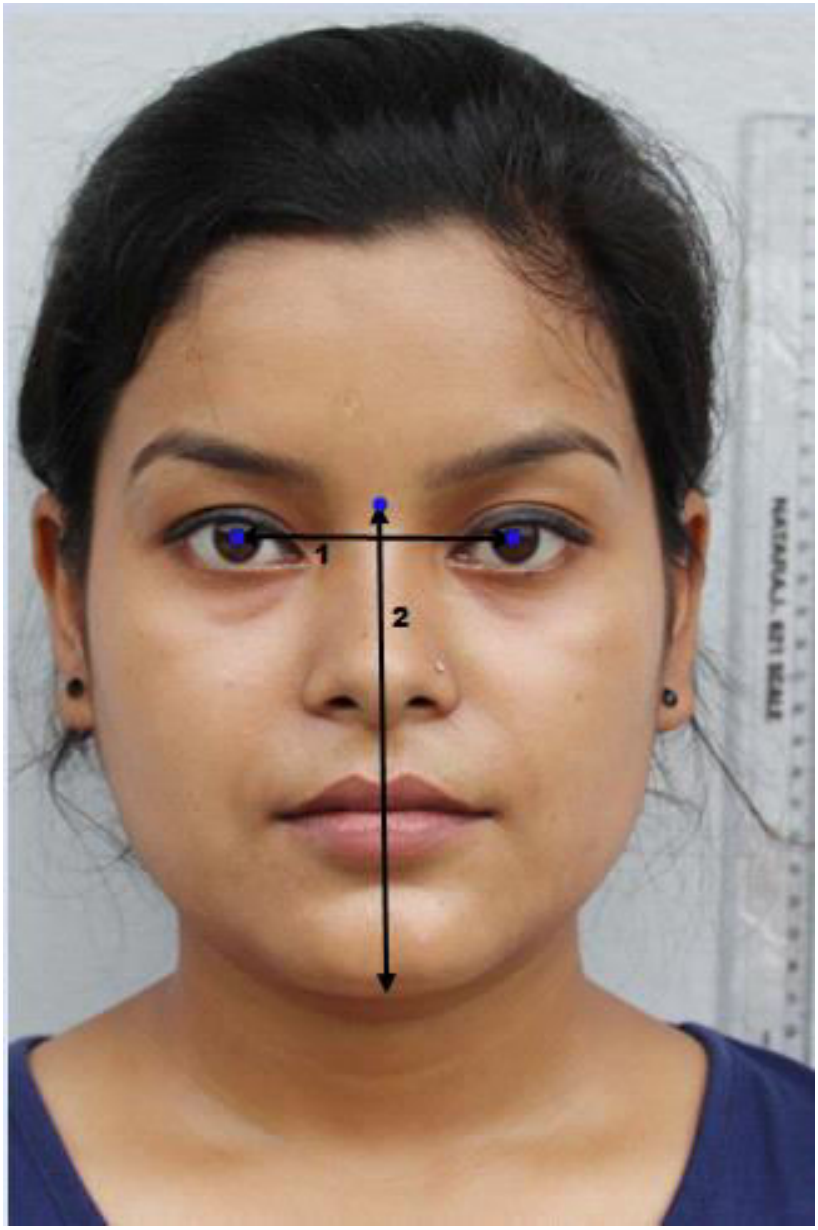


Fig.5. Reference planes: 1. Interpupillary line (PP') , 2. Mid facial plane (Mfp)

Horizontal Parameters:

- Mfp-Exl: A distance from mid facial line to the left exocanthus.
- Mfp-Exr: A distance from mid facial line to the right exocanthus.
- Mfp-Enl: A distance from mid facial line to the left endocanthus.
- Mfp-Enr: A distance from mid facial line to the right endocanthus.
- Mfp: Psl: A distance from mid facial line to the left palpabrale superious.
- Mfp-Psr: A distance from mid facial line to the right palpabrale superious.
- Mfp-Pil: A distance from mid facial line to the left palpabrale inferious.
- Mfp-Pir: A distance from mid facial line to the right palpabrale inferious.
- Mfp-P: A distance from mid facial line to the left pupil.
- Mfp-P' : A distance from mid facial line to the right pupil.
- Mfp-Zyl: A distance from mid facial line to the left zygion.
- Mfp-Zyr: A distance from mid facial line to the right zygion.
- Mfp-All: A distance from mid facial line to the left ala of the nose.
- Mfp-Alr: A distance from mid facial line to the right ala of the nose.
- Mfp-Sal: A distance from mid facial line to the left subaurale.
- Mfp- Sar: A distance from mid facial line to the right subaurale.
- Mfp-Cpl: A distance from mid facial line to the left crista philter.

- Mfp-Cpr: A distance from mid facial line to the right crista philter.
- Mfp-Chl: A distance from mid facial line to the left chelion.
- Mfp-Chr: A distance from mid facial line to the right chelion.
- Mfp-Gol: A distance from mid facial line to the left gonion.
- Mfp-Gor: A distance from mid facial line to the right gonion.

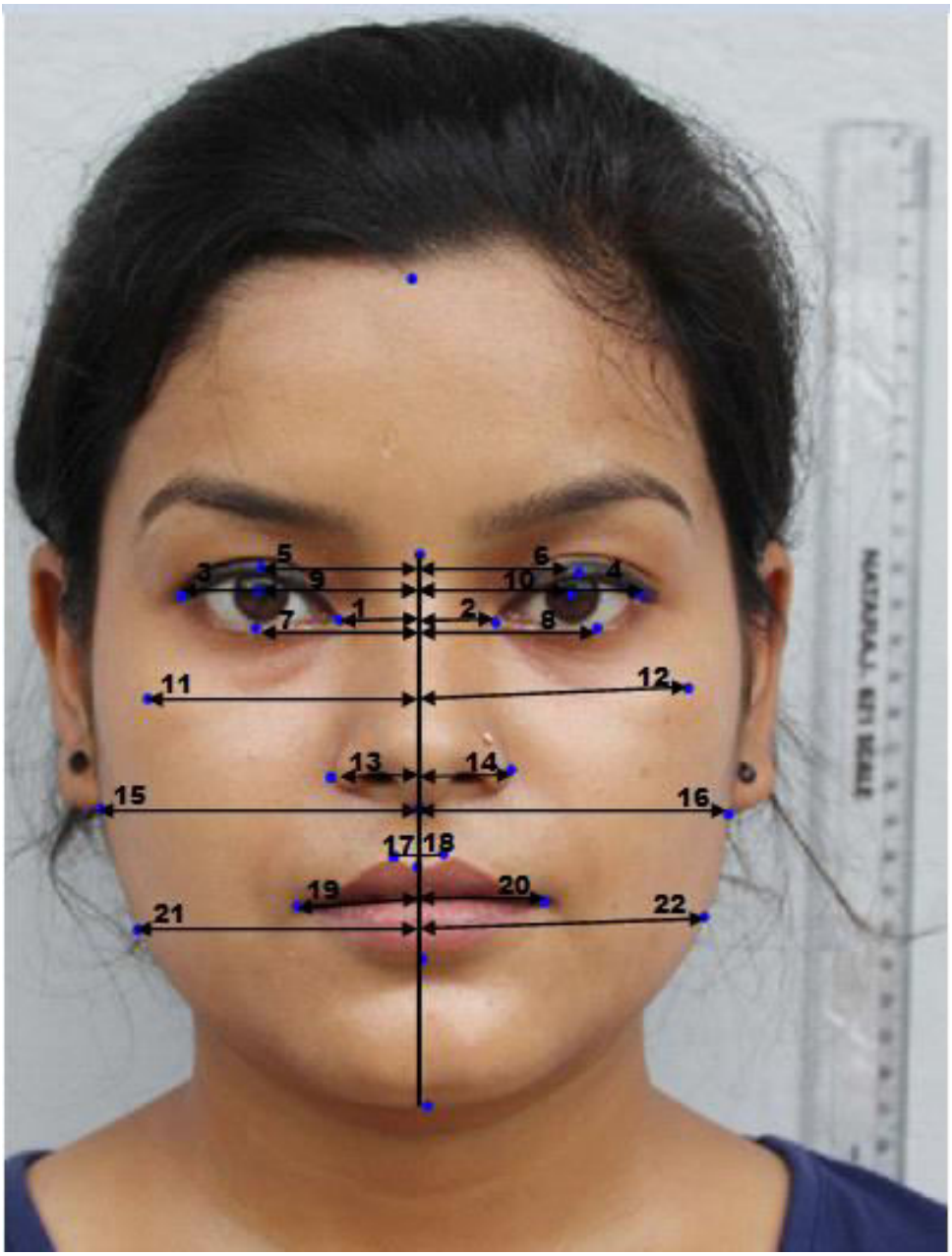


Fig.6. Horizontal parameters: 1.Mfp-Exl, 2.Mfp-Exr, 3.Mfp-Enl, 4.Mfp-Enr, 5.Mfp: Psl, 6.Mfp-Psr, 7.Mfp-Pil, 8.Mfp-Pir, 9.Mfp-P, 10. Mfp-P', 11. Mfp-Zyl, 12. Mfp-Zyr, 13.Mfp-All, 14.Mfp-Alr, 15.Mfp-Sal, 16.Mfp- Sar, 17.Mfp-Cpl, 18.Mfp-Cpr, 19.Mfp-Chl, 20. Mfp-Chr, 21.Mfp-Gol, 22.Mfp-Gor

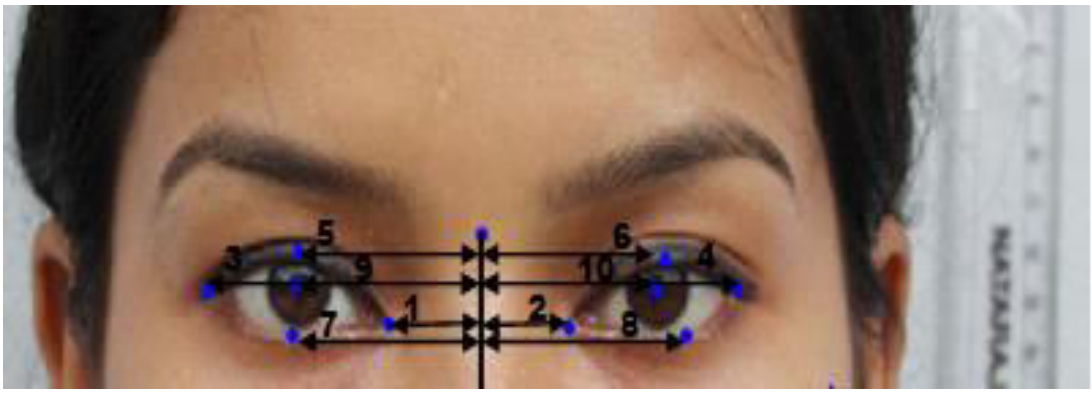


Fig. 7. EYE'S HORIZONTAL PARAMETER: 1.Mfp-Exl, 2.Mfp-Exr, 3.Mfp-Enl, 4.Mfp-Enr, 5.Mfp: Psl, 6.Mfp-Psr, 7.Mfp-Pil, 8.Mfp-Pir, 9.Mfp-P, 10. Mfp-P'

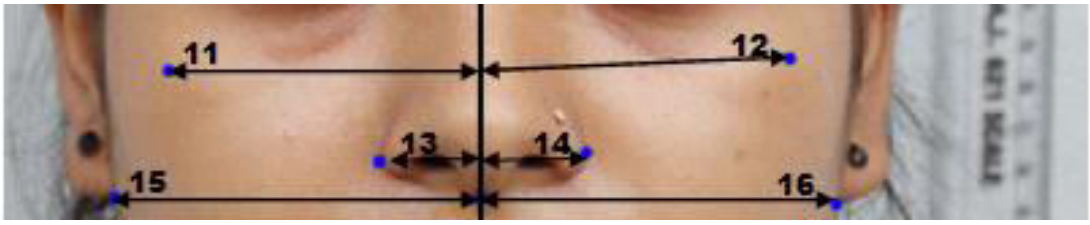


Fig 8: NOSE AND EAR HORIZONTAL PARAMETER: 11. Mfp-Zyl, 12. Mfp-Zyr, 13.Mfp-All, 14.Mfp-Alr, 15.Mfp-Sal, 16.Mfp- Sar.

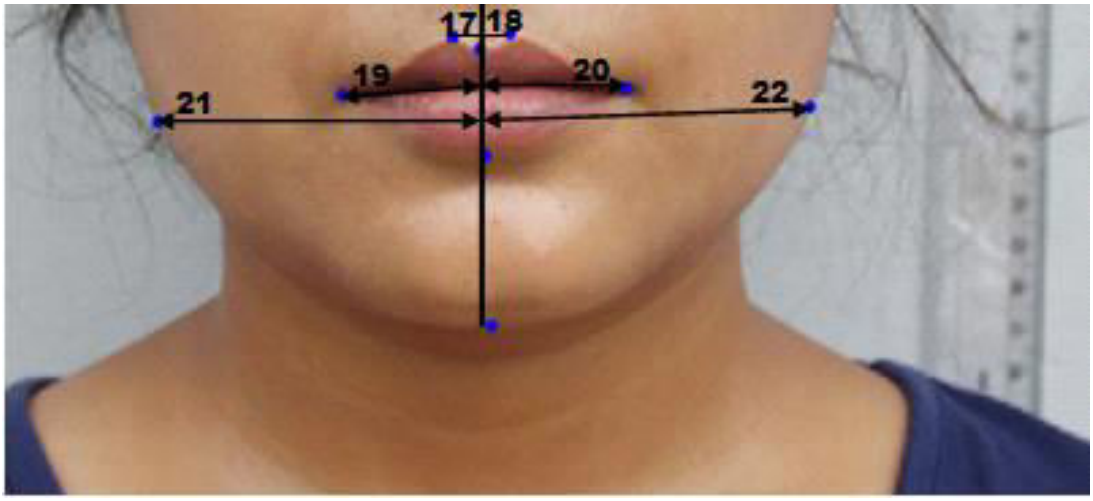


Fig.9. LIP'S HORIZONTAL PARAMETER: 17.Mfp-Cpl, 18.Mfp-Cpr, 19.Mfp-Chl, 20.Mfp-Chr, 21.Mfp-Gol, 22.Mfp-Gor

Vertical parameters

- Exl- Me': A linear distance from left exocanthus to the menton.
- Exr- Me': A linear distance from rightt exocanthus to the menton
- Chl- P': A linear distance from left chelion to the interpupillary line.
- Chr- PP': A linear distance from right chelion to the interpupillary line
- Gol-PP: A linear distance from left gonion to the interpupillary.
- Gor-PP': A linear distance from right gonion to the interpupillary.

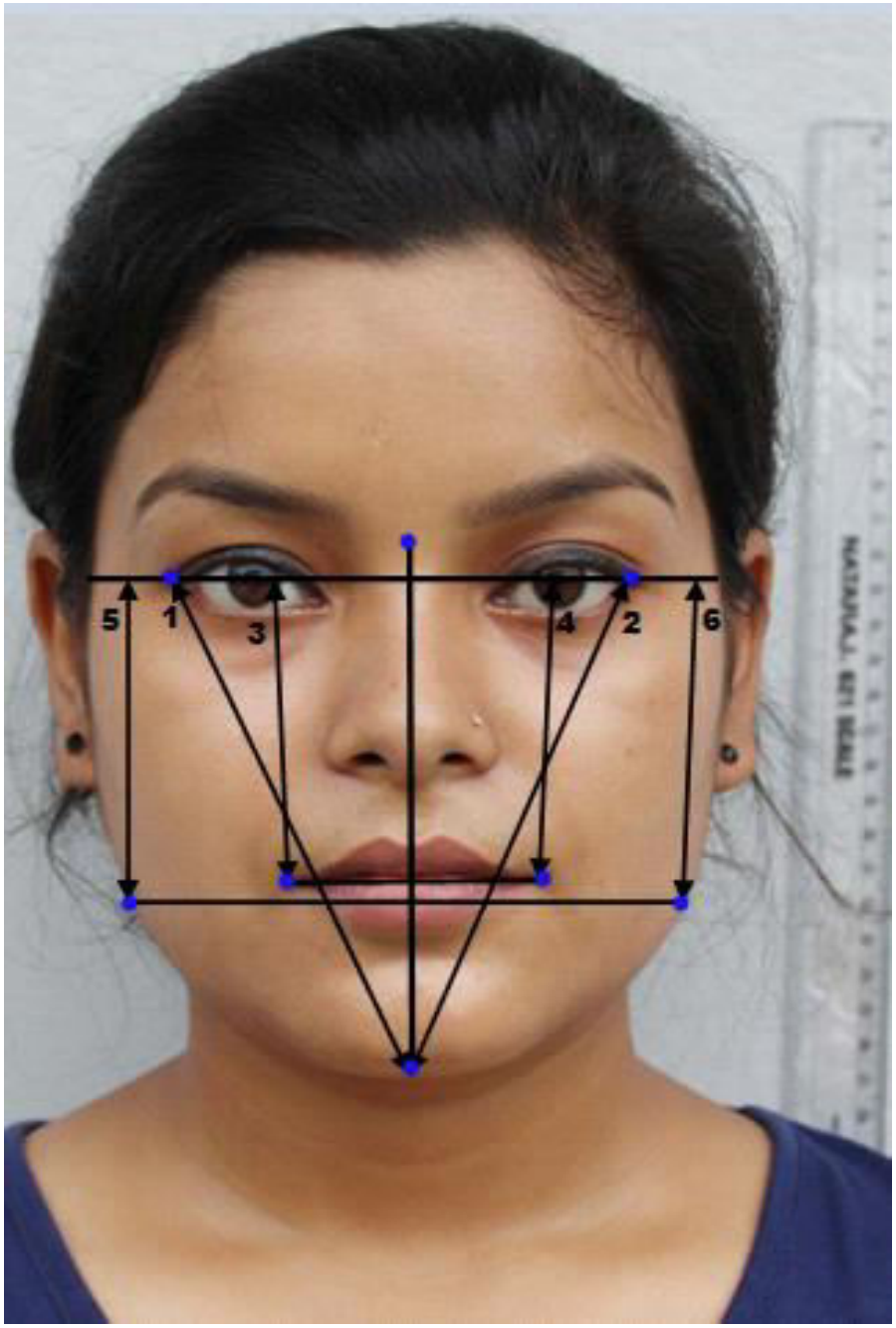


Fig.10: VERTICAL PARAMETER: 1.Exl- Me', 2. Exr- Me', 3.Chl- PP',4.Chr- PP', 5Gol-PP',6.Gor-PP'.

Ratios:

- Orbital ratio: Orbital length (Ps-Pi) / Orbital width (Ex-En) *100
- Nose ratio: Nose length (Sn-N) / Nose width (All-Alr) *100
- Lip ratio: Lip length (Ls-Li)/Lip width (Chl-Chr) *100
- Face ratio: Face height (N-Me) / Face width (Zyl-Zyr) *100

Fig. 11.ORBITAL LENGTH (Ps-Pi)/ ORBITAL WIDTH (Ex-En)

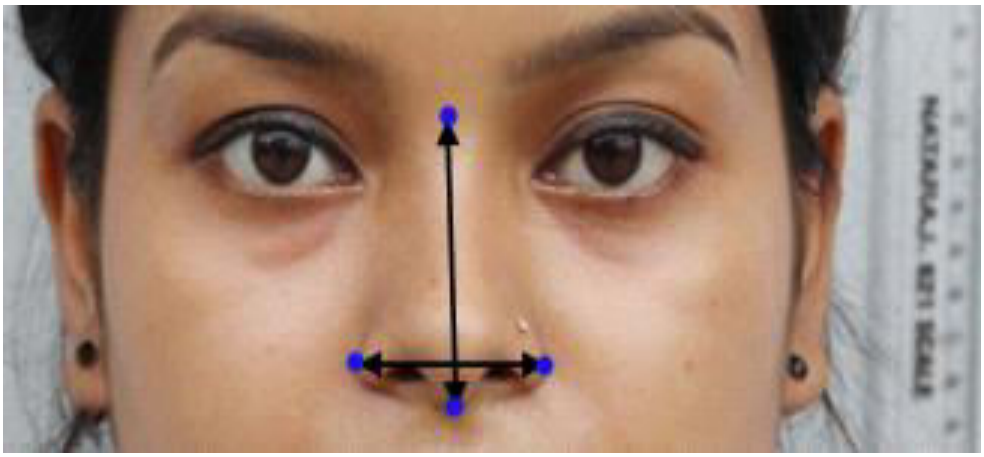


Fig. 12. NOSE LENGTH (Sn-N)/ NOSE WIDTH (All-Alr)

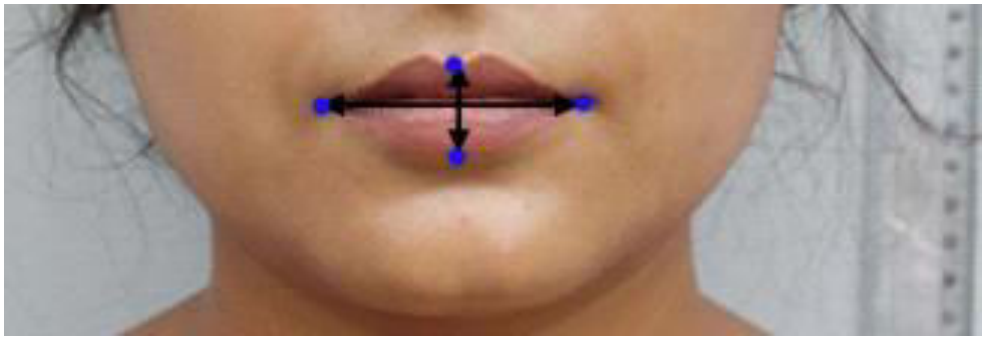


Fig. 13. LIP LENGTH (Ls-Li) /LIP WIDTH (Chl-Chr)

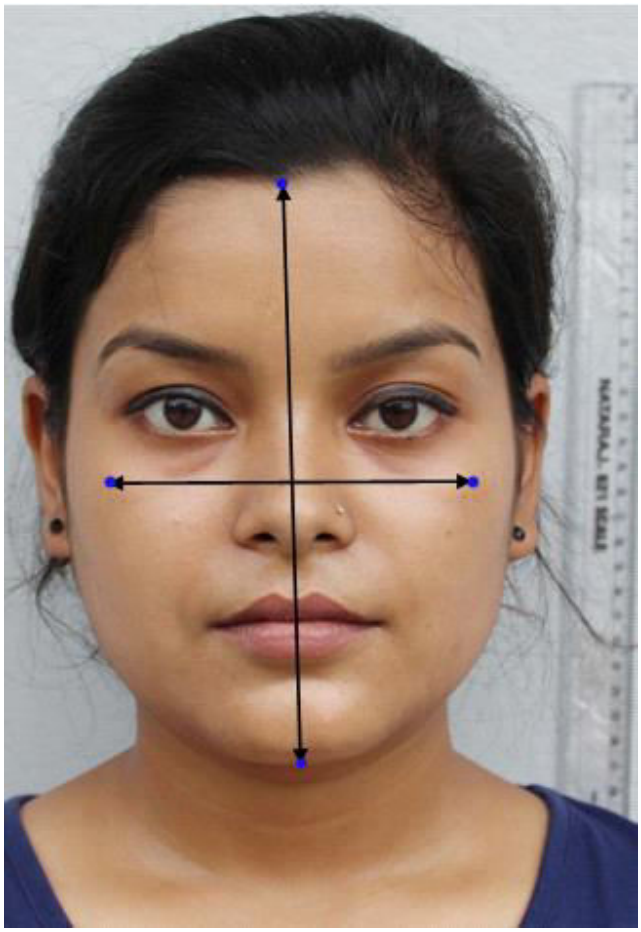


Fig. 14. FACE HEIGHT (N-Me) / FACE WIDTH (Zyl-Zyr)

Midline Parameters:

1.Prn-Mfp: A linear distance from the Mid facial plane to pronasale.

2.Ls- Mfp: A linear distance from the Mid facial plane to labiale superious.

3.Me'-Mfp: A linear distance from mid facial plane to Menton.

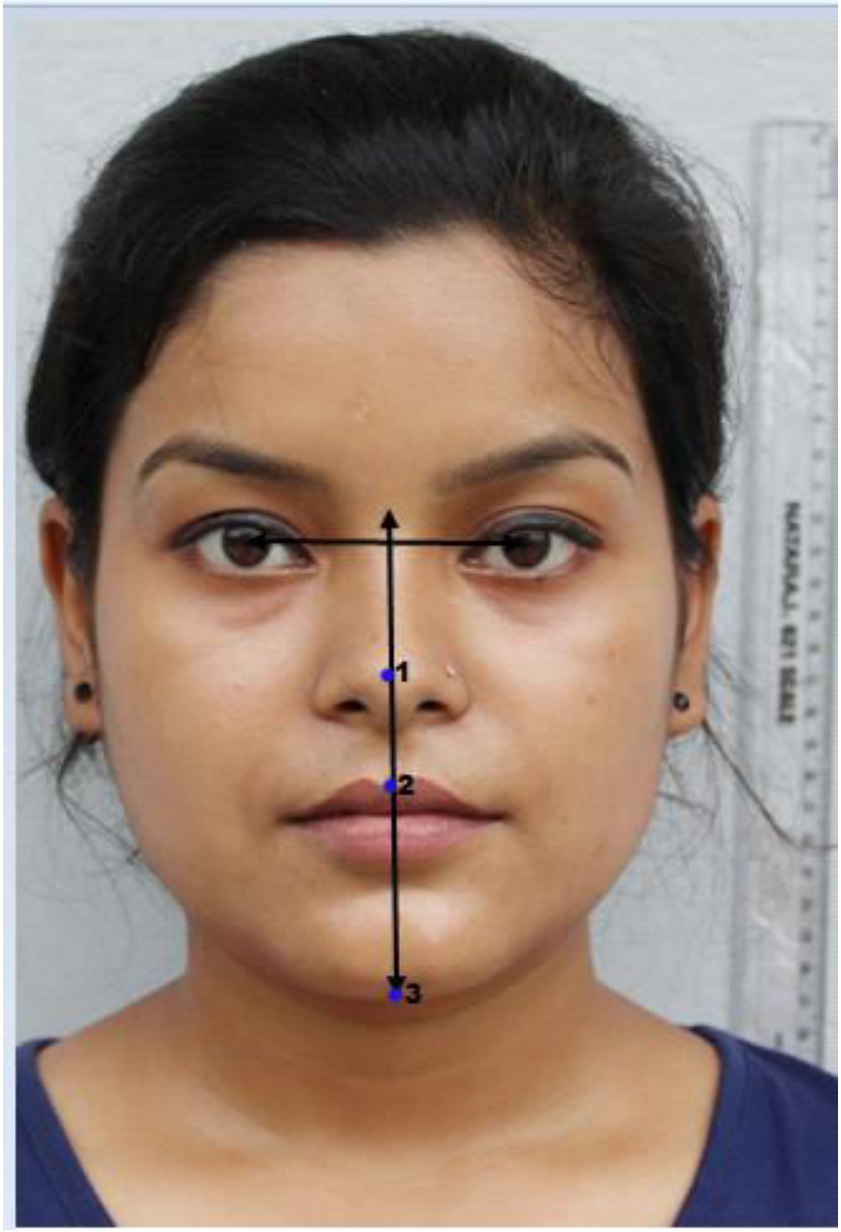


Fig.15: MIDLINE PARAMETER: 1.Prn-Mfp, 2.Ls-Mfp, 3.Me'-Mfp

Formula used for the analysis:

1) **The Arithmetic Mean:**

To obtain the mean, the individual observations were first added together and then divided by the number of observations. The operation of adding together or summation is denoted by the sign 'Σ'.

The individual observation is denoted by the sign 'X', number of observation denoted by 'n' and the mean by '$\overline{X}$'.

$$\bar{X} = \frac{\Sigma X}{\text{no. of observation (n)}}$$

2) **The Standard Deviation:**

It is denoted by the Greek letter σ.

If a sample is more than 30 then:

$$\sigma = \sqrt{\frac{\Sigma(X - \bar{X})^2}{n}}$$

When sample is less than 30 then:

$$\sigma = \sqrt{\frac{\Sigma(X - \bar{X})^2}{n - 1}}$$

3) **Minimum and Maximum:**

Minimum and maximum are the minimum and maximum values respectively in the measure data and range are calculated by subtracting minimum from maximum and calculated as:

Range = Maximum value – Minimum value

4) **Student 't' test**: To test the significance of two means the student 't' test was used

$$t = \frac{\overline{X}_1 - \overline{X}_2}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$\text{where } S^2 = \frac{(N_1 - 1)SD_1^2 + (N_2 - 1)SD_2^2}{N_1 + N_2 - 2}$$

where $\overline{X}_1$, $\overline{X}_2$ are means of group 1 and group 2

N_1, N_2 are number of observation group1 and group 2
SD_1, SD_2 are standard deviation in group1 and group 2

5. Level of significance: "p" is level of significance

p > 0.05 Not significant

p < 0.05 Significant

p < 0.01 Highly significant

p < 0.001 Very highly significant

The present study was conducted in the Department of Orthodontics & Dentofacial Orthopaedics, Babu Banarasi Das college of Dental sciences, Lucknow to evaluate facial asymmetry in 700 subjects of North Indian population divided in two Groups – Group I and II, Group I had 350 males with mean age of 21.5± 1.5yrs and Group II had 350 females with mean age 20.5± 1.5yrs .The Group I was further subdivided into Group Ia and I b for parameter of right and left side respectively. Similarly Group II was divided into Group II a and IIb for parameter of right and left side respectively. The data obtained for 41 linear parameters were recorded on microsoft excel sheet and subjected to statistical analysis. The result of the study is tabulated as follows :

- Table 2: Descriptive statistics of various horizontal parameters for evaluation of facial asymmetry in Group Ia and Ib.
- Table 3: Descriptive statistics of various horizontal parameters for evaluation of facial asymmetry in Group IIa and IIb.
- Table 4: Descriptive statistics of various vertical parameters for evaluation of facial asymmetry in Group Ia and Ib.
- Table 5: Descriptive statistics of various vertical parameters for evaluation of facial asymmetry in Group IIa and IIb.
- Table 6: Descriptive statistics of various index parameters for evaluation of facial asymmetry indices in Group I
- Table 7: Descriptive statistics of various index parameters for evaluation of facial asymmetry indices in Group II.

- Table 8: Comparison of Horizontal, Vertical parameters and indices between Group Ia and I b for laterality in facial asymmetry in males.

- Table 9: Comparison of Horizontal ,Vertical parameters and indices between Group IIa and II b for laterality in facial asymmetry in females.

- Table 10: Comparison of laterality of facial asymmetry in males and females.(Group I and Group II)

Table 2: Descriptive statistics of various horizontal parameters for evaluation of facial asymmetry in Group Ia and Ib(Males).

Group I a (RIGHT SIDE)							
Horizontal parameters	**Mean (in mm)**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum (in mm)**	**Maximum (in mm)**
				Lower Bound	**Upper Bound**		
Mfp-Enr	23.6	03.3	0.2	23.3	23.9	13.0	29.7
Mfp-Exr	65.4	05.2	0.4	64.7	66.1	52.2	76.9
Mfp-Psr	46.3	05.0	0.3	45.8	46.8	32.4	55.7
Mfp-Pir	47.6	05.2	0.3	47.1	48.1	35.4	57.6
Mfp-Pr	45.2	04.9	0.3	44.7	45.7	30.3	55.8
Mfp-Alr	28.6	03.4	0.2	28.3	29.0	20.1	36.1
Mfp-Sar	88.7	07.5	0.6	87.5	89.9	71.9	106.6
Mfp-Cpr	08.6	01.6	.08	09.1	09.7	04.3	13.6
Mfp-Chr	36.4	02.9	0.1	35.7	37.2	30.0	45.7
Mfp-Gor	78.4	07.5	0.5	77.4	79.4	61.3	98.4
Mfp-Zyr	72.7	06.2	0.5	71.8	73.6	59.4	90.3
Group I b (LEFT SIDE)							
Mfp-Enl	23.0	03.1	0.2	22.7	23.4	11.9	30.0
Mfp-Exl	64.1	04.9	0.3	63.5	64.8	52.3	77.7
Mfp-Psl	47.1	04.8	0.3	46.6	47.6	36.4	58.5
Mfp-Pil	48.7	05.0	0.3	48.2	49.2	36.8	59.2
Mfp-Pl	43.9	04.6	0.2	43.5	44.4	33.1	57.6
Mfp-All	27.8	03.0	0.3	27.1	28.4	20.2	35.8
Mfp-Sal	85.9	7.6	0.6	84.8	87.1	69.1	105.0
Mfp-Cpl	08.4	1.7	0.09	08.9	09.5	04.2	14.0
Mfp-Chl	35.5	2.8	0.1	34.8	36.2	30.0	44.4
Mfp-Gol	76.6	7.8	0.5	75.6	77.6	60.6	99.7
Mfp-Zyl	73.7	6.0	0.6	72.6	74.8	57.9	89.6

Table 2: Showed the descriptive statistics of various horizontal parameters for evaluation of facial asymmetry in Group Ia and Ib(Males).

The mean value of different horizontal parameters of right side from Mid Facial plane (Mfp) to Endocanthus (Enr) was 23.6± 03.3mm, to Exocanthus (Exr) was 65.4± 05.2mm , to Palpabrale superious (Psr) was 46.3 ± 05.0mm and to palpabrale inferious(Pir) was 47.6 ± 05.2mm. The mean value from Mfp to mid of the pupil (P') was 45.2 ±04.9mm, to Ala of the nose (Alr) was 28.6 ± 03.4mm, to Sub aurale (Sar) was 88.7 ± 7.5mm, to Crista philter (Cpr) was 8.6 ± 1.6mm, to Chelion(Chr) was 36.4 +- 02.9 mm, to Gonion (Gor) was 78.4 ± 07.5 mm and to Zygion (Zyr) was 72.7 ±06.2 mm.

The mean value of different horizontal parameters of left side from Mid Facial plane (Mfp) to Endocanthus (Enl) was 23.0± 03.1mm, to Exocanthus (Exl) was 64.1± 04.9 mm, to Palpabrale superious (Psl) was 47.1 ± 04.8mm and to palpabrale inferious(Pil) was 48.7 ± 05.0mm. The mean value from Mfp to mid of the pupil (P) was 43.9 ± 04.6mm, to Ala of the nose (All) was 27.8 ± 3.0 mm, to Sub aurale (Sal) was 85.9 ± 7.6 mm, to Crista philter (Cpl) was 8.4 ± 1.7 mm, to Chelion (Chl) was 35.5 ± 02.8 mm, to Gonion (Gol) was 76.6 ± 07.8 mm and to Zygion (Zyl) was 73.7 ± 6.0 mm.

Table 3: Descriptive statistics of various horizontal parameters for evaluation of facial asymmetry in Group II a and II b(Females).

Group II a							
horizontal Parameters	Mean (in mm)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum (in mm)	Maximum (in mm)
				Lower Bound	Upper Bound		
Mfp-Enr	24.5	03.5	0.2	24.1	24.8	16.3	33.8
Mfp-Exr	68.1	06.7	0.5	67.2	69.0	54.5	88.7
Mfp-Psr	47.6	06.7	0.4	46.9	48.3	40.2	61.6
Mfp-Pir	48.5	06.2	0.3	47.9	49.2	40.0	64.2
Mfp-Pr	46.4	06.0	0.3	45.8	47.1	40.0	63.2
Mfp-Alr	29.1	03.5	0.1	28.4	29.8	18.5	37.5
Mfp-Sar	89.3	9.2	0.4	87.8	90.7	70.2	109.4
Mfp-Cpr	8.8	01.8	0.09	08.8	10.8	03.0	14.2
Mfp-Chr	36.5	04.3	0.3	35.8	37.2	28.0	49.2
Mfp-Gor	78.2	9.2	0.6	77.1	79.3	56.9	104.4
Mfp-Zyr	74.2	07.9	0.5	73.2	75.1	60.6	94.6
Group II b							
Mfp-Enl	24.4	03.6	0.2	24.0	24.8	17.8	35.8
Mfp-Exl	68.3	06.8	0.4	67.4	69.2	54.5	89.5
Mfp-Psl	49.4	06.6	0.4	48.7	50.1	40.1	66.7
Mfp-Pil	50.6	06.3	0.3	50.0	51.3	41.3	68.4
Mfp-Pl	46.9	06.1	0.3	46.2	47.5	40.0	61.7
Mfp-All	27.8	03.3	0.1	27.2	28.3	20.2	36.4
Mfp-Sal	90.3	9.2	0.4	88.9	91.7	71.6	109.3
Mfp-Cpl	8.6	01.6	0.09	08.3	08.8	03.7	12.9
Mfp-Chl	35.7	04.6	0.3	35.1	36.3	24.2	49.0
Mfp-Gol	79.3	9.8	0.6	78.1.	80.4	60.0	108.4
Mfp-Zyl	77.4	8.8	0.6	76.3	7.85	61.9	99.3

Table 3: Showed the descriptive statistics of various horizontal parameters for evaluation of facial asymmetry in Group II a and II b(Females).

The mean value of different horizontal parameters of right side from Mid Facial plane (Mfp) to Endocanthus (Enr) was 24.5± 03.5mm, to Exocanthus (Enr) was 68.1± 06.7 mm, to Palpabrale superious (Psr) was 47.6 ± 06.7mm, to palpabrale inferious(Pir) was 48.5 ± 06.2mm. The mean value from Mfp to mid of the pupil (P') was 46.4 ± 06.0mm, to Ala of the nose (Alr) was 29.1 ± 03.5 mm, to Sub aurale (Sar) was 89.3 ± 9.2, to Crista philter (Cpr) was 8.8 ± 1.8 mm, to Chelion (Chr) was 36.5 ± 04.3, to Gonion (Gor) was 78.2 ± 9., to Zygion (Zyr) was 74.2 ± 7.9 mm.

The mean value of different horizontal parameters of left side from Mid Facial plane (Mfp) to Endocanthus (Enl) was 24.4± 03.6mm, to Exocanthus (Exl) was 68.3± 06.8 mm, to Palpabrale superious (Psl) was 49.4 ±06.6mm and to palpabrale inferious(Pil) was 50.6 ± 06.3mm. The mean value from Mfp to mid of the pupil (P) was 46.9 ± 06.1mm, to Ala of the nose (All) was 27.8 ± 3.3mm, to Sub aurale (Sa) was 90.3 ± 9.2 mm, to Crista philter (Cp) was 8.4 ± 1.6 mm, to Chelion (Chl) was 35.7 ± 04.6 mm, to Gonion (Gol) was 79.3 ± 9.8 mm, to Zygion (Zyl) was 77.4 ± 8.8 mm.

Table 4: Descriptive statistics of various Vertical parameters for evaluation of facial asymmetry in Group Ia and Ib .

Group Ia							
Vertical Parameters	Mean (In mm)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum (in mm)	Maximum (in mm)
				Lower Bound	Upper Bound		
Exr-Me'	166.6	16.5	0.9	164.9	168.8	124.5	195.2
Chr- PP'	91.5	08.6	0.5	90.6	92.4	68.3	112.6
Gor-PP'	103.7	11.0	0.6	102.5	104.9	78.2	127.3
Group Ib							
Exl-Me'	166.7	16.5	0.9	165.0	168.4	122.9	195.6
Chl-PP'	92.0	08.5	0.5	91.1	92.9	66.8	111.7
Gol-PP'	104.7	10.9	0.6	103.5	105.8	74.7	126.5

Table 4: Showed the descriptive statistics of various Vertical parameters for evaluation of facial asymmetry in Group Ia and Ib .

The mean value of the parameter from exocanthus to menton (Exr-Me') was 166.6 ± 16.5mm on right side and 166.7± 16.5mm on left side. A distance from Chelion to inter pupillary line at right side (Chr-Pp') was 91.5± 08mm, while on left side 92.0 ± 08.5mm. A distance from right gonion to inter pupillary line (Gor-Pp') was found to be 103.7± 11mm , while on left side the distance was 104.7 ± 10.9mm.

Table 5: Descriptive statistics of various Vertical parameters for evaluation of facial asymmetry in Group II a and IIb.

Group II a

Vertical parameters	Mean (in mm)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum (in mm)	Maximum (in mm)
				Lower Bound	Upper Bound		
Exr-Me'	158.2	12.3	0.7	156.9	159.5	114.9	186.9
Chr- PP'	88.1	07.2	0.4	87.4	88.9	64.3	106.2
Gor-PP'	93.2	08.2	0.4	92.4	94.1	69.1	114.0
Group II b							
Exl-Me'	158.5	12.5	0.7	157.1	159.8	113.9	188.21
Chl-PP'	88.5	07.0	0.4	87.7	89.2	66.5	105.0
Gol-PP'	94.7	08.1	0.4	93.8	95.5	73.7	123.9

Table 5: Showed the descriptive statistics of various Vertical parameters for evaluation of facial asymmetry in Group II a and IIb.

The mean value of the parameter from exocanthus to menton (Exr-Me')was 158.2 ± 12.3mm on right side and158.5± 12.5mm on left side. A distance from Chelion to inter pupillary line at right side (Chr-Pp') was 88.1± 7.2mm, while on left side 88.5 ± 7.0mm. A distance from right gonion to inter pupillary line (Gor-Pp') was found to be 93.2± 08.2mm, while on left side the distance was 94.7 ± 08.1mm.

Table 6: Descriptive statistics of various facial asymmetry indices in Group I.

Index Parameters	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
Right eye index	35.74	8.22	0.44	34.87	36.60	24.12	104.86
Left eye index	40.70	8.80	1.70	37.36	44.05	26.17	113.41
Nose index	122.31	14.84	1.60	119.17	125.45	88.27	162.68
Lip index	34.53	8.96	0.48	33.58	35.47	21.93	116.31
face index	170.56	10.85	1.95	166.72	174.41	119.85	189.16

Table 6: Showed the descriptive statistics of various facial asymmetry indices in Group I.

Right eye index was measured as ratio between Exocanthus – Endocanthus(Exr-Enr) / palpabrale superious - palpabrale inferious(Psr-Pir) and had a mean value of 35.74± 8.22, while left eye index had a mean value of 40.70 ±8.80. Nose index measured as ratio between right ala to left ala of the nose (Alr-All) / nasion - subnasale (N-Sn) was 122.31± 14.84. Lip index measured as ratio between right Chelione to left Chelion (Chr-Chl)/ Labiale superius to Labiale inferius (Ls-Li) was 34.53 ± 8.96. Face index measured as ratio between right zygion to left zygion (Zyr-Zyl) / Trichion to menton(Tr-Me') had a mean value of 170.56 ±10.85.

Table 7: Descriptive statistics of various facial asymmetry indices in Group II.

Index Parameters	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
Right eye index	37.57	8.25	0.44	36.71	38.44	23.92	93.99
Left eye index	40.63	8.03	0.43	39.78	41.47	30.96	100.00
Nose index	117.32	14.18	0.76	115.83	118.82	87.32	158.53
Lip index	34.09	7.10	0.27	33.55	34.62	21.78	106.93
face index	163.03	10.45	0.56	161.93	164.13	137.04	187.77

Table 7: Showed the descriptive statistics of various facial asymmetry indices in Group II.

Right eye index was measured as ratio between Exocanthus – Endocanthus (Exr-Enr) / palpabrale superious - palpabrale inferious (Psr-Pir) and had a mean value of 37.57± 8.25, while left eye index had a mean value of 40.63 ±8.03. Nose index measured as ratio between right ala to left ala of the nose (Alr-All) / nasion - subnasale (N-Sn) was 117.32± 14.18.Lip index measured as ratio between right Chelion to left Chelion (Chr-Chl) / Labiale superius - Labiale inferius (Ls-Li) was 34.09 ± 7.10. Face index measured as ratio between right zygion - left zygion (Zyr-Zyl) / Trichion – menton (Tr-Me') had a mean value of 163.03 ±10.45.

Table 8: Comparison of Horizontal, Vertical parameters and indices between Group Ia and I b for laterality in facial asymmetry in males.

Right side parameters	Group I a(N=350)		Left side parameters	Group Ib(N=350)		Mean difference	P value
	Mean	SD		Mean	SD		
Horizontal parameters							
Mfp-Enr	23.6	3.3	Mfp-Enl	23.0	3.1	0.6	<0.01**
Mfp-Exr	65.4	5.2	Mfp-Exl	64.1	4.9	1.3	<0.001***
Mfp-Psr	46.3	5.0	Mfp-Psl	47.1	4.8	-0.8	<0.001***
Mfp-Pir	47.6	5.2	Mfp-Pil	48.7	5.0	-1.1	<0.001***
Mfp-P’	45.2	4.9	Mfp-P	43.9	4.6	1.3	<0.001***
Mfp-Alr	28.6	3.4	Mfp-All	27.8	3.0	0.8	<0.05**
Mfp-Sar	88.7	7.5	Mfp-Sal	85.9	7.6	2.8	<0.001***
Mfp-Cpr	08.6	1.6	Mfp-Cpl	08.4	1.7	0.2	0.121
Mfp-Chr	36.4	2.9	Mfp-Chl	35.5	2.8	0.9	<0.001***
Mfp-Gor	78.4	7.5	Mfp-Gol	76.6	7.8	1.8	<0.001***
Mfp-Zyr	72.7	6.2	Mfp-Zyl	73.7	6.0	-1.0	<0.05**
Vertical parameters							
Exr-Me'	166.6	16.5	Exl-Me'	166.7	16.5	-0.1	0.555
Chr- PP'	91.5	08.6	Chl- PP'	92.0	08.5	-0.5	<0.001***
Gor-PP'	103.7	11.0	Gol-PP'	104.7	10.9	-1.0	<0.001***
Index parameters							
Eye index	35.74	8.22	Eye index	40.70	7.80	-4.97	<0.01**

Table 8: Showed the comparison of Horizontal, Vertical parameters and indices between Group Ia and I b for laterality in facial asymmetry in males.

Horizontal parameters:

Eight out of eleven horizontal parameters measured from Mfp to Endocanthus (En),Exocanthus (Ex), Mid of the Pupil (p'), Ala of the nose (Al), Subaurale (Sa), Chelion(Ch), Gonion (Go) had significantly higher value on right side than left side with a mean difference of right and left was 0.6 mm($p<0.01$) , 1.3mm($P<0.001$), 1.3 ($P<0.001$), 0.8 mm ($P<0.05$), 2.8 mm ($P<0.001$), 0.9 mm ($P<0.001$), 1.8 mm ($P<0.001$) respectively whereas three the parameters Palpabrale superious (Ps), Palpabrale inferious (Pi) and Zygion (Zy) from Mfp had significantly higher on left side than right side with a mean difference of right and left was 0.8 mm ($P<0.001$), 1.1 mm ($P<0.001$) and 1.0 mm ($P<0.05$) respectively. The parameter Crista philter (Cp) from Mfp did not show statistically significant difference between right and left side 0.2 mm($P=0.121$).

Vertical parameters

Amongst the three vertical parameters, two parameters Chelion to interpuppilary line (Ch-PP') and Gonion to interpupillary line (Go-PP') higher value on left side than right side with a mean difference of right and left side was 0.5 mm and 1.0 mm respectively that was highly significant ($p<.0001$). Ex-Me' did not show statistically significant($P=0.555$).

On right side Eye Index had a lower mean value than left side and the mean difference of 4.97 was stastically significant between right and left side($P<0.01$).

Table 9: Comparison of Horizontal ,Vertical parameters and indices between Group IIa and II b for laterality in facial asymmetry in females.

Right side parameters	Group II a (N=350)		Left side parameters	Group II b (N=350)		Mean difference	P value
	Mean	SD		Mean	SD		
Horizontal parameters							
Mfp-Enr	24.5	3.5	Mfp-Enl	24.4	3.6	0.1	NS
Mfp-Exr	68.1	6.7	Mfp-Exl	68.3	6.8	-0.3	NS
Mfp-Psr	47.6	6.7	Mfp-Psl	49.4	6.6	-1.8	<0.001***
Mfp-Pir	48.5	6.2	Mfp-Pil	50.6	6.3	-2.1	<0.001***
Mfp-P’	46.4	6.0	Mfp-P	46.9	6.1	-0.4	0.021*
Mfp-Alr	29.1	3.5	Mfp-All	27.8	3.3	1.3	<0.001***
Mfp-Sar	89.3	9.2	Mfp-Sal	90.3	9.2	-1.0	0.05*
Mfp-Cpr	08.8	1.8	Mfp-Cpl	08.6	1.6	0.2	<0.05*
Mfp-Chr	36.5	4.3	Mfp-Chl	35.7	4.6	0.8	<0.01**
Mfp-Gor	78.2	9.2	Mfp-Gol	79.3	9.8	-1.1	<0.05*
Mfp-Zyr	74.2	7.9	Mfp-Zyl	77.4	8.8	-3.2	<0.001***
Vertical parameters							
Exr-Me'	158.2	12.3	Exl-Me'	158.5	12.5	-0.3	<0.01**
Chr- PP'	88.1	7.2	Chl- PP'	88.5	7.0	-0.3	<0.001***
Gor-PP'	93.2	8.2	Gol-PP'	94.7	8.1	-1.4	<0.001***
Index parameters							
Eye index	37.57	8.25	Eye index	40.63	8.03	-3.06	<0.001***

Table 9: Showed the comparison of Horizontal ,Vertical parameters and indices between Group IIa and II b for laterality in facial asymmetry in females.

Horizontal parameters

Three out of eleven horizontal parameters Ala of the nose(Al), Crista philter (Cp) and Chelion (Ch) fro Mfp had significantly higher value on right side than left side with a mean difference of 1.3 mm (P<0.001), 0.2 mm (P<0.05) and 0.8 mm (P<0.01) respectively whereas the six parameters Palpabrale superious (Ps), Palpabrale inferious (Pi),Mid of the Pupil (P'), Subaurale (Sa), Gonion (Go) and Zygion (Zy) from Mfp had signicantly higher value on left side than right side with a mean difference of right and left was 1.8 mm (P<0.001), 2.1 mm (P<0.001), 0.4 mm (P<0.05), 1.0 mm (P=0.05), 1.1 mm (P<0.05) and 3.2 mm (P>0.001) respectively. The parameters Endocanthus (En) and Exocanthus (Ex) did not show stastically significant difference between right and left side with a mean difference of 0.1 mm (P=0.551) and 0.3mm(P=0.403) respectively.

Vertical parameters

Amongst the three vertical parameters, all three parameters Exocanthus to Menton (Ex-Me'), Chelion to interpupillary line (Ch-PP')and Gonion to interpupillary line (Go-PP') higher value on left side than right side with a mean difference of 0.3 mm, 0.3 mm and 1.4 mm respectively that was highly significant (p<.0001).

On right side Eye Index had a lower mean value than left side and the mean difference of 3.06 was stastically highly significant between right and left side(P<0.001).

Table 10: Comparison of mean difference of right and left parameters according to their groups. (males and females):

Parameters	Group I (N=350)		Group II (N=350)		P value
	Mean	SD	Mean	SD	
Horizontal parameters					
Mfp-En	0.6	3.3	0.1	3.1	<0.05*
Mfp-Enx	1.3	3.7	0.3	5.6	<0.01**
Mfp-Ps	0.8	3.7	1.8	4.3	<0.01*
Mfp-Pi	1.1	3.5	2.1	3.2	<0.001***
Mfp-P	1.2	3.9	0.4	3.6	<0.01**
Mfp-Al	0.9	5.2	1.3	3.5	NS
Mfp-Sa	2.8	7.0	1.0	9.8	<0.01**
Mfp-Cp	0.2	2.5	0 .2	8.8	<0.05*
Mfp-Ch	0.9	4.0	0.8	4.7	NS
Mfp-Go	1.8	6.8	1.1	8.6	NS
Mfp-Zy	1.0	6.2	3.2	5.3	<0.001***
Vertical parameters					
Ex-Me'	0.1	0.24	0.3	2.0	NS
Ch- PP'	0.5	0.19	0.3	1.4	NS
Go-PP'	1.0	0.33	1.4	3.3	NS
Index parameters					
Eye index	4.97	27.48	3.06	4.66	NS
Nose index	122.31	29.84	117.32	14.18	0.005**
Lip index	34.53	8.96	34.09	5.10	NS
face index	170.56	36.55	163.03	10.45	<0.001***

Table 10: showed the mean difference between right and left values of different parameters (En, Ex, Ps, Pi, P, Al, Sa, Cp, Ch, Go and Zy) were taken for group I and Group II. Amongst the horizontal parameters eight out of eleven parameters En, Ex, Ps, Pi, P, Sa, Cp and Zy from Mfp showed significant difference between males and females. Ex, En, P and Sa from Mfp had significantly higher in males whereas distance of Mfp to Ps, Pi , Cp and Zy had significantly higher values in females.

In vertical parameter, all the three parameters showed statistically insignificant difference between males and females.

Eye index and lip index showed statistically insignificant difference between males and females. Nose and Face index significant mean value between male and females.

Table 11: Comparison of mean difference of right and left midline parameters according to their groups. (males and females):

	Left		Right		Centre		P value
	N	%	N	%	N	%	
NOSE							
Group I	175	50.00	130	37.14	45	12.86	0.006
Group II	145	41.43	130	37.14	75	21.43	
LIP							
Group I	105	30.00	125	35.71	120	34.29	<0.001
Group II	170	48.57	60	17.14	120	34.29	
CHIN							
Group I	245	70.00	55	15.71	50	14.29	0.045
Group II	235	67.14	65	18.57	50	14.29	

Table 11: showed in Group I, 50 % had deviation of Pronasale (tip of the nose) to left, 37.14% had deviation towards right whereas it was central in remained 12.8% as well as in Group II, 41.43 % had deviation to left, 37.14% had deviation towards right whereas it was central in remained 21.43% . In Group I, 30 % had deviation of Labiale superious (Ls) to left, 35.71% had deviation towards right whereas it was central in remained 34.29% as well as in Group II, 48.57 % had deviation to left, 35.71% had deviation towards right whereas it was central in remained 34.29%. In Group I, 70 % had deviation of Menton (Me') to left, 15.71% had deviation towards right whereas it was central in remained 14.29% as well as in Group II, 67.14 % had deviation left, 18.57% had deviation towards right whereas it was central in remained 14.29%.

The normal facial contour defined by Tweed as being "balance and harmony of proportion is considered by the majority of us as the most pleasing aspect in the human face'. Thomas Aquinas[4] stated that "The senses delight in things duly proportioned", thus the importance of a well proportioned human face cannot be underestimated. Evaluation of facial esthetics is at best objective, because balance and harmony of facial components do not necessarily mean an attractive face. Despite the fact, that improvement of facial aesthetics is the cornerstone of any orthodontic treatment. Our diagnostic considerations were initially based on Angle's paradigm which was based on the assumption that an ideal hard tissue proportions produce an ideal soft tissue proportions of profile. In early 21st century, an emphasis shifted on consideration of the oral and facial soft tissues. The soft tissue profile and assessment of the soft tissue symmetry gained extra importance in Orthodontics diagnosis.[4]

Slight facial asymmetry is a common biological variation in 'normal' humans[28] and perfect symmetry is a theoretical concept that is rarely observed in real world. The minor facial asymmetry does not require any treatment. The point at which normal asymmetry becomes abnormal cannot be easily defined and is often determined by the clinician's sense of balance and the patient's sense of imbalance.[9] Clinical facial asymmetry in the craniofacial complex ranges from the barely detectable to gross discrepancies between the right and left halves of the face[29,52,53]. The normal asymmetry which usually results from a small size difference between the two sides should be distinguished from a chin or nose that deviates to one side, which can produce severe disproportion and esthetic problems.

Cheong and Lo[6] reported that the causes of facial asymmetry can be grouped into three main categories: (I) congenital, of prenatal origin; (II) acquired, resulting from injury or disease; and (III) developmental, arising during development and of

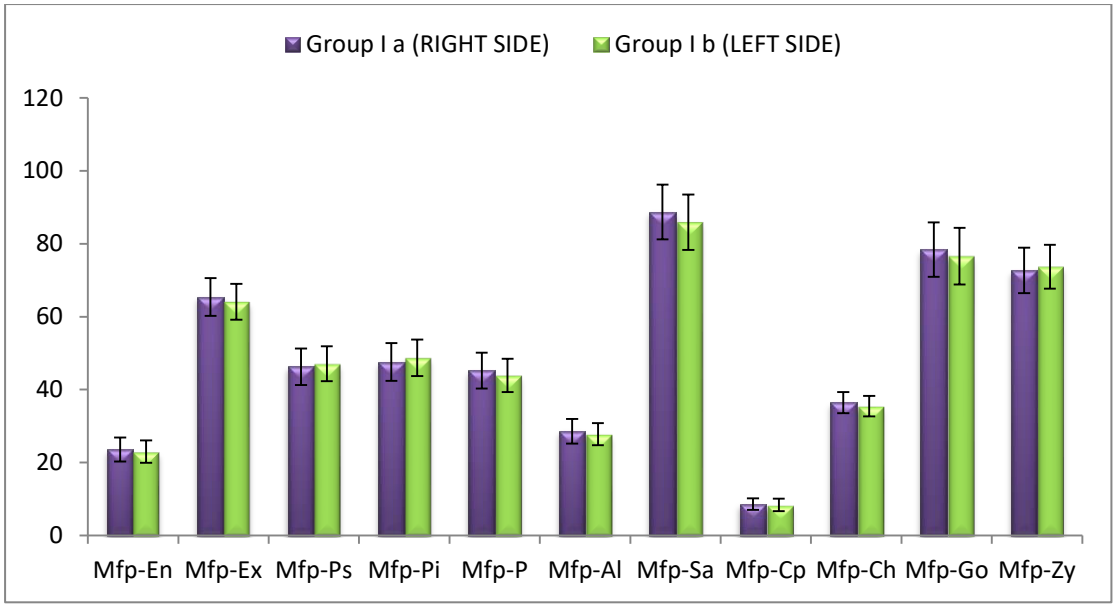
unknown etiology .The etiology of subclinical asymmetry remains controversial and various reasons have been given.

The facial asymmetry of the human face has been investigated using methods involving frontal facial photographs[12,23], posteroanterior cephalograms[14,19-22,24], and stereophotogrammetry[2]. The photographic assessment besides being a great diagnostic tool ad reliable method, for epidemiologic studies, it is cost effective and does not expose the patient to potentially harmful radiation hence photographs create a more comprehensive virtual model of the patient.[26] It remains the most important diagnostic tool in the evaluation of facial and dental asymmetry. Soft tissue measurements useful for characterizing facial morphology can be reliably measured from facial photographs. Hence it was decided to evaluate facial asymmetry using photographs in the present study.

The studies conducted on Turkish[11], Korean[2], Japanese[12], Brazilian[13] and Chinese[14] population have shown population difference in laterality of facial asymmetry with right side of the face being larger than left side in some studies and vice versa in others. As population differences were seen in laterality of facial asymmetry, various studies have been conducted on Indian population to evaluate facial asymmetry using posteroanterior cephalometric radiographs and photographs. The study conducted on South Indian population by Taneja et al[19], by Shah et al[2O] in the Ahmadabad population , by Rajpara et al[21] in Udaipur population and Goel et al[22] in Karnataka population had given variable results in terms of laterality of facial symmetry.

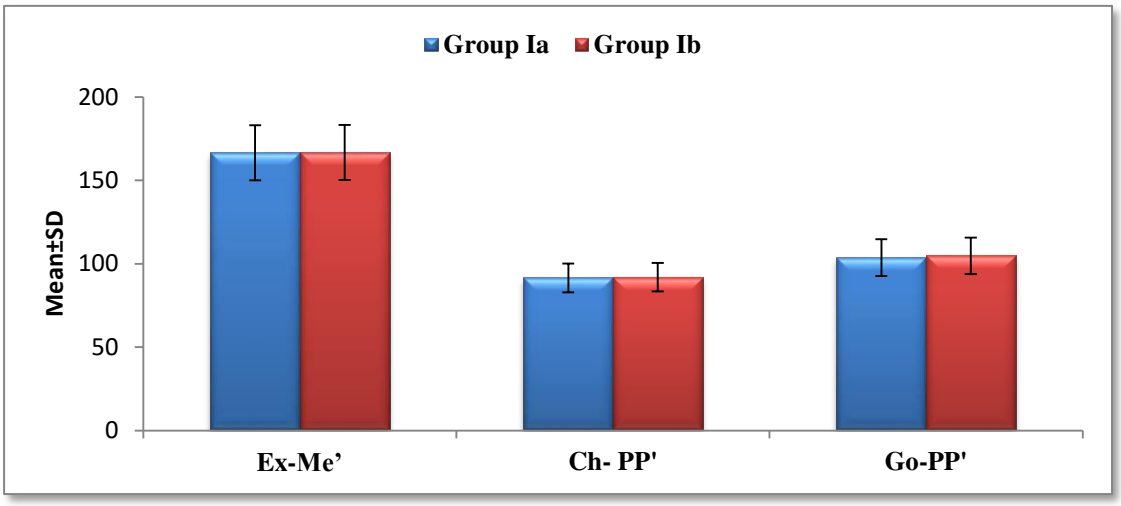
Till date no study had been conducted to evaluate facial asymmetry in the North Indian population so it was decided to evaluate and compare the facial asymmetry and laterality of the normal subjects with class I molar relation in North Indian population.

The present study was conducted in the Department of Orthodontics & Dentofacial Orthopaedics, Babu Banarasi Das college of Dental sciences, Lucknow to evaluate facial asymmetry in 700 subjects of North Indian population divided in two Groups- Group I had 350 males with mean age of 21.5± 1.5yrs and Group II had 350 females with mean age 20.5± 1.5yrs .Diagnosed as compare measurements of right side and left side were as subgroup 'a' and as subgroup 'b' respectively. The digital photographs of the subjects was 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 twenty-two horizontal, six vertical and ten index parameters using Digimizer software after identification of required landmarks. Mid facial Plane (Mfp) was used as refrence plane to measure the parameters, it was as a perpendicular line to interpupillary line and passing through nasion. The data obtained for 41 linear parameters were recorded on microsoft excel sheet and subjected to statistical analysis.



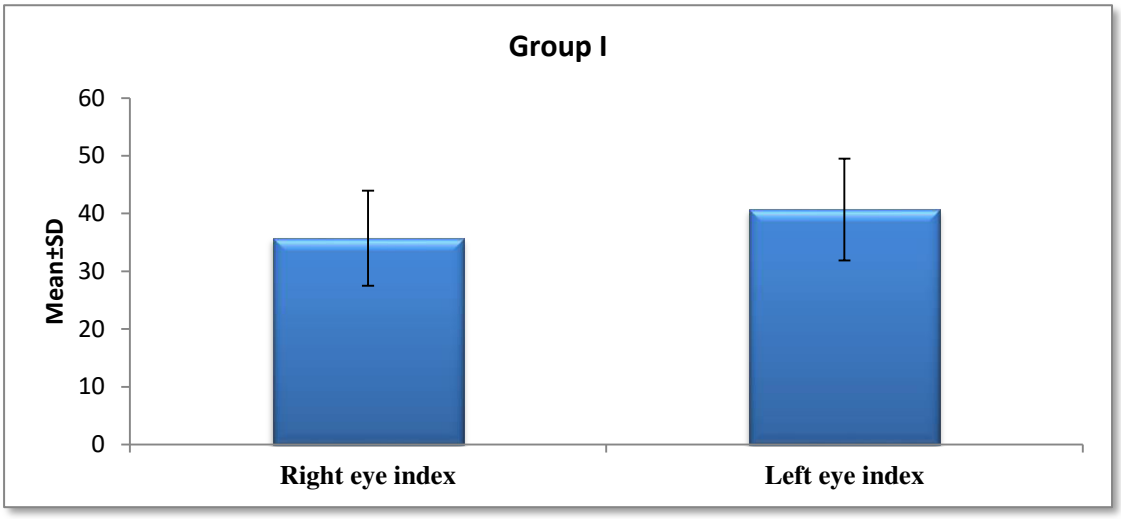
Graph 1: Comparison of Horizontal parameters between Group Ia and I b for laterality in facial asymmetry in males.

The result of the present study suggested that in Group I (males) most of the horizontal parameters on right side had significantly higher mean value than the left side parameters (Mfp to Endocanthus (En), Exocanthus (Ex), Mid of the Pupil (p'), Ala of the nose (Al), Subaurale (Sa), Chelion(Ch), Gonion (Go)).



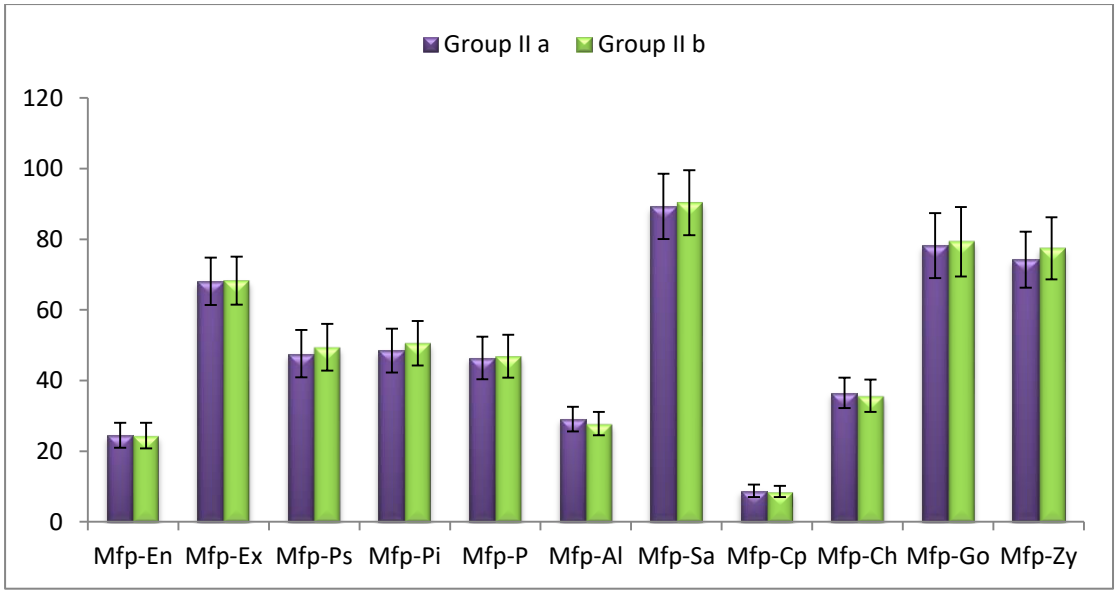
Graph 2: Comparison of Vertical parameters between Group Ia and I b for laterality in facial asymmetry in males.

Amongst the three vertical parameters in Group I, two parameters Chelion to interpuppilary line (Ch-PP') and Gonion to interpupillary line (Go-PP') had higher mean value on left side than right side and difference between them was highly significant (p<.0001) .



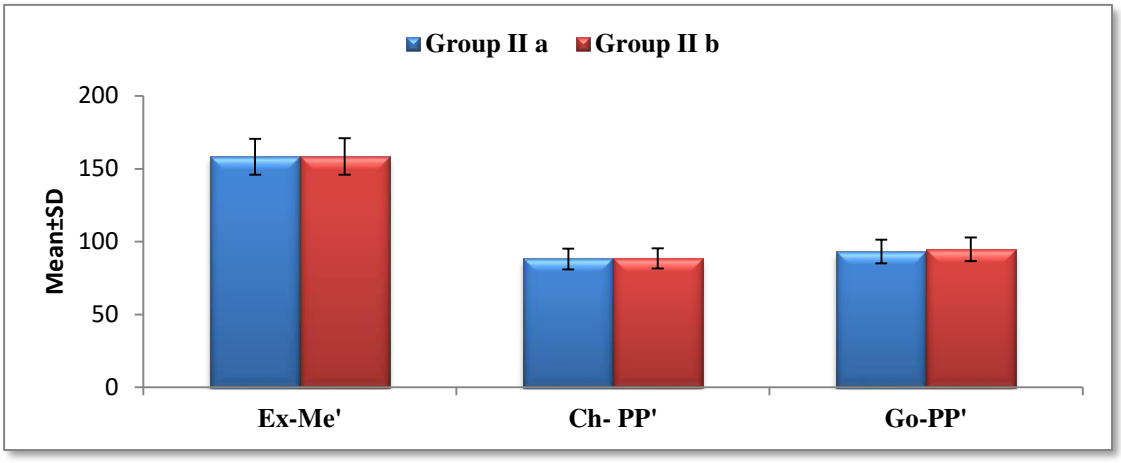
Graph 3: Comparison of eye indices between Group Ia and I b in males.

Right side Eye Index had a lower mean value than left side and the mean difference was stastically significant (P<0.01). All the midline landmarks (Pronasale (Prn), Labiale superious (Ls) and Menton (Me') from Mfp) in Group I had deviated more towards the left side.



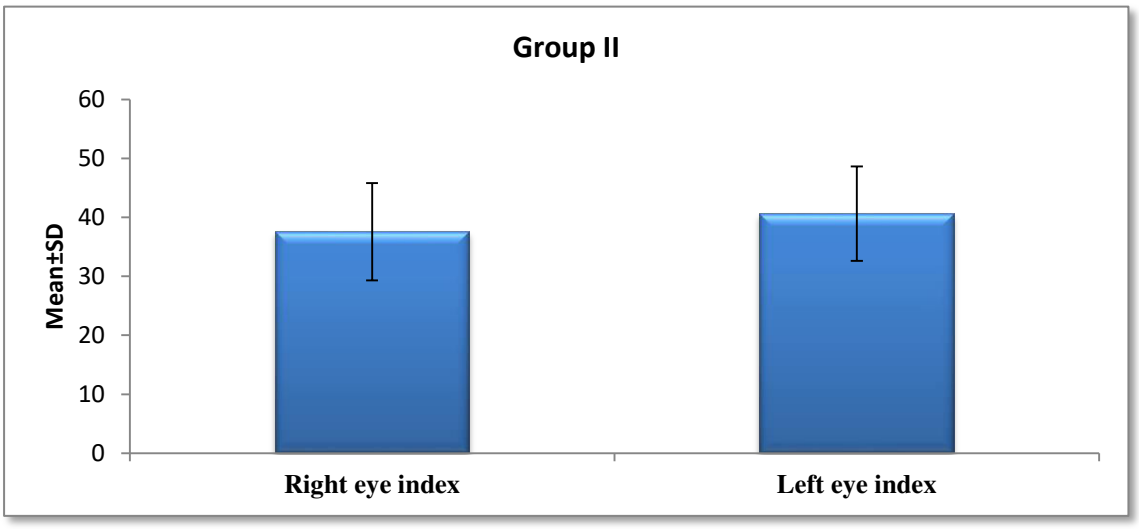
Graph 4: Comparison of Horizontal parameters between Group IIa and IIb for laterality in facial asymmetry in females.

In this study, in contrast to Group I (males), Group II (females) had higher mean value of most of the horizontal parameters in left side with statistically significant difference between left and right side which were Palpabrale superious (Ps), Palpabrale inferious (Pi), Mid of the pupil (P),Subaurale (Sa), Gonion (Go) and Zygion (Zy) from Mfp.



Graph 5: Comparison of Vertical parameters between Group IIa and IIb for laterality in facial asymmetry in females.

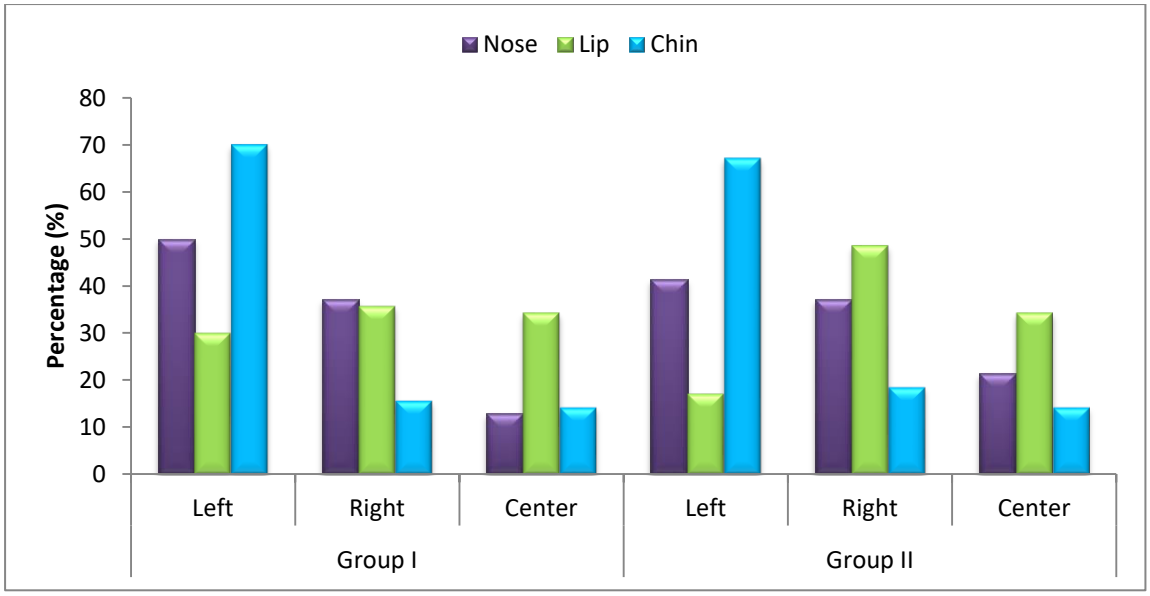
All vertical parameters,ie Exocanthus to Menton (Ex-Me'), Chelion to interpupillary line (Ch-PP')and Gonion to interpupillary line (Go-PP') higher mean value on left side than right side and the difference was highly significant (p<.0001).



Graph 6: Comparison of eye indices between Group IIa and II b in females.

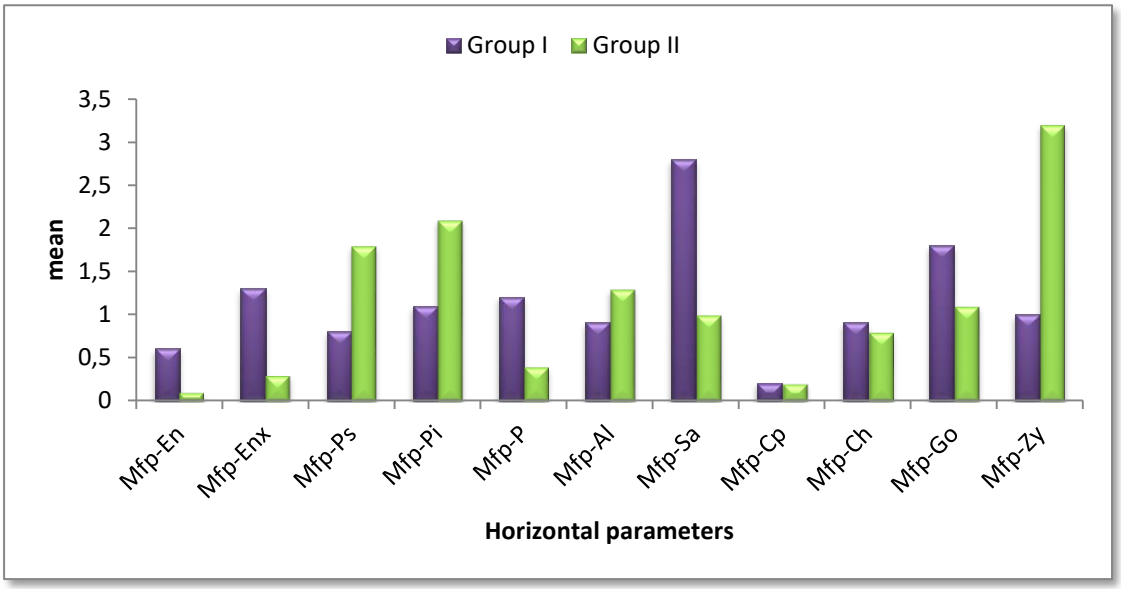
Similar to Group I (males), Group II (females) also had lower mean value for right side eye index than left side and difference was stastically highly significant (P<0.001).

Lateral landmarks like Sa, Zy, Go showed greater variation ranging from 1 to 1.8 mm in males and 1 to 3.2 in females than the landmarks closer to the midline ie En, Al and Cp with value ranging between .2 to .8 mm in males and .1 to 1.3 in females.



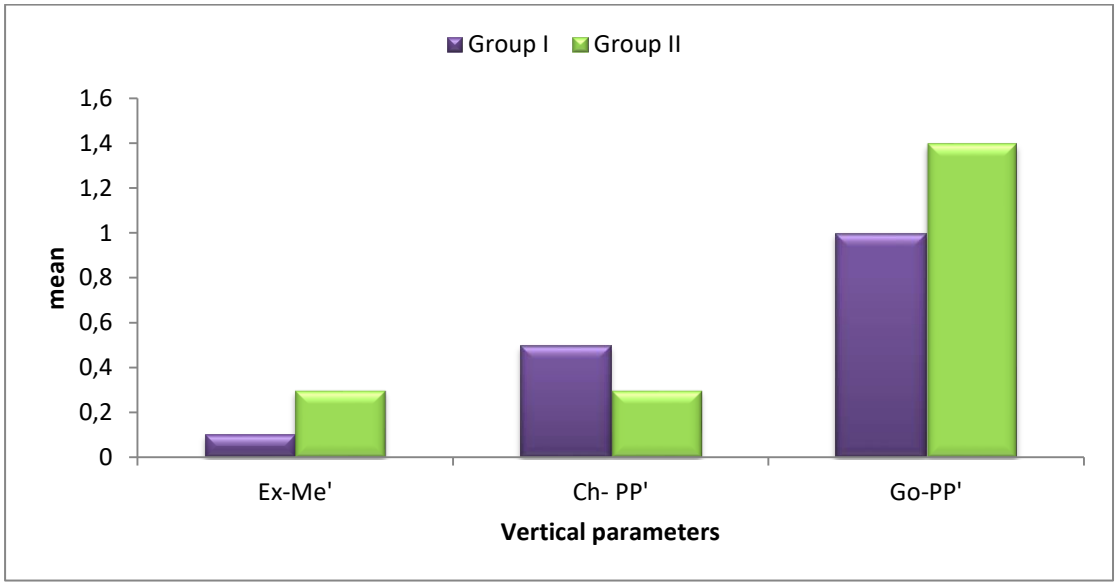
Graph 7: Comparison of mean difference of right and left midline parameters in Group I and Group II. (males and females)

Laterality was seen on left side in both the groups. In the present study all the midline landmarks (Pronasale (Prn), Labiale superious (Ls) and Menton (Me') from Mfp) in Group II had more deviation towards the left side.



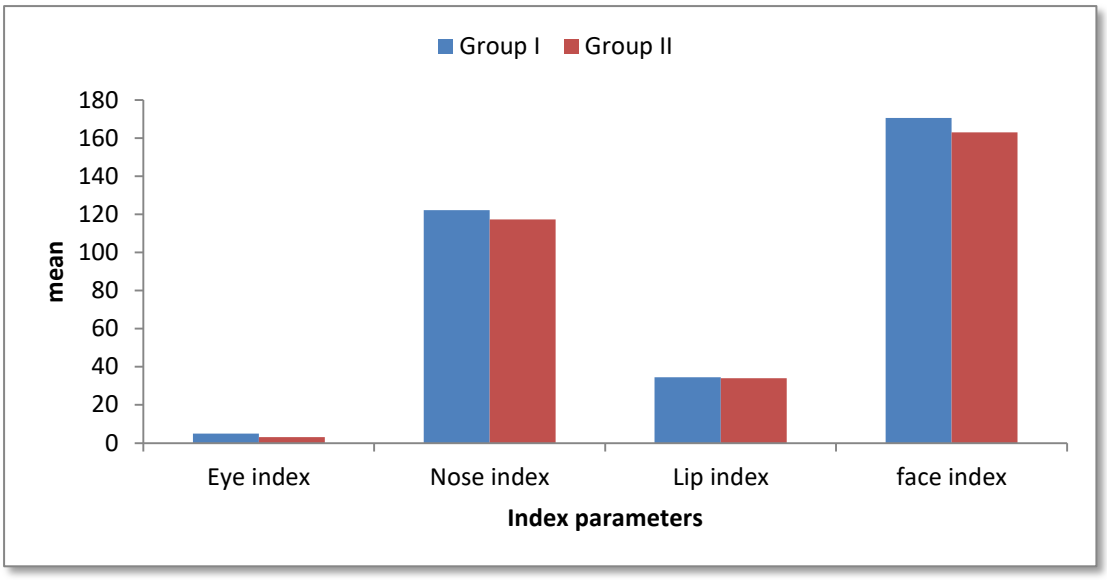
Graph 8: Comparison of mean difference of horizontal parameters in Group I and Group II. (males and females)

In present study , when comparison of horizontal parameters between Group I (males) and Group II (females) was done, the distance from Mid facial plane(Mfp) to Exocanthus (Ex), Endocanthus (En), Mid of the Pupil (P) and Subaurale (Sa) had significantly higher mean values in males whereas distance from Mfp to Palpabrale superious (Ps), Palpabrale inferious (Pi) , Crista philter (Cp) and Zygion (Zy) had significantly higher mean values in females. It was seen that parameter with greatest variation were Zy, Pi and Ps had mean difference of 3.2 mm followed by 2.1, 1.3 mm and so on in females whereas highest mean difference was 2.8, followed by 1.8 and 1.3 mm so on in males for the parameters Sa, Go and Ex respectively .This suggest that female showed more amount of asymmetry between right and left side than males.



Graph 9: Comparison of mean difference of vertical parameters in Group I and Group II. (males and females)

In vertical parameter, all the three parameters showed statistically insignificant difference between males and females throughout and the values were higher in females.



Graph 10: Comparison of mean difference of index parameters in Group I and Group II. (males and females)

Eye and Lip index show statistically insignificant difference between males and females with higher mean value for males whereas Nose and face index had higher mean value for males than females which was statistically significant. The midline parameters was noted more in males than females.

Many investigators have also found asymmetry as a normal facial feature, there is no consensus in the literature regarding the degree, side and spatial localization of facial asymmetry[32,34,54]. In all investigations, a significant facial asymmetry has been demonstrated even in aesthetically pleasing faces, but no agreement exists regarding the side of dominance. Similar to present study , studies by **Reddy et al**[51] and **Ferrario et al**[18,34'54] showed right hemiface wider than left in males and studies by **Adamyu et al**[47] and **Ercan et al**[23] showed left hemiface wider than right in females. In contrast to our study, males had wider left hemiface than right in the studies by **Smith**[33]**,Adamu**[17] **and Ercan et al.**[23] Right hemiface was wider then left in females in the studies by **Smith**[33] **and Reddy et al**[51]. Few studies by **Ferrario**[18]**,**

Haraguchi[11], Reddy[51],Farkas[28],Rajpara[21],Shah[20] and Peck et al[29] found right side was larger than left side and studies by **Taneja[19],Vig[15] and Chebib[16] et al** found left side was larger than right side but in these studies gender differences were not considered.

Haraguchi et al[11] conducted a study on frontal facial photographs (651 males and 1149 females) of Japanese origin. They measured distance of right side and left side ear rod to facial midline and found that both males and females had significantly wider right hemiface. The results of their study are similar for male subjects of present study whereas in contrast to female population of our study. The study was conducted by **Reddy et al[51]** on 100 subjects (50 males and 50 females) of Tirupati population using both the photographs and Posteroanterior cephalograms . The parameters were measured from Mid saggital reference plane (MSR) that closely follows visual plane formed by subnasale and the midpoint between the eyes. They found values were higher on right side than left side in males. Most of the parameters except for condylion showed statistically insignificant difference between right and left in both males and females. They constructed composite photographs of all subjects and found on subjective evaluation that both males and females had greater right hemiface than left and this is in contrast to their results by posteroanterior cephalometrics.Another study was conducted by **Ferrario et al[26]** on photographs of 108 healthy young adults (57 men and 51 women) showed that male face was larger than females.The right side of the face appeared to be wider and longer in men than in women, while the left side did not present a sexual dimorphism so clearly. **Moshkelgosha et al[46]** conducted a study of Persian population on frontal photographs in of 240 subjects (110 females and 130 males). The photographic records were analysed using a aesthetic analyser software program. They found that all participants

showed Right side laterality, in frontal measurements. Another study done by **Ferrario et al**[18] of Italy caucasian population (40 men and 40 women) on photographs where the dimensional coordinates of 16 standardized facial landmarks were collected automatically using the Elite system they concluded that right side of the face was larger than left side in both male amd females with range of 1.3% to 4.4%. Study conducted by **Kumar et al**[42] on 90 subjects (45 male and 45 female) of Karnataka population using frontal cephalogram showed that the distance from Condylion to Mid sagittal reference plane (MSR) was higher on right side than left side in both males and females. Other study was conducted by **Ercan et al**[23] on the 2 dimensional digital images of young healthy subjects (150 males and 171 females) of Turkish population using Euclidean distance matrix analysis, found that asymmetric linear distances between the two sides of the face were found more commonly at the middle 3rd of the face in both sexes.33%of distances demonstrated asymmetry regarding the difference between left and right sides of the face in females. In this group , 86% of asymmetric linear distances were larger on the left side and 14% were larger on right side. In females, among all significantly asymmetric linear distances, the number of linear distances involving the Zygion was the highest. Distances important for mandibular width labiale inferious- gonion, sublabiale-gonion, gnathion-gonion were found to be wider on the left side of the face than on right side in females. In males ,13 % of the distances demonstrated asymmetry regarding the differences between right and left sides of the face. In this group, 81% of asymmetric linear distances were larger on the left and 19%were larger on the right side. In males , among all significantly asymmetric linear distances , the number of linear distances involving the zygion was the highest and the asymmetric linear distances were larger on the left side.

In another study by **Smith**[33], he calculated area of right and left hemiface below interpupillay line using CANVAS software and found that the left hemiface was larger than that for the right hemiface in males, the difference being .13 sq. cm. (3.8%) The variation among males in this respect was from .3 to 14.2% for the females, the right hemiface mean was larger by .09 sq.cm.(2.7%) and the variation among females in this respect was .6-12.8%.[2] The result for both the sexes were in contrast to our study. In a study conducted by **Adamyu et al**[47] on facial photographs, females had higher mean value on right side for the parameter (orbital width) as compared to males. Males tend to have leftward signed asymmetry in orbital width. Study conducted by **Mcintyre and Mossey**[35] on PA ceph concluded that left side of the face was wider in subjects with cleft lip and palate. Another study conducted by **Taneja et al**[19] on Posteroanterior cephalograms of 60 subjects of South Indian population (30 males and 30 females) found that the cranial base region was found to be insignificantly larger on the left side. Also the total facial structure was bigger on the left than on the right both in males and females. Similarly in females the cranial base region and maxillary region were found to be larger on left side whereas upper maxillary region was found to be larger on the right side.The study was conducted by **Goel et al**[22] on Indian population (Karnataka population) using Posteroanterior cephalograms of 120 subjects (males and females) with Class I occlusion, the bilateral widths were observed to be larger at right side than left side. Another study was conducted by **Farkas and Cheung**[28], on North American 308 (154 boys and 154 girls) healthy subjects using Anthropometric measurements where they found asymmetry was very common, but average difference between right and left measurements were mild (3 mm or 3%). The right side usually was the largest and was in the upper third of the face. The study was conducted by **Peck et al**[29] consisted

of 52 white adult subject (49 females and 3 males) on Posteroanterior cephalogram and photographs. They found wider hemiface in right side than left side but the difference was not statistically significant. The study was conducted by **Shah et al**[20] on 43 subjects of Indian population using postero anterior radiographs. The total facial structure was significantly larger on right side than left side. The total maxillary area was significantly larger on right than on the left side. The study was conducted by **Vig P.S. and Hewitt A.B**.[15] on Cephalometric radiographs of 63 subjects of London population. They found that the middle third of the face was wider on the left side.The cranial base region and maxillary regions exhibited an overall asymmetry with the larger side being the left. The study was conducted by **Chebib and Chamma**[16] on posteroanterior ceph in the University of Manitoba of 64 subjects (32 male and 32 female) on Canadian population showed a larger left side of the face compared to the right.

Very few parameters for vertical asymmetry and indices of facial asymmetry had been evaluated in previous strudies.

A cross sectional study was conducted by **Duggal et al**[48] on frontal photographs of Indian population composed of an equal number of males and females ,divided into two groups Group I(unattractive) and group II (attractive). In order to analyse the face objectivally, an experimental photogrametric facial analysis BAPA program was utilized. On comparison between Group I and Group II of both males and females demonstrated that upper face index and the mandible index to be highly significant between the groups. In contrast , no significant differences (.15-4.63) were found between the groups in term of the lower face index, interpupillary index, eye height index, eye width index, nasal index and the lip index. For female faces, the facial index as well as the indices reflecing the upper face, mandible, left and right mandible

angle, and left and right lateral gonial angle were significantly higher in group II than in group 1. Study conducted by **Kumar et al**[42] of 90 subjects (45 male and 45 female) of Karnataka population on frontal cephalogram. According to their study the vertical parameter CO-Me was higher on right side than left side in male whereas Co-Me was higher on left side than right side in females and higher in male than female which was statistically not significant. In present study the parameter Ex-Me was significantly higher on the left side in female and insignificantly higher on male. Sexual dimorphism was not seen for all the parameters. Similarly in our study none of the parameters to asses vertical asymmetry was statistically significant amongs male and females. Another study was conducted by **Farkas and Cheung**[28], 308 (154 boys and 154 girls) healthy Canadian Caucasians on Anthropometry where they found asymmetry to be very common, but average difference in right and left measurements were mild with the right side was more longer than the left. In a study conducted by **Adamyu et al**[47] on facial photographs, Zygion to Gnathion facial distance on left side was significant higher in males. Study conducted by **Mcintyre and Mossey**[35] on cleft lip and palate patients on PA ceph were found shorter vertical dimension on right side.

As the results of the present study are similar to some studies and in contrast to other studies, it can be suggested that population difference are evident in presence of facial asymmetry both in horizontal and vertical plane between right and left side.Smith[55] 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 eviden (Smith, 2000)[33]. 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). In addition, the right and the left difference values showed a tendency to increase according to lateral positioning of the landmarks. It was seen that horizontal parameter with greatest variation ie Zy, Pi and Ps had mean difference of 3.2 mm followed by 2.1, 1.3 mm and so on in females whereas highest mean difference was 2.8, followed by 1.8 and 1.3 mm so on in males for the horizontal parameters Sa,Go and Ex respectively. Similar to our study, most of the the studies got more variation in lateral landmarks than the midline one. Ferrario et al (1994)[18] showed that there was a certain degree of soft tissue facial asymmetry both in individuals and in global populations and that this was specially evident the tragus in middle and Gonion in lower thirds of the face. Above finding is same as the present study where facial asymmetry was more in subaurale, gonion and zygion parameter of the face in comparison to midline landmarks. Shaner et al (2000)[32] have stated that the measurements that involved tragion and gonion in the mouth and chin regions had a much greater normal variability. Ferrario et al (2001)[34] reported that the tragion , gonion and zygion were the most asymmetrical landmarks. Asymmetric linear distances between the two sides of the face were found more commonly at the middle third of the face (maxillary bone, zygomatic corner and lower orbital border) in both he sexes (Ercan et al)[23]. As an example, the subaurale and soft tissue gonion showed over two times greater values than upper lip point and alare in the study by Hwang et al[2] suggested that facial asymmetry increases as we go away from midline.

Laterality of facial asymmetry was evaluated by assessing deviation of midline landmarks in different studies. Present study concluded that midline landmarks were deviated toward the left side. Our result were similar to the previous studies which also demonstrated deviation toward left side. Survey done by **Miller et al**[56] utilized the midline of philtrum as the midline of the face and considered it the most reliable guide for the same. 70% of their subjects had maxillary dental midlines that coincided with the midline of the philtrum in subjects with pleasant faces. **Haraguchi et al**[12] found that cephalometric landmarks ANS, U1, L1 and Me' representing the anatomic components ie the maxilla, the upper incisor, the lower incisor, and the mandible respectively had an obvious tendency towards left sided facial laterality in subjects having skeletal class III deformity. **Fong et al**[38] found in 25 patients (14 male and 11 female) of Taiwan population 68% showed chin deviation to left side on PA ceph. The direction of chin deviation was significantlty associated with the difference in bilateral mandibular effective length. For every 1mm the left mandibular effective length was longer than that of right side, the possibility of chin deviation to right side was 2.2 fold than that of the left. **Kumar et al**[42] found Chin deviation toward left side in both male and female with higher values in male on posteroanterior cephalograms of 90 subjects of Karnataka population.

In general , skeletal deviation must be equal to or greater than 4 mm in order to render the asymmetry visible in an individual's face.[12.57-60] Whenever the degree of asymmetry is lower , the conditions tends to be considered mild and unperceivable. Nevertheless, asymmetry perception or blinding will also depend on individual characterstics , such as soft tissue thickness in the region. **Amara et al** showed that the deviation <1.7 mm are clinically difficult to notice.[61] Other auther consider an asymmetrical face as having bone deviations equal to or greater than 2mm.[62-64] As

deviation in our study also lesser than .74 mm, hence were not perceived by patients as facial asymmetry. The reason for laterality in facial asymmetry had been attributed to various causes in different studies. Mobility of facial expression exhibits facial asymmetry (Haraguchi et al. 2008)[11]. Most studies suggested that the left side of the face is more expressive of emotions: an asymmetry that probably stems from the right hemisphere dominance for emotional expression, hence left side laterality had been observed in most of the studies[12,31,36]. Another possible source is habitual chewing on one side, which is responsible for increased skeletal development on the ipsilateral side.[20]

Sexual dimorphism with respect to facial asymmetry had been assessed in few studies. As parameters were different, hence their comparison was not possible. Sexual dimorphism was observed for these parameters in our study endocanthus, exocanthus, palpabrale superious, palpabrale inferious , mid of the pupil, subaurale ,cristaphilter and zygion.

Hwang et al[2] conducted a study on CT (Cone beam computed tomography) of 48 subjects (24 males and 24 females) on Korean population.He reconstructed 3 dimensional model by using a 3D image software. They found the difference of right and left horizontal parameters like Chelion, Ala of the nose , Endocanthus, Exocanthus, and Gonion was higher in females than males and other horizontal parameters like Zygion, Crista philter, Tragus and Subaurale had higher mean value (1.46-4.78) in males than females which was statistically not significant. The study was conducted by **Ferrario et al[34]** on 314 (40 males and 33 females) subjects divided into three groups according to age. The reference plane of symmetry in the D space was the vertical plane passing through landmark nasion and perpendicular to the plane connecting the two exocanthi. The landmarks used in their study were midline

landmarks like pronasale, menton and paired landmarks like exocanthus , endocanthus, orbitale superious, zygion, tragion, nasal alar crest, chelion and Gonion. All the parameters measured had more mean value in males except for the parameter ala of the nose which was more in females in the adolescent period. The study was conducted by **Moshkelgosha et al**[46] on frontal photographs of 240 subjects (110 females and 130 males) on Persian population using a aesthetic analyser software program. It was observed that the boys had larger facial dimensions than females. Mouth width and nasal base width were significantly higher in males. In a study was conducted by **Ercan et al**[23], according to them the number of significantly asymmetric linear distances between two halves of the face was greater in females than males. Smith in his study found females to the right faced and males to be left face. According to Smith[33] females were more faced and adapt verbally than males whereas males were advantaged in visuospatial relation. Gender bias was explained in terms of the contralateral control (below the eyes) of the two sides of the face by the two hemispheres, and the known differences in cognitive processing by the two hemispheres (left hemisphere –verbal; right hemisphere-visospatial in females and males.They suggested that this alone cannot explain sexual dimorphism observed in facial asymmetry. Besides, this different muscular development of 2 sides of face also plays a role.

Our results are in contrast to this study where females were left faced and males were right face. This could be explained on the basis of difference in method of assessing width of right and left side in both the studies. It can be suggested that sexual dimorphism as observed in other studies was also evident in the present study.

Within limitation of the present study, it can suggested that mild form of facial asymmetry is evident in normal subjects with class I occlusion, both in horizontal and

vertical plane in the present study. Laterality of facial asymmetry being mild was not perceived by the individuals as a problem. In such cases no treatment is required but it has to be explained to the patients before starting Orthodontic treatment. At times, on correction of dentition in patients undergoing Orthodontic treatment, they perceived mild form of facial asymmetry present to be due to treatment mechanics. In other cases where patients are conscious of their facial asymmetry, certain soft tissue surgeries like sliding genioplasty can be planned or Orthodontic mechanics can be employed to solve this disharmony by compensation. Depending on patient's age and the severity of the condition, a variety of Orthodontics and Orthopaedics options has been described in the literature with a view to correcting obvious facial asymmetries of the many therapeutic approaches that have been reported, asymmetrical mechanics, asymmetrical extractions or surgical interventions are highlighted.

Further studies with large sample size can validate the results of present study. Also studies can be conducted on subjects with Class II and Class III malocclusion or studies can be conducted to compare different population groups.The photogrammetric method of assessment of soft tissue asymmetry can be compared with asymmetries of underlying hard tissues using Posteroanterior cephalogram in future studies.

The following conclusions may be drawn from the present study conducted to evaluate facial asymmetry in North Indian Population using Digimizer software:

1. Wider hemiface was seen on right side in males with significantly higher mean value of 7 out of 11 horizontal parameters (Mid facial plane (Mfp) to Endocanthus (En), Exocanthus (Ex), Mid of the pupil (P'), Ala of the nose (Al), Subaurale (Sa), Chelion (Ch) and Gonion (Go)
2. Wider hemiface was seen on left side in females with significantly higher mean value of 6 out of 11 horizontal parameters (Mid facial plane (Mfp) to Palpabrale superious (Ps), Palpabrale inferious (Pi), Mid of the pupil (P'), Subaurale (Sa), Gonion (Go) and Zygion (Zy))
3. The face was longer vertically on left side in both male and females with significantly higher value for Chelion to Interpupillary line (Ch-PP') and Gonion to Interpupillary line (Go-PP') in males and of all the parameters for females.
4. Both males and females had significantly higher mean value on left side of eye index.
5. Landmarks away from the midline showed more variation between right and left side than landmarks closer to midline. The midline parameters pronasale (Prn), labiale superious (Ls) and menton (Me') deviated towards left side in both males and females.
6. Sexual dimorphism was observed for horizontal parameters (Mfp to Exocanthus (Ex), Endocanthus (En), Mid of the pupil (P) and Subaurale (Sa) had higher values in males and Mfp to Palpabrale superious (Ps), Palpabrale inferious (Pi), Crista philter (Cp) and Zygion (Zy) had higher value in females.

Sexual dimorphism was also seen for index parameters ie Nose and Face index.None of the vertical parameters showed sexual dimorphism.The midline landmarks from Mfp showed significantly higher values in males than females.

Overall, it can be concluded that mild form of facial asymmetry is evident in normal subjects with class I malocclusion and sexual dimorphism is evident in facial asymmetry.

Further studies with large sample size can validate the results of present study. Also studies can be conducted on subjects with Class II and Class III malocclusion or studies can be conducted to compare different population groups. 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.

Tweed defined the normal facial contour as being "balance and harmony of proportion" considered by the majority of us as most pleasing in the human face'.Though the importance of a well proportioned human face cannot be underestimated. Evaluation of facial esthetics is at best objective, because balance and harmony of facial components do not necessarily mean an attractive face. Despite the fact, that improvement of facial aesthetics is the cornerstone of any orthodontic treatment; our diagnostic considerations were initially based on Angle's paradigm which was based on the assumption that an ideal hard tissue proportions produce an ideal soft tissue proportions of profile. In early 21st century, an emphasis shifted on consideration of the oral and facial soft tissues[4]. Patients with facial asymmetry can be evaluated through clinical assessment, photographs[12-23], posteroanterior cephalograms[14,19-22,24], and occasionally 3D-computed tomography[2]. Clinical examination reveals asymmetry in the sagittal, coronal and vertical dimensions[6]. Soft tissue measurements useful for characterizing facial morphology can be reliably measured from facial photographs hence it is decided to evaluate facial asymmetry using photographs in the present study. The purpose of this study is to investigate the prevalence of facial asymmetry and laterality of the normal asymmetry on digital photographs taken of normal subjects with class I molar relation from North Indian population.

The present study was conducted in the Department of Orthodontics & Dentofacial Orthopaedics, Babu Banarasi Das college of Dental sciences, Lucknow to evaluate facial asymmetry in 700 subjects of North Indian population divided in two Groups- Group I had 350 males with mean age of 21.5± 1.5yrs and Group II had 350 females with mean age 20.5± 1.5yrs . Both groups were further subdivided into subgroup a and b for evaluation of parameters of right and left side respectively. The digital

photographs of the subjects was 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 twenty-two horizontal, six vertical and ten index parameters using Digimizer software after identification of required landmarks. Mid facial Plane (Mfp) was used as refrence plane to measure the parameters it was as a perpendicular line to interpupillary line and passing through nasion. The data obtained for 41 linear parameters were recorded on microsoft excel sheet and subjected to statistical analysis.

The following conclusions may be drawn from the present study conducted to evaluate facial asymmetry in North Indian Population using Digimizer software:

1) Wider hemiface was seen on right side in males with significantly higher mean value of 7 out of 11 horizontal parameters (Mid facial plane (Mfp) to Endocanthus (En), Exocanthus (Ex), Mid of the pupil (P'), Ala of the nose (Al), Subaurale (Sa), Chelion (Ch) and Gonion (Go).
2) Wider hemiface was seen on left side in females with significantly higher mean value of 6 out of 11 horizontal parameters (Mid facial plane (Mfp) to Palpabrale superious (Ps), Palpabrale inferious (Pi), Mid of the pupil (P'), Subaurale (Sa), Gonion (Go) and Zygion (Zy)).
3) The face was longer vertically on left side in both male and females with significantly higher value for Chelion to Interpupillary line (Ch-PP') and

Gonion to Interpupillary line (Go-PP') in males and of all the parameters for females. Both males and females had significantly higher mean value on left side of eye index.

4) Landmarks away from the midline showed more variation between right and left side than landmarks closer to midline. The midline parameters pronasale (Prn), labiale superious (Ls) and menton (Me') deviated towards left side in both males and females.
5) Sexual dimorphism was observed for horizontal parameters (Mfp to Exocanthus (Ex), Endocanthus (En), Mid of the pupil (P) and Subaurale (Sa) had higher values in males and Mfp to Palpabrale superious (Ps), Palpabrale inferious (Pi), Crista philter (Cp) and Zygion (Zy) had higher value in females. Sexual dimorphism was also seen for index parameters ie Nose and Face index.None of the vertical parameters showed sexual dimorphism.The midline landmarks from Mfp showed significantly higher values in males than females.

Overall, it can be concluded that mild form of facial asymmetry is evident in normal subjects with class I malocclusion and sexual dimorphism is evident in facial asymmetry. Wider (horizontal) hemiface on right side in males and on left side in female. Left side was longer vertically in both male and females. Facial asymmetry increases as we go away from midline. Laterality of facial asymmetry was evident with deviation towards left side of midline landmarks. Sexual dimorphism was observed in various parameters used to assess facial asymmetry.

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Babu Banarasi Das University

Babu Banarasi Das College of Dental Sciences,
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

Dr. Lakshmi Bala
Professor and Head Biochemistry and
Member-Secretary, Institutional Ethics Committee

Communication of the Decision of the IIIrd Institutional Ethics Sub - Committee

IEC Code: 26 **BBDCODS/05/2016**

Title of the Project: Evaluation of facial asymmetry in North Indian Population: A photographic study.

Principal Investigator: Dr. Anshu Agarwal **Department:** Orthodontics & Dentofacial Orthopedics

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

Type of Submission: New, MDS Project Protocol

Dear Dr. Anshu Agarwal,

The Institutional Ethics Sub- Committee meeting comprising following four members was held on 03rd May, 2016.

1.	Dr. Lakshmi Bala Member Secretary	Prof. and Head, Department of Biochemistry, BBDCODS, Lucknow
2.	Dr. Narendra Kumar Gupta Member	Prof., Department of Prosthodontics, BBDCODS, Lucknow
3.	Dr. Smita Govila Member	Reader, Department of Conservative Dentistry, BBDCODS, Lucknow
4.	Dr. Subhash Singh	Reader, Department of Pedodontics, BBDCODS, Lucknow

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

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

Lakshmi Bala 12/05/16

(Dr. Lakshmi Bala)
Member-Secretary
IEC

Member-Secretary
Institutional Ethic Committee
BBD College of Dental Sciences
BBD University
Faizabad Road, Lucknow-226028

Forwarded by:

(Dr. Vivek Govila)
Principal
BBDCODS

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

Babu Banarasi Das College of Dental Sciences

(A constituent institution of Babu Banarasi Das University)

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

Participant Information Document (PID)

1. Study title

Evaluation of facial asymmetry in North Indian Population – A photographic study.

2 Invitation paragraph?

You are being invited to take part in a research study, it therefore is important for you to understand why the study is being done and what it will involve. Please take time to read the following information carefully. Ask us for any clarifications or further information. Whether or not you wish to take part is your decision.

3. What is the purpose of the study?

The purpose of this study is to evaluate various parameters of facial asymmetry in North Indian subjects using nemoceph software and compare the prevalence and laterality of facial asymmetry in males and females.

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 lifestyles for the investigation 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 between males and females.

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?

You will know whether prevalence and laterality of your face is according to orthodontists, plastic surgeons, beauticians and laymen. 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?

If additional information becomes available during the course of the research you will be told about these and you are free to discuss it with your researcher, your researcher will tell you whether you want to continue in the study. If you decide to withdraw, your researcher 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. You do not have to pay for any procedures involved.

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. Anshu Agarwal

Department of Orthodontics & Dentofacial Orthopaedics

Babu Banarasi College of Dental Sciences

Lucknow- 227105

9458321985

Dr. Tripti Tikku

Professor and Head

Department of Orthodontics & Dentofacial Orthopaedics

Babu Banarasi College of Dental Sciences

Lucknow- 227105

9554832799

OR

Dr. Laxmi Bala,

Member Secretary

Babu Banarasi College of Dental Sciences

Lucknow

bbdcods.iec@gmail.com

Signature of PI……

Name……

Date ……

प्रतिभागी जानकारी दस्तावेज़ (पीआईडी)

1. अध्ययन खिताब

उत्तर भारतीय जनसंख्या में चेहरे की सौंदर्यता की चित्रात्मक तुलना|

2 निमंत्रण पैराग्राफ?

आपको एक शोध अध्ययन में भाग लेने के लिए आमंत्रित किया जा रहा है, यह अध्ययन क्यों किया जा रहा है क्या आप समझते हैं और क्या आप शामिल होगी, ये आप के लिए महत्वपूर्ण है। कृपया निम्नलिखित जानकारी को ध्यान से पढ़ने के लिए समय ले। किसी भी स्पष्टीकरण या अधिक जानकारी के लिए पूछो। चाहे या नहीं चाहे आप हिस्सा लेने के निर्णय के लिये स्वतंत्र है ।

3। अध्ययन का उद्देश्य क्या है?

इस अध्ययन का उद्देश् डीजीमाइजर सॉफ्टवेयर का उपयोग कर उत्तर भारत की आबादी का नरम ऊतक की फोटोग्राममेट्रिक मानदंडों द्वारा प्रमुखता स्थापित करने के लिए है।

4। मैं क्यों चुना गया हूँ ?

आप इस अध्ययन के लिए चुना गया है क्योकि आप इस अध्ययन के लिए आवश्यक मानदंडों को पूरा कर रहे हैं।

5 . मैं भाग लेने के लिए है?

अनुसंधान के क्षेत्र में आपकी भागीदारी पूरी तरह स्वैच्छिक है। यदि आप करते हैं, तो आप इस जानकारी को रखने के लिए पत्र दिया जाएगा और एक सहमति पत्र पर हस्ताक्षर करने के लिए कहा जाएगा। अध्ययन के दौरान आप अभी भी किसी भी समय और एक कारण देने के बिना वापस लेने के लिए स्वतंत्र हैं।

6. भाग लेने के लिए मुझेका क्या होगा?

मेरे अध्ययन के लिए आप अपने चेहरे की एक सही पार्श्व फोटोग्राफ प्रदान करने के लिए शामिल किया जाएगा और उसके बाद आप वापस बुलाया नहीं किया जाएगा। आप प्राकृतिक सिर की स्थिति में आपके चेहरे की फोटोग्राफ लिया जाएगा और अंशांकन पैमाने के साथ मुहिम शुरू की। तीन से चार बाद चेहरे की फोटोग्राफ ले जाया जाएगा और सबसे अच्छा चयन किया जाएगा।

7. क्या मुझे कुछ अलग करने की क्या ज़रूरत है?

आप अध्ययन की जांच के लिए अपने नियमित जीवन शैली बदलने की जरूरत नहीं है।

8. क्या प्रक्रिया है परीक्षण का ?

चेहरे सौंदर्यशास्त्र प्रमुखता के विश्लेषण सही चेहरे प्रोफ़ाइल डीजीमाइजर कंप्यूटर आधारित सॉफ्टवेयर प्रोग्राम का उपयोग कर तस्वीरों पर किया जाएगा।

9. अध्ययन के लिए हस्तक्षेप कर रहे हैं?

कोई हस्तक्षेप नहीं किया जाएगा।

10 भाग लेने के दुष्प्रभाव क्या हैं?

इस अध्ययन के मरीजों पर कोई साइड इफेक्ट नहीं होते हैं।

11. संभावित नुकसान और भाग लेने का जोखिम क्या हैं?

वहाँ कोई खतरा नहीं इस अध्ययन में शामिल किया है,

12. भाग लेने के संभावित लाभ क्या हैं?

आपको पता होगा कि अपने सौंदर्यशास्त्र प्रमुखता मनभावन या गैर मनभावन, प्लास्टिक ऑर्थोडोंटिक्स, सर्जन, ब्यूटिशियन और laymen के अनुसार। उत्तर भारतीय आबादी के लिए नरम ऊतक की फोटोग्राममेट्रिक मानदंडों के द्वार्रा स्थापना और तुलना की जाएगी।

13. यदि क्या नई जानकारी उपलब्ध हो जाता है?

अतिरिक्त जानकारी के अनुसंधान आप इन के बारे में बताया जाएगा के दौरान उपलब्ध हो जाता है और आप अपने शोधकर्ता के साथ इस पर चर्चा करने के लिए स्वतंत्र हैं, अपने शोधकर्ता आपको बता देगा कि आप अध्ययन में जारी रखना चाहते हैं। आप वापस लेने का फैसला करते हैं, तो आपके शोधकर्ता अपनी वापसी के लिए व्यवस्था कर देगा। आप अध्ययन में जारी रखने का फैसला करते हैं, तो आप एक अद्यतन सहमति पत्र पर हस्ताक्षर करने के लिए कहा जा सकता है।

14. जब शोध अध्ययन बंद हो जाता है क्या होता है?

अध्ययन बंद हो जाता है न /िर्धारित समय से पहले खत्म, इस मरीज स्वयंसेवक के लिए समझाया / जाएगा।

15. क्या कुछ गलत हो जाता है?

किसी भी गंभीर प्रतिकूल घटना होती है, या कुछ और अध्ययन के दौरान गलत हो जाता है, शिकायतों संस्था के लिए रिपोर्टिंग द्वारा नियंत्रित किया जाएगा (ओं), और संस्थागत नैतिक समुदाय।

16. इस अध्ययन में मेरी एक हिस्से को गोपनीय रखा जाएगा?

हाँ, यह गोपनीय रखा जाएगा।

17. शोध अध्ययन के परिणामों का क्या होगा?

अध्ययन के परिणामों के चेहरे के मापदंडों के बारे में ज्ञान विचार प्रदान और उत्तर भारतीय आबादी के / विषयों की तस्वीरों पर नरम ऊतक सौंदर्यशास्त्र तुलना करने के लिए मदद करने के लिए इस्तेमाल किया जा सकता है। आपकी पहचान किसी भी रिपोर्ट प्रकाशनों के मामले में गोपनीय रखा जाएगा। /

18. जो अनुसंधान का आयोजन किया जाता है?

इस शोध अध्ययन शैक्षणिक संस्था द्वारा आयोजित किया जाता है। आप किसी भी शामिल प्रक्रियाओं के लिए भुगतान करने की जरूरत नहीं है।

19. अध्ययन के परिणामों को उपलब्ध कराया जाएगा के बाद अध्ययन खत्म हो गया है?

हाँ ।

20. कौन अध्ययन की समीक्षा की है?

अध्ययन की समीक्षा की और विभाग के प्रमुख, और संस्था के आईईसी आईआरसी द्वारा अनुमो /दित किया गया है।

अधिक जानकारी के लिए संपर्क 21.

MkW va'kq vxzoky

vkFkksZMksfUVl और **MSUVSQsf'k;y** आर्थोपेडिक्स विभाग

दंत चिकित्सा विज्ञान के बाबू बनारसी कॉलेज

लखनऊ 227,105

9695368450

डॉ तृप्ति **fVDdw**

प्रोफेसर और प्रमुख

vkFkksZMksfUVl और **MSUVSQsf'k;y** आर्थोपेडिक्स विभाग

दंत चिकित्सा विज्ञान के बाबू बनारसी कॉलेज

लखनऊ 227,105

9554832799

bbdcods.iec@gmail.com

पीआई के हस्ताक्षर .....

नाम .....

तारीख .....

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‘s Name…….
Date …….
Signature of the Investigator……
Date……..
Study Investigator‘s Name.....
Date…….. Signature of the witness……
Date…….. Name of the witness……
Received a signed copy of the PID and consent form
Signature/thumb impression of the subject or legally acceptable representattive
Date……..

सहमति फॉर्म)हिंदी(

अध्ययन का शीर्षक– उत्तर भारतीय और दक्षिण भारतीय जनसंख्या में चेहरे की सौंदर्यता की, मलार हड्डी सहित चित्रात्मक तुलना|

अध्ययन संख्या .. ..

प्रतिभगी का पूरा नाम ।.....

जन्म .. .. आयु दिनांक /

पता .....

फोन नंबर। और ई ।..... मेल पता-व्यवसाय :

.1मैरी पुष्टि है कि मैंने अध्ययन हेतु सुचना पत्र दिनांक को .....पढ़ व समझ लिया तथा मुझे प्रश्न पूछने या मुझे अध्ययन अन्वेषक ने सभी तथ्यो को समझा दिया है तथा मुझे प्रश्न पूछने के समान अवसर प्रदान किये गये है

.2मैं समझता हूँ कि इस अध्ययन में मेरी भागीदारी स्वैच्छिक है और मैं किसी भी दबाव के बिना स्वतंत्र इच्छा के साथ दिया है । किसी भी समय, किसी भी कारण देने के बिना और अपनी चिकित्सीय देखभाल या कानूनी अधिकार को प्रभावित किये बिना अध्ययन मे भाग न लेने के लिये स्वतंत्र हु।

3. मैं समझता हूँ कि इस परियोजना का प्रायोजक है, दूसरों के प्रायोजक की ओर से काम करने वाले लोग, आचार समिति और नियामक अधिकारियों को मेरे दांतो के रेकर्द को वर्तमान अध्ययन या आगे के अध्ययन के संदर्भ देख्रने के लिये मेरी अनुमति की जरूरत नहीं होगी, चाहे मैंने इस अध्ययन से नाम वापिस ले लिया है। हालांकि,मैं समझता हूँ कि मेरी पहचान तीसरे पक्ष के लिए जारी या प्रकाशित माध्यम मे नहीं दी जाएगी।

4. मैं इससे सह्मत हु कि कोई भी डेटा या परिणाम जो इस अध्ययन से प्राप्त होता है उसका वैज्ञानिक उद्देश्य के (ओं) लिये मेरी तरफ से कोई प्रतिबंध नहीं है।

6. मैं उपरोक्त अध्ययन में भाग लेने के लिए सहमत हु। मुझे जटिलताओं के बारे में विस्तार से बताया गया है और साइड इफेक्ट है, यदि कोई हो, और उन्हें पूरी तरह समझ लिया है।

हस्ताक्षर कानूनी तौर पर स्वीकार्य / विषय की (या अंगूठे का निशान)

प्रतिनिधि... ..... :

हस्ताक्षरकर्ता का नाम ।.....दिनांक .....।

अन्वेषक के हस्ताक्षर .....दिनांक .. ..

अध्ययन जांचकर्ता का नाम .. .. दिनांक .....

गवाह के हस्ताक्षर .....दिनांक ..... गवाह का नाम .. ..

पीआईडी और सहमति पत्र पर हस्ताक्षर किए की एक प्रति प्राप्त

विषय के हस्ताक्षर .. .. अंगूठे का निशान या कानूनी तौर पर तिथि /