Review Article

A Chronicle Overview of Cephalometric Parameters for assessing Sagittal Jaw Disparity

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ABSTRACT

Introduction: Assessment of sagittal jaws relation is a vital procedure in establishing a good diagnosis for all orthodontic cases. Various analyses have been introduced over the years with varying degrees of reliability and validity. Orthodontist should be aware of a range of analyses to be used in diagnosing different cases. This review provides a brief information about the various cephalometrics parameters i.e angular & linear which are used for assessing sagittal jaw discrepancy in their chronologic order.

KEYWORDS: Cephalometric Parameters, Sagittal Jaw Discrepancy

INTRODUCTION

Accurate diagnosis is the most important step in successful orthodontic treatment. Cephalometrics plays a key role in assessing jaw disparities in all 3 planes of space i.e transverse, anteroposterior and vertical. Sagittal jaw relationship assessment is of utmost important in orthodontic diagnosis & treatment planning[1]. Various angular & linear parameters such as ANB angle (1952)[2], Wits analysis (1975)[3], AF-BF (1987)[4], APDI (1978)[5], Beta angle (2004)[6], Yen angle (2009)[7], Pi analysis (2012)[8], and W angle (2013)[9] have been introduced and used effectively. There are obvious shortcomings of these angular & linear parameters.[10,11] Various cranial reference planes (SN , FH etc) as well as extracranial parameters has been used which reflects true apical base relationship.[12,13,14,15] Although these parameters have both merits as well as having inaccuracies associated with them. This article is a review and compilation of the various parameters used for assessment of sagittal jaw discrepancy in chronicle order and their implications in clinical orthodontic.

Assessment of Sagittal Dysplasia by Wendell L Wylie

Wylie (1947)[16] was the first to assess sagittal apical base relationship cephalometrically. He proposed an analysis where perpendiculars from glenoid fossa, sella turcica, pterygomaxillary fissure, buccal groove of maxillary first molar and anterior nasal spine are projected to FH plane and horizontal distances measured. Any increase or decrease in patient values are designated as orthognathic and prognathic respectively. Mandibular length is assessed by perpendiculars drawn from pogonion and posterior surface of condyle to a tangent drawn to lower border of mandible. Maxillary values above the norm and mandibular values below the norm are considered Class II, orthognathic (negative sign). Vice versa to this situation are considered Class III, prognathic (positive sign).A disadvantage here is that linear measurements are more prone to errors than angular.

Down's AB Plane Angle and Angle of Convexity

WB Downs (1948)17 described A-B plane angle. Location of this plane in relation to facial plane is the measure of the anterior limit of the denture bases to each other and to the profile. In the control group the relation of this plane to the facial plane was found to range from 0º to a posterior position of B which could be read as –9º. The mean was –4.8º (Fig 1). Downs also proposed angle of convexity i.e (Nasion-Point A-Pogonion) which measures protrusion of the face. If Point A fell posterior to the facial plane, angle formed

is read in minus degrees, and if anterior, in plus degrees. The normal range is +10º to –8.5º (Fig 2). Being angular measurements, these were more reliable as it eliminated differences due to absolute size.

ANB Angle[2]

Riedel (1952)[2] introduced ANB angle and later popularized by Cecil C Steiner (1953)[12] (mean value of 2° in adults and 2.8° in children, range 2-4°) (Fig 3). This has been most commonly and routinely used parameter. It has been demonstrated that there is often a difference between the interpretation of this angle and the actual discrepancy between the apical bases.[4,13,14,18] Several authors have shown that the position of nasion is not fixed during growth (nasion grows 1 mm per year), and any displacement of nasion, jaw rotations and orthodontic intervention will directly affect the ANB angle.[4,11,15,18] With advancing age, ANB decreases due to counterclockwise growth rotation of jaws.[3] Binder (1979)[19] described that for every 5 mm of anterior displacement of Nasion horizontally, ANB angle reduces by 2.5.° A 5 mm upward displacement of Nasion decreases ANB angle by 0.5° and 5 mm downward displacement increases ANB angle by 1°.

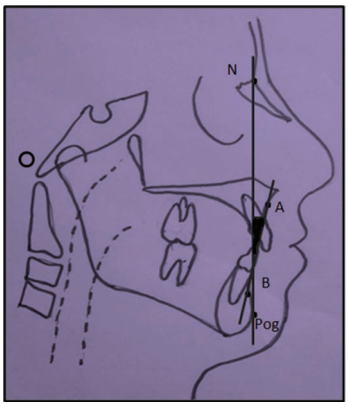

Fig-1 AB Plane Angle

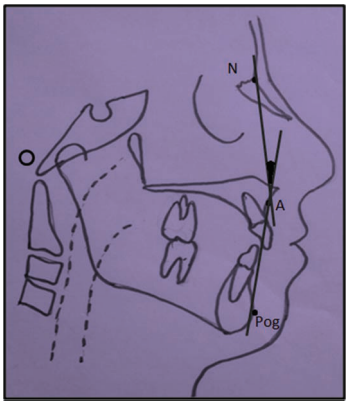

Fig-2 Angle of Convexity

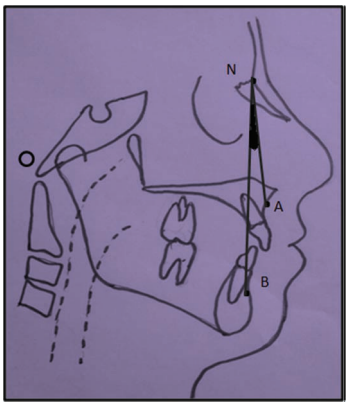

Fig-3 ANB Angle

Jenkin's 'a' Plane

Jenkins (1955)20 established 'a' plane, a perpendicular dropped from point A to occlusal plane. Linear distances from 'a' plane to point B [+3 mm], Gnathion [+5 mm], and mandibular incisors [+2 mm] are computed for dysplasia identification.

Taylor's AB' Linear Distance

Taylor (1969)4 introduced a linear distance between Point A and B'. B' is the perpendicular from point B to the sella-nasion plane (Fig 4). Its mean value was 13.2 mm. This study concluded that there was 1 mm of change from point A to the perpendicular B' for each degree of change in ANB.

AXD Angle and A-D' Distance

Beatty (1975)[21] introduced AXD angle - interior angle formed by intersection of the lines extending from points A and D at point X (X is point of intersection of perpendicular from point A to SN plane). Instead of point B, point D is taken as it is center of bony symphysis and not affected by changes in incisor position or chin prominence. He also introduced the linear measurement A-D', distance from point A to line DD' (Perpendicular from D to sella-nasion plane) (Fig 5). Mean value for AXD angle and A-D' distance was 9.3º and 15.5 mm respectively.

Wits Appraisal of Jaw Disharmony

Jacobson (1975)[3] in order to overcome the inaccuracies of ANB angle, introduced 'Wits' Appraisal (Wits stands for University of the Witswatersrand, Johannesburg, South Africa) which is independent of cranial landmarks. Perpendiculars drawn from points A and B on the maxilla and mandible, respectively, onto the functional occlusal plane denoted as AO and BO respectively and

measuring distance between them (Fig 6). For skeletal Class I, in females, AO and BO should coincide whereas in males, BO is ahead of AO by 1 mm.

Limitations - Wits appraisal uses occlusal plane, which is a dental parameter and can be easily affected by tooth eruption and dental development as well as by orthodontic treatment.[22,23,24] Furthermore, accurate identification of occlusal plane is not always easy or accurately reproducible.[25,26]

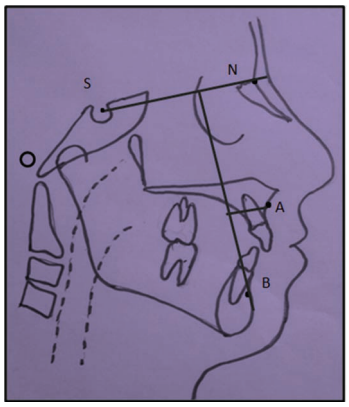

Fig-4 AB' Linear Distance

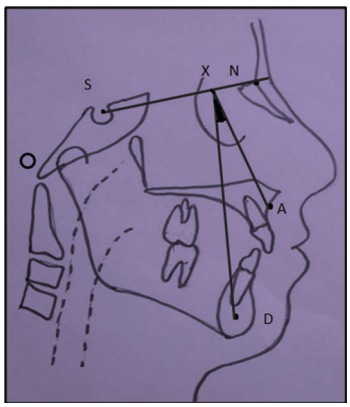

Fig-5 AXD & A-D' Distance

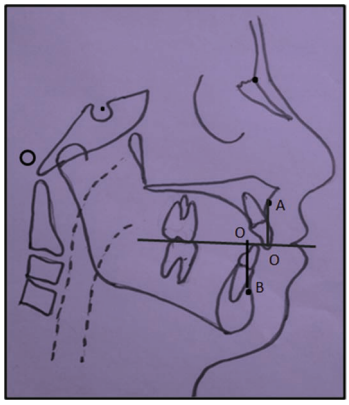

Fig-6 Wits Appraisal

Anteroposterior Dysplasia Indicator (APDI)

Kim and Vieta (1978)5 proposed APDI which is obtained by tabulating facial angle (FH to NPog) ± A-B plane angle (AB to NPog) ± palatal plane angle (ANS-PNS to FH plane) (Fig 7). Mean value was 81.4º, with a standard deviation of 3.79. Lesser values indicate distoocclusion and greater indicates mesio-occlusion.

Freeman's AXB Angle

Freeman (1981)13 introduced AXB Angle- constructed by dropping a perpendicular from point A to FH, establishing point X. A line from points X to B. (Fig 8). Mean of AXB in normal occlusion cases was approximately 4º. A variation of this is to draw perpendicular from point A to SN plane (X-point), giving an angle of 6.5°. He also proposed a simple method of correction of ANB angle by adjusting or modifying the measurements by merely subtracting 1º from the ANB value for every 2º that the SNA reading exceeds 81.5º. Conversely, add 1º to ANB for every 2º that the SNA reading is under 81.5°. This modification over-corrects slightly, so with cases that are more than 10º above or below, the total adjustment should be reduced by 1º; a 1/2º adjustment may be made for 5º difference if desired.

JYD Angle

Seppo Jarvinen (1982)[27] proposed JYD angle, formed by the intersection of lines extending from points J and D to point Y (Fig 9). Point J is the center of the cross-section of the anterior body of maxilla, and point Y is the point of intersection of SN plane and the perpendicular to SN plane from point J. Mean value is 5.25 ± 1.97º. It eliminates use of point A. But, disadvantage is that it is affected by jaw rotation and vertical facial growth.

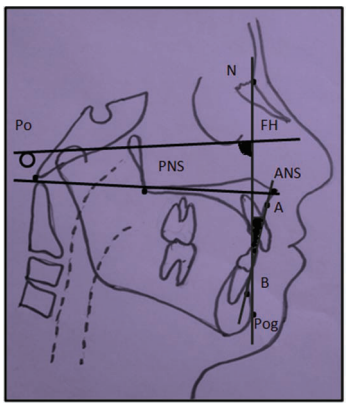

Fig-7 APDI

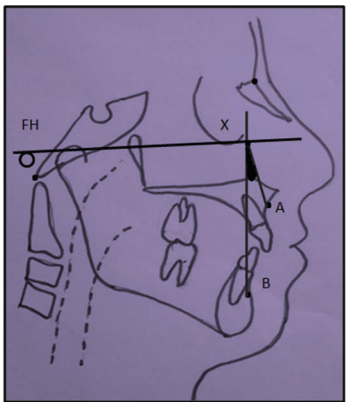

Fig-8 AXB Angle

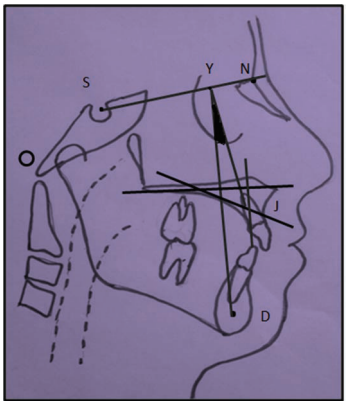

Fig-9 JYD Angle

Quadrilateral Analysis or Proportional Analysis

Rocco di Paolo (1983)[28] proposed quadrilateral analysis based on concept of lower facial proportionality which states that in a balanced facial pattern there is a 1:1 proportionality that exists between the maxillary base length and mandibular base length; also that the average of the anterior lower facial height (ALFH) and posterior lower facial height (PLFH) equals these denture base lengths (Fig 10). Maxillary length = mandibular length = ALFH + PLFH/2 Clinically, the biggest advantage of quadrilateral analysis is that it offers an individualized cephalometric diagnosis (not dependent on established angular or linear norms) on patients with or without skeletal dysplasia. This analysis mainly used in surgical orthodontics.

McNamara's Maxillomandibular Differential

McNamara (1984)[29] introduced differential and was calculated by subtracting effective midfacial length from effective mandibular length. First the effective midfacial length is determined by measuring a line from condylion to point A. Then, the effective mandibular length is derived by constructing a line from condylion to anatomic gnathion (Fig 11). A geometric relationship exists between the effective length of the midface and that of the mandible. Any given effective midfacial length corresponds to a given effective mandibular length. Ideal maxillomandibular differentials are: small-20 mm; medium-25to27 mm and large-30to33 mm.

AF-BF Distance

Chang (1987)[30] described AF-BF distance obtained by projecting perpendiculars from points A and B to the FH plane. (Fig 12). Mean value for male and female were 3.43 ± 2.93 mm & 3.87 ± 2.63 mm respectively. Positive value indicates point AF ahead of point BF; and negative- AF behind of BF. An extension of this analysis is to draw perpendiculars from N to FH plane and measure distances from points A and B to N vertical. The difference between two values should be equal to the AF-BF distance. This value can be affected by inclination of FH plane.

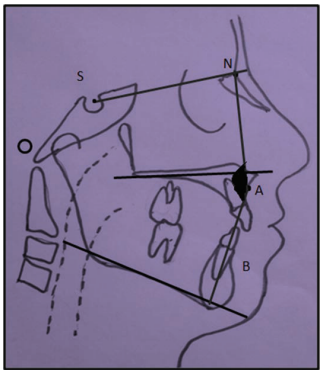

Fig-10 Quadrilateral Analysis

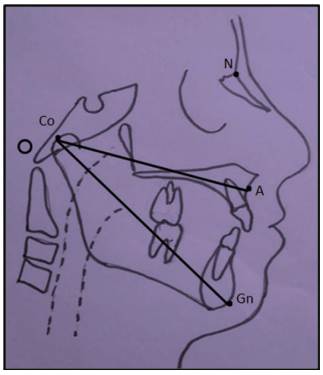

Fig-11 Maxillomandibular Differential

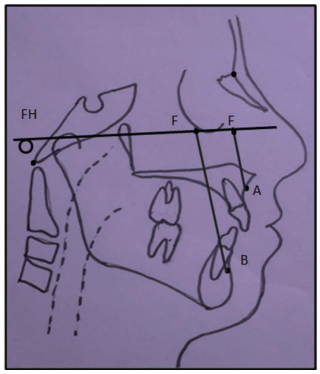

Fig-12 AF-BF Distance

App-Bpp Distance

Nanda and Merril (1994)[31] proposed App-Bpp linear distance measurement based on claimed advantages of palatal plane (Fig 13). This perpendicular projection of points A and B to palatal plane (App-Bpp) averaged 5.2 ± 2.9 mm in white women with normal occlusions compared with 4.8 ± 3.6 mm for white men. It increases in Class II and decreases in Class III.

FH to AB Plane Angle (FABA)

Sang and Suhr (1995)[32] proposed FH to AB angle (Fig 14). Mean value was 80.91 ± 2.53º with range of 10.5º. Values for males and females were not significant. However, from a clinical standpoint, when FABA was compared with AXB angle and AF-BF, it shows more sensitivity to vertical relationship between points A and B.

Beta Angle

Baik and Ververidou (2004)[6] proposed Beta angle to measure sagittal jaw discrepancy. It uses 3 skeletal landmarks- points A, B, and the apparent axis of condyle C- to measure an angle that indicates severity and type of skeletal dysplasia (Fig 15). Beta angle between 27° and 35° have a Class I skeletal pattern; less than 27° indicates skeletal Class II and greater than 34° indicates skeletal Class III. Advantage of Beta angle over ANB and Wits appraisal is that (1) it remains relatively stable even if the jaws are rotated and (2) it can be used in consecutive comparisons throughout orthodontic treatment.

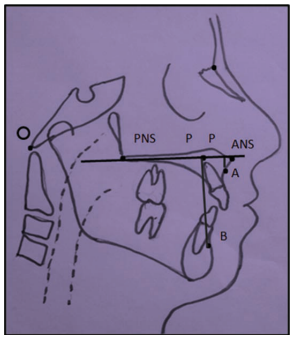

Fig-13 App-Bpp Distance

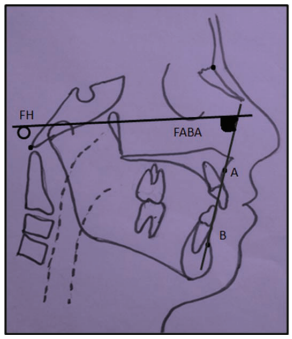

Fig-14 FABA Angle

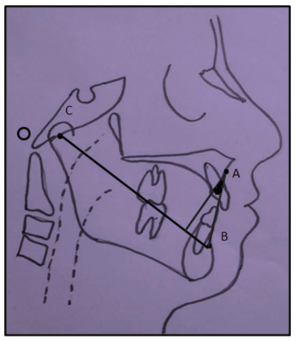

Fig-15 Beta Angle

µ Angle

Fattahi HR (2006)[33] introduced µ angle to assess sagittal jaw relationship with accuracy and reproducibility. This angle uses 3 skeletal landmarks, point A, point B and a perpendicular line from point A to the mandibular plan. (Fig 16). µ angle between 16.1º and 23.9º have a class I skeletal pattern. A more acute µ angle indicates class II skeletal pattern and a more obtuse indicates a class III skeletal pattern.

Overjet as Predictor of Sagittal Dysplasia

Zupancic et al (2008)[34] reported a study to determine whether any correlation exists between overjet value, as measured on study casts, and cephalometric parameters, which evaluate the craniofacial complex in the sagittal plane. Authors concluded that for Class I and III malocclusion, overjet is not a good predictor of sagittal dysplasia; however, for Class II division 1 malocclusion, overjet is a statistically significant predictor.

Yen Angle

Neela et al (2009)[7] introduced Yen angle. It uses 3 reference points: S-midpoint of sella turcica; M-midpoint of premaxilla and G-center of the largest circle that is tangent to the internal inferior, anterior and posterior surfaces of the mandibular symphysis (Fig 17). Mean value of 117 to 123º can be considered a skeletal Class I, less than 117º for skeletal Class II, and greater than 123º as a skeletal Class III. Advantage is that it eliminates the difficulty in locating points A and B, or the functional occlusal plane used in Wits and condyle axis in Beta angle analyses. As it is not influenced by growth changes, it can be used in mixed dentition as well. But, rotation of jaws can mask true sagittal dysplasia here also.

Dentoskeletal Overjet

AL-Hammadi (2011)1 introduced dentoskeletal overjet (Fig 18). This depends on 2 basic principles; first is

dentoalveolar compensation for underlying skeletal base relation; and second is the overjet that remains due to incomplete dentoalveolar compensation as a result of large skeletal discrepancy. Mean value of –1 to +2.5 mm, classified as skeletal Class I, skeletal Class II is more than 2.5 mm, and skeletal Class III is less than –1 mm.

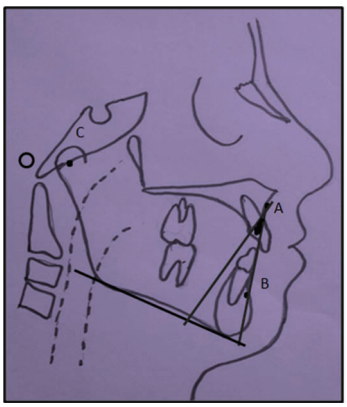

Fig-16 μ Angle

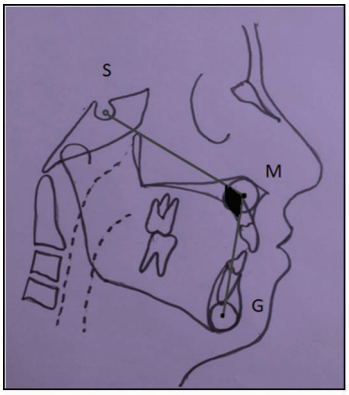

Fig-17 Yen Angle

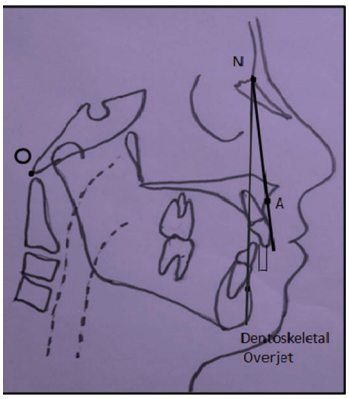

Fig-18 Dentoskeletal Overjet

Pi Analysis (2012)

Kumar S et al (2012)8 introduced Pi analysis . It consists of two variables, Pi-angle and Pi-linear and utilizes the skeletal landmarks G and M points to represent the mandible and maxilla, respectively. A true horizontal line is drawn perpendicular to true vertical through nasion. Perpendiculars are projected from both points to true horizontal giving the Pi-angle (GG'M) and Pi-linear (G'-M') (Fig 19). Mean value of Pi Angle for skeletal Class I, II and III are 3.40 (±2.04), 8.94 (±3.16) and 23.57 (±1.61) degrees respectively. Mean value for Pi-linear (G'–M') is 3.40 (±2.20), 8.90 (±3.56) and 23.30 ± (2.30) mm, respectively for Class I, II and III groups.

W-Angle

Bhad et al (2013)9 introduced W angle. Points S, G and M are used. Angle between a perpendicular line from point M to the S-G line and the M-G line is measured (Fig 20). W angle between 51 and 56° represents Class I skeletal pattern. Value less than 51° represents skeletal Class II pattern and greater than 56° has a skeletal Class III pattern. In females with Class III skeletal pattern, W angle has a mean value of 57.4°, while in males, it is 60.4° and this difference was statistically significant.

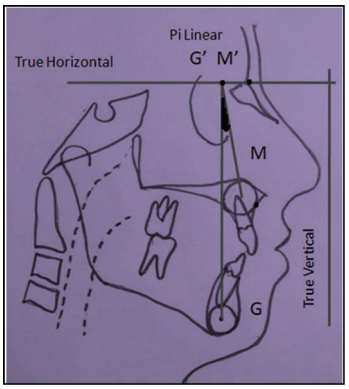

Fig-19 Pi Analysis

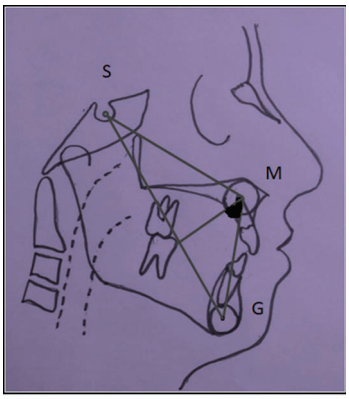

Fig- 20 W Angle

SAR Angle

Agarwal S et al (2014)[35] introduced SAR angle . It uses 3 skeletal reference points: Point M, Point G and Point W (Walkers Point): The mean intersection point of the lower contours of the anterior clinoid processes and contour of the anterior wall of sella turcica. (Fig 21) The SAR angle that is formed between the perpendicular line

from point M to W-G line and the M-G line. Mean value for Skeletal Class I,II &III group were 55.98º (SD 2.24), 50.18º (SD 2.70) and 63.65º (SD 2.25) respectively.

HBN Angle

Dave HB (2015)[36] introduced HBN Angle. 3 skeletal landmarks were used: C (the apparent axis of the condyle), Point M and G (Fig 22) This angle was developed as a diagnostic aid to evaluate the sagittal jaw relationship more consistently. HBN angle 40° and 46° indicates Skeletal Class I, a more acute HBN angle indicates a Class II, and a more obtuse HBN angle indicates a Class III skeletal pattern.

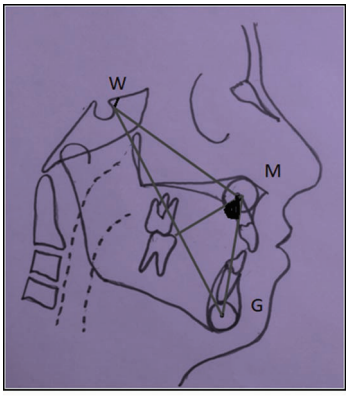

Fig-21 SAR Angle

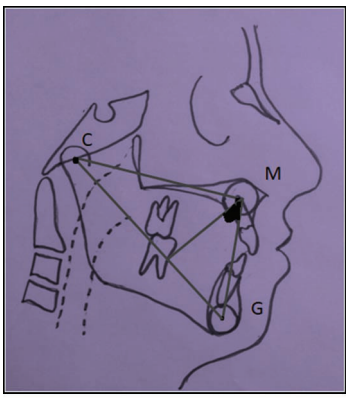

Fig- 22 HBN Angle

DISCUSSION

Inspite of various sagittal dysplasia indicators, ANB angle remains the most widely and routinely used one due to its simplicity and global acceptability. However, it has its own constraints. Wits appraisal is also used frequently.Quadrilateral analysis being individualized, and not dependent on established norms, would be an excellent tool in cases with underlying skeletal discrepancies. Beta angle is claimed to reflect true changes in sagittal dysplasia. But it can be affected by errors in locating points A and B, and clockwise rotation of the jaws. Yen angle and W angle also have same difficulties in locating anatomical points. Pi analysis defines ease of application and does not seem to offer significant advantages. The most recent angles SAR and HBN claim to be most reliable indicator for assessing sagittal jaw discrepancies as they dependent on skeletal landmarks. The best way to diagnosis sagittal jaw discrepancy would be to use composite analyses in each individual case.

CONCLUSION

This review provides a compilation of various parameters used for assessing antero-posterior jaw discrepancy in order to overcome the limitations of each parameters. Due to the large variability in human population, a single cephalometric analysis may not provide an accurate diagnosis. An orthodontist should be aware of a range of cephalometric analyses and instead of relying on any one single parameter,others parameters should also be checked and correlated with clinical findings.

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