

Comparative Assessment of Sagittal Skeletal Discrepancy: A Cephalometric Study

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ABSTRACT

Background and Objectives: Evaluating the sagittal apical base relationship during orthodontic diagnosis and treatment planning is an important step. This study was aimed at comparison of Beta angle, ANB angle and Wits appraisal for assessment of sagittal skeletal discrepancy.

Materials and Methods: Eighty six young adults (43 female and 43 male) were selected from the patient's reporting to Department of Orthodontics, College of Dental Sciences, Davangere, India. Family lineage was studied to know the nativity of Davangere. The standardized pre-treatment lateral cephalogram of the chosen sample was traced. The sample was divided into three skeletal pattern groups: Class I, Class II and Class III, based on the ANB angle and profile, Beta angle was assessed in each group.

Statistical Analysis: The data was subjected to statistical analysis student's t-test, ANOVA test and correlation and regression analysis, using the software namely SPSS Software version 13. Microsoft word and Excel were used to generate graphs and tables.

Results: In the local Davangere population, Class I skeletal pattern group exhibited Beta angle between 26°–34°, Beta angle less than 27° was found in Class II skeletal pattern, and Beta angle greater than 32° was seen Class III skeletal pattern. The coefficient of variation of Beta angle in all the three groups was significantly homogenous compared to ANB angle and Wits appraisal. The correlation and regression analysis of the total sample indicated a highly significant correlation between Beta angle and ANB angle ($p < .001$), and between Beta angle and Wits appraisal ($p < .01$).

Conclusion: Beta angle can be used to classify subjects into different skeletal patterns. The Correlation and regression analysis for the total sample suggests a highly significant relation between Beta angle and ANB angle and, between Beta angle and Wits appraisal. It can be more reliably used to assess sagittal jaw discrepancies than ANB angle and Wits appraisal.

Keywords: ANB angle, Beta angle, Orthodontic diagnosis, Sagittal discrepancies, Skeletal pattern, Wits appraisal

INTRODUCTION

Assessment of anteroposterior jaw relationship is of great clinical importance in diagnosis and treatment planning. The skeletal pattern plays an important role in occlusal development and also imposes limitation to the anteroposterior movement of incisors during treatment [1]. To aid in diagnosing anteroposterior discrepancies, cephalometric analyses have incorporated various angular and linear measurements.

Historically, orthodontists have related both the maxilla and the mandible to reference points in the cranial base of the skull. The first step in evaluating anteroposterior apical base relationship cephalometrically was by Down's description of points A and B [2]. Reidel measured the SNA and SNB angle and used their difference or ANB angle as an expression of dental apical base relationship [3]. Steiner proposed the appraisal of various parts of the skull separately, namely the skeletal, dental and soft tissues. The 'Wits' appraisal was suggested by Jacobson, relates points A and B to the occlusal plane [4]. Beta angle was introduced by Baik and Ververidou, as the angle between the last perpendicular line from point A to the C-B line, and the A-B line. This angle does not depend on any cranial landmarks or dental occlusion [5]. The present study was aimed at comparison of Beta angle, ANB angle and Wits appraisal for assessment of sagittal skeletal discrepancy in the local population.

MATERIALS AND METHODS

Lateral cephalograms of 86 young adults (43 men and 43 women) who reported to the Department of orthodontics, College of Dental Sciences, Davangere, India, were chosen randomly for the study.

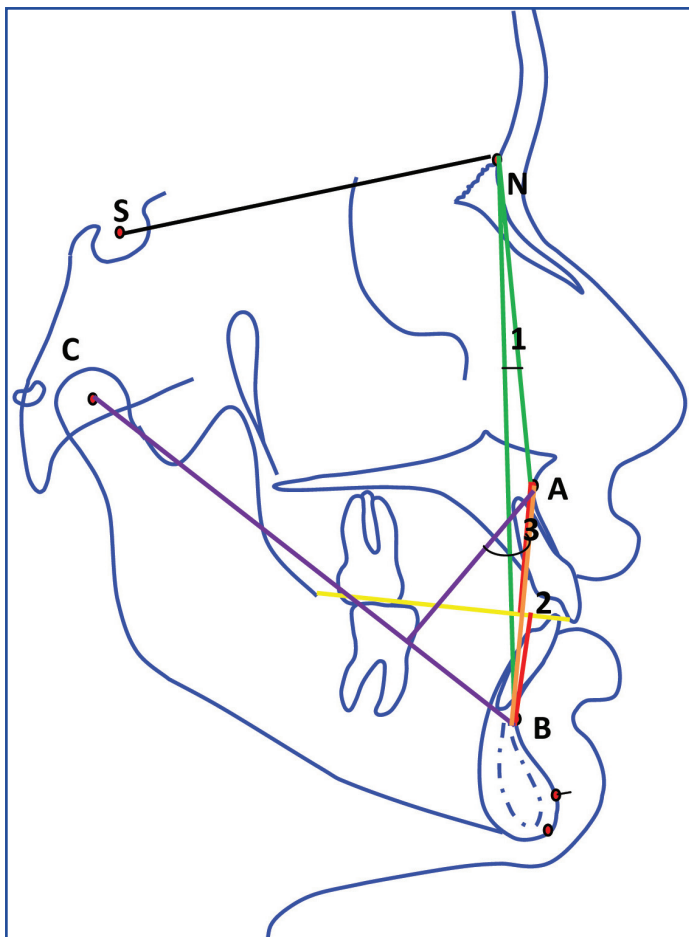
Family lineage was studied to know the nativity of Davangere. Ethical clearance was obtained by the institutional review board to conduct the study. The cephalometric tracing was done by a single investigator on to acetate tracing paper using 0.3mm pencil. Based on ANB angle and patient's profile, sample were divided into Class I skeletal group, Class II skeletal group and Class III skeletal group. The landmarks, planes and angles measured in the study were ANB angle, Wits appraisal and Beta angle.

STATISTICAL ANALYSIS

The data was subjected to statistical analysis student's t-test, ANOVA test and correlation and regression analysis, using the software namely SPSS Software version 13. Microsoft word and Excel were used to generate graphs and tables.

Definition of Landmarks [6-8] [Table/Fig-1]

- Sella (S): The midpoint of the hypophysial fossa.
- Nasion (N): The most anterior point of the frontonasal suture in median plane.
- Anterior nasal spine (ANS): The tip of the bony anterior nasal spine, in median plane.
- Point A: The deepest midline point in the curved bony outline from the base to the alveolar process of the maxilla.
- Point B: The most posterior point in the outer contour of the mandibular alveolar process, in the median plane.
- Gonion (Go): A constructed point, the intersection of the lines tangent to the posterior margin of the ascending ramus and the mandibular base.



[Table/Fig-1]: Cephalometric measurements used in the study
 *Point A, Point B and Point C-Center of condyle
 † 1-ANB Angle, 2-Wit's appraisal, 3-Beta angle

- **Gnathion (Gn):** It is located in the median plane of the mandible, where the anterior curve in the outline of the chin merges into the body of the mandible.
- **Menton (Me):** The most caudal point in the outline of the symphysis.
- **Center of condyle(C):** Found by tracing the head of the condyle and approximating the center.

Angular and Linear Measurements

- **S-N plane:** Line joining points Sella and Nasion.
- **SNA angle:** Angle formed between S-N plane and line joining point N and point A.
- **SNB angle:** Angle formed between S-N plane and line joining point N and point B.
- **ANB:** Angle between point A, N, and point B.
- **Wits:** Distance between the perpendicular projection of A and B on the occlusal plane.
- **Beta angle:** The angle between the last perpendicular line from point A to C- B line and the A-B line.

Assessment of Error

Cephalograms were retraced by the same investigator. To determine the reliability of results, 15 randomly selected radiographs were traced and digitized by the same investigator, after a 20-day interval. Statistically insignificant difference was found between the first and second measurements.

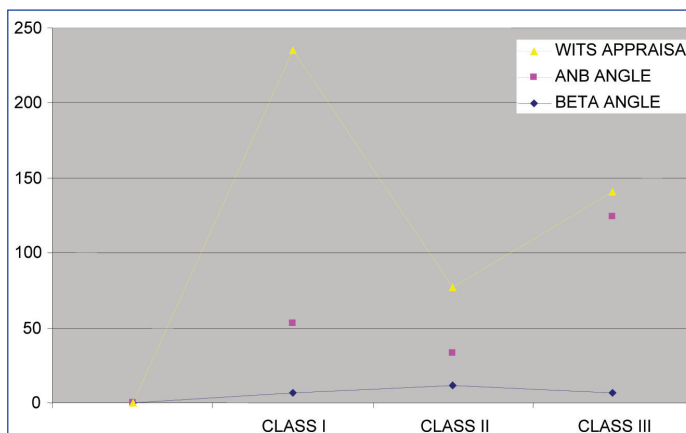
RESULTS

The mean value, standard deviation and range for Beta angle in three groups are shown in [Table/Fig-2]. The ANOVA test showed the three groups were significantly different from each other (F= 233.8,

p<.001) and Beta angle varied significantly in the three groups. The comparison of Beta angle, ANB angle and Wits appraisal was assessed by coefficient of variation suggesting that Beta angle was significantly consistent than the values of ANB angle and Wits appraisal and more reliable as shown in [Table/Fig-3]. The total sample consisting of Group I, Group II and Group III was considered for the correlation and regression analysis as shown in [Table/Fig-4]. The relation between ANB angle and Beta angle was highly significant (r-0.82, p-value ≤0.001). The Coefficient of determination (R²) was 67%. It suggests that proportion of variability in Beta angle accounted for by the ANB angle is 67%. The relation between Wits appraisal and Beta angle was also highly significant (r -0.83, p value <.01) and the coefficient of determination (R²) was 69%. It suggests that proportion of variability in Beta angle accounted for by the Wits appraisal is 69%.

Parameters	Classification	Range	MEAN±SD	C.V. (%)
WITS APPRAISAL (mm)	CLASS I=32	-3-1	-0.8±1.4	182
	CLASS II=34	2-10	4.8±2.1	44
	CLASS III=20	-6--4	-4.8±0.8	17
ANB ANGLE (degrees)	CLASS I=32	1-4	2.5±1.1	46
	CLASS II=34	5-9	6.6±1.4	21
	CLASS III=20	-8--2	-1.6±1.9	117
BETA ANGLE (degrees)	CLASS I=32	27-35	30±2.2	7
	CLASS II=34	17-28	23.1±2.8	12
	CLASS III=20	36-45	38.5±2.6	7

[Table/Fig-2]: Comparison of Mean values, range and C.V. of Wits appraisal, ANB angle and Beta angle in skeletal Class I, II and III.
 ‡ Coefficient of variation C.V. § Standard Deviation SD



[Table/Fig-3]: Comparison of coefficient of variation of Beta angle, ANB angle and Wits appraisal

Groups	Relation Between	Corelation Coefficient r-value	R ²	p-Value
CLASS I	ANB α BETA ANGLE	-0.02	-	0.91 NS
	WITS α BETA ANGLE	0.03	-	0.87 NS
CLASS II	ANB α BETA ANGLE	-0.34	0.12 (12%)	≤0.05 S
	WITS α BETA ANGLE	-0.43	0.19 (19%)	0.05 S
CLASS III	ANB α BETA ANGLE	-0.04	-	0.86 NS
	WITS α BETA ANGLE	0.24	-	0.30 NS
TOTAL (CL I, II & III)	ANB α BETA ANGLE	-0.82	67%	<.001 HS
	WITS α BETA ANGLE	-0.83	69%	<.01 HS

[Table/Fig-4]: Correlation and Regression Analysis

DISCUSSION

The anteroposterior relationship between the maxillary and mandibular dental bases is defined as the dental base relationship. It is also called the skeletal pattern, jaw relationship, or the sagittal apical base relationship. In orthodontic diagnosis, it is important to recognize the sagittal difference between the maxillary and mandibular apical bases as treatment planning aims at normalization of the maxillo-mandibular relationship. Studies have been conducted to assess the reliability and accuracy of these measurements and a need has been found to establish parameters which are accurate, reproducible and independent of cranial base and dental structures [9].

In our study a comparison of Beta angle, ANB angle and Wits appraisal for assessing sagittal relationships has been made, to know the reliability of Beta angle. The parameters compared in present study are similar to Yang and Suhr, who used ANB angle, Wits appraisal and APDI [10]. Also, Ferrario et al., analysed ANB angle, corrected ANB angle, Wits appraisal and MM-Wits [11]. Yang and Suhr evaluated the coefficient of variability in Class I skeletal group to indicate the anteroposterior relationship which is similar to current study in which coefficient of variation has been evaluated for three skeletal groups. Significantly lower values were found by the above authors for ANB angle (4.5%) and Wits (90%) than our study which estimated 46% and 182% for ANB angle and Wits respectively. But, Chang had reported higher values for the coefficient of variability of ANB angle than our study [8].

In the present study, Beta angle, ANB angle and Wits appraisal was compared by coefficient of variation. The coefficient of variation of Beta angle was significantly consistent in all the groups compared to ANB angle and Wits appraisal, suggesting that Beta angle is a reliable measurement.

Jarvinen used regression model between ANB angle and Wits appraisal which is similar to the present study conducted to understand the proportion of variability in Beta angle accounted for ANB angle and Wits appraisal [12]. Likewise, Chandra and Godfrey evaluated relation between ANB angle and Wits appraisal [13]. Jarvinen in 1985 evaluated regression model between ANB angle, SN-GoGn and SNA in all malocclusion groups which resembles the present study [14]. The author found highest coefficient of determination for the Class I group ($R^2=0.671$) and lowest for the Class II group ($R^2=0.311$), while we found no significant relation between ANB angle and Beta angle or between Wits appraisal and Beta angle in the Class I group. In Class II group the relation between ANB angle and Beta angle was significant (p -value ≤ 0.05). The relation between Wits appraisal and Beta angle was also significant (p -value < 0.05). The relation between ANB angle and Beta angle was not significant in Class III group. Also the relation between Wits appraisal and Beta angle was not significant in this group (r 0.24, p -value 0.30).

Sherman et al., analysed that the value of Wits appraisal does not remain stable throughout the growth period [15]. The readings are not entirely dependent upon the relative sagittal movements of points A and B. They also showed that any change in the angulation of the functional occlusal plane may profoundly influence the positions of points A and B relative to that plane, and therefore to the value of the Wits appraisal. The direction and magnitude of any change in the Wits appraisal depends upon the direction of facial growth and treatment mechanics.

Attempts were further made to identify an appropriate reference line by Nanda and Merrill by using palatal plane [6]. The projections from points A and B on the palatal plane (App-Bpp) was found the best indicator of sagittal jaw relationships. Similarly, an absolute measurement of the distance between points A and B projected onto the FH plane was suggested by Chang and termed as AF-BF distance [8]. Hall-Scott in 1994 suggested MM-Wits as a linear distance between the projections of points A and points B on the Bisector of palatal plane to mandibular plane angle [16].

The renewed quest for identifying anteroposterior maxillo-mandibular relationships led Baik and Ververidou to develop Beta angle, which uses 3 skeletal land marks – point A, point B and point C. This angle does not depend on any cranial landmarks or dental occlusion and would be valuable whenever previously established cephalometric measurements, such as the ANB angle and the Wits appraisal, cannot be accurately used because of their dependence on varying factors [8].

Bhad WA et al., introduced W angle to assess the sagittal relationship between maxilla and mandible [17]. Sachdeva k et al., compared ANB angle, Wits appraisal, Beta angle, Yen angle and W angle, to assess the most reliable measurement. They concluded that Beta angle, Yen angle and W angle are significant angles to assess the sagittal jaw relationship between maxilla and mandible [18]. Prasad M et al., established the norms of Beta angle to assess the sagittal discrepancy for Nellore district. They found statistically significant difference for the mean values and the standard deviation for Beta angle within the Class I, Class II and Class III skeletal patterns [19].

Kannan S et al., evaluated the reliability of sagittal methods utilizing FABA, AXD, MM Bisector, Beta angle, JYD angle, AB plane angle, ANB angle, AXB angle, AF- BF and App-Bpp. They suggested that angular methods such as FABA, AXD, Beta angle and linear measurements such as App-Bpp, MM Bisector could demonstrate superiority for assessing anteroposterior jaw relationship over the methods such as AXB, AB plane, ANB angle and AF-BF [20]. Similarly, Bhardwaj P et al., compared and correlated Beta angle with other angular and linear measurements for assessment of sagittal skeletal discrepancy. They also found that correlation between Beta angle and ANB, AFB, AO-BO, AF-BF and App-Bpp demonstrate that with the increase of Beta angle antero-posteriorly skeletal dysplasia decreases significantly [21].

CONCLUSION

The mean value for Beta angle in Class I skeletal group was found to be 30°, with a standard deviation of 2.2 and range of 27°-35°. The mean value for Beta angle in Class II skeletal group was found to be 23.1°, with a standard deviation of 2.8 and range of 17°-28°. The mean value for Beta angle in Class III skeletal group was found to be 38.5°, with a standard deviation of 2.6 and range of 36°-45°. The Coefficient of Variation values of Beta angle are significantly consistent than ANB angle and Wits appraisal suggesting that Beta angle is reliable. The Correlation and regression analysis for the total sample suggests a highly significant relation between Beta angle and ANB angle and, between Beta angle and Wits appraisal. Since, it has been found that Beta angle could assess sagittal discrepancies in the population; it can be used in orthodontic diagnosis and treatment planning in addition to the traditionally used measurements.

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