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Accuracy of beta angle in assessment of sagittal skeletal discrepancy in Chennai population – A cephalometric study

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1. Introduction

Diagnosis and treatment planning in orthodontics and dentofacial orthopaedics have heavily relied on technology. Imaging is one of the most ubiquitous tools used by an orthodontist to measure and record the size and form of the craniofacial structures. Though introduced by Broadbent, cephalometrics might best be ascribed to J.A.W. Van Loon of Holland who described a technique, which related the teeth to the rest of the face, which showed the true picture of the patient's malocclusion. Both angular and linear measurements have been incorporated into the various cephalometric analyses to measure the anteroposterior discrepancies and come to a treatment plan.[1]

The ANB angle though very popular to describe skeletal discrepancies between maxilla and mandible,[2] the displacement of the nasion and rotation of the jaws, as during growth, can change the reading.[3] Some authors have stated that point A and B are influenced by growth or orthodontic treatment.[4–6]

Jacobson's Wits appraisal overcame the ANB angle problem and related point A and B to the occlusal plane. But it may not be accurately reproducible in case of openbite.[7,8] Furthermore, any change in the occlusal plane during normal development or during orthodontic treatment can significantly change the readings.[9,10] Any change in angulation of the functional occlusal plane caused by growth, development of dentition can influence the Wits appraisal.[11,12]

To overcome the limitations and drawbacks of Wits appraisal Baik CY and Ververidou M introduced beta angle as new angular measurement for assessing the skeletal discrepancy between maxilla and mandible in the sagittal plane. This measurement was found to remain constant even with the changes in the position of cranial landmarks, jaw rotations or dental occlusion.[13]

The beta angle has three points and three lines.

The three points are:

(1) A point (subspinale) – the deepest midline point on the premaxilla between the ANS and prosthion (described by Downs).
(2) B point (supramentale) – the most posterior point in the concavity between infradentale and pogonion (described by Downs).
(3) C point – the centre of the condyle, found by tracing the head of the condyle and approximating its centre.

The three lines are:

(1) Line connecting the point C to point B.
(2) Line connecting the point B to point A.
(3) Line perpendicular from point A to line C–B (Fig. 1).

Finally the angle is measured between the perpendicular line and the AB line. Any angle between 27° and 35° has been found to have a Class I skeletal pattern and anything more acute or obtuse had a skeletal Class II or skeletal Class III pattern respectively.

Various authors have done study on beta angle in different populations. There was statistically significant difference found among the mean values of beta angle, as compared to the original study, in a study done in population of Nellore district.[14] There was little change in the mean values of beta angle in the

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different skeletal patterns in North Indian population as well.[15] The beta angle range for Garhwali population also varied from the normal range as proposed by the authors.[16] In a study done in Pakistani population found that the beta angle range was equally reliable and similar to the original study.[17]

There was no study found in the literature about the range of beta angle in population of Chennai district, hence the aim of our present study is to check the accuracy of beta angle in Chennai population.

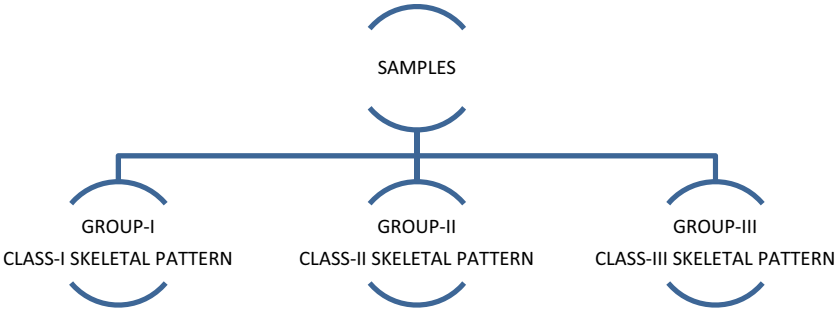
2. Materials and methods

Study was done using the available pre-treatment lateral cephalometric X-rays/cephalograms of patients with malocclusion requiring orthodontic treatment. Patients selected were between the age group of 9–25 years and had not undergone any orthodontic treatment before. 150 lateral cephalograms were evaluated for ANB angle and Wits appraisal. On the basis of the values obtained for ANB angle and Wits appraisal the samples were assigned to one of the three groups: Group I, Group II and Group III.

Group I included patients with Class I skeletal pattern with ANB angle of 1°–3° and Wits appraisal between −3 and 0 mm. Group I consisted of 30 patients (16 males, 14 females).

Group II included patients with Class II skeletal pattern with ANB angle equal to or greater than 4° and Wits appraisal greater than or equal to −1 mm. Group II consisted of 30 patients (13 males, 17 females).

Group III included patients with Class III skeletal pattern with ANB angle less than or equal to 1° and Wits appraisal less than or equal to −4 mm. Group III consisted of 30 patients (15 males, 15 females).



The beta angle was measured for each patient in all the three groups and the mean values were calculated (Fig. 2).

2.1. Statistical analysis

Data collected were summarized by finding means and standard deviations. ANOVA (analysis of variance) test was done to determine the statistically significant difference among the mean values of the three groups. A *P* value less than or equal to 0.05 was considered statistically significant.

3. Results

The values of ANB, Wits appraisal and beta angle for Group I, Group II and Group III patients were listed. The mean value for beta angle in class I patients was found to be 30.9° with a standard deviation of 3.2°. The mean value for beta angle in class II patients was found to be 26° with a standard deviation of 6.4°. The mean value for beta angle in class III patients was found to be 41.7° with standard deviation of 5.4° (Table 1). ANOVA showed that the *P* value is less than 0.05, which shows statistically significant difference between the groups (Table 2). The difference in the mean value of beta angle between males and females showed no statistically significant difference (Table 3) (Fig. 3).

4. Discussion

Accuracy of sagittal relationship plays a very crucial role in orthodontic treatment planning for which both linear and angular measurements have been consistently used. Changes in the facial height, jaw inclination and jaw prognathism can cause an error in the angular measurements whereas inclination of the reference line gives a faulty linear variable. Moyers et al. in his article has categorically stated about the shortcomings of such cephalometric analysis.[1]

The most popular parameter for assessing the sagittal jaw relationship, ANB angle, which is affected by various factors, has shown discrepancies between the interpretation and the actual difference in the apical bases.[4–6] These shortcomings were overcome by the WITS appraisal which though did not depend on the cranial landmarks but had issues with marking the correct occlusal planes especially when it came down to cases with mixed dentition or a case with an open-bite.[7,8]

Chong Yol Baik and Maria Verveidou from the Tufts University in Greece brought in a new concept of beta angle, which was independent of cranial landmarks and the functional occlusal plane. The usage of only Point A, Point B and the apparent axis of the condyle (Point C) made it sure that changes in these points reflected only changes of the jaws. It is also easier for the clinician to trace the head of the condyle. Very precise tracing of the contour of the condyle head is not needed when the centre of the head of the condyle is marked.

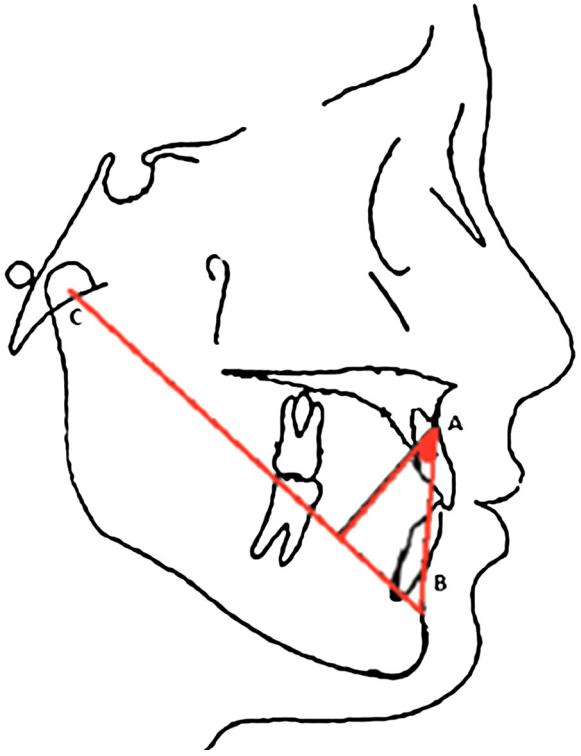


Fig. 1 – Landmarks for the measurement of beta angle.

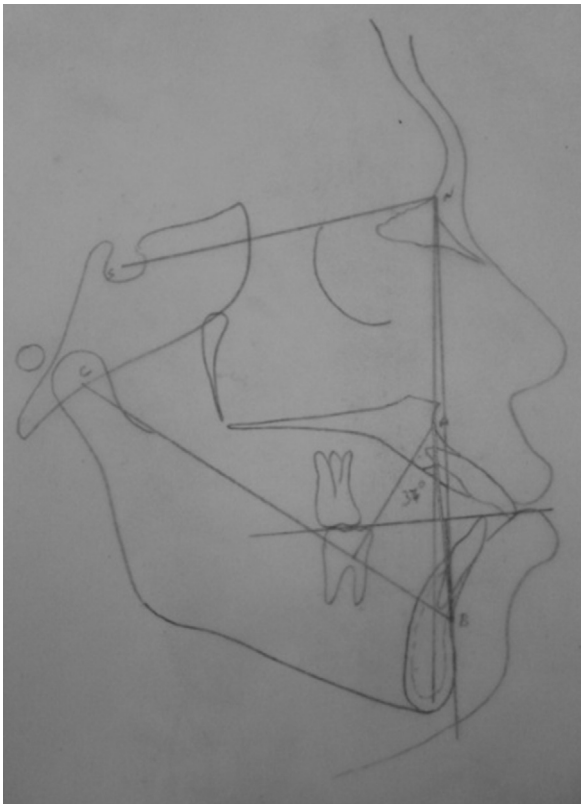


Fig. 2 – Tracing of patient lateral cephalograms.

The beta angle also has the advantage of an unchanged value even after the rotation of the jaws. It also can be used for serial comparisons throughout the treatment, which may be because of growth or orthodontic treatment. It is a valuable tool for surgical planning for patients with sagittal or vertical discrepancies who may need either a camouflage or surgery proper.[13] But the main drawback of beta angle is that it does not tell us about the prognathism or retrognatism of a jaw and needs further cephalometric data to diagnose which skeletal base has abnormal growth.

In the study for White subjects, Baik et al. found that with beta angle between 27° and 35° indicates Class I skeletal pattern, a beta angle less than 27° indicates Class II skeletal pattern and a beta angle more than 34° indicates Class III skeletal pattern.

In our study it was inferred that beta angle between 26° and 36° showed class I skeletal relationship which had a very minimal deviation from the original study done by Baik et al. Singh and Kumar in their study of North Indian population also showed a variation from the original study in values

Table 1 – Beta angle values for different groups.

Groups	ANB angle	Wits appraisal	Beta angle
Group I (Class I)	1°–3°	−3 to 0 mm	30.9° ± 3.2°
Group II (Class II)	≥4°	≥−1	26° ± 6.4°
Group III (Class III)	≤1°	≤−4	41.7° ± 5.4°

Table 2 – ANOVA table showing statistical difference between the groups.

Beta angle	Sum of squares	Degree of freedom	Mean square	*F* value	Sig.
Between groups	2294.200	2	1147.100	102.173	0.001
Within group	415.400	37	11.227		
Total	2709.600	39			

P value is less than 0.05.

Table 3 – Mean values of beta angle between males and females.

Classes	Males	Females
Class I	30.9	31.0
Class II	25.8	26.2
Class III	41.4	40.8

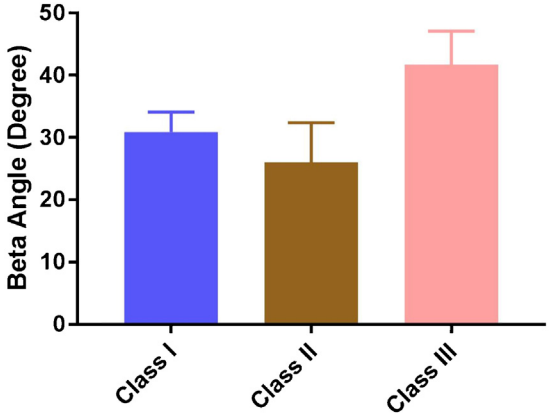


Fig. 3 – Bar diagram showing beta angle values for different groups.

representing Class I skeletal pattern. They found that beta angle for class I patients was between 26° and 37.5°.[15] In a study done for Mysore population, the beta angle for class I skeletal base was found to be 30.9 ± 2.57.[18] The relationship of the beta angle with ANB and WITS appraisal was also compared which showed the inverse relation of beta angle to the other two values.[14]

In our study a more acute angle or less than 26° showed a class II skeletal relationship which is in association with the study done on North Indian population, which also showed mild variation in Class II skeletal pattern as 26° or less.[15] Study done with Garhwali population, beta angle of less than 28° was considered hypodivergent facial pattern.[16] For class II skeletal base the Mysore population showed a beta angle of 23.76° ± 2.86°.[18]

For Class III skeletal pattern Garhwali population showed beta angle greater than 32° considered as hyperdivergent facial pattern.[16] In North Indian population Class III skeletal pattern showed beta angle of more than 37.5°.[15] While the Mysore population showed that values of 39.2° ± 3.82° suggest class III skeletal pattern.[18] In our study beta angle above 36° represented a class III skeletal pattern.

5. Conclusion

Beta angle is quite reliable for assessing the skeletal discrepancies between maxilla and mandible in the sagittal plane. This measurement remains constant even with the changes in the position of cranial landmarks, jaw rotations or dental occlusion. According to our study conducted in Chennai population the beta angle values were slightly different from the original values given for white population. Class I skeletal pattern was found to have beta angle between 26° and 36°, Class II skeletal pattern had beta angle less than 26°, Class III skeletal pattern had angle greater than 36°. These values did not show significant difference from the values in the original study. There was no statistical significant difference between the mean beta angle value for male and female samples.

Conflicts of interest

The authors have none to declare.

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