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RESEARCH ARTICLE

A CEPHALOMETRIC STUDY EVALUATING THE SAGITTAL JAW RELATIONSHIP IN THE BENGALI POPULATION USING THE BETA ANGLE

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ABSTRACT

Background and Objectives: In orthodontic diagnosis and treatment planning, the assessment of anteroposterior (AP) discrepancy is of importance to the orthodontist. Both angular and linear measurements have been incorporated into various cephalometric analyses to help the clinician diagnose AP discrepancies and establish the most appropriate treatment plan. Hence, the present study is designed to establish the norms of beta angle to assess the sagittal discrepancy for Bengali population. **Materials and Methods:** The samples were screened from the records of the patient who visited Orthodontic Department. 254 pretreatment cephalometric radiographs were divided into three groups based upon Angle's Class I, II, III. The three cephalometric parameters ANB angle, Wit's appraisal and Beta angle were compared in each group. A total of 254 subjects were included in the study with the age group between 12 and 18 years old. **Results:** The ANOVA showed that the 3 parameters are not the same, Beta angle is more significant than Wits appraisal followed by ANB. **Conclusion:** The Beta angle was developed as a diagnostic aid to evaluate the sagittal jaw relationship and it is more consistent than Wits appraisal followed by ANB angle. The findings of ANB angle, Wits appraisal and Beta angle was unable to find any variation from the standard values of other populations.

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INTRODUCTION

Accurate planning and a precise diagnosis are crucial for a good orthodontic treatment outcome. In turn, a number of factors influence the proper diagnosis and treatment planning. The assessment of the sagittal connection is one of the important variables. To accurately diagnose antero-posterior discrepancies, cephalometric investigations integrate a variety of angular and linear measures. In quest of a simple and organized way of thinking about the arrangement of teeth in as well as between the dental arches E. H. Angle (1899) (1) put forward the "concept of occlusion". He classified the dental arch relation based on permanent 1st molar in sagittal variations with its impact on facial profile for communicating.

ANB angle is one of the parameters of Steiner's analysis which measures sagittal relationships (2). It is one of the commonly used measurements for analyzing the antero-posterior discrepancy (3). However, over the years the accuracy of this angular measurement has been questioned because of various factors like the position of Nasion, the change in rotation of the jaws due to growth and degree of facial prognathism (4). Jacobson (5) in 1975 realising the limitations of point N being used in references planes, introduced the Wits appraisal, a linear method of measuring the relationship of point A to point B along the functional occlusal plane. Identifying and reproducing the occlusal plane, an important measuring parameter, is a significant challenge . Identifying the occlusal plane is crucial in situations like as multiple impactions, deep curve of Spee , mixed dentition,etc as it impacts the plane's reproducibility (6) . To address these issues, Baik et al. (2004)

developed the Beta angle, an angular measurement. This angle is independent of cranial references and the dental occlusal plane (7). It accurately represents antero-posterior changes without being altered by growth or orthodontic interventions. This angle is effective for analysing changes in sagittal relation before and after therapy. The aim of this study was to establish the norm for Beta angle in Bengali population by comparing it with WITS appraisal keeping ANB angle as the standard and also to determine the range for Cl I, Cl II and Cl III malocclusions for the same.

Figure 1. Taking Lateral cephalogram with Cephalostat

Figure 2. Lateral cephalogram

Figure 3. Materials used for tracing

MATERIAL AND METHODS

Sample Selection: This retrospective cross-sectional study was conducted with the lateral cephalograms of patients who had reported to the department for orthodontic treatment. These lateral cephalograms were obtained from the archives of the Department of Orthodontics, Dr. R. Ahmed Dental College & Hospital, Kolkata, West Bengal after the approval from the scientific board with the following inclusion and exclusion criteria:

Inclusion criteria for patients were

- That of Bengali ancestry
- Aged 12-18 years
- Permanent dentition with no missing teeth except third molars
- Synchronous molar relation and facial profile

Exclusion criteria included patients with

- Previous history of orthodontic treatment;
- Cleft lip and palate, cranial or facial malformation and no history of craniofacial trauma
- Discrepancies in molar relation and its associated profile judged clinically.
- Any asymmetric molar relation.

About 254 samples matched the above criteria and they were divided into Group 1,2 and 3. Group 1 comprised of patients with Class I molar relation and were 110 in number. Group 2 comprised of subjects with Class II molar relation and 106 in number. Group 3 consisted of patients with Class III molar relation and were 38 in number. In this study on Bengali population ethnic homogeneity was achieved by selecting most of the sample from population living outside of the Kolkata metropolitan. The rural area of West Bengal has a stable demographic structure where migration from neighboring regions is low. All the subjects selected were again traced their ancestry to their grandparents.

Methodology

Lateral cephalogram of all the samples were procured from the same X-ray machine (Planmeca Proline XC Dimax3) with teeth in maximum intercuspation and lips in repose. All the lateral cephalograms were traced by a single operator on

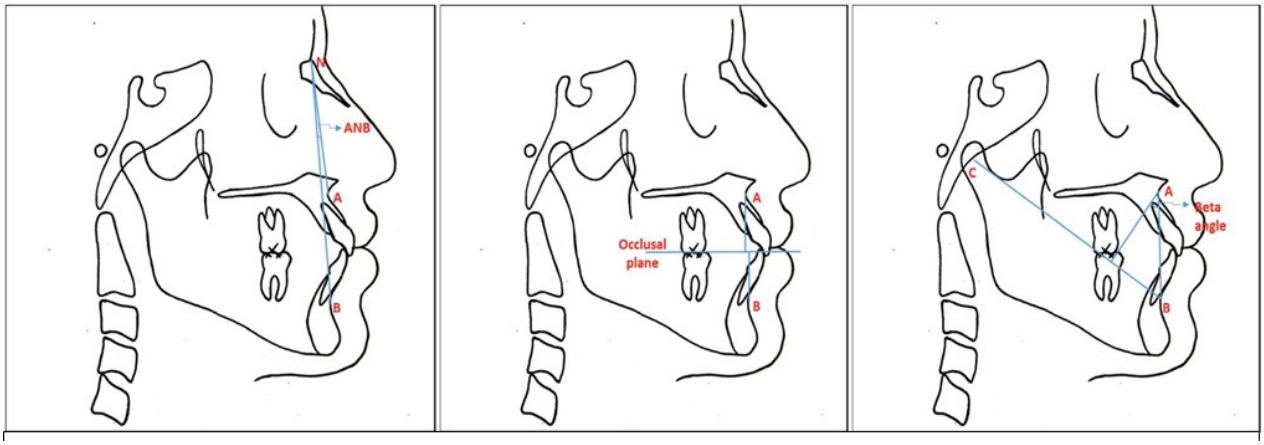

Figure 4. Angular and linear parameters used in the study

	Valid N	Mean	Confidence -95.000%	Confidence +95.000%	Minimum	Maximum	Std.Dev.	Standard Error
ANB	254	3.78150	3.32551	4.23749	-8.0000	13.00000	3.690134	0.231540
Wits Appraisal	254	-0.02165	-0.58756	0.54425	-22.0000	10.00000	4.579612	0.287350
Beta Angle	254	31.29921	30.38958	32.20885	8.0000	56.00000	7.361302	0.461889
	Valid N	**Median**	**Minimum**	**Maximum**	**Lower Quartile**	**Upper Quartile**	**Percentile 10.00000**	**Percentile 90.00000**
ANB	254	4.00000	-8.0000	13.00000	2.00000	6.00000	-2.00000	8.00000
Wits Appraisal	254	0.50000	-22.0000	10.00000	-2.00000	3.00000	-6.00000	5.00000
Beta Angle	254	31.00000	8.0000	56.00000	26.00000	35.00000	23.00000	42.00000

Table 2. Normative data of CL I cohort (n = 110)

	Valid N	Mean	Confidence -95.000%	Confidence +95.000%	Minimum	Maximum	Std.Dev.	Standard Error
ANB	110	3.71364	3.33128	4.09599	-1.00000	8.00000	2.023326	0.192917
Wits Appraisal	110	-0.34091	-0.72550	0.04368	-8.00000	4.00000	2.035163	0.194045
Beta Angle	110	32.77273	32.07350	33.47195	21.00000	41.00000	3.700134	0.352794
	Valid N	**Median**	**Minimum**	**Maximum**	**Lower Quartile**	**Upper Quartile**	**Percentile 10.00000**	**Percentile 90.00000**
ANB	110	4.00000	-1.00000	8.00000	2.00000	5.00000	1.00000	6.00000
Wits Appraisal	110	0.00000	-8.00000	4.00000	-2.00000	1.00000	-2.50000	2.50000
Beta Angle	110	33.00000	21.00000	41.00000	31.00000	35.00000	27.50000	37.25000

Table 3. Normative data of CL II cohort (n = 106)

	Valid N	Mean	Confidence -95.000%	Confidence +95.000%	Minimum	Maximum	Std.Dev.	Standard Error
ANB	106	6.19340	5.74753	6.63926	1.00000	13.00000	2.315137	0.224866
Wits Appraisal	106	3.20755	2.74605	3.66904	-3.00000	10.00000	2.396295	0.232749
Beta Angle	106	25.32075	24.53483	26.10668	8.00000	32.00000	4.080843	0.396367
	Valid N	**Median**	**Minimum**	**Maximum**	**Lower Quartile**	**Upper Quartile**	**Percentile 10.00000**	**Percentile 90.00000**
ANB	106	6.00000	1.00000	13.00000	5.00000	8.00000	3.00000	9.00000
Wits Appraisal	106	3.00000	-3.00000	10.00000	2.00000	5.00000	0.00000	6.00000
Beta Angle	106	26.00000	8.00000	32.00000	23.00000	28.00000	20.00000	30.00000

Table 4. Normative data of CL III cohort (n = 38)

	Valid N	Mean	Confidence -95.000%	Confidence +95.000%	Minimum	Maximum	Std.Dev.	Standard Error
ANB	38	-2.75000	-3.51012	-1.98988	-8.0000	1.50000	2.312568	0.375148
Wits Appraisal	38	-8.10526	-9.48513	-6.72539	-22.0000	-2.00000	4.198066	0.681016
Beta Angle	38	43.71053	42.40041	45.02064	35.0000	56.00000	3.985839	0.646588
	Valid N	**Median**	**Minimum**	**Maximum**	**Lower Quartile**	**Upper Quartile**	**Percentile 10.00000**	**Percentile 90.00000**
ANB	38	-2.25000	-8.0000	1.50000	-4.0000	-1.00000	-6.0000	0.00000
Wits Appraisal	38	-7.00000	-22.0000	-2.00000	-10.0000	-6.00000	-11.0000	-4.00000
Beta Angle	38	43.00000	35.0000	56.00000	42.0000	45.00000	39.0000	50.00000

0.003-inch acetate matte tracing paper using 3H lead pencil in a standardized manner to avoid inter-operator variations. The following measurements to analyse maxillo-mandibular relationship were done on all tracings:

- ANB angle
- Wits' appraisal
- Beta angle

Table 5. One-way ANOVA followed by Newman-Keuls Multiple Comparison Test to determine between which two groups significant difference lies, if ANOVA returns *p* value < 0.05

ANB: One-way analysis of variance					
P value	**< 0.001**	Number of groups	3	F	232.75
Newman-Keuls Multiple Comparison Test		**Mean Diff.**	**q**		**P value**
ANB_CIII v/s ANB_CII		-8.9434	30.506		**P < 0.001**
ANB_CIII v/s ANB_CI		-6.4636	22.154		**P < 0.001**
ANB_CI v/s ANB_CII		-2.4798	11.750		**P < 0.001**
Wits Appraisal: One-way analysis of variance					
P value	**< 0.001**	Number of groups	3	F	264.73
Newman-Keuls Multiple Comparison Test		**Mean Diff.**	**q**		**P value**
Wits Appraisal _CIII v/s Wits Appraisal _CII		-11.313	32.452		**P < 0.001**
Wits Appraisal _CIII v/s Wits Appraisal _CI		-7.7644	22.380		**P < 0.001**
Wits Appraisal _CI v/s Wits Appraisal _CII		-3.5485	14.140		**P < 0.001**
Beta Angle: One-way analysis of variance					
P value	**< 0.001**	Number of groups	3	F	323.89
Newman-Keuls Multiple Comparison Test		**Mean Diff.**	**q**		**P value**
Beta Angle _CII v/s Beta Angle _CIII		-18.390	35.218		**P < 0.001**
Beta Angle _CI v/s Beta Angle _CIII		-10.938	21.048		**P < 0.001**
Beta Angle _CII v/s Beta Angle _CI		-7.4520	19.825		**P < 0.001**

Definition of landmarks

- **Sella (S):** The midpoint of the hypophysial fossa.
- **Nasion (N):** The most anterior point of the frontonasal suture 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.
- **Center of condyle (C):** Found by tracing the head of thecondyle and approximating the center.

Angular and linear measurements

Functional occlusal plane: drawn through the region of overlapping cusps of maxillary first molar and bicuspids.

ANB: Angle between points A, N, and point B

Wits: Distance between the perpendicular projection of A and B on the functional occlusal plane

Beta angle: Angle formed between A-B line and the perpendicular line dropped from point A on line connecting point C and point B.

Result and Analysis

Software used

- Statistica version 6 (Tulsa, Oklahoma: Stat Soft Inc., 2001)
- Graph Pad Prism version 4 (San Diego, California: GraphPad Software Inc., 2005)
- Med Calc version 9.6.2 (Frank Schoonjans, 2008)

In the CL I sample mean values for ANB, Wits appraisal & β-angle are 3.71°, -0.34mm & 32.77° respectively. Median values are 4.00°, 0.00mm and 33° with range from -1° to 8°, -8mm to 4mm and 41° to 21° respectively. Similarly, for CL II sample mean values for ANB, Wits appraisal & β-angle are 6.19°, 3.2mm & 25.32° respectively. Median values are 6.00°, 3.00mm and 26° with range from 1° to 13°, -3mm to 10mm and 32° to 8° respectively. In the CL III sample mean values for ANB, Wits appraisal & βangle are -2.75°, -8.10mm & 43.71° respectively. Median values are -2.25°, -7.00mm, 43° with range from -8° to 1.5°, -22mm to -2mm and 56° to 35° respectively. The ANOVA showed that the 3 parameters are not the same, Beta angle is more significant than Wits appraisal followed by ANB. Then Newman-Keuls Multiple Comparison Test showed it easy to distinguish between CL I from CL III than CL I from CL II.

DISCUSSION

Assessing the sagittal disparity between the upper and lower jaws is crucial for identifying patients who require orthognathic surgery, orthodontic treatment, or both. For this objective, ANB and Wits evaluation are frequently utilised indicators. A more accurate linear or angular measurement is required to accurately assess the anteroposterior discrepancy, as numerous research have shown that ANB and Wits appraisal depend on a variety of parameters. Using point A, point B, and the condyle center, Baik and Ververidou (7) created a novel angle known as the Beta angle, which they utilised to calculate the sagittal jaw relationship. The skeleton class I group's Beta angle value in the current study was 32.77 ± 3.7°, the skeletal class II group's was 25.32 ± 4.08°, and the skeletal class III group's was 43.71 ± 3.98°. These readings were in line with the standards provided by Baik et al. (7) for Caucasian populations. According to the current study, skeletal class II malocclusion was indicated by any beta angle value less than 27°, and skeletal class III malocclusion was indicated by any value larger than 35°. Additionally, Singh et al. (8) determined Beta angle values for populations in north India, and these values matched the standards set by Baik et al. for Caucasians. In a similar vein, Prasad et al. (9) and Kedar MW et al (10) evaluated anteroposterior discrepancy for the Nellore district and Maratha population respectively by examining Beta angle standards. There were no differences between the Nellore district and the Maratha population and Caucasian

norms, however there was a statistically significant difference for beta angle among the three skeletal forms. Roy P et al.(11) found a significant correlation between Beta angle, ANB angle, and Wits appraisal with other sagittal parameters allowing for classification of subjects into different skeletal patterns. Beta angle is more reliable in detecting sagittal jaw discrepancies than Wits appraisal and ANB angle. Beta angle does not use the functional plane and is unaffected by jaw rotations (7) . However, point A and B can be remodelled by orthodontic treatment and growth (12). The analysis of the data showed minor variation in the reading of Beta angle from the work of Baik & Ververidou (7). This variation can be attributed to either sample selection or ethnic variations. These variations are better explained on the basis of sample selection criteria as Baik & Ververidou had first selected sample which were strictly fall in a particular category and excluded those sample which creates confusion. But the present study included samples where ANB and Wits Appraisal disagree with each other's without any bias. Ethnicity is less likely to cause these variations because ANB, Wits appraisal and Beta angle showed measurements of central tendencies fall well within normal values and their range overlap each other.

The Beta angle can be a valuable tool when planning orthognathic surgery for patients with sagittal and vertical skeletal deformities, because it can help to distinguish between true skeletal Class I, Class II, and Class III patterns, as compare to ANB & Wits appraisal, regardless of factors that would tend to camouflage those patterns (13). This would help the clinician to decide whether orthodontic camouflage would be acceptable or whether surgery would be more appropriate. A Beta angle indicating a Class II or Class III skeletal pattern does not determine which jaw is prognathic or retrognathic. If the clinician needs to diagnose which jaw is at fault or whether the deformity is due to the aberrant growth of both the jaws, further cephalometric data are needed. The Beta angle enriches the current cephalometric tools available to the clinician and enables better diagnosis and treatment planning for patients. Any clinician should be aware of as many cephalometric analyses as possible but should use them cautiously, appropriately and substantiated through clinical observations. By relying on a single cephalometric analysis diagnosis might be misleading and treatment planning based on such a diagnosis can be insufficient.

CONCLUSION

The conclusion drawn from this study that all the parameter for assessing the sagittal jaw relationship are not full proof. The Beta angle was developed as a diagnostic aid to evaluate the sagittal jaw relationship and it is more consistent than Wits appraisal followed by ANB angle. Accurate determination of CL I is most difficult as compared to CL II followed by CL III. The findings of ANB angle, Wits appraisal and Beta angle was unable to find any variation from the standard values of other populations.

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