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Mean values of Beta Angle and YEN Angle in Maratha ethnic population and their reliability on select local population: A cephalometric observational study

Kedar M. Wani[1,*], Ravindra Manerikar[2], Sandeep Jethe[3], Sonali Deshmukh[4], Jayesh Rahalkar[5]

[1]PG Student, [2,4]Professor, [3]Assistant Professor, [5]Professor & HOD, Dept. of Orthodontics & Dentofacial Orthopedics, Dr. DY Patil Dental College, Pune, Maharashtra

***Corresponding Author:**
Email: kedarwani777@gmail.com

Abstract
Objective: Different ethnic groups present variations in the various cephalometric analyses that are performed to determine the sagittal relation. This study is aimed at establishing the norms for Beta angle and Yen angle in Maratha population and to evaluate their reliability in sagittal malocclusions from amongst select local population.
Materials and Method: A total of 120 samples were divided into three categories. 60 samples of Class I normal occlusion (30 males and 30 females) were used to establish the norms. 60 samples with skeletal Class II and Class III relation were used for checking the reliability of the established norms. Lateral cephalogram of all the samples was procured and tracings were done to calculate ANB Angle, Wits appraisal, McNamara differential, Beta angle and Yen angle. Oneway ANOVA was done to determine the means of Beta and YEN angle in Maratha population.
Results: The Maratha population norms for Beta angle is 31.5^0 +/- 2.7^0 and for YEN angle is 122.2^0 +/- 2.9^0. The values less than this indicate Class II relation and more than this indicate Class III relation.
Conclusion: The established norms are reliable and comparable with the local population with no significant difference between the genders.

Keywords: Beta angle, YEN angle, Maratha population norms.

Introduction
Significant importance is given to evaluate the anteroposterior maxillomandibular relationship for diagnosing and planning the treatment in orthodontics. Many linear and angular measurements are utilised by the orthodontist to diagnose sagittal discrepancies and create a suitable treatment plan.(1)

Many analyses like Downs, Steiner's, Tweeds, Wits Appraisal, McNamara, etc. used cranial reference plane or occlusal plane as reference planes.(2,3,4,5) Each of these had their own limitations. So, a parameter which does not depend on cranial or occlusal reference planes could be an appropriate aide to diagnose the correct maxillomandibular relation.(6)

Hence, considering these drawbacks the Beta angle was introduced by Baik and Ververidou. Point A, point B, and the apparent axis of the condyle (point C) are the cephalometric landmarks when joined form an angle that determines the amount of sagittal skeletal discrepancy.(1)

Later, YEN angle was developed by Neela P.K. and Mascarenhas R. without taking any reference plane into consideration. It is formed by joining Point S, M which is the midpoint of the anterior maxilla and G which is the center at the bottom of Symphysis.(7)

Since, different ethnic groups may present variations, there is a need to establish the cephalometric norms for Maratha population and also it is necessary to find out if they are comparable with the previously established norms. Thus, this study was done with the purpose of establishing the norms for Beta angle and Yen angle in Maratha population and to evaluate their reliability in sagittal malocclusions from amongst select local population.

Materials and Methods
The study was done in two parts:
- **Part 1:** Sample Size: 60 lateral cephalometric radiographs (30 males and 30 females). This sample consisted of Maratha ethnic individuals, traced back to two generations. Subjects aging 18 years and above with acceptable, pleasing and preferably straight profiles having Class I normal occlusion with normal overjet and overbite with no or minimal crowding or spacing were included for establishment of norms.14
- **Part 2:** Sample size: 60 pretreatment lateral cephalometric radiographs from local population aging 14 years and above.

They were further divided into:
- Group I: 40 lateral cephalograms of Skeletal Class II malocclusion.
- Group II: 20 lateral cephalograms of Skeletal Class III malocclusion.

Patients with history of orthodontic treatment /ongoing orthodontic treatment, medically compromised condition, history of trauma, dentofacial anomaly, TMJ abnormality and missing teeth except third molars were excluded from the study.

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.(14) All the lateral cephalograms were traced by a single operator on 50µm lacquered polyester paper using a 0.3 mm 2H 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
- McNamara differential.
- **Beta angle:** The angle formed between the perpendicular extended from Point A on to line CB and line AB is the beta angle.

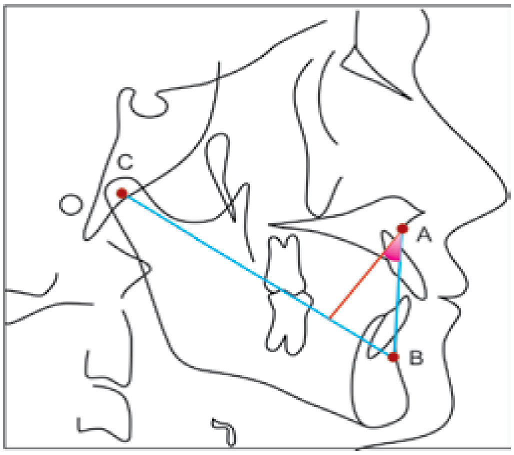


Fig. 1: Beta Angle[8]

YEN angle: Points S, M, and G are connected to form the YEN angle, which is measured at M.

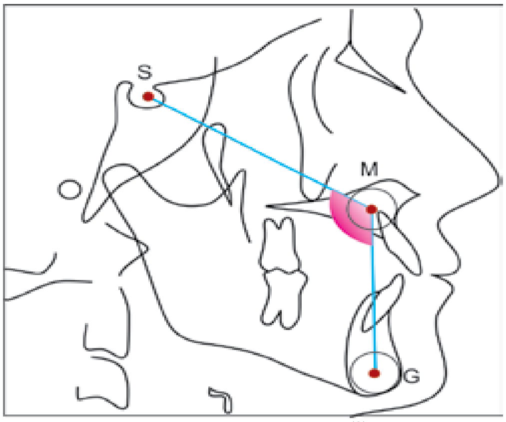
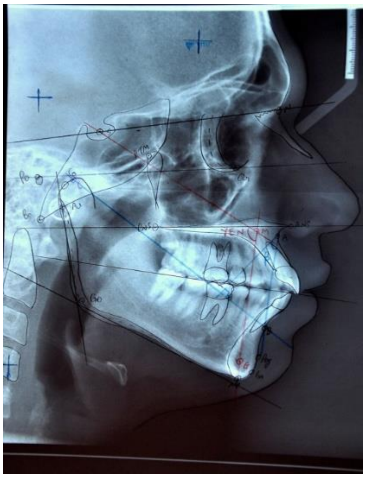


Fig. 2: YEN Angle[8]

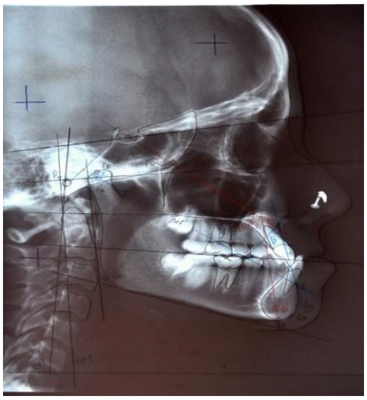


Photograph 1: Class I Sample

Patient Name	Gender	ANB	WITS	Mc. Diff	Beta	YEN
P D	M	2	1	6	31	120

Photograph 2: Class II Sample

Patient Name	Gender	ANB	WITS	Mc. Diff	Beta	YEN
F P	F	5	2	8	27	118



Photograph 3: Class III Sample

Patient Name	Gender	ANB	WITS	Mc. Diff	Beta	YEN
P B	F	-5	-7	-3	43	138

Statistical Analysis: Sample size was calculated by relative prevalence of the groups using the formula n=

$z^2p(1-p)/d^2$.(9) The ANOVA was used to calculate the mean and standard deviation of Beta and YEN angle. Bonnferoni's Post Hoc Analysis was performed to estimate the difference in the means of different groups.

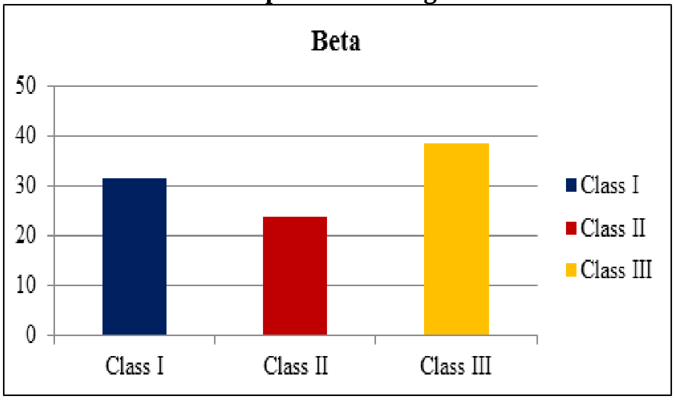
Results

Table 1: Beta Angle

		N	Mean	Std. Deviation	95% Confidence Interval for Mean		F	P value
					Lower Bound	Upper Bound		
Beta	Class I	60	31.50	2.753	30.79	32.21	253.62	<0.001
	Class II	40	24.03	2.057	23.37	24.68		
	Class III	20	38.50	2.065	37.53	39.47		
	Total	120	30.18	5.574	29.17	31.18		

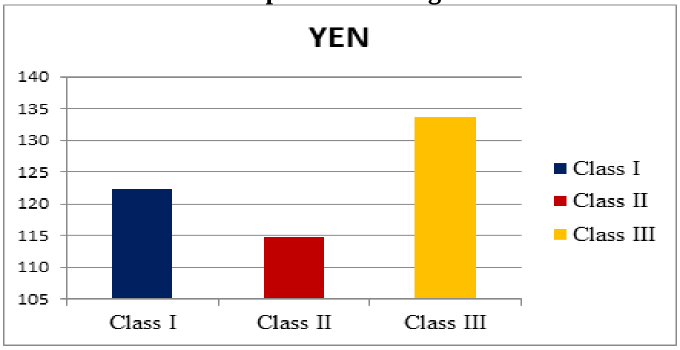
Table 1 shows that mean value of Beta Angle in Maratha population with Class 1 normal occlusion was 31.50^0 with a standard deviation of 2.753^0. The mean value of Beta Angle in select local population having Class II malocclusion was 24.03^0 with a standard deviation of 2.057^0. The mean value of Beta Angle in select local population having Class III malocclusion was 38.50^0 with a standard deviation of 2.065^0.

Graph 1: Beta Angle



This graph represents the mean values of Beta angle in Class I, Class II and Class III malocclusion.

Graph 2: YEN Angle



This graph represents the mean values of YEN angle in Class I, Class II and Class III malocclusion.

Table 2: YEN Angle

		N	Mean	Std. Deviation	95% Confidence Interval for Mean		F	P value
					Lower Bound	Upper Bound		
YEN	Class I	60	122.20	2.922	121.45	122.95	352.6	<0.001
	Class II	40	114.78	2.057	114.12	115.43		
	Class III	20	133.75	2.653	132.51	134.99		
	Total	120	121.65	6.884	120.41	122.89		

Table 2 shows the mean value of YEN Angle in Maratha population with Class 1 normal occlusion was 122.20^0 with a standard deviation of 2.922^0. The mean value of YEN Angle in select local population having Class II malocclusion was 114.78^0 with a standard deviation of 2.057^0. The mean value of YEN Angle in select local population having Class III malocclusion was 133.75^0 with a standard deviation of 2.653^0.

Post HOC Tests for Intergroup Comparison

Table 3: BETA Angle

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	P value	95% Confidence Interval	
					Lower Bound	Upper Bound
Beta	Class I	Class II	7.475*	<.001	6.27	8.68
		Class III	-7.000*	<.001	-8.53	-5.47
	Class II	Class I	-7.475*	<.001	-8.68	-6.27
		Class III	-14.475*	<.001	-16.09	-12.86
	Class III	Class I	7.000*	<.001	5.47	8.53
		Class II	14.475*	<.001	12.86	16.09

Table 4: YEN Angle

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	P value	95% Confidence Interval	
					Lower Bound	Upper Bound
YEN	Class I	Class II	7.425*	<.001	6.13	8.72
		Class III	-11.550*	<.001	-13.19	-9.91
	Class II	Class I	-7.425*	<.001	-8.72	-6.13
		Class III	-18.975*	<.001	-20.72	-17.23
	Class III	Class I	11.550*	<.001	9.91	13.19
		Class II	18.975*	<.001	17.23	20.72

Result

Table 3 and 4 show that there was a statistically significant difference in the values of Beta Angle and YEN angle between each of the three groups that is Class I, Class II and Class III.

Table 5: Difference of means between gender for beta and yen angle norms for class I Maratha population

	Gender	N	Mean	Standard Deviation
Beta	Male	30	31.17	2.937
	Female	30	31.83	2.561
YEN	Male	30	122.67	3.055
	Female	30	121.73	2.753

Table 5 shows the mean value of norms of Beta Angle and YEN Angle between the genders. There is no significant difference between the norms of Males and Females.

Graph 3: Differences in the norms according to gender

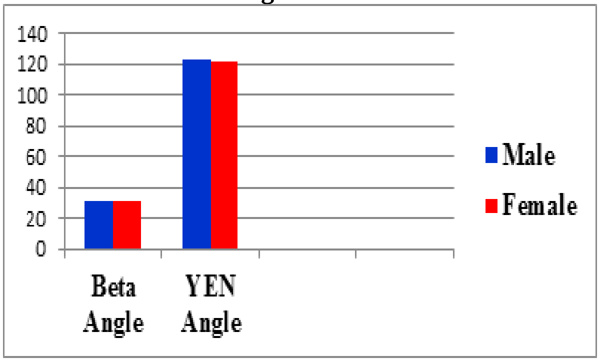


Table 6: Norms of BETA angle and YEN angle in Maratha population

	Beta Angle		YEN Angle	
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Class I	31.50	+/- 2.753	122.20	+/- 2.922
Class II	24.03	+/- 2.057	114.78	+/- 2.057
Class III	38.50	+/- 2.065	133.75	+/- 2.653

Discussion

A precise sagittal measurement for detecting maxillomandibular discrepancies is clinically imperative for accurate diagnosis and appropriate treatment planning. Angular parameters are inaccurate due to changes in facial height, inclination and prognathism of jaws, and total jaw prognathism whereas linear parameters are influenced by the reference plane inclinations.[1,16]

The ANB angle and Wits appraisal of jaw disharmony are the most commonly used parameters to assess the sagittal jaw relationships. The reliability and validity of these measurements has been investigated by many studies. Jacobson showed that the ANB angle does not provide an adequate assessment of jaw relationships because rotational growth of the jaws and the anteroposterior position of nasion influence the ANB angle.[4,17] Roth and Chang showed that the Wits appraisal is affected by the vertical dimensions of the jaws and the occlusal plane inclination.[8,17] Rushton and Cohen deduced that nasion is not used in WITS appraisal instead the occlusal plane is considered. Thus, a dental measurement is used to describe the skeletal relation.[10,18] Hussels and Nanda noticed that the vertical lengths from nasion to point B and from point A to point B also affect the ANB angle.[11]

Baik and Ververidou established Beta angle for assessing the sagittal relation with reproducibility and precision. 76 pre-treatment cephalometric radiographs (35 males, 41 females) were selected and classified into normal Class I relation, skeletal Class II and skeletal Class III relation. The Class II group had a sample of 42 (23 females, 19 males) and Class III group had a sample of 46 (28 females, 18 males). They found out that, the value of Beta angle was from 27^0 to 33^0 for Class 1 skeletal relation while less than 27^0 indicated Class II skeletal relation and more than 33^0 indicated Class III relation. There was no sexual dimorphism observed, which was significant statistically.[1]

In the present study, the Maratha population norms for Class I normal occlusion came out to be at a mean of 31.50^0 with a standard deviation of 2.753^0 which is in resemblance to the study by Baik and Ververidou which had a mean of 31.1^0 with a standard deviation of $2.0^{0.}$ Similarly, the select local population with Class II skeletal relation in the present study had a range of 24.03^0 +/- 2.057^0 which was comparable to the study of Baik and Ververidou having range of 24^0 +/- 3^0. In this study, select local population with Class III skeletal relation had a mean of 38.5^0 with a standard deviation of 2.065^0 in resemblance to the values of Baik and Ververidou which had a mean of 40^0 and standard deviation of 4.2^0. Although there is no significant difference compared with the values of Baik and Ververidou, the severity of Class III malocclusion seemed to be more in their study compared to the present study. This may happen because of ethnic and geographical variations, but further studies are required to prove this.

In a study by Dr. Rajesh Agarwal et al, they compared various angular parameters for evaluating the sagittal relationship in local Jaipur population and showed similar set of results for Beta angle as that achieved in this study which was in concordance with the values of Baik and Ververidou.[12]

This study confirms that values of Beta Angle between the three subgroups are significant statistically ($p < 0.001$). Baik and Ververidou identified that Beta Angle is independent of cranial planes and functional planes thereby remaining stable in presence of jaw rotations. Point A, point B, and the apparent axis of the condyle (point C) are the cephalometric landmarks when joined form Beta Angle. Hence, any variation in measurement reflects deviations in the jaws. Thus, Beta Angle can evaluate the skeletal anteroposterior relationships, even in presence of clockwise or anticlockwise jaw rotation which has a tendency to hide the true sagittal discrepancy. The Beta angle can thus be used in comparing the progress of orthodontic treatment as any alteration in the anteroposterior relationship occurring because of growth or orthodontic/ orthognathic treatment can be consistently measured.

Nevertheless, accurate tracing of the axis of condyle is not easy and because of this some orthodontists may falter in using Beta Angle. Locating the center of condylar axis is more advantageous than locating the condylion point, as used by McNamara,[5] because very precise tracing of the condylar contour is not required. The orthodontist can visually locate Point C with reliability.

Another factor which might affect the validity and reliability of the Beta angle is that it uses point A and point B. These landmarks often change during the course of Orthodontic treatment as remodelling is bound to happen at these points.

Neela P.K. and Mascarenhas R. developed another parameter to evaluate the anteroposterior relationship called the YEN angle in 2009. In this study 75 pretreatment lateral cephalograms were divided into skeletal Class I, II, and III based on Beta angle, ANB angle and WITS appraisal. They found that subjects with YEN angle from 117^0 to 123^0 show skeletal Class I jaw relation. YEN angle < 117^0 represented skeletal Class II jaw relation whereas greater than 123^0 represented Class III skeletal jaw relation.[7]

In the present study, the Maratha population norms for Class I normal occlusion came out to be at a mean of 122.2^0 with a standard deviation of 2.922^0 which is in resemblance to the study by Neela P.K. and Mascarenhas R which had a mean of 120.5^0 with a standard deviation of 2.9^0. Similarly, the select local population with Class II skeletal relation in the present study had a range of 114.78^0 +/- 2.057^0 which was comparable to the study of Neela P.K. and Mascarenhas R which had a mean of 114.26^0 and standard deviation of 3.6^0. In the present study, the select local population with Class III skeletal relation had a mean of 133.75^0 with a standard deviation of 2.653^0 in resemblance to the values of Neela P.K. and Mascarenhas R which had a mean of 129.38^0 and standard deviation of 4.6^0.

Another study by Jigar R. Doshi et al determined the predictability of YEN angle in assessing the sagittal skeletal relationship in Class II malocclusion. They stated that values for YEN angle in class II malocclusion were at par with those of Neela P.K. and Mascarenhas R both of which are in concordance with the present study.[13]

The YEN angle is calculated by joining Point S, M which is the midpoint of the anterior maxilla and G which is the center at the bottom of Symphysis. The construction of points G and M requires dexterity and as they are constructed points there are chances of variability from operator to operator. The orthodontist has to determine the midpoint in premaxilla and the centre of largest circle to the borders of symphysis which becomes difficult to trace. Although Jigar R. Doshi et al in their study concluded that YEN angle is a more reliable measurement done for assessing antero-posterior discrepancy compared to other angular measurements. Additional studies will be necessary to check this finding amongst various population groups.[13]

Due to the large variability in human population, a single cephalometric analysis may not provide an accurate diagnosis. Moreover, cephalometrics has its noticeable limitations as the analyses are based on angular and linear measurements. So, it is imperative that an orthodontist is mindful of a various cephalometric parameters to be implemented appropriately as the need arises.[8]

Thus, banking on any 1 cephalometric parameter which is established years ago, may mislead to inappropriate diagnosis. Hence, multiple analyses should be done and only then the clinician should arrive at a definitive diagnosis and accurate treatment plan can be implemented accordingly. The Beta Angle and YEN Angle are new parameters which can be included in the cephalometric analyses as they are stable and reliable.

This study was done on Maratha ethnics and select local population. Similar studies can be done for different ethnicities and with a larger sample size. In this study, a single operator categorised the samples into Class I, II and III based on ANB angle, WITS appraisal and McNamara differential and the same operator measured the Beta angle and YEN angle. Further work needs to be done to avoid this by blinding two operators in which one will categorise them into Class I, II and III whereas, the other operator will measure the Beta Angle and YEN Angle respectively.

The Maratha population norms for many previous cephalometric parameters have already been established.[14,15] This study is a step forward in accumulation of a set of norms for Maratha population which will include all the commonly used cephalometric parameters and analyses which can be used and referred to do accurate diagnosis and treatment planning.

Conclusion

- The Maratha population norms for Beta angle are 31.5^0 +/- 2.7^0 and for YEN angle is 122.2^0 +/- 2.9^0. The values less than this indicate Class II relation and more than this indicate Class III relation.
- The values for skeletal Class II and Class III relation amongst select local population fall within the range of Maratha population norms suggesting that both the angles are reliable.
- There is no significant difference between males and females for the established norms.

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