Original Article

To cite: Jaina Dubey, Amitabh Kallury, Rajesh Kumar Balani, Chandni Bharti, Chandrika Dubey, Deepika Dhali

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J Contemp Orthod 2020;4(2): 25-32

Received on: 11-05-2020

Accepted on: 21-06-2020

Source of Support: Nil

Conflict of Interest: None

Comparative Assessment of Sagittal Jaw Discrepancies by Various Cephalometric Parameters in Skeletal Class I and Class II Malocclusion among Bhopal Population: A Cephalometric Study

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ABSTRACT

Aim-Purpose of this study is to compare the validity of different cephalometric angles like Beta, Yen, Pi and W angle for evaluating sagittal jaw dysplasia in Skeletal Class I and Class II malocclusion among Bhopal population and to obtain most reliable parameter for orthodontic diagnosis. Material and Method-120 pretreatment lateral cephalograms were selected on the basis of inclusion criteria and were divided into 2 groups (n= 60) i.e. Skeletal Class I and II on the basis of ANB Angle and Wits Appraisal between ages of 16-35 years which further subdivided into Male and Female (n=30). Landmarks were located, traced and analyzed. Results- There was statistically highly significant difference found for cephalometric parameters in Skeletal Class I and Class II Malocclusion. (p=0.001) Mean value of ANB angle was 1.917±1.37 and 6.292±1.27, Wits was -0.742±3.02 and 3.442±2, Beta angle was 31.692±4.41 and 24.125±5.60, Yen angle was 123.28±3.47 and 117.16±4.47, Pi angle was -0.658±3.37 and 4.817±3.14 and W angle was 55.792±2.61 and 52.017±3.34 among Skeletal Class I and II groups respectively. Yen angle (91.67 % & 76.67 %) and Pi angle (90.00 % & 71.67 %) had high sensitivity and specificity to discriminate between Class I & II. Cut off value was ≤ 3for Pi and >119 for Yen angle. Conclusion- Yen Angle is the most accurate and reliable parameter to differentiate between Skeletal Class I and Class II Groups with highest sensitivity and specificity followed by Pi Angle.

Keywords- Sagittal dysplasia, Beta Angle, Yen Angle, Pi Angle, W Angle.

INTRODUCTION

Cephalometric is an essential clinical tool for assessing jaw discrepancies. The sagittal dimension is usually of utmost importance to the orthodontist and needs a critical evaluation.[1] Several parameters (AB Plane Angle, ADPI, AXB Angle, AF-BF etc) were proposed but had obvious shortcomings to assess anteroposterior jaw discrepancies.[2] Wylie was the first to evaluate anteroposterior apical base relationship cephalometrically.[3] Description of point A and point B was given by Down's (1948) to find the apical base discrepancies.[4] SNA, SNB and its difference ANB was used as an expression of dental apical base relationship by Rediel R.[5] Although ANB is most commonly used parameter to assess sagittal jaw discrepancies, several authors have noted its drawbacks.[6] The position of nasion is not fixed when growth is occurring and any change in its position directly affects the ANB angle.[7] ANB related problems were resolved after the introduction of Wits appraisal by Jacobson.[8] However, it had its own limitations. Tooth eruption, dental development and orthodontic intervention could affect the occlusal plane which adversely influenced Wits appraisal.[9] Thus, to overcome these shortcomings, four different angular parameters, namely Beta Angle,[10] Yen Angle,[11] Pi Angle [12] and W Angle [13] were introduced.

The purpose of this study is to compare the validity of different cephalometric angles like Beta, Yen, Pi and W angle for

evaluating sagittal jaw dysplasia in Skeletal Class I and Class II malocclusion among Bhopal population and to obtain the most reliable parameter for the orthodontic diagnosis. Along with correlation of various angles with ANB and Wits Appraisal and compare the sensitivity and specificity of all measured parameters.

MATERIAL AND METHOD

A cross-sectional study was conducted among the patients seeking for orthodontic treatment. Total 689 pre-treatment lateral cephalograms were scrutinized among which 120 lateral cephalograms were selected on the basis of inclusion criteria. These were divided into 2 groups (n= 60) i.e. Skeletal Class I and Skeletal Class II on the basis of ANB Angle and Wits Appraisal between the ages of 16-35 years which further subdivided into 2 sub-groups i.e Male(n = 30) and Female(n=30) .

A) *Inclusion Criteria* - Age between 16- 35 years, Good quality lateral cephalograms from same machine For the Class I Skeletal pattern group- ANB angle = 2-4 degree ,Wits Appraisal: Male = -1mm, Female = 0mm , Angle's Class I molar relationship. For the Class II Skeletal pattern group - ANB angle = greater than 4 degree , Wits appraisal: Male >-1mm, Female > 0mm ,Angle's Class II molar relationship.

B) *Exclusion Criteria* - Unacceptable quality of radiographs , History of orthodontic intervention/ TMJ trauma case ,Facial asymmetry, End on relationship, Missing canine/ molar, Skeletal Class III pattern.

C) *Apparatus and Materials* - High quality Lateral Cephalograms of all patients ,75µm/ 0.003inches Acetate Matte Sheet (Grafix) ,0.35mm lead pencil (Rotring) , 0.40mm Microtip tracing pen (PIGMA MICRONTM 04), Eraser, Metallic scale, Protractor, Transparent template. (Fig.1)

Fig. 1 Materials Used

Data Collection Procedure- All lateral cephalograms were taken on a Planmeca Proline XC Trophy Radiographic Lateral Cephalogram X- ray machine, Italy. All lateral cephalograms were taken in the natural head position (NHP). The radiographs were exposed at 85KV/ 10mA for 1.75 second. X ray source to mid- sagittal plane of patient's head distance was 5 feet (152.4cm). Patient's mid- sagittal plan to film distance was 15cm. All lateral cephalograms were read on 0.003inches lacquered polyester tracing papers i.e acetate matte sheet using 0.35 mm lead pencil under the same illumination. All cephalograms were traced and analyzed by a single operator in a standardized manner to avoid errors due to inter-operator variations. To determine Beta Angle, Yen Angle, Pi Angle and W Angle, Points G and M were located using a transparent template containing number of circles. These landmarks were utilized to represent the maxilla and mandible respectively. Each center was identified by a pinhole in the template.

1. Point M was determined by the center of the largest best fit circle tangent to anterior, superior and palatal surface of premaxilla in each radiograph.
2. Point G was determined by the center of the largest best fit circle tangent to the internal, anterior, inferior and posterior surfaces of mandibular symphysis.
3. A point (subspinale) – deepest midline point on the premaxillae between ANS and prosthion (described by Downs)
4. B point (supramentale) – most posterior point in the concavity between infradentale and pogonion (described by Downs)
5. Center of condyle found by tracing the head of condyle and approximating its center (C)
6. Point S – midpoint of sella turcica
7. Point M – midpoint of premaxilla

Beta Angle (Fig.2), Yen Angle (Fig.3), Pi Angle (Fig.4) and W Angle (Fig.5) were measured for all the subjects in both the groups

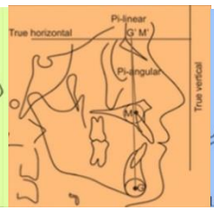


Fig. 2 Beta Angle **Fig. 3** Yen Angle **Fig. 4** Pi Angle

Fig. 5 W Angle

D) Ethical Clearance And Informed Consent- Ethical clearance was received for the study from the Ethics Committee of respective Institute and written consent were taken from all the subjects participating in the present study.

Groups	ANB-Angle		Wits (mm)		Beta-angle		Yen Angle		Pi Angle		W Angle	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Class I (N=60)	1.917	1.37	-0.742	3.02	31.692	4.41	123.28	3.47	-0.658	3.37	55.792	2.61
Class II (N=60)	6.292	1.27	3.442	2.89	24.125	5.60	117.16	4.47	4.817	3.14	52.017	3.34
Student 't' test Value	18.082		7.736		8.216		8.358		9.189		6.887	
Significance 'p' Value	0.001(HS)		0.001(HS)		0.001(HS)		0.001(HS)		0.001(HS)		0.001(HS)	

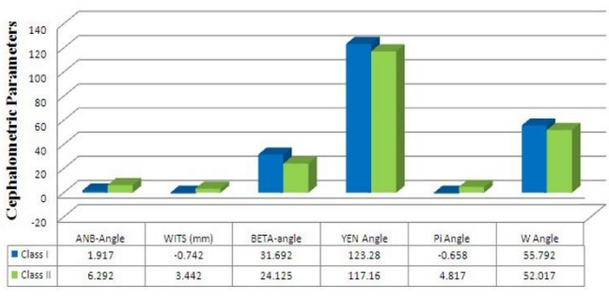
Table 1 - Comparative evaluation of various cephalometric parameters in Skeletal Class I and Class II Malocclusion.

RESULTS

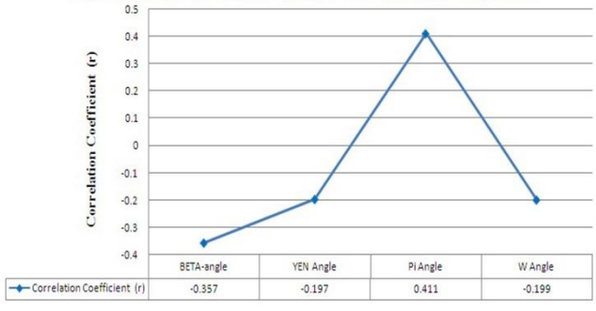
Table 1/Graph 1 reveals comparative evaluation of various cephalometric parameters in Skeletal Class I and Class II Malocclusion. Mean value of ANB angle was 1.917±1.37 and 6.292±1.27 Mean Wits was -0.742±3.02 and 3.442±2.89 mm, Mean Beta angle was 31.692±4.41 and 24.125±5.60, mean Yen angle was 123.28±3.47 and 117.16±4.47, mean Pi angle was -0.658±3.37 and 4.817±3.14 and mean W angle was 55.792±2.61 and 52.017±3.34 among Skeletal Class I and II groups respectively. Mean Pi angle found very less in Class I as compare to Class II groups while all other angles were found significantly higher in Class I as compare to Class II. There was statistically highly significant difference found for cephalometric parameters in Skeletal Class I and Class II Malocclusion. (p=0.001).

Table 2/Graph 2&3 reveals Correlation Coefficient between various cephalometric parameters among Skeletal Class I Malocclusion patients. It shows that ANB angle had significant moderate positive correlation with Pi angle(r=0.411**) while ANB angle had significant moderate negative correlation with Beta angle(r=-0.351**) and ANB had not significant weak negative correlation with Yen angle(r=-0.197) and W angle (r=-0.199). WITS also had significant moderate positive correlation with Pi angle. (r=0.338**)

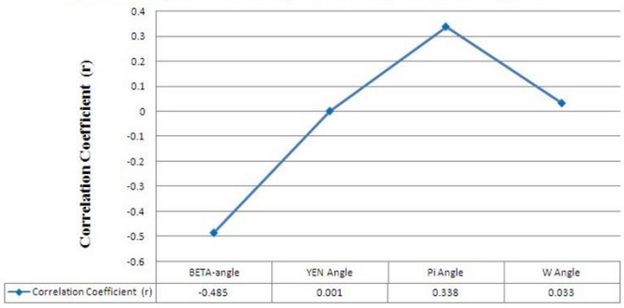
Graph 1: Comparative evaluation of various cephalometric parameters in Skeletal Class I and Class II Malocclusion.



Graph 2 : Correlation Coefficient of ANB angle with various new cephalometric parameters among Skeletal Class I Malocclusion patients.



Graph 3 : Correlation Coefficient of Wits (mm) with various new cephalometric parameters among Skeletal Class I Malocclusion patients.



Graph 4 : Correlation Coefficient of ANB angle with various new cephalometric parameters among Skeletal Class II Malocclusion patients

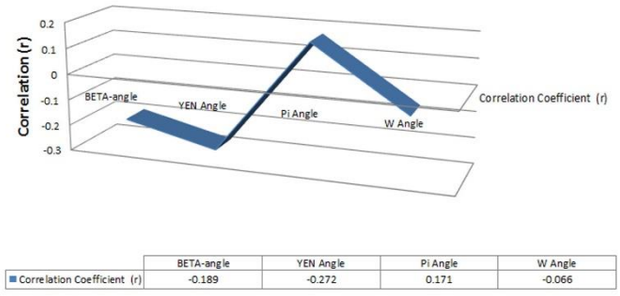


Table 3/Graph 4&5 reveals Correlation Coefficient between various cephalometric parameters among Skeletal Class II Malocclusion patients. It shows that ANB angle had not significant weak but positive correlation with Pi angle(r=0.171) while ANB angle had significant weak negative correlation with Yen angle (r=-0.272*) and ANB had not significant weak negative correlation with Beta angle(r=-0.189) and W angle (r=-0.066). WITS also had significant strong negative correlation with Beta angle. (r=-0.599**) and not significant weak but positive correlation with Pi angle(r=0.203).

Correlation Coefficient		ANB-Angle	WITS (mm)	BETA-angle	YEN Angle	Pi Angle	W Angle
ANB-Angle	Correlation (r)	-	.278*	-.357**	-.197	.411**	-.199
	P-Value	-	.031	.005	.131	.001	.127
WITS (mm)	Correlation (r)		-	-.485**	.001	.338**	.033
	P-Value		-	.000	.994	.008	.804
BETA-angle	Correlation (r)			-	.207	-.254*	.248
	P-Value			-	.112	.050	.056
YEN Angle	Correlation (r)				-	-.148	.820**
	P-Value				-	.260	.000
Pi Angle	Correlation (r)					-	-.071
	P-Value					-	.588
W Angle	Correlation (r)						-
	P-Value						-

Table 2 - reveals Correlation Coefficient between various cephalometric parameters among Skeletal Class I Malocclusion patients.

Graph 5: Correlation Coefficient of Wits(mm) with various new cephalometric parameters among Skeletal Class II Malocclusion patients

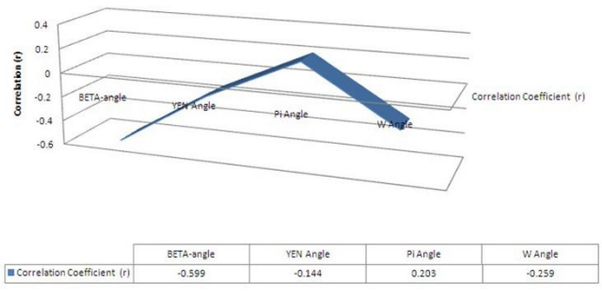


Table 4 reveals Sensitivity and Specificity analysis by Receiver Operating Characteristics (ROC Curve) analysis. ANB angle had 100 % sensitivity and specificity to discriminate between Class I and II. Its cut off value was ≤4 for discrimination. Pi angle and Yen angle had high sensitivity and specificity to discriminate between class I & II and they also comparatively high ROC curve area. AUC is a measure of the overall performance of a diagnostic test and is interpreted as the average value of sensitivity for all possible values of specificity. It can take on any value between 0 and 1. The closer AUC is to 1, the better the overall diagnostic performance of the test. Sensitivity and specificity was 91.67 % & 76.67 % for Yen angle and 90.00 % & 71.67 % for Pi angle respectively. Cut off value was ≤3 for Pi and >119 for Yen angle. Beta & W angle had weak sensitivity and low ROC curve area. The P-value <0.0001 means, there is evidence that the angle does have an ability to distinguish between the two groups.

norms established for evaluating the sagittal jaw discrepancies in different populations, specific to their ethnic and racial groups. Classifying and evaluating the severity of sagittal jaw discrepancy is specifically determined by the normal values of that particular population. Keeping this in mind , the present study is designed to compare the validity of newer angles and to obtain the most reliable parameter for the orthodontic diagnosis. Till date no such norms have been undertaken to establish such norms for Bhopal population.

In the present study, student t Test is performed and highly significant difference was found in ANB, Wits Appraisal, Beta Angle, Yen Angle, Pi Angle and W Angle in both groups showing statistically highly significant difference between Skeletal Class I and Class II Malocclusion for all cephalometric parameters.

In our research, mean value of ANB Angle was 1.917±1.37 and 6.292±1.27 for Skeletal Class I and II patients respectively

Correlation Coefficient		ANB-Angle	WITS (mm)	BETA-angle	YEN Angle	Pi Angle	W Angle
ANB-Angle	Correlation (r)	-	.275*	-.189	-.272*	.171	-.066
	P-Value	-	.034	.148	.036	.191	.617
WITS (mm)	Correlation (r)		-	-.599**	-.144	.203	-.259*
	P-Value		-	.000	.272	.119	.046
BETA-angle	Correlation (r)			-	.114	.137	.428**
	P-Value			-	.387	.295	.001
YEN Angle	Correlation (r)				-	-.216	.584**
	P-Value				-	.097	.000
Pi Angle	Correlation (r)					-	-.008
	P-Value					-	.953
W Angle	Correlation (r)						-
	P-Value						-
*. Correlation is significant at the 0.05 level (2-tailed).							
**. Correlation is significant at the 0.01 level (2-tailed).							

Table 3 - Correlation Coefficient between various cephalometric parameters among Skeletal Class II Malocclusion group.

DISCUSSION

Various cephalometric parameters have been developed and

which shows that ANB values were significant (p=0.00) among both groups that are closer to the values in study done by Mittal et al.[14] (Table-1) However Jacobson [8] claimed that any

change in the SN plane had an effect on ANB. This is also supported by Rotberg et al.[15] who also stated that nasion usually moved in an anterior and slightly superior direction because of the growth increments on the cranial base plan passing through sella and nasion. In our study the Skeletal Class I group shows that ANB Angle had significant moderate positive correlation with Pi Angle(r=0.411**). This result is in accordance with the study by Jain et al.[16] and in contrast with the study by Kumar et al.[12] while ANB Angle had significant moderate negative correlation with Beta Angle (r=-0.351**) which was supported by Bhardwaj et al.,[17] Sharma et al.,[18] Kapadia et al.,[19] and ANB had non significant weak negative correlation with Yen Angle (r=-0.197) which is in accordance with the findings by Mittal et al.,[14] Jain et al.,[16] and W Angle (r=-0.199) Sharma et al.,[18] Kapadia et al.[19]. (Table-2)

In the Skeletal Class II group, it is also found that the ANB Angle had a non significant, weak but positive correlation with Pi Angle (r=0.171). This is supported by the study of Jain et al.[16] and Kumar et al.[12] while ANB Angle had significant weak negative correlation with Yen Angle (r=-0.272*) which is in accordance with the study by Mittal et al.,[14] Jain et al.[16] and non significant weak negative correlation with Beta Angle(r=0.189) which is supported by Bhardwaj et al.17, Sharma et al.[18], Kapadia et al.[19] and W Angle (r=0.066). Sharma et al.,[18] Kapadia et al.,[19] and Parvez et al.[20] (Table-3) Our results show that ANB Angle had 100 % sensitivity and specificity to discriminate between Skeletal Class I and II groups. Its cut off value was ≤4 for discrimination. (Table-4)

Angles	Cut off Value	ROC Curve Area (AUC)	Sensitivity	Specificity	Significance 'p' Value
ANB-Angle	≤4	1.000	100	100	<0.0001
Wits (mm)	≤1.5	0.839	76.67	81.67	<0.0001
Beta-Angle	>29	0.853	75.0	81.67	<0.0001
Yen Angle	>119	0.868	91.67	76.67	<0.0001
Pi Angle	≤3	0.885	90.00	71.67	<0.0001
W Angle	>54	0.831	75.0	81.67	<0.0001

Mean value of Wits Appraisal was 0.742±3.02 and 3.442±2.89 mm in Skeletal Class I and II patients respectively in the current study, which was highly significant (p=0.001) among the both groups. (Table-1) These values are closer to the study by Qamaruddin et al.[21] and in contrast with the results of Moore et al.[2] stated that Wits Appraisal was not influenced by rotations of jaws or landmarks but still had problem in recognizing functional occlusal plane correctly specially in mixed dentition or in cases of apertognathia, multiple impactions, skeletal asymmetries, severe cants, deep curve of spee or missing teeth.

In Skeletal Class I group it was found that Wits Appraisal had significant moderate negative correlation with Beta Angle(r=-0.351**) which is supported with study done by Bhardwaj et al.,[17] Sharma et al.,[18] Kapadia et al.[19] and had significant moderate positive correlation with Pi Angle (r=0.338**) which is in accordance with results of Jain et al.[16] and in contrast with the study conducted by Kumar et al.[12] (Table-2) In Skeletal Class II group Wits had a significant strong negative correlation with Beta Angle. (r=-0.599**) which is in accordance with the study by Bhardwaj et al.,[17] Sharma et al.,[18] Kapadia et al.[19] and non significant weak but positive correlation with Pi Angle (r=0.203) which favours the results of studies done by Jain et al.[16] and Kumar et al.[12] (Table-3)

Beta Angle was introduced by Chong Yol Baik and Marie Ververidou.[10] They uses 3 Skeletal landmarks i.e Points A , Point B and apparent axis of condyle (Point C). The present study shows that mean value of Beta Angle was 31.692±4.41 and 24.125±5.60 in Skeletal Class I and II group respectively which was highly significant (p=0.001) among both groups. (Table-1) Present study values are in accordance with the study conducted by Baik and Ververidou [10] in which mean value of Beta Angle in Skeletal Class I was 31.1±2, Skeletal Class II (24.5±3) and the studies by Qamruddin et al.,[22] Kannan et al.[23] Beta Angle had weak sensitivity and low ROC curve area as stated in (Table-4).

Beta Angle still uses point A and B which has its own limitations. To overcome this, the Yen angle was introduced by Neela et al.[11] which uses the stable skeletal landmarks i.e midpoint of Sella Turcica (S), Premaxilla (M) and Point G.

The concept of Centroid was described in orthodontics by Johnson and Hubbold.[24] It is the centre of an image representing the mean point within the shape, about which it varies and is subject to least variation relative to non mean anatomic points and therefore provides more stable reference points.[24]

The mean value of Yen Angle was 123.28±3.47 and 117.16±4.47 in Skeletal Class I and II patients respectively in the present study, which was highly significant (p=0.001) among the both groups. (Table-1) This result values are closer to the values of study done by Neela et al.,[11] Mittal et al.,[14] Polina et al.,[25] Bohra et al.[26] Yen Angle had high sensitivity and specificity to discriminate between Skeletal Class I and II and it had comparatively high ROC curve area. Yen Angle was highly reliable for differentiating Skeletal Class I and II groups followed by Pi Angle. This result is in accordance with the study by Jain et al.,[16] Qamaruddin et al.,[21] Sachdeva et al.[27] Sensitivity and Specificity were 91.67 % and 76.67 % for Yen Angle and cut off value was >119 for Yen Angle.

The Pi Angle was introduced by Kumar et al.[12] which was independent of cranial reference planes and dental occlusion. Pi angle utilizes the true horizontal, a line perpendicular to true vertical obtained in natural head position (NHP). According to some researchers NHP has been shown to be highly reproducible.[28] Cooke and Wei [29] reported variance of intra-cranial reference planes to the true vertical in NHP ranging between 25º and 36º. In contrast, the variance in NHP was 4º. Analysis based on NHP and true horizontal should be more clinically relevant.[28]

This study shows that mean value of Pi Angle was -0.658±3.37 and 4.817±3.14 in Skeletal Class I and II patients respectively which was highly significant (p=0.001) among both groups. (Table-1) These values are in contrast to the study done by Mittal A et al.,[14] Bohra S et al.,[26] Kumar et al.[12] in which value of Pi Angle in Skeletal Class I was 3.40±2.04 and Skeletal Class II was 8.94±3.16. This is because of racial variation as all the previous studies were conducted in South Indian population. Cephalometric norms may vary in different population and no generalization of these findings is possible.[26]

W Angle was introduced by Bhad et al.[13] as a sagittal skeletal dysplasia indicator. This angle assesses true sagittal changes occurring during growth as well as by orthodontic intervention. W Angle measurement is effective sagittal parameter in Skeletal pattern with clockwise or anti clockwise jaw rotations as well as when the facial growth is occurring vertically.[26] This study shows that mean value of W angle was 55.792±2.61 and 52.017±3.34 in Skeletal Class I and II patients respectively which was highly significant (p=0.001) among both groups. (Table-1) These results are in accordance with the studies by Bhad et al.,[13] Mittal et al.,[14] Jain et al.,[16] Bohra et al.[26]

CONCLUSION

This study concluded that-

1. Yen Angle is the most accurate and reliable parameter to differentiate between Skeletal Class I and Class II Groups with highest sensitivity (91.67 %) and specificity (76.67 %)
2. Pi Angle is the second most reliable parameter having sensitivity and specificity of 90.00% and 71.67 % respectively.
3. Beta Angle and W Angle have weak sensitivity of 75 %.

However there is large variability seen among human populations and a single cephalometric analysis cannot assess the true Skeletal relationship consistently in all situations. Therefore, orthodontist should be aware of a range of cephalometric analyses and use them appropriately in a composite analysis.

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