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A Comparative Evaluation of ANB Angle with other Linear cum Angular Skeletal and Occlusal Parameters in Different Sagittal Dysplasias

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Abstract
Introduction: ANB angle is the most commonly used measurement for assessing sagittal jaw discrepancy, however various new measurements have been introduced recently to overcome some inherent deficiencies associated with ANB angle, so it becomes necessary to compare their reliability and predictability with routinely used methods like ANB angle.
Aims and objectives: To assess the reliability and comparison of ANB angle over other newly introduced linear cum angular skeletal and occlusal cephalometric parameters.
Materials and Methods: A total of 60 lateral cephalograms of class I, class II, class III subjects were selected and traced as per inclusion criteria. ANB angle was measured and compared with other methods and reliability was checked and comparisons were made in each class.
Results: The results showed that there was statistically significant and highly correlated relationship between ANB angle and other parameters used in the study for assessment of sagittal jaw relationship. The angular measurements with most homogenous distribution in the group were FABA angle (CV=5.1) followed by YEN, W-angle, and BETA angle, AF-BF, AXB and ANB angle. In linear measurements, most homogenously distributed was APP-BPP distance (CV=101.9) and measurements with least homogenous distribution was the Wits Appraisal (CV=-1142.9).
Conclusion: ANB angle is the most commonly used parameter for assessing sagittal dysplasia, however ANB angle is affected by several environmental factors and thus a diagnosis based on this angle may give false results. No single measurement is perfect in all the cases. Therefore a number of different measurements should be used in combination to diagnose the actual sagittal skeletal discrepancy.

Keywords: ANB angle, sagittal malocclusion, cephalometrics.

1. Introduction
The evaluation of sagittal jaw relationship between maxilla and mandible has been one of the major problems in the field of orthodontics, which is of prime importance in diagnosis and treatment planning. This is because of rotations of jaws during growth, vertical relationships between the jaws and reference planes, and a lack of validity of the various methods proposed for their evaluation and appropriate treatment plan. The sagittal relationship is usually of utmost concern to the patient and needs a critical evaluation. Previously established parameters such as ANB angle, Wits analysis, AF-BF, APDI, Beta angle, Yen angle, W angle and the recently introduced Pi analysis have been defined and used effectively for evaluation of anteroposterior dysplasia affecting the apical bases of jaws. These analyses have both advantages and inaccuracies associated with their use which needs to be understood. Therefore it was necessary to compare the predictability of mostly routinely used ANB angle with other sagittal jaw indicators. [1-9]

2. Aims and objectives
- To assess and compare the predictability of ANB angle over other newly introduced skeletal and occlusal cephalometric parameters for assessing sagittal jaw discrepancy in different skeletal malocclusion groups.
- To determine the level of agreement between ANB angle and other methods.

- To evaluate which of the criteria is more reliable for clinicians.

3. Materials and Methods

A total of 60 lateral cephalometric radiographs of Class I, Class II and Class III subjects were selected and traced as per the inclusion criteria who had to undergo orthodontic treatment at the Department of Orthodontics Government Dental College and Hospital Srinagar, Kashmir. All cephalograms were taken with patients in standing position with teeth in centric occlusion and lips relaxed. All the cephalograms were taken using the same x-ray machine and a standard technique. The machine used was NewTom Giana NNT. No corrections for enlargement were made in the lateral cephalograms as all the cephalograms were taken using the same machine and the same operator. All the films were exposed with 64 KVp, 8 mA and an exposure time of 0.9 seconds. All the cephalograms were traced on a standard acetate paper of 8”x10 inch size and 0.003”inch thickness by a standard technique using a soft 3H pencil using a view box. Tracings were done in a darkened room with no additional light. All the tracings were done by a single observer. Reproducibility was checked by retracing a random 10% segment of the original sample after a gap of 3 weeks with 0.5 mm linear ad 0.5 degree angular correction.

3.1 Inclusion criteria

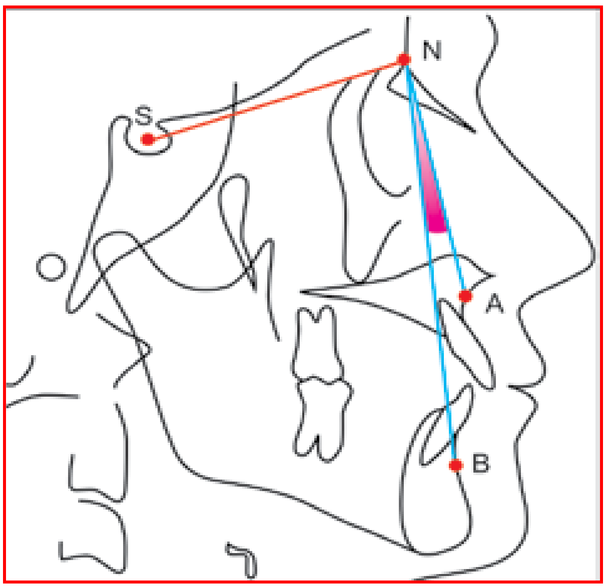
- Patients with different types of skeletal malocclusions.
- Patients not more than 30 years of age.
- Complete eruption of the all the permanent teeth.
- Patients who are undergoing orthodontic treatment.
- The radiographs had to be of high quality and sharpness.
- All the radiographs to be taken by the same operator and in the natural head position.

3.2 Exclusion Criteria

- Patients with craniofacial anomalies and syndromes.
- Cleft lip and cleft palate patients.
- Cases with congenitally missing teeth.
- X-Ray scans showing supernumerary teeth, enlarged/cystic follicle, or any other pathology.
- History of facial trauma

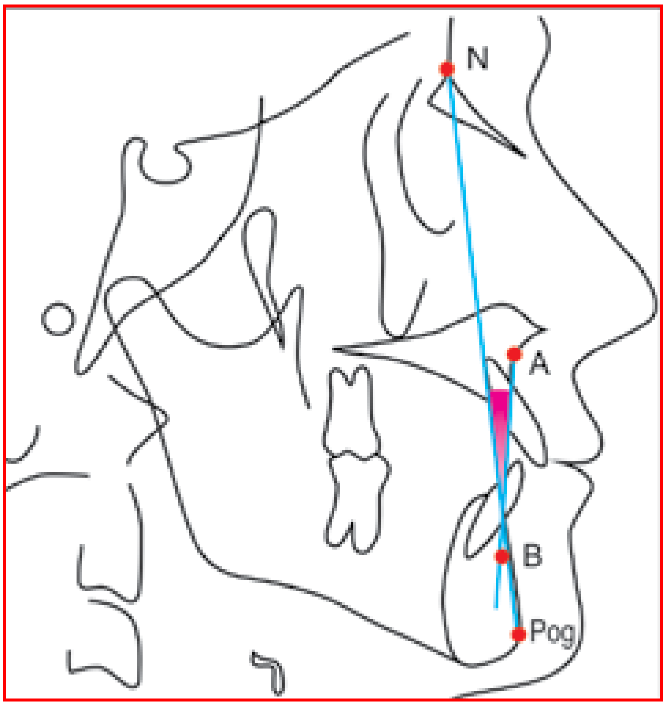
3.3 Parameters defined

Angular measurements



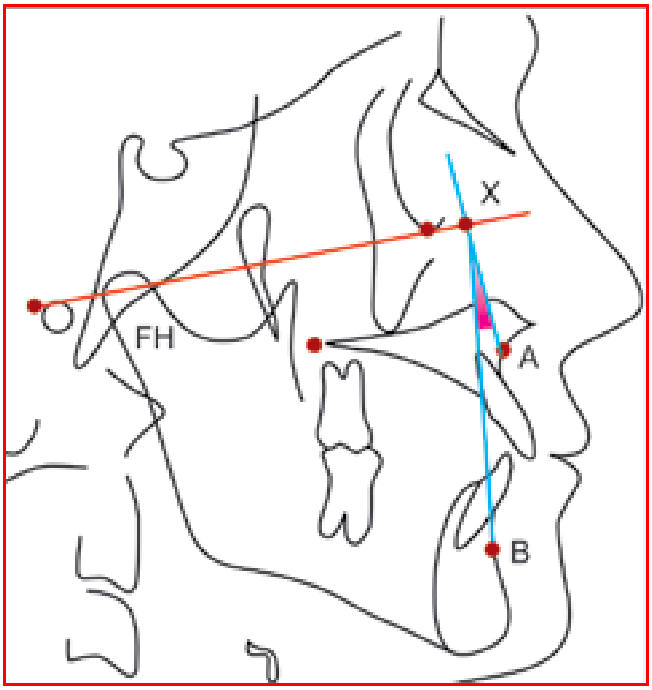
ANB angle

Riedel (1952) measured the SNA & SNB angles and used their difference (ANB) as an expression of dental apical base relationship. The angle ranges from 2-4 degrees with a range of 0-4 degrees. [11]



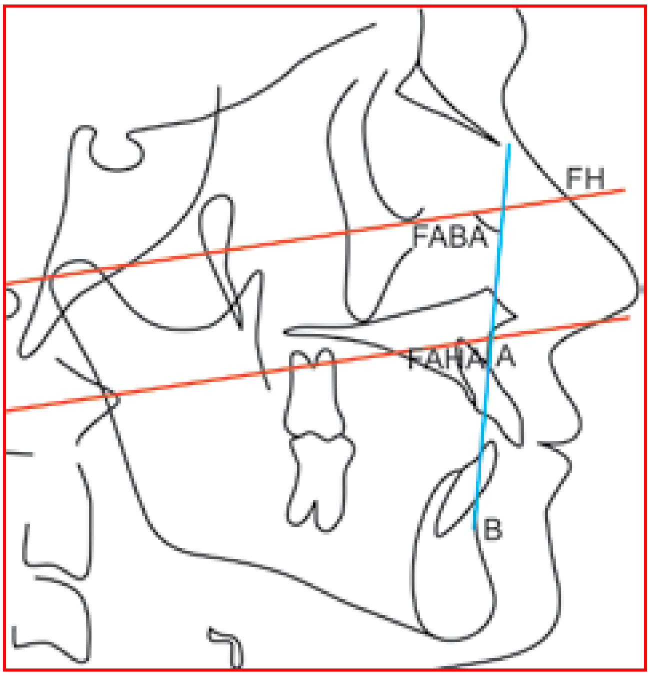
A-B plane angle

The AB plane to the facial plane to assess the relationship of the anterior limit of the denture bases to the facial profile. The range of AB plane to the facial plane was found to be 0° to a posterior position of point B that could be read as −9°. The mean for this angle is 4.6 degrees. The normal range is −8.5 to+10°. [10]



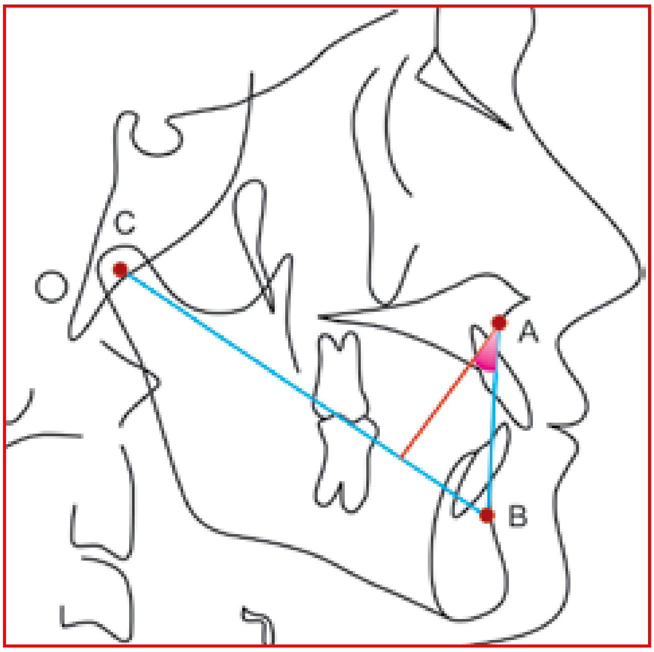
AXB angle

Freeman described AXB angle by eliminating the point N. Instead of using point N, a perpendicular is constructed from point A to Frankfurt Horizontal plane and named a point X. A line from point X to point B forms AXB angle. The mean value for AXB angle is 4°. [12]



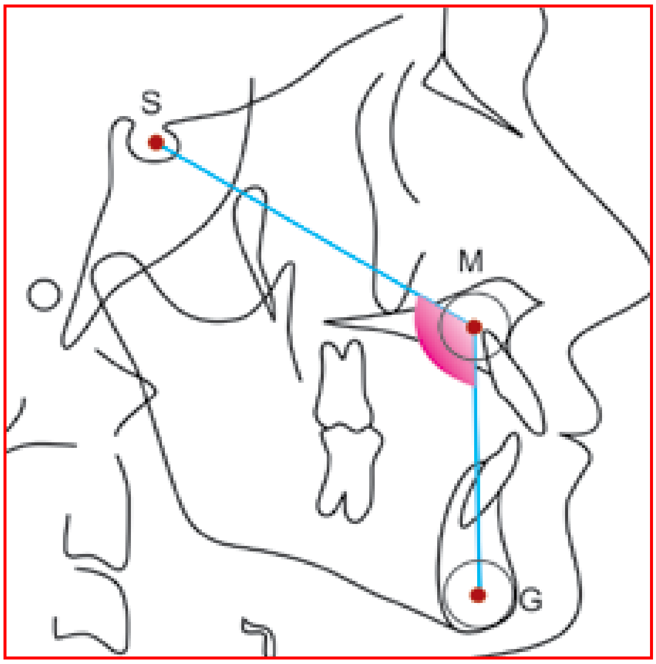
FABA angle

Yang and Suhr described FH to AB plane angle to measure sagittal discrepancies of jaws. In this, from points A and B a line is drawn to FH plane, and the inner angle is FABA. Mean value of this angle was 80.91± 2.53° with the range of ±10.5°.[13]



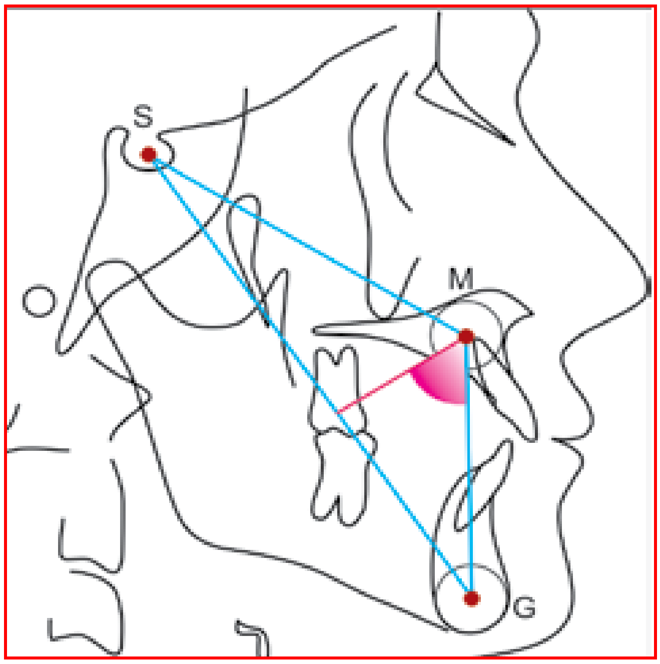
Beta angle

Baik and Ververidou (2004) proposed the Beta angle. It uses three skeletal landmarks- point A, B and apparent axis of the condyle C- to measure an angle that indicates the severity and type of skeletal dysplasia in the sagittal dimension. Beta angle between 27^0 and 35^0 indicates class I skeletal pattern; Beta angle less than 27^0 indicates a class II skeletal pattern, and a Beta angle more than 34^0 indicates class III skeletal pattern.[14]



Yen angle

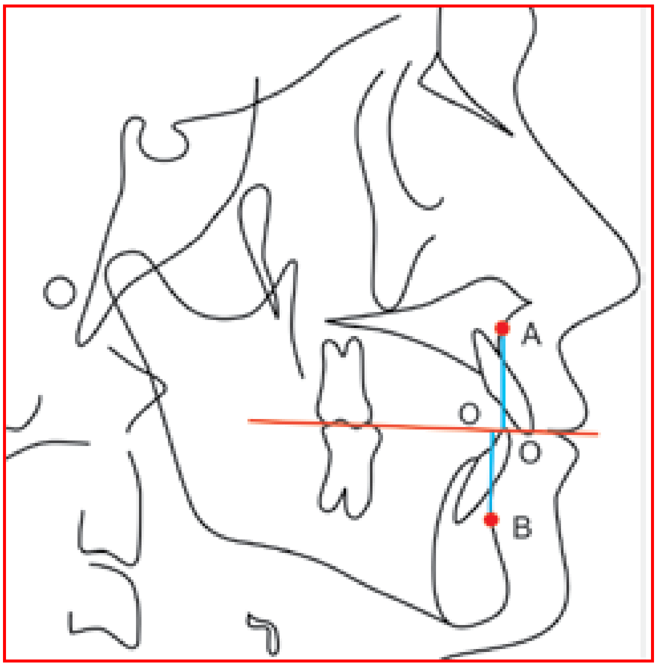
Neela et.al (2009) developed the Yen angle. It uses the landmarks: Points S (mid-point of sella turcica), M (midpoint of the anterior maxilla) and G (center of the bottom of the mandibular symphysis). YEN angle value of 117° to 123° indicated a skeletal Class I pattern. More acute value denotes skeletal Class II and more obtuse values denote Class III. [15]



W angle

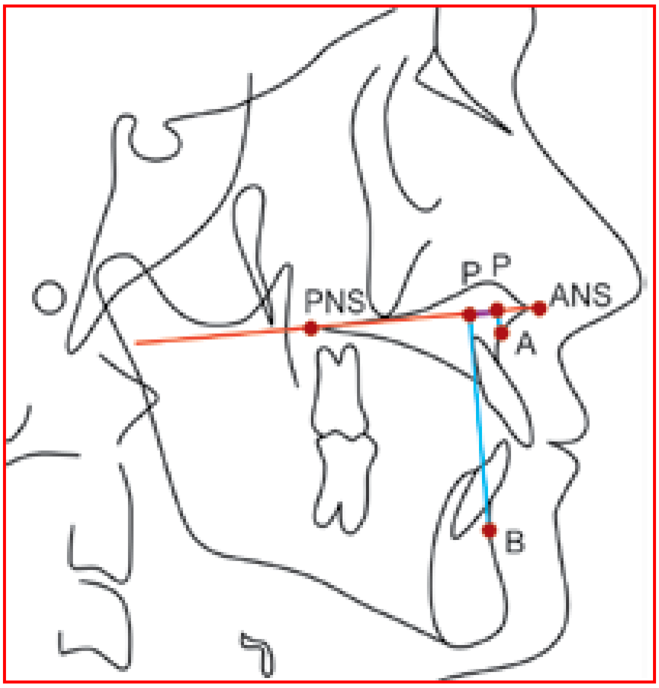
Bhad *et al.* (2013) developed W-angle. This angle uses three skeletal landmarks – point S, point M, and point G – to measure an angle that indicates the severity and the type of skeletal dysplasia in the sagittal dimension. This angle showed that a patient with a W angle between 51 and 56° can be considered to have a Class I skeletal pattern. With an angle <51°, patients are considered to have a skeletal Class II relationship and with an angle >56°, patients have a skeletal Class III relationship. [16]

Linear measurements



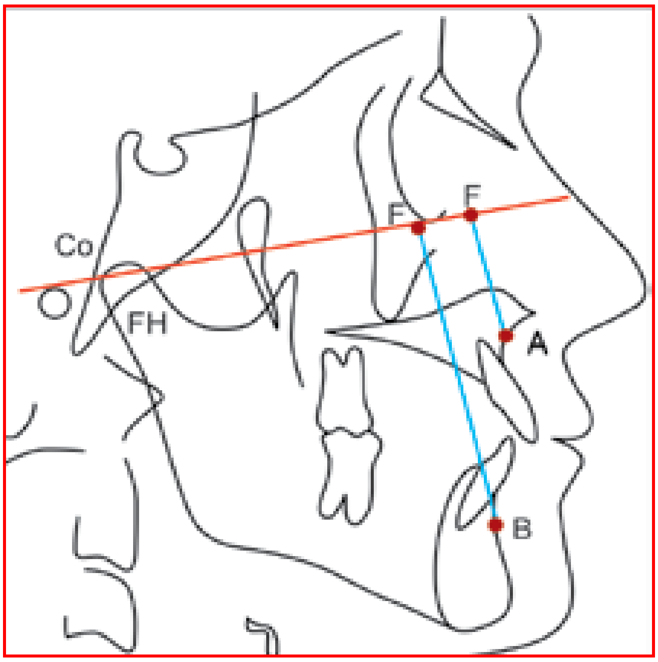
Wits appraisal

Jacobson studied “Wits” appraisal of jaw disharmony in which the point of contact of the perpendiculars onto the occlusal plane were labeled as AO and BO and the results showed that, in females points AO and BO coincided and in males point BO was located 1mm ahead of point AO. In Class II skeletal dysplasias, point BO would be positioned behind point AO whereas in Class III skeletal jaw disharmonies point BO was ahead of the point AO. [17]



APP-BPP distance

In this, a perpendicular line is drawn from point A and point B to the palatal plane i.e. APP-BPP. The mean value for white women was 5.2 ± 2.9 mm and for white men was 4.8 ± 3.6 mm. The increased values showed Class II and decreased values showed Class III skeletal patterns. [18]



AF-BF distance

Chang16 (1987) described a method for assessing sagittal discrepancy of jaws by taking perpendiculars from point A and point B to the FH plane. The mean value for males was 3.87 ± 2.93 mm, whereas for females 3.87 ± 2.63 mm. any deviations from this i.e. above or below this value would give positive and negative values. [19]

3.4 Statistical analysis

Statistical package SPSS (Version 20.0) was used to carry out the statistical analysis of data. The statistical analysis of data was carried by applying descriptive statistics viz. percentages, means and standard deviations. Data was presented by pie diagram. Relationships of the data were studied by applying Chi-square or Fisher’s exact test. A P-value of less than 0.05 was considered statistically significant as shown in the Correlation matrix table (1) below.

4. Results

The results showed that there was statistically significant and highly correlated relationship between ANB angle and other parameters used in the study for assessment of sagittal jaw relationship. The angular measurements with most homogenous distribution in the group were FABA angle (CV=5.1) followed by YEN, W-angle, and BETA angle, AF-BF, AXB and ANB. In linear measurements, most homogenously distributed was APP-BPP distance (CV=101.9) and measurements with least homogenous distribution was the Wits Appraisal (CV=-1142.9). Statistically significant correlations were found among ten sagittal parameters with p-value < 0.001. The correlation was very strong between FABA and AF-BF (r=0.931). Moreover, strong correlations existed between FABA angle and AXB (r=0.924), ANB angle and A-B plane angle(r=0.909). Lowest significant positive correlation was present between Wits and W-angle (r = 0.603) followed by Wits and APP-BPP (r= 0.652). When angular and linear parameters were compared, high significant positive correlation was found between FABA angle and AF-BF distance (r = 0.931). FABA had the lowest coefficient of variability among the cephalometric parameters measured (CV= 5.1), indicating that it was the most homogenously distributed parameter. In order to analyze the data, within the entire sample, class strata of ANB angle, AB plane angle, Wits, AXB angle, FABA angle, AF-BF distance, APP-BPP distance, beta angle, YEN angle and W-angle angle were defined. The assessments of sagittal jaw relationship, by these different methods of analyses, showed the differences in distribution of cases in each skeletal class as shown in graph below (fig 1)

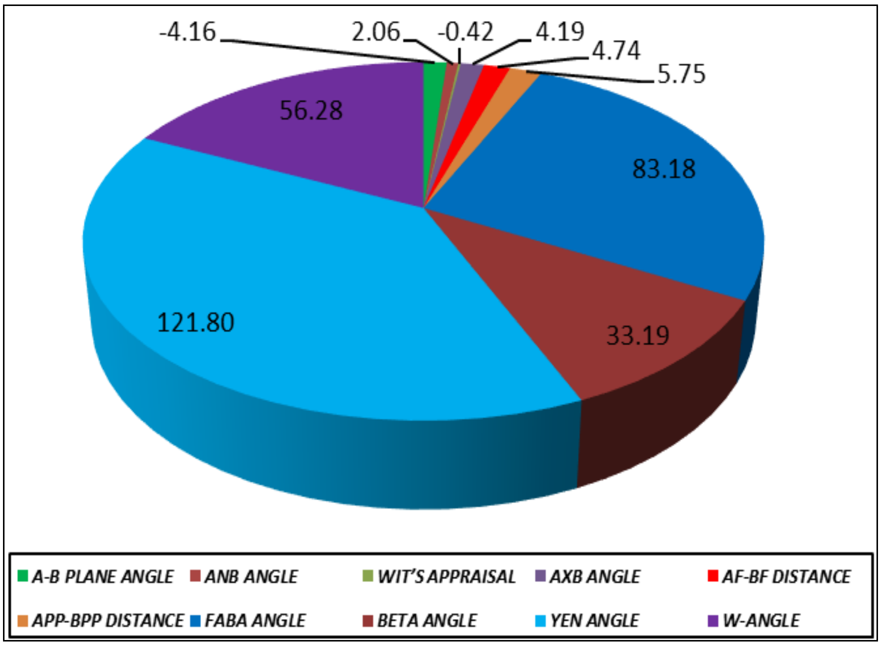


Fig 1: Graphical distribution of each parameter in different classes.

Table 1: Correlation matrix for A-B plane, ANB, Wits, AXB, AFBF, APP-BPP, FABA, BETA, YEN AND W-Angles (r- correlation coefficient; p-value) as shown in the)

Table 1- Correlation matrix

		AB PLANE	ANB	WIT'S	AXB	AFBF	APP BPP	FABA	BETA	YEN	W
AB PLANE	r										
	P-value										
ANB	r	0.873									
	P-value	***									
WITS	r	0.785	0.518								
	P-value	***	***								
AXB	r	0.857	0.886	0.792							
	P-value	***	***	***							
AFBF	r	0.801	0.837	0.688	0.890						
	P-value	***	***	***	***						
APP BPP	r	0.803	0.882	0.753	0.887	0.847					
	P-value	***	***	***	***	***					
FABA	r	0.876	0.893	0.753	0.924	0.931	0.867				
	P-value	***	***	***	***	***	***				
BETA	r	0.829	0.826	0.817	0.833	0.756	0.751	0.833			
	P-value	***	***	***	***	***	***	***			
YEN	r	0.842	0.848	0.683	0.846	0.800	0.819	0.825	0.766		
	P-value	***	***	***	***	***	***	***	***		
W	r	0.803	0.726	0.603	0.754	0.696	0.652	0.740	0.746	0.874	
	P-value	***	***	***	***	***	***	***	***	***	
***Statistically Significant Correlation(*P*-value<0.05)											

5. Discussion

Cephalometric radiograph is a valuable tool in orthodontic diagnosis and treatment planning. Even before Angle introduced his classification of malocclusion to the profession in the early 1900s, the anteroposterior relationship of mandible to maxilla was the most important diagnostic criterion.[9] This relationship can be determined from clinical observation to some degree, but it can be much more accurately evaluated from a lateral radiograph, ever since the introduction of the angle ANB, it has become one of the most popular means for evaluating the anteroposterior relationship of the apical bases. More recently, it has been claimed that the ANB angle is affected by several environmental factors [20], and thus a diagnosis based on this angle may give false results. The following factors have been reported to affect the ANB angle:

The patient's age, the change of the spatial position of the nasion either in the vertical or anteroposterior direction or both, the upward or downward rotation of the SN plane, the upward or downward rotation of the Jaws, the change in the angle SN to the occlusal plane, the degree of facial prognathism. [21, 22] A number of studies have been done to investigate the effectiveness of angle ANB in assessing the maxillo-mandibular relationship. Many other measurements have also been suggested for the same purpose which include the Wits analysis, [17] AF-BF [19] measurement, App-Bpp [18] and the MM bisector [23]. Although the present literature reveals the inconsistencies of angle ANB as true indicator of sagittal jaw relationship but very few studies are available on the effectiveness of other measurements for evaluation of maxillo-mandibular relationship. Due to the above mentioned factors affecting the accuracy of ANB angle measurement, a number of different, new measurements have been developed to determine the actual sagittal skeletal discrepancy.

From above analysis and obtained results it can be inferred that consistency could be demonstrated by all the methods assessed by anteroposterior jaw relationship. There was a statistically significant and high correlation between FABA, AFBF, AXB, YEN, and APP-BPP parameters used for assessment of sagittal jaw relationship. Angular methods used for assessing jaw relationship such as FABA, AXB, YEN, W and Beta and linear measurements such as AF-BF and APP-BPP could demonstrate superiority for assessing anteroposterior jaw relationship over other methods such as Wits, AB plane, and ANB which showed more variability. The FABA, AF-BF and YEN angle are a diagnostic tool to evaluate the AP jaw relationship more consistently. Based on the obtained results, it can be concluded that FABA, AXB, YEN angle, AF-BF and APP-BPP distance can be used one instead of another for the assessment of sagittal Whilst Wit's, ANB angle and AB-plane angle should be used in combination with other indicators of this relationship for a more realistic diagnosis. FABA had highest correlation with AF-BF (r=0.931) closely followed by FABA and AXB (r=0.924).FABA was found to be least variable indicating that it was the most homogeneously distributed parameter (CV=5.1) and is more accurate in assessing sagittal jaw relationship when compared with other angular and linear measurements. Among linear measurements, the parameter with most homogenous distribution was APP-BPP (CV= 101.9) and the least homogenous was Wits (CV=-1142.9) in our study. Wits appraisal was found to be skewed in the class III direction in our study. When angular and linear parameters were compared, high significant positive correlation was found between FABA angle and AF-BF distance (r = 0.931, $p<0.05$). No single measurement is perfect in all the cases. A combination of different measurements should be used to have a true assessment of sagittal jaw relationship.

6. Conclusion

Consistency could be demonstrated by all the methods assessed by anteroposterior jaw relationship. Ever since the introduction of the ANB angle, it is the most commonly used parameter for assessing sagittal dysplasia, however ANB angle is affected by several environmental factors and thus a diagnosis based on this angle may give false results. Therefore a number of different, new measurements have been developed to determine the actual sagittal skeletal discrepancy. No single measurement is perfect in all the cases. A combination of different measurements should be used to have a true assessment of sagittal jaw relationship.

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