Original Article

A "new vista" in the assessment of antero-posterior jaw relationship

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Abstract

Aim: The purpose of this investigation was to (1) compare the credibility of four recently introduced cephalometric measurements in assessing the antero-posterior jaw relationship; (2) To assess the correlation between various measurements used for assessment of antero-posterior discrepancy, including Yen linear, Yen angle, W angle and Pi angle. **Materials and Methods:** The sample size for the study consisted of 45 subjects with age group of 15-19 years (mean age 17 ± 2.1) and was subdivided into Skeletal Class I, II and III groups of 15 each based upon the ANB angle derived from the pre treatment lateral cephalogram. Landmarks were located and Yen angle, Yen linear, W angle and Pi angle were assessed for each group. All the lateral cephalograms were traced by a single examiner. Intra examiner reliability was assessed by Intraclass co-efficient correlation (ICC) test. Correlation coefficients were obtained for each of parameters to compare their relationship with other parameters in Class I group. Receiver operating characteristics (ROC) curves were run to examine sensitivity and specificity of all the angles. **Results:** The results showed that ICC for all the groups were ≥0.90 showing good repeatability of the measurements. There was statistically significant correlation between Yen angle and ANB angle, Yen linear and Yen angle for Class I group, between W angle and Yen angle for Class II group, between Yen angle, Yen linear and ANB for Class III group. ROC curves showed that Pi angle had 100% sensitivity and specificity to discriminate a Class II and a Class III group from a Class I and a Class III group from a Class II. Yen linear and W angle showed very low specificity to differentiate a Class II from a Class I group. **Interpretation and Conclusion:** The new parameters considered in the study were found to be equally reliable and are not affected much by local remodeling due to tooth movements or by occlusal or Frankfurt horizontal plane. These parameters measure the antero-posterior discrepancy more consistently and accurately, with Pi angle being the most accurate.

Key words: Lateral Cephalogram, Pi angle, W angle, Yen angle, Yen linear

INTRODUCTION

Malocclusions are classified broadly based on dental and skeletal discrepancies. Skeletal discrepancies are further sub classified based on the plane of discrepancy present, that is, sagittal, transverse and vertical discrepancies.[1] An accurate antero-posterior measurement of the jaw relationship is critically important in orthodontic diagnosis and treatment planning of these skeletal discrepancies. Since Broadbent's

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introduction of the cephalostat in 1931, a number of geometrical parameters, such as ANB angle,[2] WITS appraisal,[3] AF-BF[4] linear, APDI[5] angular measurement and Beta angle[6] have been defined and used effectively for the evaluation of antero-posterior discrepancies affecting the apical bases of the jaws.[15-20] However, various studies have questioned the reliability of these parameters as none of them currently gives a definitive picture of the antero-posterior jaw relationship. ANB angle has been found to be affected by rotation of the Sella-Nasion (S-N) plane, the relative length of the S-N plane and the rotation of the jaws during growth and treatment.[2] As an alternative, it was suggested that perpendiculars be drawn from points A to B on the occlusal plane (WITS appraisal), but misinterpretation of WITS value can be encountered due to variability in the occlusal plane, which is easily affected by tooth eruption and orthodontic treatment.[7] Although Beta angle does not use the cranial reference planes but it uses point A, which is affected by the orthodontic tooth movement of upper incisors and also point C is difficult to be located on the lateral cephalogram.[8]

Various cranial reference planes, such as Frankfort-Horizontal (FH) plane and S-N plane have been used in determination of antero-posterior jaw dysplasia: However, measurements related to cranium do not provide a wholly reliable estimation of the antero-posterior jaw relationship within the dentofacial complex.[2] Thus, calibrations independent of cranial reference planes or dental occlusion were introduced to determine the apical base relationship, reflecting true skeletal antero-posterior relationship without being influenced by changes in other parameters. These measurements included Yen angle,[9] Yen linear,[1] W angle[10] and Pi angle.[11] They utilize skeletal landmarks G and M points, to represent the mandible and maxilla respectively, which will be discussed later in this article.

However, despite introduction of the newer angles the orthodontist is in a dilemma over choosing the right parameter for assessment of antero-posterior jaw relationship. Therefore, the aims of this study were:

1. To compare the credibility of four cephalometric measurements in assessing the antero-posterior jaw relationship and.
2. To assess the correlation between various measurements used for antero-posterior discrepancy, including Yen linear, Yen angle, W angle and Pi angle.

MATERIALS AND METHODS

The sample size for the study consisted of 45 subjects (age 15-19 years) who had reported for orthodontic treatment in the Department of Orthodontics and Dentofacial Orthopedics, MS Ramaiah Dental College, Bengaluru, India. The subjects were subdivided into Skeletal Class I, II and III groups of 15 each based upon the ANB angle derived from the pretreatment cephalogram. Inclusion criteria for subjects were:

1. ANB angle between 1° and 4° for Class I; >4° for Class II and ≤0° for Class III.[11]
2. Permanent dentition with no missing teeth;
3. Patients with age group between 15 and 19 years.

Exclusion criteria included:

1. No previous history of orthodontic treatment;
2. No cranial or facial malformation and no history of craniofacial trauma;
3. Poor quality of cephalograms.

The cephalostat with following specifications was used for all subjects to obtain lateral cephalograms in Natural Head Position-Planmecca PM 2002 CC Proline Pan/Ceph (manufactured in Helinski, Finland, with voltage of 70 kV, current 10 mA and exposure time of 1.2 s). All the radiographs were hand traced by a single investigator (D. M.). To determine Yen angle, Yen linear, W angle and Pi angle, Points G and M were located using a transparent template containing number of circles whose inner diameter increased in 1 mm increments.[11] These landmarks were utilized to represent the maxilla and mandible respectively. Each center was identified by a pinhole in the template.

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.

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.[12,13]

The Yen angle, Yen linear, W angle and Pi angle were calculated for all the subjects in all the groups [Figures 1 and 2]. All the tracings and measurements were repeated after 3 weeks to evaluate the intraexaminer reliability and the mean values were tabulated in Microsoft Excel sheet (Microsoft, Redmond, Washington, USA).

Statistical analysis

All statistical analysis was performed using SPSS Statistics Version 10.0.5 (SPSS Inc., Chicago, IL). Intra examiner reliability was assessed by intraclass co-efficient correlation test. Descriptive data that included arithmetic means and standard deviations of all the four angles were calculated. Receiver operating characteristics curves were run to examine sensitivity and specificity of all the angles. Correlation coefficients were obtained for each of parameters to compare their relationship with

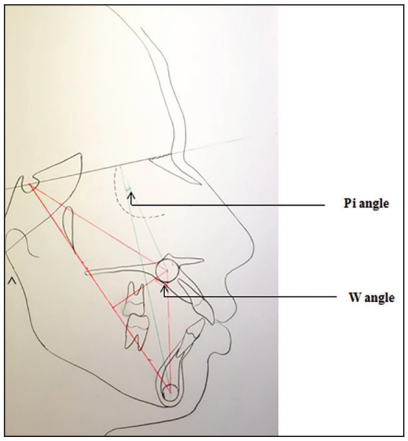

Figure 1: Lateral cephalometric tracing showing Pi angle and W angle

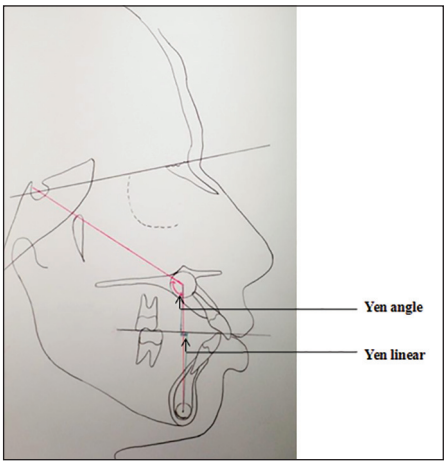

Figure 2: Lateral cephalometric tracing showing Yen angle and Yen linear

other parameters in Class I group. The level of statistical significance was established at $P < 0.05$.

RESULTS

The mean values for all the angles in the three skeletal groups are listed in the Table 1. One-way ANOVA showed statistically significant differences between mean values of all the angles among the three skeletal groups. Mean values of Yen angle were 126.36 ± 3.02, 117.57 ± 2.44, 137.79 ± 4.93, For Yen linear, −1.93 ± 1.68, 1.07 ± 1.97, −11.71 ± 4.48, For Pi angle, 2.71 ± 1.43, 8.36 ± 1.69, −9.79 ± 4.11 and For W angle, 55.5 ± 1.95, 52.14 ± 1.91, 67.29 ± 3.14 respectively for Class I, II and III groups. There was statistically significant correlation between Yen angle and ANB angle, Yen linear and Yen angle for Class I, between W angle and Yen angle for Class II, between Yen angle, Yen linear and ANB for Class III [Table 2]. Table 3 gives the cut-off values for all the 4 angles to determine Class I, Class II and Class III skeletal groups. The results show that Pi angle has 100% sensitivity and specificity to discriminate a Class II and a Class III case from a Class I to a Class III case from a Class II. Yen linear and W angle showed very low specificity to differentiate a Class II from a Class I.

Table 1: Descriptive statistics showing mean and SD for Class I, II and III groups

Group	*n*	Mean ± SD
ANB		
Class I	15	1.321±1.0116
Class II	15	5.857±1.7913
Class III	15	−7.071±3.4522
Yen angle		
Class I	15	126.36±3.028
Class II	15	117.57±2.441
Class III	15	137.79±4.933
Yen linear		
Class I	15	−1.93±1.685
Class II	15	1.07±1.979
Class III	15	−11.71±4.48
Pi angle		
Class I	15	2.71±1.437
Class II	15	8.36±1.692
Class III	15	−9.79±4.117
W angle		
Class I	15	55.5±1.951
Class II	15	52.14±1.916
Class III	15	67.29±3.148

SD – Standard deviation

DISCUSSION

In orthodontic diagnosis and treatment planning, the evaluation of the antero-posterior jaw relationship is an indispensable step and this relationship is generally determined by using lateral cephalograms, which have been used for many decades now for this purpose. Various angular and linear measurements have been incorporated into the various cephalometric analyses for diagnosing these antero-posterior discrepancies. However, these can be erroneous as angular measurements are affected by changes in facial height, jaw inclination, and total jaw prognathism, whereas linear variables can be affected by the inclination of the reference line.[8] ANB is still widely used but it has its own demerits as already discussed. To overcome some of the deficits of previous parameters, measurements such as W angle, Pi angle, Yen linear and Yen angle were introduced. These do not utilize A and B points as skeletal landmarks, which are affected by local remodeling due to orthodontic treatment. Instead they utilize points M and G which are not affected by local remodeling and they approximate to being centroid points similar to sella. Concept of centroid was given by Johnson. It's the center of an area of an image representing the mean point within the shape, about which it varies and

is subject to least variation relative to nonmean anatomic points and therefore provides more stable reference points.[14]

Table 2: Correlation coefficients between the parameters for Class I, II and III groups

Group	Yen angle	Yen linear	Pi angle	W angle
Class I				
ANB				
Correlation	−0.643	0.459	−0.170	−0.633
P	0.013	0.099	0.561	0.015
Yen angle				
Correlation		−0.759	−0.311	0.631
P		0.002	0.280	0.015
Yen linear				
Correlation			0.263	−0.526
P			0.363	0.053
Pi angle				
Correlation				−0.219
P				0.451
Class II				
ANB				
Correlation	−0.191	0.198	0.018	−0.330
P	0.513	0.497	0.951	0.249
Yen angle				
Correlation		−0.152	0.021	0.722
P		0.603	0.942	0.004
Yen linear				
Correlation			−0.330	−0.226
P			0.250	0.437
Pi angle				
Correlation				0.197
P				0.500
Class III				
ANB				
Correlation	−0.706	0.777	0.412	−0.529
P	0.005	0.001	0.143	0.052
Yen angle				
Correlation		−0.759	−0.403	0.589
P		0.002	0.153	0.027
Yen linear				
Correlation			0.205	−0.830
P			0.482	<0.001
Pi angle				
Correlation				−0.248
P				0.392

In the current study, we traced the lateral cephalograms of 45 patients who fulfilled the inclusion and exclusion criteria, after which a transparent template was used to determine points M and G, centroid points of anterior maxilla and mandible respectively, which are not subjected to local remodeling due to tooth movements, unlike point A and B. Once these reference points were marked, all four measurements - Yen angle, Yen linear, W angle and Pi angle were made for the three skeletal groups, along with ANB angle which was the control.

All the parameters were found to be equally significant in assessing the antero-posterior discrepancy, however localization of the skeletal defect was ineffective. Pi angle is helpful in this regard as it utilizes true horizontal and nasion and thus gives a more accurate picture of which jaw is at fault. The results in the present study revealed that all the 4 parameters considered in the study are accurate in determining the antero-posterior jaw discrepancy with Pi angle being 100% sensitive and specific for discriminating a Class I from Class II, Class III malocclusion and also Class II from Class III malocclusion. In a similar study the overall accuracy for discriminating skeletal Class II from skeletal Class I was found to be 85% and for discriminating skeletal Class III from skeletal Class I, was found to be 90%.[10] Thus, a cut-off point between Class I and II groups was considered a Pi angle of approximately 5° and between Class I and III approximately 1.3°.[11]

The second objective of this study was to assess the correlation between various parameters used to measure the antero-posterior discrepancy-including ANB angle, W angle, Yen angle, Yen linear and Pi angle. For this purpose, multiple correlation analysis was performed between the various parameters used in this study. There was statistically significant correlation between Yen angle and ANB angle, Yen linear and Yen angle for Class I, between W angle and Yen angle for Class II, between Yen angle, Yen linear and ANB for Class III. The correlation of Pi angle with other angles was weak for all the skeletal groups. In a similar study Horowitz and Hixon stated that a correlation coefficient better than 0.8 can be used

Table 3: Receiver operating characteristics (ROC) curves showing sensitivity and specificity for all the parameters

	Cut off	Class II from Class I		Class III from Class I		Class III from Class II	
		Sensitivity (%)	Sensitivity (%)	Sensitivity (%)	Sensitivity (%)	Sensitivity (%)	Sensitivity (%)
ANB	>3	100	100	100	100	100	100
Yen angle	≤120	92.9	100	92.9	92.9	100	100
Yen linear	≥2	92.9	71.4	100	100	100	100
Pi angle	>5	100	100	100	100	100	100
W angle	≤54	92.9	64.3	100	100	100	100

in clinical predictions, on this basis the Pi angle may be considered highly inter-changeable in the assessment of antero-posterior jaw relationship.[11]

Although this study proves that all the parameters were efficient in determining antero-posterior skeletal discrepancy, Pi angle being the most credible angle, the study has some limitations. The fact that this study was performed on a smaller sample size was probably a reason why most of the parameters assessed were effective in determining the skeletal discrepancy with a uniform outcome. Further investigation with the larger sample size might provide a better overview of determining the preferred parameter among others to evaluate the skeletal discrepancy

CONCLUSION

Previously established parameters for assessing the antero-posterior jaw discrepancy have inaccuracies associated with them. The new parameters considered in the study were found to be equally reliable and are not affected much by local remodeling due to tooth movements or by occlusal or FH plane. These measure the antero-posterior discrepancy more consistently and accurately, with Pi angle being the most accurate. However, there is large variability among human populations and a single cephalometric analysis cannot assess the true skeletal relationship consistently in all situations.

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Conflict of interest

There are no conflicts of interest.

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