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RESEARCH ARTICLE

CORRELATION BETWEEN W ANGLE AND DIFFERENT ANGULAR AND LINEAR SAGITTAL SKELETAL DISCREPANCY INDICATORS – A CEPHALOMETRIC STUDY

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ABSTRACT

Introduction: In orthodontics, for diagnosis and treatment planning, an accurate antero-posterior measurement of jaw relationships is of critical importance. Various angular and linear measurements that have been proposed from time to time and are currently in use to assess the antero-posterior discrepancy between maxilla and mandible can at times be inaccurate due to their dependency on certain factors which have been found to be unreliable at times. So the purpose of this study is to compare and find a co-relation between the most commonly used parameters for finding sagittal discrepancy (ANB angle, WITS appraisal and BETA angle) and a relatively newly introduced parameter (W angle).

Materials and method: The sample consisted of 42 pre-treatment lateral cephalograms of orthodontic patients, who reported for treatment in the Department of Orthodontics and Dentofacial Orthopaedics of Maharana Pratap College of Dentistry and Research Centre, divided into following three groups: Group I – Class I skeletal pattern (n=14), Group II – Class II skeletal pattern (n=14) and Group III – Class III skeletal pattern (n=14) based on the inclusion and exclusion criteria selected.

Results : Pearsons correlation statistical analysis was performed and results indicated significant association between W angle and ANB angle in class II group ($p < 0.05$) also significant association between W angle and all the other selected parameters in class III group ($p < 0.05$)

Conclusion: W angle is comparable to the widely accepted sagittal discrepancy parameters in assisting diagnosis of Class II and Class III sagittal discrepancies as effectively as ANB angle, WITS appraisal and Beta angle.

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INTRODUCTION

The evaluation of sagittal relationship between maxilla and mandible is of utmost importance in the field of Orthodontics, for accurate diagnosis and ultimately correct treatment planning. This evaluation is generally a major problem because of rotations of jaws during growth, vertical relationships between the jaws and reference planes, and a lack of overall validity of the various methods that have been proposed for their evaluation (Jacobson, 1975; Moyers, 1979; Baik, 2004 and Nanda, 2005). Orthodontics deals with discrepancies in all three planes namely transverse, sagittal and vertical, of which the sagittal discrepancies are encountered more often in day to day clinical practice. Cephalometric radiographs have proven to be a valuable tool in orthodontic diagnosis and treatment planning.

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Various angular and linear cephalometric measurements have been proposed in order to assist in arriving at correct diagnosis of these discrepancies and thus formulating an appropriate treatment plan. Appraisal by linear measurements has distinct advantages over angular measurements in that there are fewer variables to effect their accuracy and therefore there is less error of measurement (Nanda, 1994). Wylie (Wylie, 1947) in 1947 made the first attempt to describe antero-posterior jaw relationship. This was followed by Down's (Downs, 1948) in 1948 as he introduced the A-B plane angle, read as positive or negative to denote protrusion or retrusion of mandible. Since then various cephalometric parameters have been proposed. Of these parameters, the ANB angle (Riedel, 1952) by Riedel in 1952, the Wits appraisal (Jacobson, 1975 by Jacobson in 1975 and recently the Beta angle (Baik, 2004) by Baik and Ververidou in 2004 and the W angle (Bhad, 2011) by Bhad et al in 2011, are the commonly used parameters. A number of studies have questioned the stability of the cephalometric point 'nasion' (Nanda, 1955; Moore, 1959; Binder, 1979 and Enlow,

1966). Therefore Down's and Riedel's methods are subject to error due to variations in the position of nasion which is generally not fixed during growth, and also due to any displacements while shooting of cephalogram due to rotation of head side wards or upward can directly affect the A-B plane angle and hence the ANB reading (Jacobson, 1975). To overcome these limitations of ANB angle, Jacobson in 1975 introduced Wits appraisal. The Wits appraisal avoids the use of nasion therefore reduces the rotational effects of jaw growth, but it uses a dental parameter (occlusal plane) to describe the skeletal discrepancies. The occlusal plane, not only at times is difficult to identify but is also not always accurately reproducible (Rushton, 1991 and Haynes, 1995), especially in mixed dentition with open bite, canted occlusal plane, multiple impactions, missing teeth, skeletal asymmetries, or in patients with steep curve of spee. The occlusal plane can also be affected by tooth eruption, dental development and as well as by orthodontic treatment, which can profoundly influence the Wits appraisal (Sherman, 1988). Baik and Ververidou in 2004 developed the Beta angle, to determine the true apical base relationship that was independent of cranial reference points/planes or dental occlusion. Although it assess the sagittal discrepancy, it depends on point A and B which are difficult to locate. The position of point A is believed to be affected by alveolar bone remodeling associated with orthodontic tooth movement of the upper incisors. (Nanda, 2005; Arvysts, 1990; Erverdi, 1991) Locating point C (condylion) is also a problem since reproducibility of the location of condylion on mouth-closed lateral cephalograms is quite limited (Adenwalla, 1988; Moore, 1989). To overcome the drawbacks of ANB angle, Wits appraisal and Beta angle, Bhad et al. (Bhad, 2011) developed W-angle which does not depend on any unstable landmarks or dental occlusion and therefore would be especially valuable to assess true sagittal changes in jaws, occurring due to growth or orthodontic treatment. The purpose of this study is to compare W angle with these three widely accepted sagittal discrepancy indicators (ANB angle, Wits appraisal and Beta angle) to find out if it is dependable enough to aid in diagnosing sagittal skeletal jaw discrepancy accurately and reliably.

MATERIALS AND METHODS

This study was carried out in the Departmant of Orthodntics and Dentofacial Orthopaedics of Maharana Pratap College of Dentistry and Research Centre, Gwalior (M.P.). For this PILOT study, many pretreatment lateral cephalograms were screened. The short listed cephalograms were traced and out of which, 42 pretreatment lateral cephalograms of patients selected randomly between the age of 13 to 30, were divided into skeletal Class I (n=14), Class II (n=14) and Class III (n=14) depending on ANB angle, Wits appraisal and Beta angle based on the following inclusion criteria:

- For a patient to be considered in skeletal Class I group – (1) ANB angle between 1° and 3°, (2) Wits appraisal between 0 and -1 mm and (3) Beta angle between 27° and 35°.
- For a patient to be considered in skeletal Class II group – (1) ANB angle more than or equal to 3°, (2) Wits appraisal greater than 0 mm and (3) Beta angle less than or equal to 27°.
- For a patient to be considered in skeletal Class III group – (1) ANB angle less than or equal to 1°, (2) Wits appraisal less than -1 mm and (3) Beta angle more than or equal to 35 °

Lateral cephalograms were exposed with jaws in centric relation, lips relaxed, and the head in natural head position using KODAK digital X-Ray machine. Same exposure parameters were used while obtaining the cephalograms. Tracing using a 0.3 mm tracing pencil was done on these lateral cephalograms. ANB angle, Wits appraisal, Beta angle and W angle were measured and then tabulated for statistical analysis to find out accuracy and reliability of W angle (Table 1).

Statistical analysis: The mean and standard deviation (SD) were calculated for the ANB angle, WITS appraisal, Beta angle and W angle among the three groups (Figures 1-3 & Tables 2-4) and Pearsons correlation statistical analysis was performed between all the selected parameters.

RESULTS

For the Class I group the statistical analysis revealed no significant association between the selected parameters as the p value is greater than 0.05 in all.

Table 1. Skeletal Class I, II & III groups based on inclusion & exclusion criteria

Class I			
ANB angle in degrees	Wits appraisal in mm	Beta angle in degrees	W angle in degrees
1	-1	34	57
3	-1	31	57
3	0	30	51.5
3	-0.5	32	53
3	0	28	53
2	-1	28	55
2	0	31	48
2	-1	35	57
2	0	35	50
2	1	34	55
2	1	35	59
2	0	29	55
2	-1	33	56
2	0	34	59
Class II			
ANB angle in degrees	Wits appraisal in mm	Beta angle in degrees	W angle in degrees
6.5	7	25	54
7	3	25	45
6.5	5	26	51
7	5.5	21	50
5	3.5	24	54
6	4.5	14	47
10	6	25	45
8	7.5	24	52
4.5	2.5	21	51
6	4	25	51
5	2.5	22	50
8	4.5	20	41
13.5	7.5	14	43
6	2.5	29	46
Class III			
ANB angle in degrees	Wits appraisal in mm	Beta angle in degrees	W angle in degrees
0.5	-8	42	64
-1.5	-1.5	36	61
-0.5	-3.5	38	60
-0.5	-4	37	60
1	-1	36	58
1	-1.5	39	58
0	-3	36	60
-1.5	-1.5	37	60
-0.5	-4	39	61
3	-4.5	40	60
-2	-6	43	60
-9	-8	47	65
0	-1.5	41	59
-4	-4	36	60

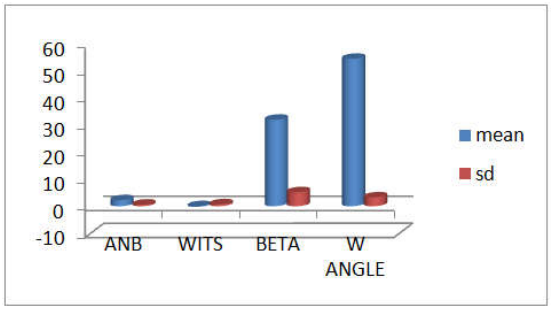

Figure 1. Representation of Mean & SD of ANB angle, WITS appraisal, Beta angle and W angle for skeletal Class I group

Table 2. Values of mean & SD of ANB angle, WITS appraisal, Beta angle and W angle for skeletal Class I group

Class I				
	ANB	WITS	BETA	W ANGLE
mean	2.214	-0.25	32.071	54.678
sd	0.578934	0.700275	5.171775	3.255806

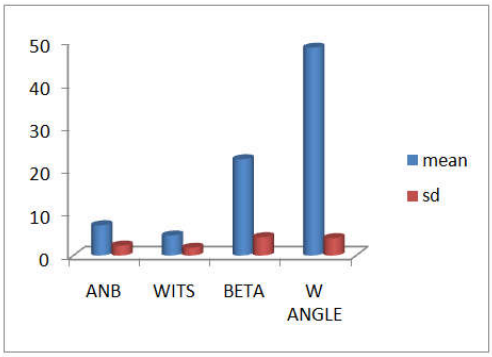

Figure 2. Representation of Mean & SD of ANB angle, WITS appraisal, Beta angle and W angle for skeletal Class II group

Table 3. Values of mean & SD of ANB angle, WITS appraisal, Beta angle and W angle for skeletal Class II group

Class II				
	ANB	WITS	BETA	W ANGLE
Mean	7.071	4.678	22.5	48.571
Sd	2.335818	1.814547	4.292211	4.070802

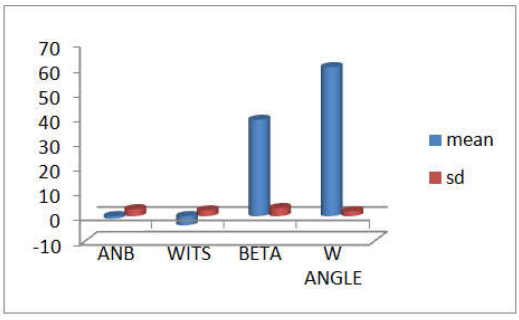

Figure 3. Representation of Mean & SD of ANB angle, WITS appraisal, Beta angle and W and for skeletal Class III group

Table 4. Values of Mean & SD of ANB angle, WITS appraisal, Beta angle and W angle for skeletal Class III group

Class III				
	ANB	WITS	BETA	W ANGLE
Mean	-1	-3.714	39.071	60.428
Sd	2.82162	2.326389	3.269069	1.949923

In the Class II group significant correlation existed between ANB angle and WITS appraisal as the p value was less than 0.05 (p=0.0048). There was also significant association between ANB angle and W angle (p=0.026). In the Class III group, significant statistical association was found between W angle and ANB angle, WITS appraisal and Beta angle (p=0.023, 0.0002 and 0.014 respectively). There is also significant association between WITS appraisal and Beta angle (p=0.0026). There is highly significant association between W angle and WITS appraisal (p=0.0002). Therefore results indicated significant association between W angle and ANB angle in class II group ($p < 0.05$) also significant association between W angle and all the other selected parameters in Class III group ($p < 0.05$).

DISCUSSION

In orthodontics, whether a patient is treated with fixed mechanotherapy alone or in conjunction with orthognathic surgery, it is very important to know the exact extent of sagittal skeletal discrepancy in order to have a correct diagnosis and to formulate an appropriate treatment plan so as to provide maximum benefit for the patient in terms of esthetics, functionality and post treatment stability. For this reason it is important to assess maxilla-mandibular discrepancy accurately. To evaluate this relationship, various angular and linear measurements have been proposed. But these measurements can be misleading as they are affected by growth changes in face height, jaw inclination, jaw prognathism and especially linear variables being affected by the inclination of the reference plane (William, 1985 and Jacobson, 1988). ANB angle remains the most popular parameter for assessing the sagittal jaw relationship, but it is affected by various factors that can often be misleading. When this angle is being used, factors such as patient's age, growth rotation of the jaws, and the length of the anterior cranial base should be considered, which makes the interpretation of this angle highly complex (Jacobson, 1975). It is also known that nasion usually moves in anterior and slightly superior direction because of the growth increments on the cranial base plane passing through sella and nasion (Rotberg, 1980). To overcome these drawbacks of ANB angle, Wits appraisal was introduced by Jacobson in 1975. Although this parameter is independent of skeletal landmarks or jaw rotations, problem arises while correctly identifying the functional occlusal plane, which at times can be quite difficult, especially in mixed dentition period. Also changes occurring in the functional occlusal plane during the orthodontic treatment brings about changes in the Wits appraisal which are actually not pure sagittal changes of the jaws (Moore, 1989 and Ishikawa, 2000). To overcome these drawbacks of ANB angle and Wits appraisal, Beta angle was introduced by Baik and Ververidou which does not depend on cranial landmarks and the functional occlusal plane and remains relatively stable even when jaws rotate. But it uses Point A and Point B, which can easily change by orthodontic treatment and growth (Rushton, 1991 and Richardson, 1982). Also studies have shown that reproducibility of condylion on mouth-closed lateral head films is limited (Adenwalla, 1988 and Moore, 1989). All these skeletal sagittal discrepancy indicators are generally affected by either of the factors, like patient's age, jaw rotations, growth changes in reference planes/landmarks, poor reproducibility of landmarks and changes due to orthodontic treatment (Ishikawa, 2000). Bhad et al. (Bhad, 2011) introduced the W angle which is not dependent on any unstable landmarks or the functional occlusal plane. It uses three stable

points- point S, point M and point G. The geometry of W angle has the advantage to remain relatively stable even when the jaws are rotated or growing vertically, which is because S-G line rotates along with jaw rotation, which carries the perpendicular from point M with it. Since the M-G line is also rotating in the same direction, the W angle remains relatively stable. Cranial base length (position of nasion) can at times camouflage true skeletal sagittal discrepancy whereas W angle being independent of cranial base length can be a valuable tool for diagnosing the actual discrepancy. Precise tracing of a good quality cephalogran and correct identification of landmarks and planes is a must for any clinician to be able to use and get the benefit of these parameters. In skeletal class II and class III cases, both Beta angle and W angle are unable to determine which jaw is prognathic or retrognathic. Since cephalometrics is not an exact science, various analysis based on angular or linear measurements have certain obvious limitations and therefore dependency on any one parameter for assessment of skeletal discrepancy should never be encouraged. Therefore a combination of all these parameters has to be used to identify the true nature of discrepancy. Similar studies performed to compare similar parameters also found the newly introduced Beta and W angles to be quite efficient in diagnosing sagittal discrepancy (Sachdeva, 2012).

Conclusion

These various methods for assessing the sagittal discrepancy are at par with each other in determining the discrepancy, while each having some or the other disadvantages. Therefore it is recommended that any one method only should not always be relied on completely instead a combination of a few methods depending on the situation should be chosen to achieve enhanced results.

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