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RESEARCH ARTICLE

COMPARISON OF THE RELATIONSHIP BETWEEN HBN ANGLE AND W ANGLE WITH SKELETAL DISCREPANCY PARAMETERS IN GWALIOR POPULATION – A CEPHALOMETRIC STUDY

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ABSTRACT

Introduction: In the world of orthodontics, to find the sagittal discrepancy between maxilla-mandible varities of cephalometirc analyses with numerous angular and linear measurements have been proposed, since the introduction of radiographic cephalometry in 1934 by Hofrath (GERMANY) & Broadbent (USA).Sometimes inaccuracy have been found out in these cephalometric analyses because the factors they are relying came to be inconstant. So the purpose of this study is to find the co-relation between the most commonly used parameters for finding sagittal discrepancy (ANB angle, WITS appraisal and BETA angle) and newly introduced parameters (W angle) & (HBN angle) in Gwalior (M.P.) population.

Materials and method: The sample consisted of 50 pre-treatment lateral cephalograms of orthodontic patients selected randomly who reported for treatment in the Department of Orthodontics and Dentofacial Orthopaedics of Maharana Pratap College of Dentistry and Research Centre, Gwalior (M.P.).These samples were divided into following three groups: Group I – *Class I skeletal* pattern , Group II – *Class II skeletal* pattern and Group III – *Class III skeletal* pattern according to the inclusion criteria selected.

Results: Pearson coefficient test was performed which showed statistically significant relationship in class II cases between W angle – ANB (p=0.001) and HBN angle - ANB (p=0.003).In class III cases statistically significant relationship between W angle – WITS (p=0.017), HBN angle – WITS (p=0.01) & HBN angle – BETA angle (p=0.025).

Conclusion: Result showed strong correlation in class II cases between W-angle –ANB angle as compared to HBN angle – ANB. In class III cases strong correlation existed between HBN angle – WITS & HBN angle – BETA angle as compared to W angle – WITS & W angle – BETA angle respectively. As per these results we can conclude that W angle is better to identify class II cases whereas HBN angle is better to identify class III cases

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INTRODUCTION

The sagittal relation of maxilla to mandible was one of the most significant criteria in orthodontics, even before the classification of malocclusion introduced by EDWARD H ANGLE. Over the last fifty years, many angular and linear measurements have been assimilated into various cephalometric analyses to help the orthodontist to diagnose anteroposterior jaw discrepancies. 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.

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Cephalometric radiographs have proven to be a valuable tool in orthodontic diagnosis and treatment planning. Appraisal by linear measurements has noticeable advantages over angular measurements. Any cephalometric analysis based on either angular or linear measurements has obvious shortcomings, which have been discussed in detail by Moyers *et al*. The first step in evaluating sagittal jaw relationship was *Downs* description of points A and B in 1948. A few years later, *Riedel* measured the S-N-A and S-N-B angles, using nasion (N) as a reference point and used their difference, i.e. A-N-B angle, as an expression of dental apical base relationship. Since then, the A-N-B angle has been widely adopted as a principal method for evaluating sagittal jaw relationship. Wits assessment was introduced by *Jacobson* in 1975. Wits appraisal is a linear AO–BO distance between points A and B

projected perpendicularly on the functional occlusal plane. Wits appraisal is time tested, and an essential part of cephalometric analysis. A number of studies have questioned the constancy of the cephalometric point 'nasion'. Therefore *Downs* 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 sideward or upward can directly affect the A-B plane angle and hence the cephalometric reading. In 2004, *Baik* and *Ververidou* proposed the Beta angle. It uses three skeletal landmarks – point A, point B, and the apparent axis of the condyle (C) as a reference point to measure an angle that indicates the severity and the type of skeletal problem in sagittal dimension. To overcome the drawbacks of ANB angle, Wits appraisal and Beta angle, *Bhad et al* (2011) developed W-angle which does not depend on any unstable landmarks or dental occlusion and HBN angle developed by *Dave HB et al* (2015) which does not depend on any cranial reference planes or occlusal plane. Both these angles are above all better to assess sagittal discrepancy occurring in both jaws. This study was done to compare W angle & HBN angle with these three widely accepted sagittal discrepancy indicators (ANB angle, Wits appraisal and Beta angle) to find out if they are dependable enough to aid in diagnosing sagittal skeletal jaw discrepancy more precisely.

MATERIALS AND METHODS

This study was carried out in the Department of Orthodontics and Dentofacial Orthopaedics of Maharana Pratap College of Dentistry and Research Centre, Gwalior (M.P.).

The short listed cephalograms were traced and out of which 50 pre-treatment lateral cephalograms of patients selected randomly between the age of 13 to 30, were divided into skeletal class I (n=12), class II (n=23) and class III (n=15) depending on ANB angle, Wits appraisal and Beta angle based on the following inclusion criteria:

Criteria for skeletal Class I group

- ANB angle between 1° and 3°
- Wits appraisal between 0 and -1 mm
- Beta angle between 27° and 35°

Criteria for skeletal Class II group

- ANB angle more than or equal to 3°
- Wits appraisal greater than 0 mm
- Beta angle less than or equal to 27°

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

Skeletal Class I

S. no.	Age	Sex	ANB	Wits appraisal	Beta angle	W angle	HBN angle
1.	16	M	2°	1 mm	29°	56°	40°
2.	22	M	2°	-1 mm	29°	60°	43°
3.	15	M	2°	-1 mm	28°	55°	46°
4.	17	M	3°	-1 mm	27°	56°	41°
5.	21	F	2°	0 mm	31°	48°	44°
6.	20	F	2°	-1 mm	35°	57°	44°
7.	22	F	2°	0 mm	35°	50°	38°
8.	19	F	2°	1 mm	34°	55°	43°
9.	22	M	2°	1 mm	35°	59°	45°
10.	17	F	2°	0 mm	29°	55°	41°
11.	17	F	2°	-1 mm	33°	56°	43°
12.	19	M	2°	0 mm	34°	59°	47°

Skeletal Class II

S. no.	Age	Sex	ANB	Wits appraisal	Beta angle	W angle	HBN angle
1.	18	M	3°	5 mm	26°	53°	38°
2.	17	F	6°	5 mm	24°	48°	31°
3.	19	F	7°	2 mm	20°	56°	32°
4.	16	M	9°	6 mm	23°	49°	41°
5.	22	F	5°	4 mm	26°	55°	38°
6.	23	M	7°	1.5 mm	25°	57°	37°
7.	21	M	6°	4 mm	25°	54°	40°
8.	20	F	7°	8 mm	26°	46°	35°
9.	18	M	6°	4 mm	21°	59°	44°
10.	18	F	6°	4 mm	25°	49°	38°
11.	20	F	7°	4 mm	22°	54°	37°
12.	22	F	5°	3 mm	25°	54°	38°
13.	22	M	11°	8.5 mm	20°	43°	27°
14.	21	F	5°	5 mm	26°	53°	40°
15.	18	F	8°	7 mm	24°	49°	34°
16.	20	M	4°	4 mm	16°	55°	40°
17.	19	M	6°	2 mm	26°	52°	41°
18.	22	F	6°	5 mm	25°	48°	38°
19.	20	M	4°	7 mm	26°	57°	44°
20.	25	F	7°	9 mm	21°	48°	35°
21.	24	F	6°	2 mm	24°	54°	39°
22.	23	F	8°	4 mm	26°	48°	37°
23.	26	M	5°	10 mm	26°	57°	44°

Skeletal Class III

S. no.	Age	Sex	ANB	Wits appraisal	Beta angle	W angle	HBN angle
1.	25	M	1°	-1 mm	36°	58°	45°
2.	21	F	1°	-1.5 mm	39°	58°	45°
3.	27	M	1°	-4 mm	40°	55°	46°
4.	26	M	0°	-3 mm	36°	60°	48°
5.	22	M	0.5°	-8 mm	40°	64°	49°
6.	23	F	-1.5°	-1.5 mm	37°	60°	43°
7.	17	F	-0.5°	-4 mm	39°	61°	49°
8.	22	M	-3°	-4.5 mm	40°	60°	45°
9.	16	F	-2°	-6 mm	43°	60°	46°
10.	24	M	-3°	-4.5 mm	40°	59°	47°
11.	22	M	-9°	-8 mm	47°	65°	50°
12.	18	M	-4°	-5 mm	40°	66°	51°
13.	19	M	-4°	-7 mm	47°	61°	51°
14.	23	M	0°	-1.5 mm	41°	59°	48°
15.	25	M	-4°	-4 mm	36°	60°	46°

Criteria for skeletal Class III group

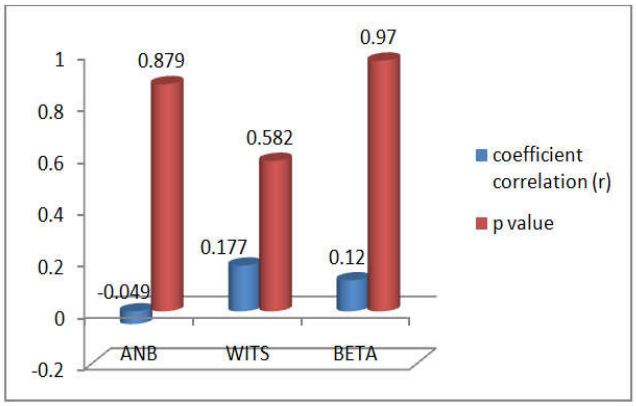
- ANB angle less than or equal to 1°
- Wits appraisal less than -1 mm
- Beta angle more than or equal to 35°

To construct the W angle, points S, M, and G were located. To locate points M and G, as suggested by Nanda and Merrill (1994) and Braun *et al.* (2004), a template with concentric circles whose diameters increased in 1 mm increments was used. To construct HBN angle three skeletal landmarks were used: "C" (the apparent axis of the condyle), "M" (midpoint of the premaxilla), and "G" (center of the largest circle that is tangent to the internal inferior, anterior, and posterior surfaces of the mandibular symphysis).

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

Descriptive Statistics

	mean	Std. deviation	N
ANB	2.083	0.288	12
WITS	0.416	1.240	12
BETA	31.580	3.052	12
W-ANG	55.50	3.503	12
HBN - ANG	42.91	2.574	12



Graph 1. W ANGLE correlation with ANB, WITS and BETA for skeletal Class I group

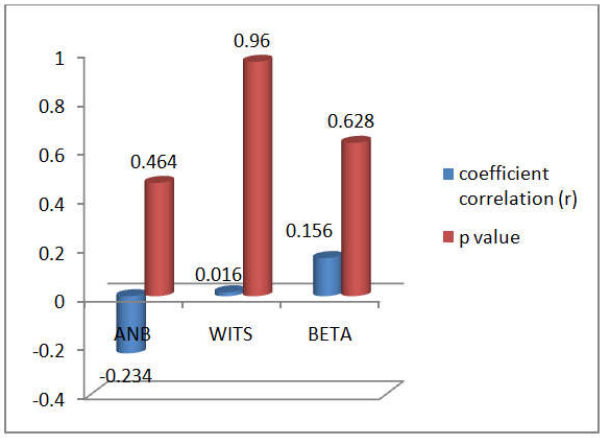
Lateral cephalograms was taken in natural head position using KODAK digital X-Ray machine. Tracing of all cephalograms used in this study were made on matte acetate sheet of 0.004 inch thick and were traced by 0.5 mm, 2HB lead pencil.

All the angles were measured and then tabulated for statistical analysis to find out accuracy and reliability of W angle & HBN angle.

Statistical Analysis: Data collected by the investigators were first entered to Excel (Microsoft, Redmond, Wash ington, USA) and screened for missing values. Data were summarized as mean and sds of ANB, WITS, BETA angle, W angle & HBN angle, A P value $\leq$ 0.05 was considered to be statistically significant. Pearson's correlation statistical analysis was performed between all the selected parameters.

RESULTS

For the Class I group the statistical analysis revealed no significant association between W and HBN (graph 1) and other methods (ANB,WITS,BETA) as the p value is greater than 0.05.

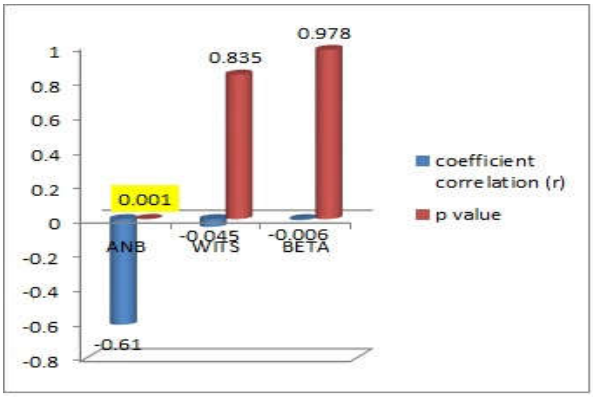


Graph 2: **HBN ANGLE correlation with ANB, WITS and BETA for skeletal Class I group**

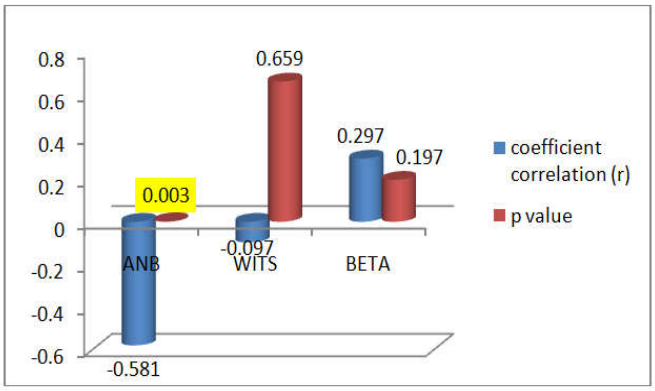
Table 3. Values of mean & SD of ANB angle, WITS appraisal, Beta angle and W angle for skeletal Class II group

Descriptive Statistics

	mean	Std. deviation	N
ANB	6.260	1.737	23
WITS	-0.416	1.240	23
BETA	23.826	2.656	23
W-ANG	52.086	4.769	23
HBN - ANG	37.739	4.158	23



Graph 3. W ANGLE correlation with ANB, WITS and BETA for skeletal Class II group

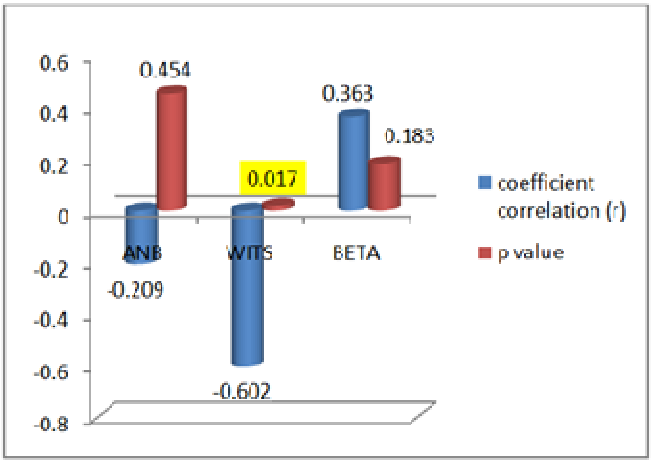


Graph 4. HBN ANGLE correlation with ANB, WITS and BETA for skeletal class II group

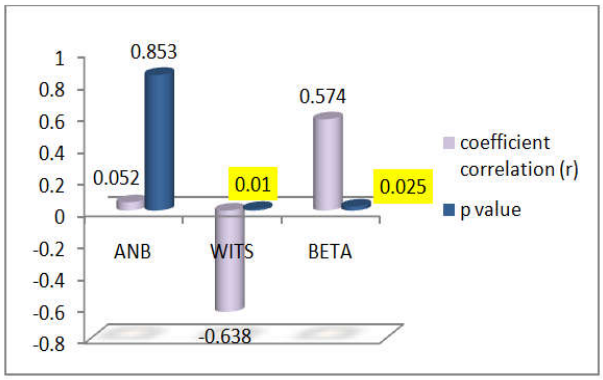
Table 4. Values of mean & SD of ANB angle, WITS appraisal, Beta angle and W angle for skeletal Class III group

Descriptive Statistics

	mean	Std. deviation	N
ANB	0.333	3.354	15
WITS	-4.233	2.305	15
BETA	40.066	3.453	15
W-ANG	60.4	2.823	15
HBN - ANG	47.26	2.404	15



Graph 5: W ANGLE correlation with ANB, WITS and BETA for skeletal Class III group



Graph 6. HBN ANGLE correlation with ANB, WITS and BETA for skeletal Class III group

Graph 2 shows there is significant correlation between W angle – ANB (p=0.001) and HBN angle - ANB (p=0.003). W angle and ANB and also HBN and ANB was highly correlated with each other and highly significant as (p=0.001 and 0.003 respectively). Graph 3 shows there is significant correlation among between W angle – WITS (p=0.017), HBN angle – WITS (p=0.01) & HBN angle – BETA angle (p=0.025).

DISCUSSION

An accurate sagittal jaw relationship is very much important in orthodontic treatment planning. The ANB angle and the Wits appraisal are the most frequently used parameters among measurements related to anteroposterior jaw relationships. Many studies have been done to find out the efficacy of these parameters. Jacobson showed that the ANB angle does not provide an adequate assessment of jaw relationships because of the anteroposterior position of nasion & growth rotation of the jaws influence the ANB angle. To eliminate the influence of the anatomic variations in nasion on the sagittal relationship of the jaws, Jacobson presented the Wits appraisal. This method, which is based on linear evaluation of the distance between points A and B projected onto the occlusal plane, was previously described by Jenkins and Harvold. To overcome these problems new measurement was developed by the name HBN angle & W angle; W angle measurement does not depend on unstable landmarks or the functional occlusal plane. It uses three stable points — point S, point M, and point G. W angle is measured between a perpendicular line from point M to the S – G line and M – G line. 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. 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. The HBN angle does not depend on cranial landmarks or the functional occlusion plane and point A and point B. It has three landmarks such as the apparent axis of the condyle, M midpoint of the premaxilla, and G center of the largest circle that is tangent to the internal inferior, anterior, and posterior surfaces of the mandibular symphysis. The advantage of locating "C" - the center of the head of the condyle versus the condylion point, as used by McNamara is that very precise tracing of the contour of the condyle is not really necessary.

The clinician can visualize and approximate the center with a minimum error in the HBN angle as long as that point is within 2 mm of its actual location.

- ANB angle was initially introduced for the sole purpose of determining skeletal sagittal discrepancy. Even though it had some drawbacks but it has stood the test of time and is still in use.
- WITS appraisal was introduced to overcome the shortcomings of ANB angle but then it had some drawbacks too. Therefore it has to be used in conjunction with ANB angle to get results.
- BETA angle quite popularly overcome the drawbacks of both ANB and WITS. But some questioned its reliability due to fact that it depended on point A which is not a stable landmark.
- W & HBN angle quite recently introduced tries to overcome the faults in all the above mentioned methods by being dependent on stable skeletal landmarks.

Conclusion

Result showed strong correlation in class II cases between W-angle –ANB angle as compared to HBN angle – ANB. In class III cases strong correlation existed between HBN angle – WITS & HBN angle – BETA angle as compared to W angle – WITS & W angle – BETA angle respectively. As per these results we can conclude that W angle is better to identify class II cases whereas HBN angle is better to identify class III cases. Old measurements for assessing the sagittal jaw relationship may be unreliable**.** Therefore it is recommended that any one should not always be relied on one method completely instead a combination of a few methods depending on the situation should be chosen to achieve enhanced results.

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