The wits appraisal using three reference planes and its interaction with the ANB angle among a sub-set of Nigerians"

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Abstract
Aims: Conjoint analysis of orthodontic patients using the Subspinale (A-point) Nasion-Supramentale (B point) (ANB) angle and the Wits appraisal is popular in many practices. This study aimed to present reference values for the Wits appraisal among Nigerians using three horizontal reference planes namely the bisected occlusal plane(BOP), the functional occlusal plane(FOP) and the maxillo-mandibular angle bisector(MM°bisector) plane. It also assessed the relationship of the Wits appraisal with the ANB angle and its interaction with clinical measures of sagittal skeletal relations among subjects with malocclusion.
Methodology: One hundred participants with normal occlusion and 120 with malocclusion were recruited in the study. Cephalometric radiographs were taken for all participants. Each radiograph was manually traced on a 0.003 matted cellulose acetate tracing paper using a sharpened 2H pencil. The Wits appraisal and ANB angle were determined. Data was analyzed using SPSS version 19.
Results: The mean age was 20.7±4.9 years for those with normal occlusion and 18.8±6.5 years in the malocclusion group. There were 91 (41.4%) males and 129(58.6%) females. Mean values for the Wits appraisal using the BOP as reference, was -1.27±2.91mm, with the FOP, it was -3.54±3.24mm, while with the MM° bisector plane, it was -4.75±2.94mm. The ANB angle showed highest correlation with the MM° bisector plane Wits value(P<0.001).
Conclusion: When the clinical and angular cephalometric findings are at variance, the ANB angle is best moderated by the MM° bisector plane Wits appraisal.

Keywords: *Wits appraisal, reference planes, ANB angle, Nigerians.*

Résumé
Objective : L'analyse conjointe des patients d'orthodontie en utilisant l'angle ANB et l'évaluation de Wits est populaire dans plusieurs pratiques. Cette étude visait à présenter des valeurs références pour l'évaluation de Wits parmi les nigérians en utilisant trois plans références horizontaux à savoir le plan occlusal bissecté (POB), le plan occlusal fonctionnel (POF) et le plan bissecteur d'angle maxillaire-mandibulaire (bissecteur°MM). Cela répartissait aussi la relation de l'évaluation du Wits avec l'angle ANB et son interaction avec les mesures cliniques des relations squelette sagittal parmi des sujets avec malocclusion.
Méthodes : Cent participants avec occlusion normale et 120 avec malocclusion étaient recrutés dans l'étude. Les radiographies céphalométriques étaient prises pour touts participants. Chaque radiographie était manuellement calquée sur un papier traçant d'acétate de cellulose emmêlé 0,003" en utilisant un crayon 2H taillé. L'évaluation de Wits et l'angle ANB étaient déterminés. Les données étaient analysées en utilisant SPSS version 19.
Résultats: L'âge moyen était 20,7±4,9 ans pour ceux avec occlusion normal et 18,86,5 ans dans le groupe de malocclusion. Ils y avaient 91 (41,4%) hommes et 129 (58,6%) femmes. La valeur moyenne pour l'évaluation de Wits en utilisant le POB comme référence était -1,272,91 mm, avec le POF c'était -3,543,24 mm, tandis qu'avec le bissecteur°MM c'était -4,752,94 mm. L'angle ANB montrait plus grande corrélation avec le plan bissecteur°MM de l'évaluation de Wits (p<0,001).
Conclusion : Quand les résultats céphalométriques clinique et angulaire sont en désaccord, l'angle ANB est mieux modéré par le plan bissecteur°MM de l'évaluation de Wits.

Mots clé: *Evaluation de Wits, plans références, angle ANB, Nigérians*

Introduction
The Wits appraisal a cephalometric assessment used in orthodontics, is based on the occlusal plane and was proposed by Jacobson [1,2]. This linear, assessment done on a lateral cephalometric radiograph uses perpendicular lines drawn from the Subspinale (A point) and supramentale (B point) to the occlusal plane. The horizontal distance between these points on the occlusal plane (AO-BO) is then measured.Mean values of 0mm for females and -1mm for males was reported by Jacobson [1,2].The

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Wits appraisal is valuable as a diagnostic aid to the ANB angle[3]whose reliability has been questioned on many bases[1,2,4-10]. TheWits appraisal does not use cranial landmarks so it is ideally more accurate than the ANB in diagnosing antero-posterior skeletal base disharmonies [1]. It is also less liable to errors of measurement because of its linear nature [11,12].

Skeletal base relationship assessed by the ANB and Wits appraisal differ significantly [1,13]. The Wits appraisal being reported to differentiate between classes I and II division I malocclusion more clearly than the ANB angle [14]. Though both ANB angle and Wits appraisal are reported to have a significant relationship with the various classes of malocclusion based on molar relationship[14], the Wits appraisal bears a more significant association than the ANB [13]. In addition, the proportion of misdiagnosis in class II malocclusion is reported to be higher with the ANB angle than with the Wits appraisal [14]. These indicate that the Wits appraisal showed a higher specificity in the diagnosis of class II relationship than the ANB. In addition, age related decrease in ANB angle have been reported [5],while the Wits appraisal showed no significant age changes in AB values in people with normal occlusion [5,15].

With respect to the Wits appraisal, problems associated with proper definition of the functional occlusal plane (FOP) defined by a line drawn through the cuspal overlap of the first molars and first premolars has led to the use of other occlusal plane variants. These problems are the result of growth, the mixed dentition [16] and presence of a steep curve of Spee [17]. The bisected occlusal plane (BOP) [17] defined by a line drawn through the cuspal overlap of the first molars and the mid-point of the overlap of the most anterior incisors, lower incisor plane (LIP) and more recently, the maxillo-mandibular angle (MM°) bisector plane [16] are the common occlusal plane variants that have been used.

The BOP is reported to correlate more with dental variables such as overjet and upper to lower incisor angulation while the FOP correlates better with the ANB angle [17]. The MM° bisector plane geometrically derived from the maxillary (palatal) and mandibular planes, is reported not to change with growth, and if at all, it changes in conjunction with the dental bases so that the true relation of the A and B points is not distorted. It is also easily reproducible [16,18] and not significantly changed by orthodontic treatment. It correlates better with ANB angle than Wits appraisal conducted using the BOP or FOP in class II division I patients [18] and is less liable to errors [19]. Since it is derived entirely from bony landmarks it presents a truer measure of antero-

posterior jaw positions than the traditional dentitio based Wits appraisal [20].

Studies carried out in Nigeria assessing th ANB angle abound in the literature [21-23 However, the need for conjoint analysis with oth methods of appraisal [1,5,24] make studies of oth assessment modalities for sagittal skeletal ba discrepancy among Nigerians pertinent.

This study has presented reference valu for the Wits appraisal among a group of Nigeria with normal occlusion, using three horizont reference planes namely the bisected occlusal plan the functional occlusal plane and the maxill mandibular angle bisector plane. It also assessed tl relationship between the Wits appraisalwith the AN angle as well as their interaction with clinic measures of sagittal skeletal relations amor Nigerians with malocclusion.

Materials and methods

A cross sectional study of 220 participants in Ibada south-western Nigeria, was carried out after approv was obtained from the University of Ibada University College Hospital Ethical Review Boar Subjects were assessed to have normal occlusi based on the following criteria: Angles' Class I mol relationship, arch crowding or spacing not great than 3mm, overjet of 2-4mm and overbite n exceeding ½ of the labial surface of the low incisors and a coincident midline. Participants wi malocclusion were recruited from the orthodont clinic of the University College Hospital, Ibad: whether they were Angle class I, II or I malocclusion. All participants were of full Nigeri: origin and have not had previous orthodont treatment.Written informed consent was request from each participant or their parents/ guardians they were minors (less than 16years old).

Using a data extraction form, soci demographic data was obtained. An intra-or examination was performed by one of us und natural light, using a sterile tongue depressor and mouth mirror. Findings including dental and occlus relationships were recorded.

Lateral cephalometric radiographs of a participants were taken using the Pan-Blue-Or machine(S/no 2402kk0164 ASSAGO, ITALY) wi participants' head held in a cephalostat, lookir forward with the Frankfort horizontal plane parall to the floor and the teeth in complete intercuspatic at standardized distance 150cm and 15cm from mi sagittal plane to the source of radiation and the fil respectively. Soft and hard tissue tracings we obtained manually on a 0.003 inch matte finis

acetate tracing paper and a sharpened 2H pencil over a light viewing box in a dark room. The ANB angle and Wits appraisal conducted with the FOP, BOP and MM° bisector planes as reference planes were obtained.The data was entered into a computer spread sheet and analysed using the IBM Statistical Package for Social Sciences (SPSS) version 19. Descriptive statistics in form of frequency tables and measures of central tendency were generated. Associations between the various continuous parameters were determined using the Pearson's bivariate correlation. The independent sample t-test and one-way ANOVA were used to assess relationships of continuous data across two or more groups respectively. Statistical significance was set at $p<0.05$.

Intra examiner variability was assessed by retracing 20 randomly selected radiographs at 2(two) weeks interval. The correlation coefficient was used for assessment and values of 0.88 for SNA, 0.84 for SNB and 0.85 ANB (all at $p< 0.01$) were obtained showing an acceptable level of agreement between the readings for the two measurements.

Results
Two hundred and twenty subjects were assessed. One hundred (45.5%) had normal occlusion, while one hundred and twenty (54.5%) had malocclusion. The latter group was further divided into three sub-groups of 40 each for the three classes of malocclusion. The mean age for participants with normal occlusion (group I) was 18.8± 6.5 years and for participants with malocclusion (group II) was 20.7± 4.9 years. Demographic distribution as well as class of malocclusion is as shown in table 1. Mean values for the Wits appraisal using the bisected occlusal plane(BOP), functional occlusal plane(FOP) and the maxillo-mandibular plane angle bisector(MM° bisector) as reference planes among participants with normal occlusion are as shown in table 2. Independent sample t-test showed that there was no significant difference for the ANB angle (p=0.47), MM° bisector (p=0.68), BOP (p=0.10) and FOP (p=0.11) Wits appraisal between the gender groups. This allowed for combined analysis across gender.

Correlation between participants' ANB angle and all Wits appraisal values as analyzed using the Pearson's bivariate analysis showed that the three variants of the Wits appraisal had significant positive correlation with the ANB angle. However the MM° bisector plane showed the highest correlation with the ANB both in normal occlusion and malocclusion (Fig 1).

One-way ANOVA showed that within the malocclusion group, ANB angle, BOP, FOP and

Table 1: Demographic distribution of the study sample

Variables	Malocclusion group N(%)	Normal occlusion group N(%)	Total N(%)
Gender			
Male	57(47.5)	34(34.0)	91(41.4)
Female	63(52.5)	66(66.6)	129(58.6)
Total	120(100)	100(100.0)	220(100.0)
Level of education			
Secondary	54(45.0)	25(25.0)	79(35.9)
Tertiary	66(55.0)	75(75.0)	141(64.1)
Total	120(100.0)	100 (100.0)	220(100.0)
Tribe			
Hausa	1(0.8)	0(0.0)	1(0.4)
Ibo	21(17.5)	15(15.0)	36 (16.4)
Yoruba	98(81.7)	85(85.0)	183(83.2)
Total	120(100.0)	100(100.0)	220(100.0)

Table 2: Wits appraisal values in normal occlusion using three reference planes.

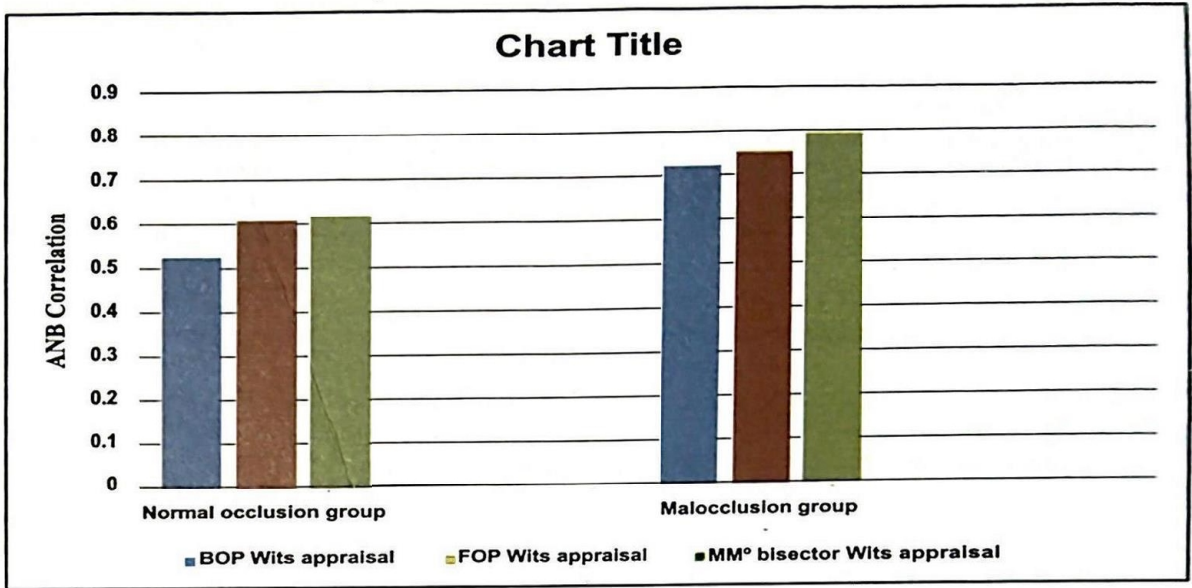| Parameter	Male	Female	Total
BOP Wits appraisal [Mean ± S.D (mm)]	-1.93±3.38	-0.93±2.59	-1.27±2.91
FOP Wits appraisal [Mean ± S.D (mm)]	-4.26±3.65	-3.17±2.96	-3.54±3.24
MM° bisector Wits appraisal [Mean ± S.D (mm)]	-4.92±3.31	-4.66±2.76	-4.75±2.94

Fig.1: Correlation between ANB angle and Wits appraisal using the three reference planes in normal occlusion and the malocclusion groups.

Table 3: ANOVA table comparing the relationship of ANB angle, BOP, FOP and MM bisector Wits appraisal with clinically determined sagittal relationship using the A-point to B-point palpation and molar relationship.

	based on A-point to		based on Angle's	
Radiological parameter	Mean(±SD)	F-test	Mean(±SD)	F-test
ANB°				
Class I	3.18(2.64)		3.02(2.60)	
Class II	7.00(2.75)	46.54*	6.63(3.00)	37.65*
Class III	-0.76(3.96)		0.25(3.81)	
BOP Wits appraisal (mm)				
Class I	-0.26(3.85)		-0.29(3.60)	
Class II	5.75(3.33)	46.78*	4.84(4.50)	35.92*
Class III	-4.18(3.82)		-3.23(3.74)	
FOP Wits appraisal(mm)				
Class I	-3.73(3.95)		-3.64(4.48)	
Class II	2.35(4.14)	46.74*	1.20(4.73)	30.87*
Class III	-8.14(4.50)		-7.06(4.34)	
MM° bisector Wits appraisal (mm)				
Class I	-4.82(4.12)		-4.57(4.49)	
Class II	1.09(3.54)	61.45*	0.27(3.80)	50.44*
Class III	-10.80(4.46)		-9.75(4.46)	

*- All significant at p<0.001
SD- Standard deviation.

MM° bisector Wits appraisal all have a statistically significant relationship with clinically determined skeletal pattern using the A point- B point palpation (F test= 46.54; 46.78; 46.74 and 61.45 respectively: p<0.01 in all cases). The same was the case when clinical classification was based on the molar relationship (F test= 37.6; 35.9; 30.9 and 50.4 respectively: p<0.01 in all cases) table 3.

To confirm this relationship, malocclusion subjects initially classified on the clinical criteria of Angle's molar relationship and A point- B point palpation were re-classified into classes I, II and III on the basis of radiological norms in this environment(with respect to the ANB angle) and from this study(for the Wits appraisal). Using Chi-square test, it was confirmed that classification based on A point to B point palpation and Angle's molar relationship was significantly related to radiological classification using the four radiological parameters as shown in table 4.

The significant positive correlation between the ANB angle and the Wits appraisal found in normal occlusion is advantageous. This must in the first case, be a good cause for combining these modalities in orthodontic diagnosis as malocclusions are deviations from the normal. Sagittal skeletal base classification by the Wits appraisal using all three reference planes showed better specificity in classifying this group of participants than the ANB angle. The ANB angle classified 35% of our normal occlusion sample as class II skeletal base highlighting still the unreliability of the ANB in this sample of

Table 4: Chi square values for classification of malocclusion based on ANB and the Wits appraisal using the three reference planes

Radiological classification	A-point to B point palpation		Molar relationship	
	Chi square value	P- value	Chi square value	P-value
ANB Angle	53.35	< 0.01	46.23	<0.01
BOP Wits appraisal	50.27	< 0.01	47.32	<0.01
FOP Wits appraisal	65.80	< 0.01	54.60	<0.01
MM° Bisector Wits appraisal	70.53	< 0.01	66.97	<0.01

Discussions

A study comparing the Wits appraisal using the three documented reference planes showed that the Bisected Occlusal Plane yielded a more positive Wits value than the Functional Occlusal Plane [16]. On the contrary, the Maxillo-mandibular plane angle bisector plane yielded a more negative Wits value relative to the Functional Occlusal Plane. This was confirmed in this study and can be attributed to the fact that the bisected occlusal plane has the most horizontal slant relative to the functional occlusal plane and the maxillo-mandibular angle bisector plane [16]. The latter planes have a downward slant anteriorly relative to the bisected occlusal plane. The AO-BO distances will thus tend to be further apart as the planes rotate on the downward slant, with the B-point being further ahead and resulting in progressive negative Wits readings. In addition, studies have shown that though males tend to have more negative Wits reading than females [25,26] the difference is not significant. These reports are in agreement with the findings of this study.

The maxillo-mandibular plane angle (MM°) bisector Wits appraisal reading obtained from this study are similar to those reported by Hall-Scott and co-workers [16]. This may be a pointer to a relative stability of the MM° Bisector Wits appraisal across races and justifies its being preferred above other Wits appraisal modalities.

participants. Indeed, ANB values of up to 10° has been reported in normal occlusion [22].

This study has also shown that when A point-B point palpation and molar relationship were the sole clinical criteria considered, one is able to establish a true separation of the various classes among people with malocclusion using both the ANB angle and the Wits appraisal. This is in agreement with a previous study [27]. However, this difference was better evaluated with the Wits appraisal in general and the MM° bisector Wits in particular rather than the ANB angle as reported in another study [19]. This variation in findings is a good reason for the need of conjoint cephalometric analysis in patient management. An additional point to note is that manual palpation of the A and B points is of higher clinical value than the molar relationship in the assessment of sagittal skeletal base discrepancy as observed from the ANOVA and chi square values. So, in the absence of cephalometry as can sometimes prevail in poorly developed countries, this clinical tool must not be disregarded.

That the ANB angle correlated best with the MM° bisector Wits appraisal is in keeping with previous reports [16,18]. This further establishes the MM° bisector plane as a better basis to measure sagittal skeletal discrepancy rather than the FOP or the BOP if the Wits appraisal is to be considered. Considering that the MM° bisector Wits appraisal is purely skeletal in origin, as against the FOP and BOP

which have dental components, the clinical value of this Wits appraisal variant in orthodontic practice cannot be overlooked. Conjoint analysis using the ANB angle and the MM° bisector Wits appraisal is therefore advocated where these two cephalometric analyses is to be combined.

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