Original Article

Comparison of Reliability and Validity of Different Discrepancy Indicators of Anteroposterior Axis of the Skull of Patients of Varying Age Groups that Visit a Tertiary Care Hospital in Karachi

Sadaf Talha[1], Attiya Sheikh[1], Sanaa Ahmed[2], Talha Bin Saeed[4], Sara Ahmed Peerzada[1] and Muhammad Atif[3]

ABSTRACT

Objective: To find out the reliability and validity of commonly used antero-posterior skeletal discrepancy indicators including WITS, ANB, Beta Angle and MMAB Class I malocclusion in different age groups.
Study Design: Cross-sectional retrospective study
Place and Duration of Study: This study was conducted at the Orthodontics department of Liaquat College of Medicine and Dentistry, Karachi from January 2018 to June 2020.
Materials and Methods: Cephalometric analysis of 100 patients who went under treatment was done. This study was conducted on patient`s cephalometric records. Data of patients from ages 12 to 26 years who attended OPD during this period was included in the study excluding known cases of syndromes and Cleft Lip and Palate. The value of SNA, SNB, WITS analysis and Beta angle were calculated on pre-treatment lateral cephalograms.
Results: Our sample is majorly composed of females predominantly belonging to the adolescent group. Independent t-test was applied for rater 1 and rater 2 readings of ANB, Beta Angle, WITS, and MMAB finding out that the most valid predictor was the Beta angle and ANB. Intraclass Correlation was almost in perfect agreement in all the parameters.
Conclusion: Our study concluded that WITS and Beta angle are valid and reliable predictors of sagittal deficiency in class I malocclusion.
Key Words: Occlusion, Sagittal Discrepancy, Cephalometric Analysis, Malocclusion, Skull Base

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INTRODUCTION

The science of Diagnosis and Treatment Planning in orthodontics mainly revolves around anteroposterior dimension discrepancy. Cephalometric analysis is very important as it is the only option for calculating this discrepancy.

[1.] Department of Orthodontics, Liaquat College of Medicine and Dentistry, Karachi.
[2.] Department of Oral Medicine / Oral Pathology[3], Jinnah Sindh Medical University, Karachi.
[4.] Department of Dentistry, Pakistan Telecommunication Company Limited, Karachi.

Correspondence: Dr. Sanaa Ahmed, Assistant Professor, Oral Medicine, Jinnah Sindh Medical University, Rafiqui HJ Road Saddar, Karachi.
Contact No: 021-99204968
Email: drsanaaumair@gmail.com

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Several sagittal discrepancy parameters have been used over the years, but none fully defined the nature of the malocclusion. Hence, the race to find a reliable and valid parameter for this purpose.[1] Previously, both the jaws that is maxilla and mandible were used as point of reference in the base of the skull. Down's work laid the foundation for this by defining points A and B and evaluating anteroposterior apical base relationship.[2] He also found that ANB is affected by changes in the nasion`s rotation and both jaws.[1] Riedel suggested using Sella-Nasion Point A (SNA) and Sella Nasion Point B (SNB) angles and their correlation with ANB for dental relationships.[3]

Steiner suggested that various parts of the skull including skull bones, dentition and the covering soft tissues should be included in the analysis of the malocclusion. Jacobson suggested "WITS" appraisal which correlated the points A and B with the plane of occlusion.[4] The maxillary and mandibular relationship is calculated by the distance between the lines intersecting at the Functional Occlusal plane drawn from Point A and B.[5] Hence, any changes in the occlusal plane angle will affect the location of A and B

points and result in the change in WITS appraisal reading.[6] Development of the teeth and their eruption can also be affected by the occlusal cantt. This required a new and more reliable plane, proposed by Scott JH, that is maxillo-mandibular plane angle bisector (MM bisector plane).[7] This plane is inferior to occlusal cantt, but it is very reliable since it is highly replicable every time, as it does not alter with growth. This will not affect the actual point A and B relationship.[7]

Further, a new parameter was suggested for assessing sagittal insufficiency: "Beta Angle".[8] Measurement between points A and B and the axis of the condyle was used to measure the Beta angle which depicted the types and severity of the skeletal problem. The authors found that if the Beta angle is 27°-35° then the patient will have Skeletal Class I but if it is < 27° then it points towards Class II and a value > 35° indicates a Class III.[9] Another study held on Sudanese population showed that in pre-treatment patients the more reliable method was W angle for Class I, although for Class II and III ANB angle and APP-BPP distance was required by Pearson correlation analysis in 107 patients.[10] A local study in Pakistan supported the ANB angle to be more reliable and valid and was backed by samples collected from multiple centers for analyzing the anteroposterior relationship in all sagittal groups in Class I. Down's angle of convexity, WITS appraisal, and Beta angle are more valid for Class III.[11]

A study conducted by Rana Tiwari concluded that MM-AB is a better predictor than other parameters in all age groups.[1] While SN-AB and β-angle are relatively less predictable, shown by CkC = 0.357 and 0.235 respectively, ANB and WITS readings had slight agreement while ANB showed low validity. For anteroposterior discrepancy multiple indicators are used to assess the lacking in Class I malocclusion. To fill this gap we wanted to find out the reliability and the validity of commonly used antero-posterior skeletal discrepancy in Class I malocclusion in different age groups.

MATERIALS AND METHODS

It is a retrospective study on cephalometric records of patients who have had their treatment at the Department of Orthodontics of Liaquat College of Medicine and Dentistry. Permission from the local institutional review board was taken as part of the protocol. This study was conducted on patients' cephalometric records. 100 patients visited the department during the time of January 2018- June 2020. Sample size was calculated through Open Epi at confidence interval of 99.99% keeping total population of 100 as 94. Random sampling was done. Patient included in the study had Class 1 malocclusion relationship and complete permanent dentition. Excluding all with craniofacial deformity/ asymmetry, Cleft Palate, and history of orthodontic treatment / maxillofacial surgical intervention. Around 64 Females and 30 males were included. Cephalometric tracings were performed by 2 researchers (Dr. Sadaf and Dr. Attiya Sheikh) and interrater reliability was calculated through Intra Class Correlation (ICC) test. STROBE checklist is used in the preparation of this manuscript.

After seeking permission from the IRB, the primary researchers performed cephalometric tracings and calculated the value of SNA, SNB, WITS analysis, and Beta angle. Measurements were calculated on pre-treatment lateral cephalograms. Anatomic tracings and the location of dento-skeletal landmarks were marked manually as per the following:

- **S-N plane:** Line joining points Center of Sella Tursica and anterior point of the fronto-nasal suture.[12]
- **SNA angle:** It is the angle between the Sella and Nasion plane and line which join N and A points.[12]
- **SNB angle:** It is the angle between the Sella and Nasion plane and line which joins N and B points.[12]
- **ANB:** Angle formed by line joining points A(anterior nasal spine), Nasion, and B.[12]
- **Wits:** It is the distance of the A and B`s perpendicular projections on the plane of occlusion.[12]
- **Beta angle:** The angle formed by the perpendicular line from point A to C- B line and the A-B line.[12]
- **MM-AB bisector:** The angle between Maxillo-Mandibular plane angle bisector to Point A and Point B distance .[12]
- **Cant of Occlusal Plane:** The angle is formed between occlusal plane and Frankfurt Horizontal plane.[12]
- **Class I Malocclusion** fulfilling the following conditions:
  - Angle`s Class I molar relationship
  - ANB angle= 1° to 3°
  - WITS= 0 to -3

RESULTS

Analysis was done through SPSS ver. 20 and bar charts depicting data of patients treated according to gender and age groups were made. Around 53% of patients were females and mostly were 13 and 22 years of age. The female-to-male ratio was 2.1:1 (figure 1 and 2).

Table No.1: Mean, Standard Deviation, Std. Error Mean of the cephalometric analysis.

	N	Mean	Std. Deviation	Std. Error Mean
WITS1	100	-.970	3.6312	.3631
WITS2	100	-.905	3.9643	.3964
MMAB1	100	-2.075	3.5635	.3564
MMAB2	100	-1.8000	3.36875	.33688
ANB1	100	4.665	2.6667	.2667
Beta1	100	31.935	4.8219	.4822
ANB2	100	4.800	2.6083	.2608
Beta2	100	31.700	4.7065	.4707

Table 1 shows the mean, standard deviation, and standard error mean for the cephalometric analysis for both rater 1 and rater 2 readings. Rater 1 analysis has "1" added to the parameter while rater 2 has "2" added to the parameter. Both raters have high variations in values for WITS analysis, MMAB, and Beta angle. The variations are due to the variety of malocclusions.

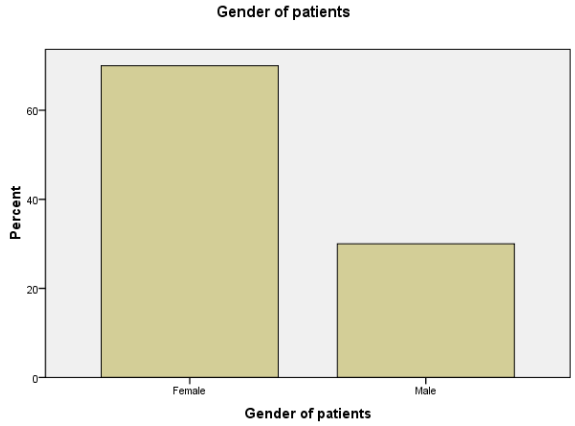

Figure No.1: Bar chart showing the percentage of female and male patients.

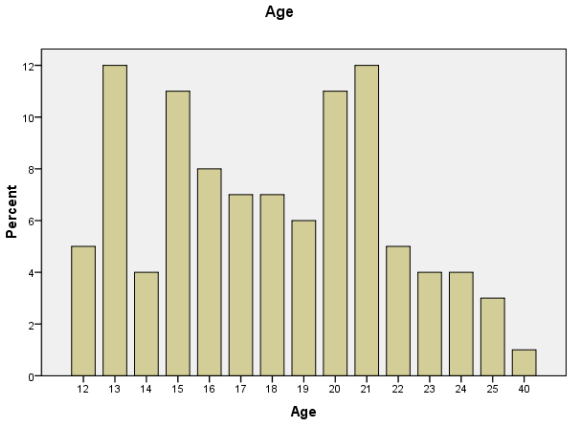

Figure No.2: Bar chart showing the number of patients according to years

Table 2 shows the independent t-test results for rater 1 readings according to their significance to the age groups that are adolescent and adult. It shows WITS appraisal (p-value =0.631), and Beta angle (p-value =0.910) readings are significant according to the age groups while ANB and MMAB have a non-significant relationship to the age of the patient.

Table No.2: Independent T-Test results of Rater 1 cephalometric readings

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	St.Error Difference	Lower	Upper
WITS1	Equal variances assumed	.232	.631	-.493	98	.623	-.3667	.7441	-1.8433	1.1099
	Equal variances not assumed			-.501	88.136	.618	-.3667	.7324	-1.8221	1.0887
ANB1	Equal variances assumed	.515	.475	-.450	98	.654	-.2458	.5465	-1.3304	.8388
	Equal variances not assumed			-.466	92.994	.642	-.2458	.5273	-1.2929	.8012
Beta1	Equal variances assumed	.013	.910	-.110	98	.913	-.1083	.9892	-2.0714	1.8547
	Equal variances not assumed			-.109	82.046	.914	-.1083	.9950	-2.0877	1.8710
MMAB1	Equal variances assumed	.479	.491	-.371	98	.712	.2708	.7306	-1.7207	1.1790
	Equal variances not assumed			-.380	90.134	.705	-.2708	.7135	-1.684	1.1467

Table No.3: Independent T-Test results of Rater 2 cephalometric readings

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	St.Error Difference	Lower	Upper
WITS2	Equal variances assumed	.474	.493	-.061	98	.951	-.0500	.8133	-1.6640	1.5640
	Equal variances not assumed			-.059	72.775	.953	-.0500	.8445	-1,7332	2,2484
Beta2	Equal variances assumed	.219	.641	.345	98	.731	.3333	.9650	-1.5817	2.2484
	Equal variances not assumed			.337	76.804	.737	.3333	.9882	-1.6345	2.3012
ANB2	Equal variances assumed	.097	.756	.039	98	.969	.0208	.5351	-1.0411	1.0828
	Equal variances not assumed			.039	83.388	.969	.0208	.5358	-1.0447	1.0864
MMAB 2	Equal variances assumed	.349	.556	-.362	98	.718	-.25000	.69068	-1.62063	1.12063
	Equal variances not assumed			-.367	87.812	.714	-.25000	.68064	-1.60267	1.10267

Table No.4: Intraclass Correlation Coefficient to find the variation in values of Rater 1 and 2 analyses

Rater 1 and 2 Readings	Intraclass Correlation average	95% Confidence Interval	
		Lower bound	Upper bound
MMAB	0.969*	0.953	0.979
Beta Angle	0.929*	0.895	0.952
ANB	0.951*	0.927	0.967
WITS	0.962*	0.944	0.975

The two-way mixed-effects model where people's effects are random and measures effects are fixed.
*This estimate is computed assuming the interaction effect is absent because it is not estimable otherwise.

In table 3 the analysis for rater 2 readings is done showing a significant relationship between ANB (p-value =0.756) and Beta angle (p-value =0.641) with the age groups. While the intra-rater variation is depicted in table 4 which shows there is no significant variation between the analysis done by the two raters. They have similar values (Intra-class coefficient higher than 0.9)

DISCUSSION

The last century set the base for our current knowledge on malocclusion and associated parameters. For over 60 years, the ANB angle and WITS analysis has stood the test of time since their discovery in analyzing anteroposterior discrepancy. ANB is affected by readings of other parameters and by growth spurts. It should be used along with other indicators. The WITS appraisal is stable that is it does not alter by landmarks or jaw rotation, but it fails to identify the occlusal plane. Using it to correct malocclusion will reflect on the occlusal plane and not on the changes in the sagittal plane. Due to these problems Beta Angle was developed to support. Which is rather dependent on the point A, B and C. Hence the changes lie within the jaws rotational plane giving it the edge over ANB and making it more accurate indicator of sagittal changes. Manipulating it, a clinician can easily camouflage the skeletal pattern discrepancy in the sagittal relationship. We can use it over the duration of treatment period to evaluate the changes due to growth and orthodontic intervention. Though the marking of point C on condyle is rather a skilled work but still it is if located within a radius of 2 mm then it is affected less than 1° making it acceptable than other parameters.

The current study sample was based on Class I malocclusion as supported by literature being the most dominant type in the population.[12,13] Building on the previous work by Qamar Uddin and Oktay, which showed a weak relationship between ANB and WITS appraisal, we tried to find a valid and reliable parameter in both adult and adolescent groups.[14, 15] Qamar Uddin compared ANB, Beta angle, WITS, Yen and W angle and found all of them to be valid and reliable in finding out the skeletal class I, II and III and can be alternatively utilized if one parameter is deemed to be difficult.[15] Oktay priorly had compared ANB, Wits,

AF-BF, and APDI and found that Wits, AF-BF, and APDI assessment criteria are less accurate in diagnosing sagittal discrepancy in contrast to ANB.[16]

Previously, only a handful of studies have correlated all the angular and linear indicators for sagittal discrepancy across various age groups reporting for orthodontic evaluation.[1, 16] Since it is part of the diagnosis and treatment planning process hence, this evaluation and correlation with the correct amount of sagittal discrepancy to be compensated by orthodontic treatment supported with or without orthodontic surgery are of immense importance. In our study predominant population belonged to the female gender and adolescent age group (adolescent 54, adults 40 out of a sample of 94) .[1] The highest reporting age was 13 and 21 years. The mean standard deviation for all the readings was above 3.5 showing high variation among the data of patients who reported with Class 1 Malocclusion.

We applied an independent t-test by making two groups: adolescent and adult and finding the significance in their relationship with the different parameters. Both of our raters had an agreement on all the readings shown by a high intra-class correlation which was above 0.9. Therefore, there are very low chances of variation in readings between the raters. Our findings support that Beta angle and WITS are the most valid and reliable parameters of the anteroposterior deficiency in adolescents and adults.

CONCLUSION

Our study concluded that WITS and Beta angle are valid and reliable predictors of sagittal deficiency in class I malocclusion.

Author's Contribution:

Concept & Design of Study:	Sadaf Talha
Drafting:	Attiya Sheikh, Sanaa Ahmed
Data Analysis:	Talha Bin Saeed, Sara Ahmed Peerzada, Muhammad Atif
Revisiting Critically:	Sadaf Talha, Attiya Sheikh
Final Approval of version:	Sadaf Talha

Conflict of Interest: The study has no conflict of interest to declare by any author.

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