ORIGINAL ARTICLE

Linear Palatal Plane A New Method To Assess Anteroposterior Jaw Relationship In Different Skeletal Classes

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OBJECTIVE: The objective of this study was to assess the palatal plane in comparison with Wits and ANB angle to determine the linear anteroposterior jaw relationship among Pakistani population in different Skeletal classes.

METHODOLOGY: This descriptive cross sectional study was conducted using pre-treatment lateral cephalograms of 256 patients, aged 12-34 years in Orthodontic department at Liaquat College of Medicine and Dentistry, Darul Sehat Hospital, Karachi. Individuals with Skeletal Class I,II and III participants were chosen through the convenience sampling method. Occlusal and palatal planes were then traced and bisected by the perpendicular lines from Point A and Point B. Different parameters including ANB angle, Wits appraisal and LPP(APP-BPP) were measured to evaluate the sagittal jaw relationship. Descriptive statistics were calculated for each parameter using SPSS Software 26.

RESULTS: The descriptive statistics revealed that the mean values of ANB, Wits appraisal and LPP were determined to be 4.398°±2.843°, 1.181±4.126 mm and 8.015±4.493mm, respectively. Mann-Whitney U test indicated a significant difference between the gender in relation to ANB angle and LPP where value was found to be (p=0.001)and (p=0.031), respectively. Whereas an insignificant result was found for Wits appraisal with a value (p=0.502). Moreover, ANB angle, Wits appraisal and LPP were found to have increased wih increasing age. A strong positive correlation was seen between the ANB angle and Wits (p=0.000, r=0.705), Wits appraisal and LPP (p=0.000,r=0.617) and LPP and ANB angle(p=0.000, r=0.800).

CONCLUSIONS: Different age categories were found to have significant influence on ANB,Wits appraisal and LPP which showed that these parameters changed significantly with age. Moreover significant relation was found between gender and different Skeletal classes which showed that ANB,Wits and LPP were found to be slightly greater in females as compared to males. A positive correlation was found among the parameters ANB angle, Wits appraisal and LPP.

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INTRODUCTION

Lateral cephalometric radiograph is regarded as one of the most crucial diagnostic tool used for the evaluation of jaw relationship in all three planes: sagittal, vertical and transverse. It shows various hard and soft tissue structures which helps the clinician to determine patient's craniofacial Skeletal pattern. The anteroposterior position of jaws in relation to each other plays a critical role in determining whether orthodontic treatment alone or in combination with surgery is needed.[1]

Several angular and linear parameters such as Frankfort horizontal plane and Sella-Nasion plane have been utilized to measure sagittal jaw disharmonies. However,these parameters have their own advantages and drawbacks such as difficulty in anatomical location of porion and inclination of FH plane which may affect the measurement.

Various methods have been introduced to assess the sagittal apical base relationship.Riedel (1952)[2] introduced ANB angle which is considered as one of the most commonly used method to determine the anteroposterior jaw discrepancy. However, significant problems were associated with this angle such as change in the position of nasion, vertical height of the face and orthodontic intervention during growth that lead to its replacement. Moreover, with advancing age, ANB angle tends to decrease as a result of counterclockwise growth rotation of jaws.[3] To overcome the shortcomings of ANB angle, occlusal (Wits) and palatal planeswere traced to assess the sagittal jaw discrepancies.

Jacobson (1975)[3] introduced 'Wits' appraisal to determine sagittal jaw relationship. In his study, he found that in Class II, BO is positioned well behind point AO (positive reading) whereas in Class III, BO is positioned ahead of point AO (negative reading). Wits measurement for men and women was found to be 1.15 mm (S.D. I .9) and -0.1 mm. (S.D.

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1.77), respectively. However,several issues were encountered with Wits measurement which showed that identification of occlusal plane is not easy or accurately reproducible[7,8] as it is considered as a dental parameter which can be easily affected by tooth eruption ,dental development as well as by orthodontic treatment.[4,5,6]

Nanda and Merrill[14] introduced LPP(APP-BPP) measurement as shown in (Fig:1) based on the palatal plane which serves as another Skeletal landmark in close proximity to the area being surveyed, and it is considered to be the most reliable and stable plane.[9,10] It maintains a constant

Fig: 1 **LPP**

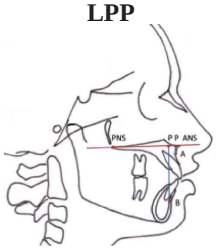


Fig: 2 **WITTS**

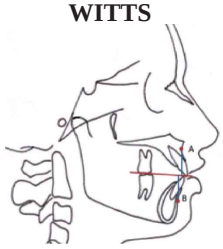
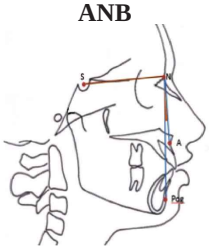


Fig: 3 **ANB**



angular relationship with the anterior cranial base throughout the individual's life.[10-13] Furthermore, palatal plane remain unaffected by the changes in the position of nasion and avoids the variations commonly encountered with ANB and occlusal measurements of the craniofacial structure. The mean value of LPP was found to be 5.2±2.9 and 4.2±3.6 for female and male, respectively. This value increased in Class II and decreased in Class III malocclusion.

Rothberg et al[19] in their study found no significant correlation between the ANB angle and the Wits appraisal. Whereas, Pyakurel et al[20] conducted a study on patients of class I malocclusion in which he found inconsistent results with respect to age group 26-34 years where the values for Wits appraisal and LPP were 0.05±3.796mm and 4.20± 3.075, respectively. Similarly, a study done by Bjork[13] using implants found that palatal plane inclination in relation to cranial base was maintained throughout growth. These results were also consistent with the findings of study done by Broadbent[11] in which a parallel relation over the growth range was maintained by palatal plane in the population he studied.

As per the literature search, till date there is no such study that has been conducted to assess the palatal plane in comparison with Wits and ANB angle among Pakistani population.Thus, the objective of this study was to assess the palatal plane in comparison with Wits and ANB angle to determine the linear anteroposterior jaw relationship among Pakistani population in different Skeletal classes. Therefore in order to accurately diagnose antero-posterior jaw relationship two or more methods can be used by clinician as an adjunt in orthodontic diagnosis and treatment planning.

METHODOLOGY

This descriptive cross-sectional study was conducted in the department of Orthodontics from July 2022 till September 2022 Liaquat College of Medicine and Dentistry, Darul Sehat Hospital, Karachi.The present study was approved by Institutional review board in which lateral cephalogram of "two hundred and fifty six" patients visiting the outpatient department after satisfying the inclusion
and exclusion criteria were recruited in the study.

INCLUSION CRITERIA

Following patients were included in the study.

- Individuals with Skeletal class I,II and III malocclusion
- Age group between 12 to 34 years
- Patients of both gender
- Those patients with high quality pretreatment lateral cephalometric radiographs were included.
- Presence of permanent dentition in both arches.
- No history of previous orthodontic treatment.

EXCLUSION CRITERIA

Following patients were excluded from the study. History of trauma to dentofacial region.

Any major illness,craniofacial syndromes and facial asymmetries.

History of orthognathic, and reconstructive surgery. History of congenitally missing teeth or anomalies in dentition.

Sample size calculation

A total sample of 256 patients (61 males and 195 female) was calculated by using WHO sample size calculator at a confidence interval of 95%, power of test 80% and margin of error 0.5.

The sampling technique used in this study was non-probability convenience sampling technique. Initially, the informed consent was taken from the selected patients. The study participants were selected based on their high quality pre-treatment lateral cephalogram which were then traced accurately by the same investigator by using an acetate matte tracing paper (0.003 inches thick, 8 x 10 inches) with 0.3mm lead pencil under optical illumination. Participants were divided into three different Skeletal classes based on ANB angle. Angular and linear parameters were traced by using a stainless-steel ruler and a protracter. It was performed by the same operator twice in the similar setting

to avoid bias and chances of error while no oral examination was performed on the study participants.

SAGITTAL SKELETAL RELATIONSHIP

The sagittal Skeletal relationship is determined by ANB angle. It was divided into 3 groups:

In Skeletal class I (ANB±2 °)[15] is determined by detecting the difference between SNA and SNB angle.

Skeletal class I indicates that maxilla and mandible are in harmony in relation to anterior cranial base.

In Skeletal class (II ANB>4°)[15] degree and is determined by detecting the difference between SNA and SNB angle. Skeletal class II indicates that maxilla is ahead of mandible in relation to anterior cranial base.

In Skeletal class III (ANB<0°)[15] is determined by detecting the difference between SNA and SNB angle. Skeletal class III indicates that maxilla lies posterior to mandible in relation to anterior cranial base.

CEPHALOMETRIC LANDMARKS

SELLA: A midpoint of the pituitary fossa or sella turcica
NASION: Anterior point of the frontonasal suture
POINT A: The inner most point on the contour of pre maxilla between ANS and incisor tooth
POINT B: The inner most point on the contour of mandible between incisor or bony chin
ANS: The anterior tip on the upper or lower contour of the spine
PNS: The tip of the posterior spine of the palatine bone at the junction of hard and soft palate
OCCLUSAL PLANE: It is formed by bisecting the molars and premolars
PALATAL PLANE: It is formed by the intersection of ANS and PNS

ANGULAR AND LINEAR PARAMETERS

SNA: The angle formed between SN to point A
SNB: The angle formed between SN to point B
ANB: The difference between SNA and SNB
LPP(APP-BPP): The perpendicular line drawn from point A and point B to the palatal plane
WITS(AO-BO): The perpendicular line drawn from point A and point B to the occlusal plane

STATISTICAL ANALYSIS

Data was entered and statistical analyses were carried out with the help of SPSS Software 26. Level of significance was set at $p < 0.05$. Mean, Median, Interquartile range and standard deviation were computed. The Shapiro-Wilk test was applied which showed that the significance level was < 0.05 which showed that data was not normally distributed so non parametric independent Mann-Whitney U test was applied between gender, spearman correlation was applied to compare the differences among the parameters and Kruskal-Wallis test was applied across different Skeletal classes for all the parameters.

RESULTS

Out of the 256 patients taken in the study,61(23.8%) were males and 195(76.2%) were females categorized into 3 skeletal classes including 125 patients of Skeletal class I,117 patients of Skeletal class II and 14 patients of Skeletal class III, respectively. The reason behind the uneven distribution is that class I and II malocclusion is more prevalent as compare to class III in the study setting. The age ranges from 12 to 34 years with a mean age of 18.42±4.936. In the present study the mean value of ANB angle was found to be 4.398°±2.843°, whereas the sagittal jaw relation with reference to Wits appraisal and LPP were determined to be 1.181±4.126 mm and 8.015±4.493mm, respectively (Table I).

Table I: Demographic and cephalometric parameter

PARAMETERS	MEAN±SD	SEM	MINIMUM	MAXIMUM
AGE	18.42±4.936	0.308	12	34
SNA°	82.79±4.059	0.253	71	95
SNB°	78.40±4.281	0.267	67	94
ANB°	4.398±2.843	0.177	-5	11
Wits(AO-BOmm)	1.181±4.126	0.257	-12	12
LPP(APP-BPPmm)	8.015±4.493	0.280	-9	22

As shown in table II out of all the parameters ANB(4.738±2.643º), Wits(1.256±4.012mm) and LPP (8.323±4.217mm) were found to be slightly greater in females as compared to males where the mean values were found to be 3.311±3.191º, 0.942±4.498mm and 7.032±5.199mm, respectively. However significant

Table II: Comparison of parameter across gender

PARAMETERS	MEAN±SD SEM	MALE(%)	FEMALE(%)	P-VALUE
SAMPLE(N)		61(23.8)	195(76.2)	
AGE	MEAN±SD SEM	17.60±4.306 0.551	18.67±5.101 0.365	
SNA°	MEAN±SD SEM	81.32±4.444 0.569	83.25±3.828 0.274	0.01
SNB°	MEAN±SD SEM	78.01±4.745 0.607	78.52±4.131 0.295	0.287
ANB°	MEAN±SD SEM	3.311±3.191 0.408	4.738±2.643 0.189	0.001
Wits(AO-BOmm)	MEAN±SD SEM	0.942±4.498 0.575	1.256±4.012 0.287	0.502
LPP(APP-BPPmm)	MEAN±SD SEM	7.032±5.199 0.665	8.323±4.217 0.302	0.031
Independent Mann-Whitney U Test ,The significance level < 0.05				

differences were found between the gender in relation to ANB angle and LPP where p value was found to be (p=0.001)and (p=0.031), respectively. In contrast an insignificant result was found for Wits appraisal with a value (p=0.502).

Table III shows the descriptive statistics according to the different age group where ANB, Wits and LPP were found to be slightly greater in age group >26 years 5.434±2.351º, 3.043±3.243mm and 9.260±3.165mm as compare to the age

Table III: Demographic and cephalometric parameter in relation to age

PARAMETERS	MEAN±SD SEM	<14 YEARS	15-25 YEARS	>26 YEARS
NO OF PATIENTS		70	163	23
GENDER	MEAN±SD	1.742±0.440	1.748±0.435	1.913±0.288
	SEM	0.052	0.034	0.060
SNAº	MEAN±SD	81.85±3.596	83.18±4.332	82.91±2.874
	SEM	0.429	0.339	0.599
SNBº	MEAN±SD	77.42±3.790	78.95±4.525	77.47±3.231
	SEM	0.453	0.354	0.673
ANBº	MEAN±SD	4.428±3.128	4.239±2.761	5.434±2.351
	SEM	0.373	0.216	0.490
Wits(AO-BOmm)	MEAN±SD	1.400±4.477	0.825±4.024	3.043±3.243
	SEM	0.535	0.315	0.676
LPP(APP-BPPmm)	MEAN±SD	8.085±4.720	7.809±4.546	9.260±3.165
	SEM	0.564	0.356	0.660

group of <14 years 4.428±3.128º, 1.400±4.477mm and 8.085±4.720mm and it tends to decrease further in age group of 15-25 years where the ANB,Wits and LPP were found to be 4.239±2.761º, 0.825±4.024mm and 7.809±4.546mm, respectively.

As shown in Table IV, a statistically significant (p<0.05) results were observed among these parameters including ANB angle, Wits appraisal and LPP across different Skeletal classes of malocclusion.

Table IV: Cephalometric parameter in relation to skeletal classes

PARAMETERS	MEAN±SD SEM	SK CLASS I	SK CLASS II	SK CLASS III	P-VALUE
NO OF PATIENTS		125	117	14	
ANBº	MEAN±S	2.816±1.117	6.854±1.604	-2.000±1.109	0.000
	DSEM	0.099	0.148	0.296	
Wits (AO-BOmm)	MEAN±SD	-0.540±3.411	3.717±3.117	-4.642±3.650	0.000
	SEM	0.305	0.288	0.975	
LPP (APP-BPPmm)	MEAN±S	5.840±3.006	11.17±3.371	1.071±4.632	0.000
	DSEM	0.268	0.311	1.237	
Kruskal-Wallis test, Level of significance <0.05					

As shown in Table V, a statistically strong positive correlation was seen between the ANB angle and Wits (p=0.000, r=0.705) , Wits appraisal and LPP (p=0.000, r=0.617) and LPP and ANB angle (p=0.000, r=0.800).

Table V: Spearman correlation test to determine relation between parameters

PARAMETERS		"r" value	*P*-value
ANBº	Wits	0.705	0.000
Wits	LPP	0.617	0.000
LPP	ANBº	0.800	0.000
**Statistical significance at p value <0.05, strong positive correlation at r value>0.7*			

DISCUSSION

Assessment of sagittal apical base relationship plays an essential role in orthodontic diagnosis and treatment planning. Many methods have been developed to evaluate the sagittal jaw discrepancy but each method has their own shortcomings. Therefore, in the current study palatal plane was assessed in relation to Wits and ANB angle in Skeletal class I ,II and III malocclusion.

Palatal plane was used as a reference plane for this study. The advantages of using this plane are that it is not influenced by growth changes of point N, rotation of the jaws and the inclination of the occlusal plane.

In the present study ANB angle was found to be 4.398°±2.843° which was not in accordance with Jarvinen[20] where it was found to be 2.08° .However, these values are also inconsistent with respect to different age groups.It tends to increased in females 4.738°±2.643° as compare to males 3.311°±3.191° which are in accordance with the values reported by Walker and Kowalski[17] for females 4.34° but disagrees for males 4.65° which showed that these variations could be due to different ethnic groups and small sample size. ANB angle was found to be increased in age group >26 years 5.434°±2.351° as compare to the age group <14 years 4.428°±3.128° and it tends to decrease in age group 15-25 years 4.239°±2.761°. The mean ANB angle was found to be increased in class II (6.854±1.604) and decreased in class I (2.816±1.117) and III (-2.000±1.109).

The mean value of Wits in the present study was determined to be 1.181±4.126mm which was not in accordance with the study done by Pyakurel et al[18] in Nepali subjects where Wits appraisal was 0.38±3.331mm being slightly greater in females 1.256±4.012mm as compared to males 0.942±4.498mm, respectively which was not in accordance with the findings of Jacobson for males (1.17±1.9mm) and for females (-0.10±1.77mm)[3] and is shown in Table II. Wits was found to be slightly greater in age group >26 years 3.043±3.243mm as compare to the age group of <14 years 1.400±4.477mm and it tends to decreased further in age group of 15-25 years where the Wits was found to be 0.825±4.024 mm, respectively. These finding suggest that Wits appraisal can be influenced with the advancing age. Whereas Wits appeared to be increased in Skeletal II (3.717±3.117mm) and decreased in Skeletal class
I(-0.540±3.411mm) and III (-4.642±3.650 mm).

In the present study the mean value of LPP was determined to be 8.015±4.493mm which is not in accordance with the study done by Pyakurel et al[18] in Nepali subjects where LPP was 3.291±4.285mm.It has increased in females 8.323±4.217mm and decreased in males 7.032±5.199mm.

In contrast Soliman et al.[16] reported the sagittal jaw relation to be 0.64±0.49mm for male and 0.61±0.39mm for female. However, the mean values for White male and female were 5.2±2.9 mm and 4.8±3.6 mm[14] which is in contrast with the present study, respectively. These discrepancies could be due to the racial and ethnic variations. It was found that LPP was increased in age group of >26 years 9.260±3.165mm as compare to the age group <14 years 8.085±4.720 mm and it tends to decrease in age group of 15-25 years 7.809±4.546mm which was inconsistent for age categories with the findings of Pyakurel et al.[18] In contrast mean LPP was found to be increased in Skeletal class II (11.17±3.371mm) and decreased in Skeletal class I (5.840±3.006mm) and III (1.071±4.632mm), respectively. However, these findings suggests that LPP can be influenced by advancing age. Therefore, larger sample size need to be taken to predict better results.

Soliman et al.[16] in his study suggested that the Wits appraisal and LPP could be used beside ANB angle as an adjunt in orthodontic diagnosis and treatment planning when identification of Nasion point is difficult. In our study a statistically positive correlation was found among the parameters such as ANB angle, Wits appraisal and LPP. These findings suggest that LPP can be used as a reliable method beside Wits and ANB angle to assess antero-posterior jaw relation.

CONCLUSION

- The present study showed strong positive relation between ANB angle and LPP among male and female whereas insignificant results were found for Wits between gender
- Different age categories were found to have significant influence on ANB, Wits and LPP which shows that these parameters changed significantly with age.
- A positive correlation was found among the parameters ANB angle, Wits appraisal and LPP.
- However in the present study significant result was found between ANB, Wits and LPP in different Skeletal classes of malocclusion. These finding indicates that these parameters can be used as an adjunct to ANB angle in orthodontic diagnosis and treatment planning.

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The author declare that there is no conflict of interest.

CONFLICT OF INTEREST

None to declare

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