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Association of Anterior and Posterior Occlusal Planes with Skeletal Class I, Class II and Class III Malocclusion

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ABSTRACT

Introduction: The occlusal plane is a very vital in stomatognathic system and the association between anterior occlusal planes and posterior occlusal plane plays an important role during orthodontic treatments.

Objectives: To assess occlusal planes in skeletal Class I, II, III malocclusion and to find the Association of Anterior and Posterior occlusal planes with skeletal Class I, Class II and Class III malocclusion.

Methods: A cross-sectional study was conducted at KIST Medical College using convenience sampling. Lateral cephalograms of 270 adults with Class I, II, III malocclusion were analyzed to assess angular measurements and their relation to skeletal and vertical patterns. Data were analyzed using SPSS version 16, and descriptive statistics (frequencies, percentages, means, and standard deviations) were computed.

Results: The skeletal patterns showed significant difference in anterior occlusal plane angle relative to Sella-Nasion plane and Frankfort Horizontal plane among all classes of malocclusion (p-value =0.001**) having a steeper inclined plane in Class II and flat inclined plane in Class III. Posterior occlusal plane in relation to Frankfort Horizontal plane and Sella-Nasion plane showed lowest angle in skeletal Class III and highest in Skeletal Class I patients.

Conclusion: The occlusal planes were found to have impact on the jaw base where variation in its angulation of different occlusal planes had affected sagittal and vertical facial patterns. Anterior occlusal plane relative to Sella-Nasion and Frankfort Horizontal were steeper in Class II and flat in Class III, while the Posterior occlusal plane relative to Frankfort Horizontal showed the same value in Classes II and III.

Keywords: Anterior occlusal plane; malocclusion; posterior occlusal plane; skeletal patterns, vertical pattern.

INTRODUCTION

In orthodontics, there are various geometric planes which serve as crucial landmarks for effective diagnosis and treatment planning. Among these, the occlusal plane is one of the primary cephalometric reference.

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Any alteration in orientation of this plane can cause occlusal instability which ultimately may impact the functioning of entire masticatory and stomatognathic systems. The occlusal plane refers to an imaginary plane that connect the biting surfaces of the upper and lower teeth. It plays an important role in orthodontic diagnosis, treatment planning. Its anterior and posterior inclinations may influence both static and dynamic occlusion, as well as the facial esthetics.

According to Fushima et al., the occlusal plane can be divided into anterior and posterior segments.[1,2,4] The anterior occlusal plane involves the anterior teeth and may significantly affects smile esthetics. The posterior occlusal plane involves the posterior teeth and it is essential for achieving proper functional occlusion.

Previous studies have shown that the inclination of the occlusal plane may vary among different skeletal patterns. A steeper occlusal plane is seen in hyperdivergent individuals, while a flat occlusal plane is found in hypodivergent types. [2] Kim et al. suggested that occlusal plane cant may influence mandibular and condylar position. [3] So, this study aims to evaluate the relationship between anterior and posterior occlusal planes in various skeletal malocclusions and vertical patterns. [5,6,7,8]

METHODS

The hospital based cross-sectional study was carried out in the Department of Orthodontics at KIST Medical College and Teaching Hospital, Lalitpur. A convenient sampling method was used All patients visiting the Department of Orthodontics at KIST Medical College and Teaching Hospital during the 4-month study period were included, yielding a total sample of 270 patients (Census Sampling Method), lasted from April 2023 to July 2023. Ethical approval for the research was obtained from KIST Medical College and Teaching Hospital, Institutional Review Committee (KIST-IRC Ref.No.2079/80/99). Informed written consent was taken from the participants involved in this study and for those below 18 years, assent was taken. The sample size was determined using the formula below: $n= (Z\alpha/2 + Z\beta)^2 \times (\sigma 1^2 + \sigma 2^2)/\Delta^2$ where,

$Z\alpha/2$: the critical value for the level of significance (usually 1.96 for a 95% confidence interval)

$Z\beta$: the critical value for the desired power (usually 0.84 for 80% power)

$\sigma 1$: the standard deviation of group 1 (4.3 in this case) [Reference: youmna etal [12], $\sigma 2$: the standard deviation of group 2 (4.7 in this case), Δ: the expected effect size (2.0 in this case)

Substituting the values:

$n= (1.96+0.84)^2 \times (4.3^2 + 4.7^2)/2.0^2$

$n=89.14$

Rounding up, we get a required sample size of 90 participants per group. As this study involves 3 skeletal pattern groups- Class I, Class II and Class III, we would need to recruit at least 90 participants per group, therefore total sample size would be 270 for three groups.

A conventional lateral cephalogram of patients visiting the department of orthodontics in the last five years served as the basis for the study. These were the routinely taken radiographs for orthodontic treatment. The jaw was in centric relations, the teeth were in occlusion, the lips were relaxed, and the head was in natural head positions when these lateral cephalometric radiographs were taken. X-ray images were captured using the same cephalometric device (Carestream, USA –ModelCS8100 SC)

The single investigator used graphite pencil to trace the anatomy on these radiographs. The cephalometric tracings of each radiograph were manually measured for the Angle of point A-Nasion-point B angle (ANB) and Tweed Frankfort-mandibular angle (FMA). The ANB angle was used to classify radiographs into the skeletal Class I, Class II, and Class III categories. Class I, Class II, and Class III ANB angles are 2-4°, > 4°, and 2°, respectively. The facial form was chosen using the Tweed FMA angle (Frank fort Mandibular Angle). The FMA is the angle between the mandibular plane (Tangent of lower border of mandible) and Frankfort plane (Po-Or), and its reference value is 25°. Values between 25° and 30° were regarded as a normalgrowth trend, values between 20° and 30° as a horizontal growth trend (Brachyfacial), and values above 30° as a vertical growth trend (Dolichofacial), (Mesiofacial).

In the cephalometric tracings of each radiograph, the following horizontal planes were constructed: the SN plane, drawn from Sella to Nasion; the FH plane, extending from Orbitale to Porion; the PP plane, joining the Anterior Nasal Spine (ANS) and Posterior Nasal Spine (PNS); the AOP plane, drawn from the maxillary incisal edge to the averaged cusp tip of the maxillary second premolar; the POP plane, extending from the averaged cusp tip of the maxillary second premolar to the midpoint between the averaged cusp tips of the maxillary second molar [9,10] ; and the MP plane, drawn from Gonion (Go) to Menton (Me).

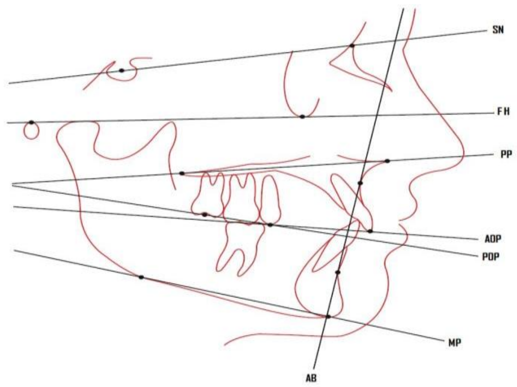

Figure 1: Different Horizontal and Vertical cepahlometric planes.

Data analysis was performed using SPSS version 16 software. Descriptive statistics including frequencies, percentages, means, standard deviations, and 95% confidence intervals were calculated for all variables. One-way Analysis of Variance (ANOVA) was conducted to compare angular measurements between skeletal Class I, II, and III groups. Statistical significance was set at $p < 0.05$, with F-statistics and p-values reported to determine significant differences between groups.

RESULTS

The current study involves 3 skeletal pattern groups- Class I, Class II and Class III and a total of 270 participants were included, comprising 60% females and 40% males. Based on facial growth patterns, 32.4% were normal, 43.3% dolichofacial (vertical), and 31.1% horizontal. (Table 1) According to sagittal skeletal types 120 were skeletal class I (44.4%) followed by 90 were skeletal class II (33.3%) and 60 were skeletal class III (22.2%). (Table 2). According to facial forms, 69 had Normal growth pattern (32.4%), 117 had Vertical growth trend- Dolichofacial (43.3%) and 84 had Horizontal growth trend (31.1%) (Figure: 2).

Table 1: Demographic Characteristics of the Study Population.

Variable	Category	Frequency (n)	Percent (%)
Gender	Male	108	40.0
	Female	162	60.0
Age group	15-19	134	49.6
	20-24	86	31.9
	25-29	27	10.0
	30-34	16	5.9
	35+	7	2.6
Total		270	100.0

Table 2: Distribution of Study Participant by Skeletal Group.

Skeletal class	Frequency (n)	Percentage (%)
Class I	120	44.4
Class II	90	33.3
Class III	60	22.2
Total	270	100.0

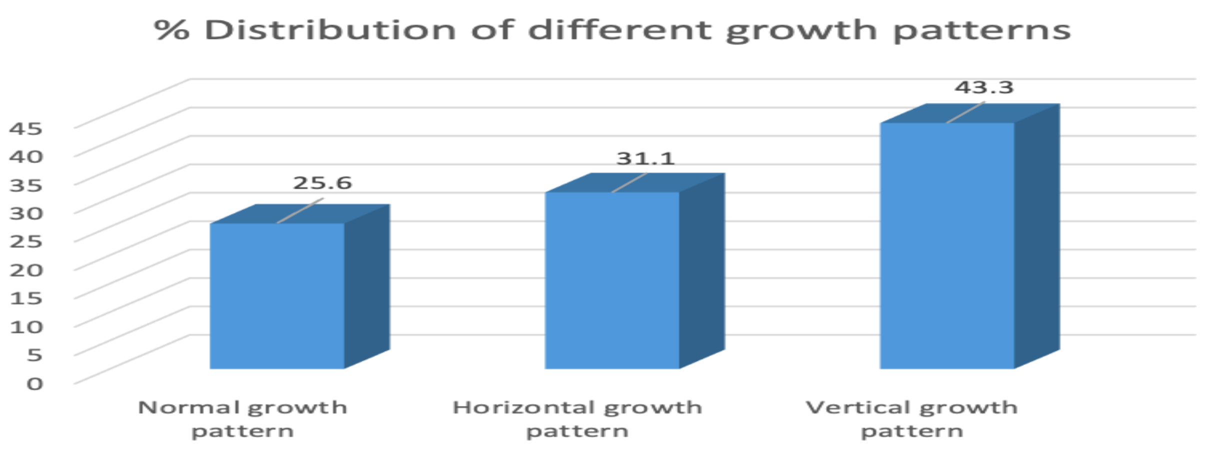

Figure 2: Distribution of Study Participants based on Skeletal Growth Pattern

Angle between FH-AOP is found highest in skeletal class II patents (13.91±6.68) and lowest in class III patients (10.37±5.2). Similarly angle between FH and POP is lowest in skeletal class III (14.41±6.9) patient but highest in skeletal class I patient (15.9±5.6). Comparison of FH plane and Anterior occlusion plane (FH – AOP) measurements among skeletal Class I, II, and III occlusions was found to be statistically significant (p value: 0.001) (Table 3).

Table 3: Comparison of Frankfort Horizontal plane measurements among skeletal Class I, II, and III occlusions

		Number (n)	Mean	SD	95% Confidence Interval for Mean		Min	Max	F	p value
					Lower Bound	Upper Bound				
FH	**Class I**	120	11.13	6.129	10.03	12.24	1	32	7.65	0.001*
AOP	**Class II**	90	13.91	6.680	12.51	15.31	2	32		

	Class III	60	10.37	5.207	9.02	11.71	2	22		
Total		270	11.89	6.282	11.14	12.64	1	32		
FH-POP	**Class I**	120	15.988	5.6559	14.965	17.010	5.0	32.0	1.32	0.267
	Class II	90	15.800	6.6960	14.398	17.202	4.0	30.0		
	Class III	60	14.417	6.9533	12.620	16.213	2.0	25.0		
Total		270	15.576	6.3231	14.818	16.334	2.0	32.0		

Angle between SN-AOP is found highest in skeletal class II patents (21.44±6.2) and lowest in class III patients (15.63±6.2). Similarly angle between SN and POP is lowest in skeletal class III (20.08±6.5) patient but highest in skeletal class I patient (23.56±7). The comparison between of SN plane and Anterior occlusal plane (AOP) measurements among skeletal Class I, II, and III occlusions was found to be statistically significant (p value: 0.001) (Table 4).

Table 4: Comparison of SN plane measurements among skeletal Class I, II, and III occlusions

		N	Mean	SD	SE	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min	Max	F	p value
SN-AOP	**Class I**	120	18.42	6.084	.555	17.32	19.52	3	33	16.4	<0.001*
	Class II	90	21.44	6.250	.659	20.14	22.75	9	36		
	Class III	60	15.63	6.214	.802	14.03	17.24	2	29		
	Total	270	18.81	6.512	.396	18.03	19.59	2	36		
SN-POP	**Class I**	119	23.56	7.009	.643	22.29	24.84	2	36	4.93	0.008
	Class II	90	22.58	7.309	.770	21.05	24.11	4	38		
	Class III	60	20.08	6.554	.846	18.39	21.78	3	32		
	Total	269	22.46	7.116	.434	21.60	23.31	2	38		

DISCUSSION

The position of jaw may be affected by the cant of occlusal plane that described a vertical morphologic trait. [1] In the present study, comparison of FH plane to AOP and SN-AOP among skeletal class I, II and III was found to be statistically significant (p value:0.001). Angle between FH-AOP and SN-POP is highest in skeletal class II patients and lowest in class III patients which is similar to findings of Celar et al but in comparison to FH-POP and SN-POP in Celar et al they found steep angle in class II and flat in class III where as in present study it was found lowest in class III and highest in skeletal class I patient. [7] In similar study, Mc Gorray et al found there was significant differences of the POP among the different skeletal malocclusions (*P* <0.0001). The POP was also compared with bilateral variables that described mandibular morphology. The POP showed significant correlations with mandibular position in the sagittal (*P* <0.0001), coronal (*P*<0.05), andaxial (*P*<0.05) planes. The POP also showed a significant correlation with mandibular morphology (*P*<0.0001); but AOP was not considered in the study.[11]

In contrast to current study, Hassouna et al found that AOP angle relative to both SN plane and FH plane had steeperinclined plane in class II and flatinclined plane in class III. While they did not find significant difference in POP angle in relation to FH plane among all skeletal classes of malocclusion. [12] Tanaka and Sato et al only used the FH plane and the study showed no statistical difference between FH-AOP and FH-OP Class III had flat FH-POP and steepplanein Class II patients.[10] In study by Ardani et al found that, the comparison of class III and class I malocclusions in the OP-SN and OP-GoGn angle, occlusal plane inclination does not have a statistically significant difference. While the comparison of class III and class I malocclusions on the occlusal plane inclination of the OP-FH and OP-A Bangle had statistically significant difference.[13]

In current study, comparison in between FH-AOP was statistically significant among Class I, II and III malocclusion whereas Liet al**.** found the bisector occlusal plane angle increased in all of the three groups but only had statistically significant differences in skeletal class II patients in a mean of 1.51° (*p* <0.05). The FOP-SN angle showed stability (*p* >0.05) in all three groups.[14] These difference in the results between current study and other studies were due to different sample size, age of patients and also due to different ethnical group between them.

Eppard, Anawarand Fida studies states that hyper-divergent tends to have steepening of the occlusal plane inclination causing an increased in facial divergence.[15] Few data exist on the occlusal plane effect on the vertical facial pattern. This current study was carried out to determine the relationship of anterior occlusal plane and posterior occlusal plane in different skeletal malocclusion and vertical pattern. The results from this study had shown a highly significant differences among all groups Class I, II and II relative to FH-AOP(P:0.001) and SN-AOP(P: 0.001) with high angle having steepest occlusal plane in skeletal Class II patients and lowest angle in Skeletal Class III patients. As few studies measured the occlusal plane inclination relative to the FH plane and vertical pattern, current study found in comparison to angle relative to FH-POP and SN-POP were highest in skeletal Class I patients and lowest in Skeletal Class III patients.

From clinical point of view, change in the occlusal plane inclination by means of orthodontic treatment of anteroposterior component of malocclusion may help adaptation of the mandible in more therapeutic position. The change in OP is not desirable esthetically so any change in OP inclination should be avoided and therapeutic change of occlusal plane requires more further studies. This study has several limitations that should be considered. The number of patients in each skeletal group was unequal, which may affect the reliability of results. Most participants were teenagers (15-19 years old), so the findings may not apply to older or younger patients. The study was conducted at only one location, so results may not represent all populations. The measurements were taken from 2D X-rays, which can have errors compared to 3D imaging.

CONCLUSION

The occlusal planes were found to have an impact on the jaw base where the variation in its angulation of different occlusal planes had affected both sagittal and vertical facial patterns. Anterior Occlusion Plane relative to SN and FH were steeper in Class II and flat in Class III, while the POP relative to FH showed the same value in Classes II and III. The findings in present study provide valuable insights into the relationship between skeletal morphology and occlusal plane orientation, which has important implications for orthodontic diagnosis and treatment planning. However, future research should address the current study's limitations by conducting longitudinal investigations with larger, more balanced sample sizes and incorporating 3D imaging techniques for improved accuracy.

Conflict of Interest: None

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