JMSCR Vol||11||Issue||08||Page 57-63||August 2023

http://jmscr.igmpublication.org/home/
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v11i8.07

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Research Article

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.*

Methods: *Lateral cephalometric radiographs of 270 adult patients of the different classes of malocclusion were used. Several angular measurements were measured and compared among all study groups to evaluate the existence of relationship between AOP and POP with skeletal and vertical patterns.*

Results: *The skeletal patterns showed a significant difference in anterior occlusal plane angle relative to both SN plane and FH 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. POP in relation to FH plane and SN plane showed lowest angle in skeletal Class III and highest in Skeletal Class I patients.*

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. AOP 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.*

Keywords: *Anterior occlusal plane, Posterior occlusal plane, Malocclusion, Skeletal patterns, Vertical pattern, Lateral cephalometric radiograph.*

Introduction

In orthodontics various planes are used as reference planes in diagnosis and treatment planning. Occlusal plane is the major plane in cephaometrics and is considered useful in treatment planning as the changes in occlusal plane can read to instability of occlusion which may affect masticatory system as well as overall stomatognatic system.

Occlusal plane in a orthodontics refers to the imaginary plane that connects the biting surface of teeth in upper and lower jaws. Occlusal plane

plays an integral part in orthodontic diagnosis, treatment planning and assessment of treatment outcomes for orthodontic patients. Apart from that the inclination of occlusal plane anteriorly and posteriorly has an effect on stomatognathic system. Occlusal plane is an important parameter in both static and dynamic occlusion. Therefore occlusal plane is used to evaluate and assess the dentofacial changes.

According to Fushima et al, occlusal plane can be again be classified as anterior occlusal plane and posterior occlusal plane[1,2,4] The anterior occlusal plane is the portion of the occlusal plane that runs through the anterior teeth. It is important in orthodontics because it plays a key role in determining the esthetics of the smile. The posterior occlusal plane is the portion of the occlusal plane that runs through the posterior teeth. It is important in orthodontics because it plays a crucial role in determining the functional occlusion of the teeth.

When comparison was done between occlusal plane and vertical patterns it had been found that steeper occlusal plane in hyper divergent individuals and flatter occlusal plane in hypo divergent individuals[2]. The study done by Kim et al had proposed that the cant of the occlusal plane could have an effect on positioning of mandible and condyle[3]. Therefore, a comprenshive analysis of occlusal plane is needed for proper diagnosis and treatment planning as well as for effective orthodontic treatment.[5,6,7,8] Furthermore occlusal plane is very important in determining the incisal smile arch.[5,7]. Thus, the aim of this study was to determine the relationship of anterior occlusal plane and posterior occlusal plane in different skeletal malocclusion and vertical patterns.

Methods

After the Institutional Review Committee gave its ethical approval (KIST- IRC Ref. No. 2079/80/99), this hospital based cross-sectional study was carried out in the Department of Orthodontics at KIST Medical College and Teaching Hospital, Lalitpur. The research lasted from April 2023 to July 2023.

The sample size was determined using the formula below: $n = (Z\alpha/2 + Z\beta)^2 \times (\sigma1^2 + \sigma2^2) / \Delta^2$

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)

$\sigma1$: the standard deviation of group 1 (4.3 in this case) [Reference: youmna et al[12]]$\sigma2$: 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. Therefore, if we want to detect an effect size of 2.0 with standard deviations of 4.3 and 4.7, a power of 80%, and a confidence level of 95%, we would need to recruit at least 90 participants per group, there total sample size would be 270 for three groups.

A convenient sampling method was used. A conventional lateral cephalogram of patients visiting the department of orthodontics at KIST Medical College and Teaching Hospital, Lalitpur, in the last five years served as the basis for the study. 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 – Model CS 8100 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 ANB angle and Tweed FMA angle. 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 (Frankfort 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 normal growth trend, values between 20° and 30° as a horizontal growth trend (brachyfacial), and values above 30° as a vertical growth trend (dolichofacial) (Mesiofacial).

Following horizonal cephalometric planes were drawn in the tracing of each radiographs.

1. SN Plane: Line joining Sella and Nasion
2. FH Plane: Line Joining Orbitale and Porion
3. PP Plane: Line joining Anterior Nasal Spine (ANS) and Posterior Nasal Spine (PNS)
4. AOP Plane: Line joining the maxillary incisal edge and the averaged cusp tip of the maxillary secondpremolar
5. POP plane: Line Joining averaged cusp tip of the maxillary second pre- molar and the midpoint between the averaged cusp tips of the maxillary second molar (9,10)
6. MP plane: Line Joining Gonion (Go) and Menton (Me) Also, vertical plane; AB Plane is drawn

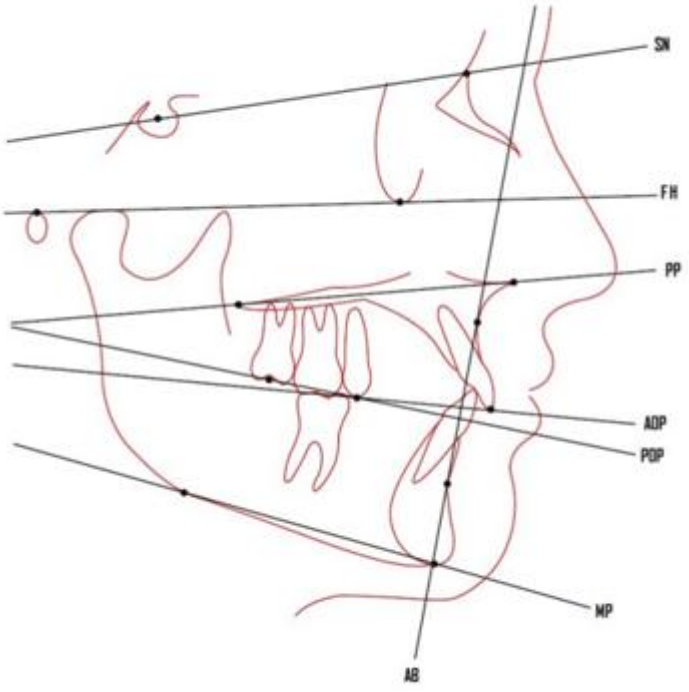

Fig 1: Different Horizontal and Vertical cepahlometric planes that were traced.

Results

A total of 270 study participants were present in our study which included 60% females and 40% males (Table 1)

Table 1: Gender Distribution of Study Population

	Frequency	Percent
Male FemaleTotal	108	40.0
	162	60.0
	270	100.0

Table 2: Distribution of Study Participant by Skeletal Group

	Frequency	Percent
Skeletal class I Skeletal class II Skeletal class IIITotal	120	44.4
	90	33.3
	60	22.2
	270	100.0

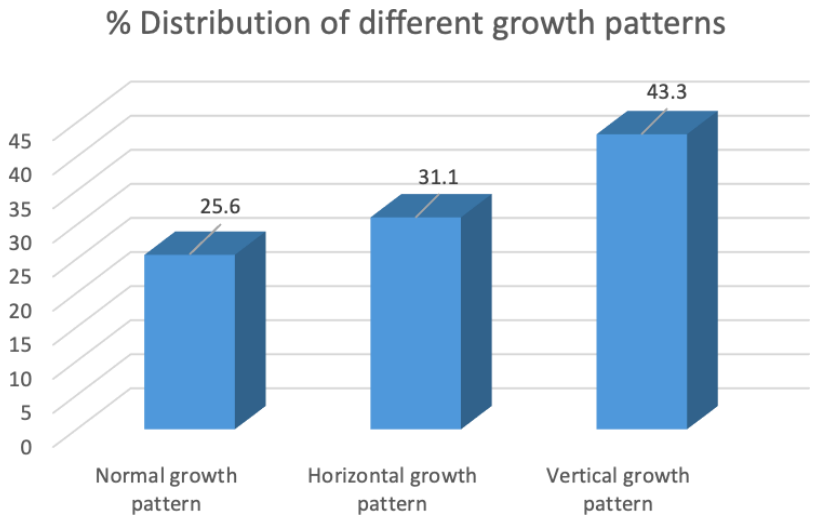

Fig 2: Distribution of Study Participants based on Skeletal Growth Pattern

Among 270 participants, according to sagittal skeletal types 120 were Skeletal class I (44.4%), 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:3)

Table 3: Distribution of Study participant according to age group

	Frequency	Percent
15-19 20-24 25-29 30-34 35+ Total	134	49.6
	86	31.9
	27	10.0
	16	5.9
	7	2.6
	270	100.0

Regarding the age distribution, majority of participants were in the age group 15-19 (49.6) and only 2.6 % wereabove 35 years

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

		N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum	F	P value
					Lower Bound	Upper Bound				
FH-AOP	skeletal class I	120	11.13	6.129	10.03	12.24	1	32	7. 65	0.001 *
	skeletal class II	90	13.91	6.680	12.51	15.31	2	32		
	Skeletal 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	skeletal class I	120	15.988	5.6559	14.965	17.010	5.0	32.0	1. 32	0.267
	skeletal class II	90	15.800	6.6960	14.398	17.202	4.0	30.0		
	Skeletal 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 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 5: Comparison of SN plane measurements among skeletal Class I, II, and III occlusions

Descriptives											
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	F	P value
						Lower Bound	Upper Bound				
SN-AOP	skeletal class I	120	18.42	6.084	.555	17.32	19.52	3	33	16.40	<0.001 *
	skeletal class II	90	21.44	6.250	.659	20.14	22.75	9	36		
	Skeletal 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	skeletal class I	119	23.56	7.009	.643	22.29	24.84	2	36	4.93	0.008
	skeletal class II	90	22.58	7.309	.770	21.05	24.11	4	38		
	Skeletal 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		

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). similary 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)

Discussion

The anteroposterior 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, McGorray et al found were 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), and axial (*P* <0.05) planes. The POP also showed a significant correlation with mandibular morphology (*P* <0.0001).But in this study, 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 steeper inclined plane in class II and flat inclined plane in class III. While they did not find significant difference in POP angle in realtion to FH plane among all 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 steep plane in 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-AB angle had statistically significant difference.[13]

In current study, comparison in between FH-AOP was statistically significant among Class I, II and III malocclusion where as Li et 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, Anawar and 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.

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. AOP 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.

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