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Relationship of Occlusal Planes with Sella-Nasion and Frankfort Horizontal Planes in Different Skeletal Malocclusion. A Cephalometric Study

Hana Pervez, Anam Sattar, Sadia Shabbir, Marium Iqbal, Faiza Malik, Filza Gul

ABSTRACT

Objective: The objective of this study is to assess the relationship of anterior and posterior occlusal planes (AOP & POP) with Sella-Nasion (SN) and Frankfort Horizontal (FH) planes in different skeletal malocclusion.

Study Design and Setting: It was a cross-sectional study carried on 202 (40 males and 190 females) pretreatment lateral cephalogram of orthodontic patients of Jinnah Medical and Dental College, Karachi from June to September 2021.

Methodology: The sample was divided into different skeletal pattern using ANB angle (Class I ANB 0-4°, Class II ANB>4° and ANB Class III <0°). The AOP and POP measured with respect to SN and FH planes in each class. Two way ANOVA was used to determine the relationship of occlusal planes among skeletal malocclusions.

Results: 202 cephalogram, 40 males and 190 females were included in this study, out of which 102 (28 males and 102 females) were of class I, 88 (12 males and 76 females) were class II and 12 females were class III. Class II showed steeper SN-AOP and FH-POP than both Class I and Class III. There was statistically significant relationship between SN and AOP among all the three skeletal malocclusions ($p<0.005$) and FH-AOP in class I and II ($p>0.025$).While SN-POP and FH-POP were not statistically significant in all the three classes.

Conclusions: Class II malocculsion showed steeper SN-AOP and FH-POP than Class I and Class III. POP to SN and FH were flatter in Class III.

Keywords: Frankfort Horizontal plane, Occlusal plane, Sella-Nasion, Skeletal malocclusion.

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INTRODUCTION:

As the social norms have changed over the past decades, the number of people seeking orthodontic treatment has increased considerably. Camouflage orthodontic treatment is developing quickly, along with technology. As a result, the paradigm has changed, and instead of some disorders requiring surgical orthodontics, they can now be treated using camouflage orthodontics.

A more thorough investigation of the occlusal plane inclination as a diagnostic characteristic is required for more effective and efficient therapies as a result, making the strategy for determining the diagnosis, prognosis, and treatment plan more difficult. The aim of orthodontic treatment is not limited to aesthetics only but also aims to improve and maintain functional occlusion.

A thorough diagnosis of all stomatognathic system components is the cornerstone of an effective treatment for skeletal and Dentoalveolar defects, including achieving stable results over time.

In the stomatognathic and aesthetic dentofacial system, the occlusal plane is extremely important. The occlusal plane's shape and inclination are unique to each person. In both static and dynamic occlusion, the slope of the occlusal plane in relation to masticatory movements is a significant element.[1]

The identification of patients at risk of having functional complaints brought on by dental treatment and the development of an individualized treatment plan for each patient depend heavily on the determination of the upper posterior and anterior occlusal planes for a thorough diagnosis. The incisal smile arch of the maxillary incisors and the tip of the canine are both affected by the occlusal plane angle. The slope of the occlusal plane becomes a crucial factor in developing harmonious orofacial functions.[2]

The relationship between the inclination of the occlusal plane and the various skeletal profiles is well documented. Studies have found that Class II malocclusions presented with steeper occlusal planes while Class III malocclusions displayed flatter occlusal planes.[3-4]

The inclination of the occlusal plane is also associated with vertical divergence pattern.[5] Steeper occlusal plane inclinations are found in hyperdivergent (long-face) individuals and flatter occlusal plane inclinations are in hypo-divergent (short-face) individuals.[6] The cusp tip of the maxillary second premolar was used to split maxillary occlusal plane into anterior occlusal plane AOP and posterior occlusal plane POP by Fushima et al.[7] and determined the association between inclinations of AOP and POP with Frankfort horizontal (FH) and found steeper POP in skeletal class II. However, FH plane was constructed by joining the inferior most point in bony orbit called orbitale (Or) with the superior most point on external auditory meatus called porion (Po), and both these cephalometric landmarks showed high variability in their identification in comparison to sella-nasion plane SN drawn by joining the mid-point of sella tursica (S) with nasion (N).[8]

From a clinical standpoint it is important to understand that orthodontic treatment of malocclusions with anteroposterior components may attempt to alter the occlusal plane's inclination, potentially aiding the mandible's adaptation to a therapeutic position, this will lead to better aesthetic and functional results. Majority of previous studies showed relationship of AOP and POP with the Angle classification which does not differentiate between dental and skeletal malocclusion. One of the aims of this study was to explore the association of AOP and POP with skeletal malocccclusion.[9,10]

Therefore the objective of this study is to investigate the relationship between occlusal planes and the Sella-Nasion (SN) and Frankfort Horizontal (FH) planes in individuals with different skeletal malocclusions.

METHODOLOGY:

This cross sectional study was conducted from June to September 2021 on 202 pretreatment lateral cephalograms (40 males and 190 females) of orthodontic patients at Jinnah Medical and Dental College, Karachi after acquiring their consent. Ethical approval was obtained from the ERC ethical review committee, JMDC Approval Number (000105/21).

The sample size was calculated from a previous study[16] using open epi online calculator keeping 95% confidence interval and 80% power of test, was 200. Non-probability (convenience) sampling technique was followed. Both males and females between ages 15-35 years who had all permanent dentition except third molar with radiographs of adequate diagnostic quality present were included in the study. Individuals with syndromes like cleft lip and palate, aged below 15years and above 35 years who had previous orthodontic and/ or orthognathic surgery treatment, any TMJ abnormality or had hypodontia were excluded from the study.

Each patient's lateral cephalometric radiograph was taken with a single Cephalometer, ASAHI at 80 kvp, 10 mA, and 0.8 s exposure duration on 8 x 10 inch Kodak green film by the same operator. A single investigator traced and measured the cephalometric radiograph using a 0.5mm lead pencil on acetate paper in a dark room. The landmarks and planes used in this investigation located were: (Figure 1),

SN (sella-nasion plane) from sella to nasion

FH (Frankfurt horizontal plane) from porion to orbitale

PP (palatal plane) from anterior nasal spine to posterior nasal spine

AOP (anterior occlusal plane) from maxillary incisal edge and the cusp tip of the maxillary second premolar.

POP (posterior occlusal plane) from cusp tip of the maxillary second premolar and the midpoint between the cusp tips of the maxillary second molar

MP (mandibular plane) from tangential gonion to menton

The following angular measurements were done with help of protractor:

SN-AOP <: angle between SN and AOP planes

SN-POP <: angle between SN and POP planes

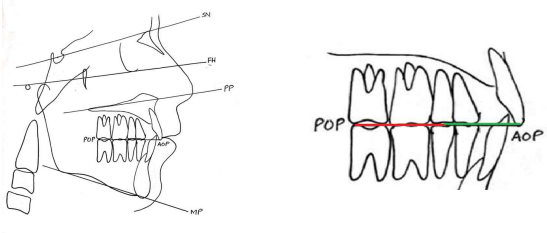
FH-AOP <: angle between FH and AOP planes

FH-POP <: angle between FH and POP planes

ANB<: angle between NA and NB planes

After 15 days, the same investigator retraced and analyzed 15 random cephalometric radiographs and a second investigator traced and analyzed15 randomly selected radiographs to check intraexaminer and interexaminer reliability respectively.

Figure 1: Cephalometric tracing showing landmarks and planes used in this study.



Statistical Analysis: Statistical analysis was done using the Statistical package for the social sciences (SPSS for windows version 21). The Shapiro-Wilk test was used to determine that the data were normal; it was found that the data had a normal distribution, hence parametric tests were applied. Two-way (ANOVA) test was applied to determine the relationship of AOP and POP to SN and FH between all classes of malocclusion. p-value of less than 0.05 and equal to was considered statistically significant.

SN sella-nasion, FH Frankfort horizontal, PP palatal plane, AOP anterior occlusal plane, POP posterior occlusal plane, MP mandibular plane

RESULTS:

202 cephalograms, 40 males and 190 females were included in this study, out of which 102 (28 males and 102 females) were of class I, 88 (12 males and 76 females) were class II and 12 females were class III as shown in Table 1. Table 2 showed the descriptive stats of different variables in all three skeletal classes. Class II showed steeper SN-AOP and FH-POP than both Class I and Class III. There was statistically significant relationship between SN and AOP among all the three skeletal malocclusion ($p<0.005$) and FH-AOP in class I and II ($p>0.025$). While SN-POP and FH-POP were not statistically significant in all the three classes. Table 3

DISCUSSION:

Tracing and analyzing lateral cephalogram is an essential part of orthodontic diagnosis and is a key factor in reaching a treatment plan. There are multiple analysis in different planes to aid the clinician and several researches have been done over planes, anatomical landmarks, angulation and their relationship to each other. Thorough review of the literature suggests that there was a need to correlate occlusal plane to skeletal form as it has shown high degree of variation in relation to skeletal form.[11-14]

In the present study, there was a significant relationship of SN-AOP in all three skeletal malocclusion with Class II demonstrating steeper anterior occlusal plane to SN in comparison to Class I and III which is in accordance with the previous studies done by Hassouna et al. and Celar et al. [15,16] FH-AOP was statistically significant only between class I and class II in this study while FH-POP was significant between I and II and between I and III in a study conducted by Hassouna et al. [15]

In our study, FH-AOP showed almost the same steepness in Class II and III skeletal malocclusion. SN-POP and FH-POP were statistically insignificant in all three skeletal malocclusion in our study, which contradicts some of the previous studies [15] in which SN-POP was found to be statistically significant between class I and class III. While POP to SN and FH were flatter in Class III as compared to class II and class I malocclusion.

FH-POP showed the same steepness in Class I and II, which is in contrast to Celar et al.[16] and Tanka and Sato[17] in which Class II had steeper POP. This contradicts the results between our study and other studies and this may be due to the identification of certain anatomical landmarks, such as the porion (Po), condylion (Co), orbitale (Or), basion, gonion (Go), anterior nasal spine (ANS), posterior nasal spine (PNS), and lower inferior apex (LIA), may be more prone to error due to overlapping structures superimposed on the landmark and its location. Likewise, the quality of radiographic images can interfere with the identification of some landmarks, such as Po, Co, Or, ANS, point B, the pogonion (Pog), Go, and the glabella.[18,19] Moreover, some authors have argued that the level of an observer's knowledge and his or her professional background play an important role in landmark identification, but this also coincides with the findings of Ishikawa [20] that AOP inclination is an of importance when it comes to skeletal malocclusion. The occlusal plane angle also affects the smile especially on the incisal smile arch of the maxillary incisors and the tip of the canine.[21] Inclination in the occlusal plane becomes an important parameter for obtaining harmonious orofacial relations.[22]

Celar et al [16] concluded that AOP inclinations did not differ significantly for both reference planes whereas POP inclinations were significantly different. Tanaka and Sato [17] only employed the FH plane in their analysis, and found no significant difference between AOP-FH, as well as the fact that Class II has the steepest POP-FH and Class III has the flattest. Ardani et al [23] found a substantial difference between classes I and III when SN-AOP and FH-AOP were included.

This discrepancy in results between this study and others is related to ethnical group differences, less reliability of SH

Table1: Descriptive statistics based on gender and angles classification

	MALE	FEMALE	TOTAL
CLASS 1	28	102	102
CLASS 2	12	76	88
CLASS 3	0	12	12

Table 2: Descriptive statistics of different variables in Class I, II and III malocclusion

	ANB	SN AOP	FH AOP	SN POP	FH POP
CLASS I	3.07 ± 0.9	14.6 ± 4.84	8.85 ± 3.99	13.62 ± 7	8.1 ± 4.62
CLASS II	6.2 ± 1.62	16.81 ± 5.93	10.52 ± 5.98	14.63 ± 5.57	8.65 ± 4.47
CLASS III	-1.83 ± 1.64	10.83 ± 5.47	10.25 ± 6.48	10.33 ± 5.53	6.08 ± 3.77

Table 3: Difference in relationship of variables between all 3 groups

ANOVA			
VARIABLES	p1	p2	p3
SN-AOP	0.032*	>0.001**	0.021*
FH-AOP	>0.025*	0.747	0.295
SN-POP	0.095	0.16	0.126
FH-POP	0.997	0.206	0.180

p1: BETWEEN CLASS I AND CLASS 2
p2: BETWEEN CLASS 2 AND CLASS 3
p3: BETWEEN CLASS 1 AND CLASS 3

*: Statistically significant at p = 0.05, ** Highly significant at p = 0.001

plane to true horizontal[24] as well as the fact that the sample size utilized in the previous studies was not evenly distributed across all groups. One of the limitations of this study is small sample size and unequal distribution of individuals among groups. Future studies are needed with much larger sample size to address this shortcoming.

It is advisable to consider the occlusal plane, while treating the anteroposterior component of malocclusion by modifying the OP inclination to adapt the mandible into a therapeutic posture.

Further studies are required for the change of occlusal plane inclination of patients in extraction-based therapy as well as surgical cases. It has been proposed that in class II patients, those cases exhibiting the greatest growth during treatment exhibited the least change in the inclination of the occlusal plane while showed the greatest tendency to return to the original inclination; conversely, those cases exhibiting the least growth during treatment exhibited the greatest change in the occlusal plane and showed less tendency to return to the original inclination.[25] It would be of interest to study the influence of occlusal plane inclination changes on the relapse of orthodontically treated patients in the long term.

CONCLUSION:

This study concluded that Class II malocculsion showed steeper SN-AOP and FH-POP than Class I and Class III. POP to SN and FH were flatter in Class III.

Authors Contribution:
Hana Pervez: Conceived the study, Manuscript writing, Design of study, Literature review
Anam Sattar: Supervised the work and final review
Sadia Shabbir: Study design & Methodology writing
Marium Iqbal: Statistical Analysis and Results
Faiza Malik: Clinical work and data collection
Filza Gul: Clinical work and data collection

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