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Angular Relationship between Frankfort Horizontal Plane and Sella-Nasion Plane: A Cross-Sectional Study

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Abstract:
Background*: The literature suggests a constant angle of 7° between Frankfort Horizontal (FH) and Sella-Nasion (SN) plane. Various studies have shown that the FH-SN angulation is not always 7°; which may affect cephalometric diagnosis. There can be variation in different ethnic groups.*
Aim &objective*: To determine the average SN-FH angle for a group of orthodontic patients from Kerala,India. The secondary objectives were to assess whether the SN-FH angle exhibits any sexual dimorphism and its variation in class I, class II and class III skeletal relation.*
Materials and Methods*: Lateral cephalograms of 72 patients (36males and 36 females) were analysed. The cephalograms were also analyzed as skeletal class I, class II and class III. The statistical analyses were made using students t- test and ANOVA analysis. p value < 0.05 was set as statistically significant.*
Results*: The average SN-FH angle was 6.5±2.07°. SN-FH angle was greater in female samples but was not statistically significant. There was no significant difference in different skeletal classes.*
Key Word*: sella- nasion plane, frankfort horizontal plane, cephalograms*

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I. Introduction

Assessment of craniofacial structures forms a part of Orthodontic diagnosis. Cephalometry forms an important component of orthodontic diagnosis and treatment planning. It involves the analysis and interpretation of standardized radiographs of facial bones using different reference planes.[1,2] Various reference planes are used for the analysis by different investigators. Among those, the most widely used lines are Frankfort horizontal line (FH) and Sella-Nasion (SN) line. FH plane is the line joining the inferior most point in bony orbit called orbitale (Or) with the superior most point on external auditory meatus called porion (Po). SN plane is constructed by joining the geometric center of sella tursica (S) with nasion (N), the most anterior point of the frontonasal suture in the midsagittal plane. Though all cephalometric planes show some variations, SN plane followed by FH plane have been found to be relatively stable.[3]

The literature suggests a constant angle of 7° between SN and FH planes. Any variation in the FH-SN inclination can affect the cephalometric diagnosis. If the given SN-FH value more or less than 7°, a corresponding alteration is made to SNA, SNB, and SND values to offset the discrepancies due to the inclination of the anterior cranial base. However various studies have shown that the FH-SN angulation can vary in different population.[4,5] In this regard, the universal use of 7° as a constant angle is not applicable.

Morphologic variations exist in different races. Even within the same race, each subgroup can show variations. The established norm for one group may not fit for the other; hence, it cannot be applied for the entire population.

Hence, the present study is intended to find out the angular relationship between FH and SN in a group of people from Kerala,India. Sexual dimorphism of SN-FH angle and its variation in class I, class II and class III skeletal relations were also evaluated.

II. Material And Methods

After obtaining the ethical clearance from the Institutional Regulatory Board, the database for cephalometric evaluation was obtained from the preexisting records of the patients who had registered for orthodontic treatment between 2017 and 2019 at PSM dental college, Kerala. The inclusion criteria comprised healthy subjects of 18–30 years of age without any facial deformity or congenital abnormality and without any history of craniofacial trauma. 72 samples (36 males and 36 females) were randomly selected from the records. For analysis purposes, the data were categorized as Class I, Class II, and Class III skeletal patterns based on the ANB angle.

All radiographs were traced by a single observer in order to eliminate inter-examiner variability and were analyzed using Nemoceph version 6.0 to find out the angle between Sella-Nasion and Frankfort horizontal lines.

Statistical analysis

SPSS software was used to calculate the means and standard deviations of all measurements, and independent t-tests were used to determine significant differences between genders. One-way analysis of variance (ANOVA) was used for assessing the relationship between FH-SN angle and the three skeletal classes.

III. Result

FH-SN angle displayed inter-individual variability. The value ranges from 2.31° to 10.87°. The average SN-FH angle was 6.5±2.07°. SN-FH angle was greater in female samples comparing to males (Table 1) but was not statistically significant (Table 2). The total sample of 72 was divided to skeletal class I, II and III ; each group having 24 samples. When the mean FH-SN angles of 3 different skeletal relationships were compared using ANOVA analysis, it was found that there was no statistically significant difference between the groups (Table 3).

Table no 1: Age and FH-SN angle of the samples

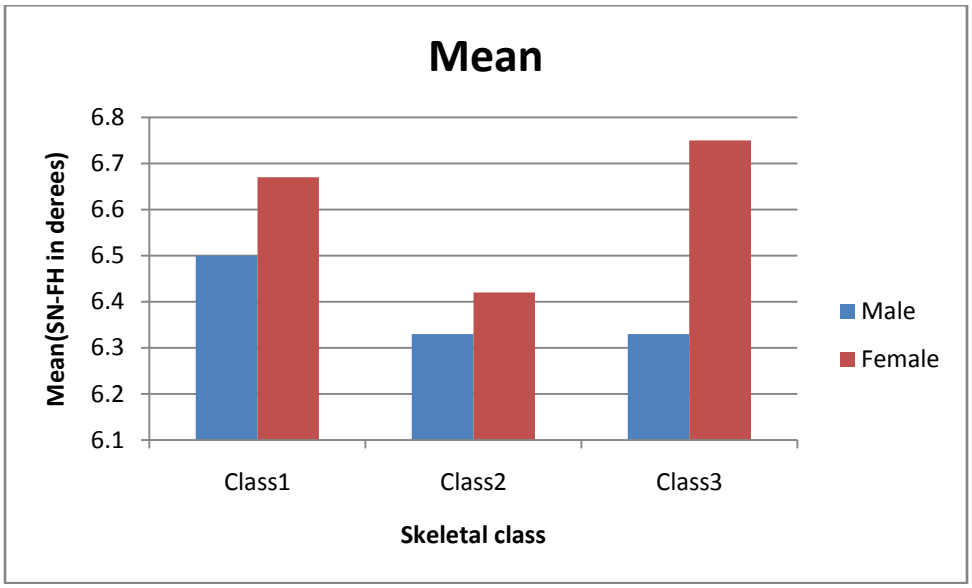
Parameters	**No. of samples**	**Mean Age (years)**	**Mean SN-FH angle (degrees)**
Male	36	21.37±2.184	6.39±1.856
Female	36	21.44±2.699	6.61±2.284
Total	72	21.40±2.44	6.5±2.07

Table no 2: Comparison of FH-SN angle between male and female

Parameters	**Male**		**Female**		**P value (students t -test**
	Mean	SD	Mean	SD	
FH-SN angle (degrees)	6.39	1.856	6.61	2.284	0.799

Table no 3: ANOVA results comparing FH-SN angle between skeletal Class I, II and III

Skeletal classes	**No.**	**SN-FH (degrees)**	**SD**	**95% Confidence Interval for Mean**		**P value**
				Lower bound	Upper bound	
Class I	24	6.585	1.698	5.39	7.95	0.953
Class II	24	6.375	2.684	4.77	8.26	
Class III	24	6.54	1.864	5.24	8.02	



IV. Discussion

The present cephalometric study was conducted to determine an average FH-SN angle for a group of orthodontic patients in Kerala. The average FH-SN angle was found to be 6.5±2.07°.This value is near to the generally accepted 7° angulation between FH and SN planes. It is evident that FH-SN angle shows inter-individual variability. The value ranges from 2.31° to 10.87°. The SN- FH angle showed variation in some other population. Shimizu et al observed an angle of 11.2±2.3° between these two planes in Spanish population, while it was 8.0+3.1° in Japanese population.[6]

The mean FH-SN angle of female samples of the present study was slightly greater than that of the male samples with 0.22° greater on average. Giri J et al reported a similar finding where the difference was 0.6°.[7] However, the difference was not statistically significant.

Another objective of this study was to evaluate the FH-SN angle in different skeletal relationships Class I, II and III. The ANOVA analysis revealed that there was no statistically significant difference between the FH-SN angles in different skeletal relationships. This finding is not in agreement with Alves et al who found that FH-SN angle was greater in skeletal Class II relationship compared to skeletal Class III.

Variation in FH-SN angle may affect the cephalometric diagnosis in orthodontic case. According to Moore, an increase in FH-SN angle is associated with decrease in SNA and SNB values.[8] The angular variation between FH and SN planes could be due to the change in inclination of SN line, FH line or both. Both Nasion point and Orbitale may have contributed to this change in inclination. In a study, Moore observed that during growth, point nasion is descending downward and forward in relation to its initial position.[9] Greiner et al found a 3.1° increase in the SN- FH angle during growth. He also noted that the distance of orbitale point increased by 3.9mm with respect to SN plane, whereas the porion point remained almost constant.[10] Hence, it is essential to evaluate the FH-SN angle before making a cephalometric diagnosis.

However, in our study the average value of SN- FH angulation did not show any significant difference from that mentioned in the literature.

V. Conclusion

The average FH-SN angle for a group of orthodontic patients in Kerala was found to be 6.5±2.07°.There was no statistically significant difference in FH-SN angle between skeletal Class I, II and III relationships. Likewise, gender dimorphism of FH-SN angle could not be established statistically.

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