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Comparison of Sella-Nasion to Frankfort-Horizontal plane angle between genders in different sagittal classes of malocclusion

Muzka Ijaz[a], Erum Amin[b], Nasira Adnan[c], Kiran Ijaz[d]

Abstract

Introduction: The most important consideration while performing lateral cephalometric analysis is selection of a different reference planes hence the main aim of this cephalometric study was to compare the Sella-Nasion to Frankfort horizontal plane (SN-FH) angle between genders in three sagittal classes of malocclusion in patients reporting to a tertiary care set up.

Material and methods: Lateral cephalometric records based on cross sectional study, was conducted on 180 patients (90 males and 90 females). Of them 60 were from each class of malocclusion (class I, II, III) and in each class, there was equal distribution of genders with 30 females and 30 males. The angle between SN and FH plane, NFH- the closest distance from FH to N (nasion), SFH- the closest distance from FH to S (sella) and the difference between NFH and SFH (Δ) was measured. Student's "*t*" test and ANOVA was used for comparison and the *P value ≤0.05* was considered significant.

Results: The overall mean values were SN-FH angle 7.21±2.46 degrees, NFH, SFH 25.75±2.91 mm, and the NFH-SFH difference was 16.04±3.72 mm, and 7.48±3.37 mm respectively. In skeletal class I the age and NFH was not statistically significant between genders while SN-FH angle (P=0.03, 95% CI= -2.8, -.11), SFH (P=0.02, 95% CI= -4.3, -.46) and difference of SFH-NFH (P=0.01, 95% CI= -4.3, -.74) were statistically significant. While in skeletal class II and class III all parameters were not statistically significant.

Conclusions: There is statistically significant sexual dimorphism was found in SN-FH angle in skeletal class I but not in class II and III. Females have steeper SN-FH angle

Keywords: Angle's classification; cranial base; dimorphism

Introduction

The objective of contemporary orthodontic care is to bring harmonious facial esthetics with consequent improvement in social well-being and quality of life of an individual.[1] One of the fundamental tool is the lateral cephalogram which is used in orthodontic diagnosis, treatment planning, evaluation of care outcome, prediction of growth and research purposes.[2,3]

The changes which occur during normal growth and orthodontic treatment needed to be measured using a reliable tool in Orthodontics. Cephalogram is one such tool which can quantify two dimensional changes during growth and treatment.[4] In order to calculate the growth activities of the craniofacial structure, an important consideration during accomplishment of cephalometric analysis is the selection of different reference planes or a coordinate

[a] BDS; Resident, Orthodontic department, Armed Forces Institute of Dentistry, Rawalpindi, Pakistan.

[b] Corresponding Author. BDS, FCPS, CHPE; Assistant Professor, Department of Orthodontics, Armed Forces Institute of Dentistry, National University of Medical Sciences, Rawalpindi, Pakistan.
Email: drerumamin@gmail.com

[c] BDS; Resident, Orthodontic department, Armed Forces Institute of Dentistry, Rawalpindi, Pakistan.

[d] BDS; Resident, Orthodontic department, Khyber College of Dentistry, Peshawar, Pakistan.

system. Stable anatomical structures can be used for these reference planes in the cranium or face where these can be measured and compared.[5] Although many such reference planes can be found in literature but most of them are unreliable, FH (Frankfort-Horizontal) plane and SN (Sella-Nasion) plane are two planes which are most commonly used.[6] These two reference planes are reliable in assessing growth changes in Orthodontics. There is constancy between these two planes throughout growth. The average of value of angle between FH and SN planes is 7[0].[7]

A number of studies can be found in the literature on the variation of sella-nasion and Frankfort plane variations in different populations in the literature.[5,8,9] However the gender dimorphism of the angle between Frankfort-horizontal (FH) and Sella-Nasion (SN) planes in different malocclusions is not very well researched. The relationship between SN and FH planes represented by the SN-FH angle, this is essential for the lateral cephalograms analysis, as one describes the anterior cranial base whereas the other FH plane closely represents the true horizontal plane.[5] Better knowledge of the craniofacial anatomy can also affect the decisions made by the orthodontists when formulating treatment plans for their patients.[10]

The rationale of this study is that growth and cephalometric parameters are affected by genetic, ethnic and environmental factors. So our results may or may not be different from Indian population. It is important to know the gender base variation in SN-FH angle because it is baseline and reference angle for orthodontic diagnosis and treatment planning. So the objective of this was to compare the Sella-nasion to Frankfort-horizontal plane (SN-FH) angle between genders in three sagittal classes of malocclusion on lateral cephalograms of the patients who reported to a tertiary care for orthodontic treatment.

Materials and methods

This retrospective cross sectional study was conducted on 180 subjects at Orthodontics department, Armed Forces Institute of Dentistry Rawalpindi (AFID) from June 2020 to October 2020. The sample size was calculated by WHO software at 5% margin of errors and 90% of power of test using the mean value of angle between the Sella-nasion (SN) plane and the Frankfort-horizontal (FH) plane 7.42 ± 3.62 degrees in males and 8.7 ± 3.48 in females degrees from previous study.[9] The calculated sample size was 166 however to make subcategories analysis easy and increase the power of study further we took total of 180 subjects.

A sample size of 180 patients was selected. 90 male patients and 90 female patients were selected. There were total 60 cases of sagittal class 1, II and III each with equal distribution of genders in each class, thus in each group of sagittal class, out of 60 cases there were 30 males and 30 females. After obtaining ethical approval of the institute ethical review committee (Ltr: No: 918/Trg-ABP1K2). The data were collected from patient's records available in the department. The inclusion criteria were pretreatment lateral cephalometric radiographs with high clarity and excellent contrast, age from 16 to 28 years, and Pakistani national. Subjects with previous history of orthodontic treatment, systemic diseases affecting general growth and development, history of trauma or surgery of head or dentofacial region, developmental or acquired anomalies in craniofacial region were excluded. Skeletal sagittal classification was done on basis of Wits appraisal[10] and ANB angle.[11]

Age, gender, and skeletal class of malocclusion were recorded from records of each participant. SN-FH angle was traced manually on acetate paper on illuminator with lead pencil. SN plane was traced as the closest distance from mid of sella to nasion point and similarly FH plane was traced as the closest distance from anatomical porion to

orbitale. The angle between SN and FH plane was recorded in degrees. Other recorded measurements were; the closest distance from the FH to the N (NFH), the closest distance from the FH to the S (SFH), and the difference between the NFH and SFH (Δ). All measurements were done twice, and then averaged by single examiner.

The data were analyzed in SPSS version 20. Frequencies and percentages were calculated for all categorical variables like gender and class of malocclusion and mean and standard deviation were calculated for continuous variables like age and SN-FH angle. Student t test was applied to define any significant differences between genders in each of the three classes of malocclusion. ANOVA was applied to see the difference in SN-FH angle among the three classes of malocclusion. P≤0.05 was considered at significant level.

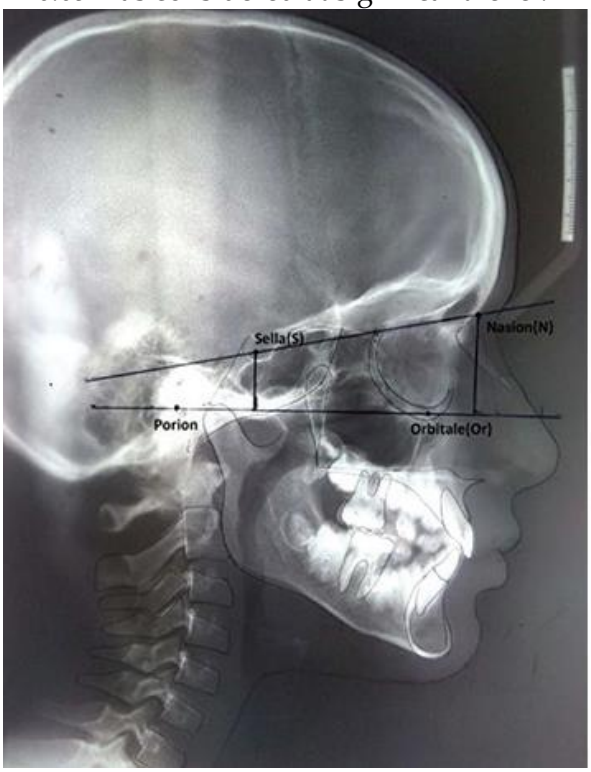

Figure 1: This lateral Cephalogram tracing contains four landmarks: Sella (S) is the midpoint of sella turcica, Nasion (N) is most anterior point of nasofrontal suture, Porion (Po) is upper most point on external auditory meatus, Orbitale (Or) is the lower most point on orbital margin. Furthermore, four planes are shown in this figure: Sella-Nasion plane (SN) is the plane connecting midpoint of sella to anterior point of frontonasal suture, Frankfort-Horizontal Plane (FH) is the plane connecting upper most point on the external auditory meatus and the lower most point on the orbital border, Nasion- Frankfort Horizontal plane (NFH) is closest distance from FH plane to nasion point (N) and Sella-Frankfort Horizontal plane (SFH) is the closest distance from Frankfort plane to sella point(S).

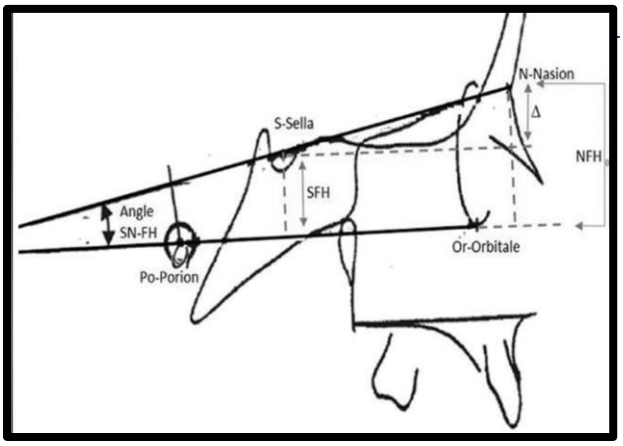

Figure 2: The landmarks shown in the figure above are: Nasion (N) is most anterior point of nasofrontal suture, Sella (S) is the midpoint of sella turcica, Porion (Po) is upper most point on external auditory meatus, Orbitale (Or)) is the lower most point on orbital margin. planes are shown in this figure: Sella-Nasion plane (SN) is the plane connecting midpoint of sella to anterior point of frontonasal suture, Frankfort-Horizontal Plane (FH) is the plane connecting upper most point on the external auditory meatus and the lower most point on the orbital border, Nasion- Frankfort Horizontal plane (NFH) is closest distance from FH plane to nasion point (N) and Sella-Frankfort Horizontal plane (SFH) is the closest distance from Frankfort plane to sella point(S).The angular measurement in this image is: SN-FH. There are two linear measurements and one angular measurement in this figure: (NFH SFH,Δ), SN-FH= Sella-Nasion-

Frankfort Horizontal, NFH= Frankfort Horizontal to Nasion which is constructed by dropping a perpendicular from nasion on to the Frankfort plane and represent closest distance from nasion point to FH plane, SFH= Frankfort Horizontal to Sella which is constructed by dropping a perpendicular from Sella on to the Frankfort plane and represents the closest distance between Sella point and the FH plane. Δ depicts the difference of NFH and SFH.

Results

Of total 180 subjects; 90 were males and 90 were females. The overall mean age was 19.42 years (±, 3.28 years). The values of Sella-Nasion to Frankfort-Horizontal plane (SN-FH) are higher for females in all sagittal classes of malocclusion (table I), however in our sample this value is found to be significantly higher in females in skeletal class I malocclusion (6.07±2.61 for males and 7.57± 2.74 for females). Linear parameters NFH and SFH showed greater dimensions in males as compared to the females in sagittal class II and III.(In skeletal class II mean difference between males and females was 0.8mm and 0.9mm for NFH and SFH respectively and for sagittal class III the mean difference was 1.033mm and 0.933mm for NFH and SFH respectively). Whereas in class I samples the linear measurements SFH and NFH showed greater values for the females as compared to males (a mean difference of 0.93mm for NFH and 2.4mm for SFH respectively). The difference between NFH-SFH (Δ) was greater in females as compared to males in sagittal class I (mean difference of -2.57mm), for sagittal class II Δ was greater in females compared to males (mean difference of 0.5mm) and for sagittal class III Δ was greater in females compared to males(mean difference of 0.1mm) The overall mean values for sella-nasion to Frankfort horizontal plane (SN-FH) angle, the closest distance from the FH to the N (NFH), the closest distance from the FH to the S (SFH), and the difference between the NFH and SFH (Δ) were 7.21±2.46 degrees, 25.75±2.91mm, 16.04±3.72 mm, and 7.48±3.37 mm.

In skeletal class I the age and NFH was not statistically significant between genders while SN-FH angle (P=0.03, 95% CI= -2.8, -.11), SFH (P=0.02, 95% CI= -4.3, -.46) and difference of SFH-NFH (P=0.01, 95% CI= -4.3, -.74) were statistically significant. However, in skeletal class II and class III all parameters were not statistically significant. The detailed statistics are given in table I.

Comparison of overall mean SN-FH angle in different skeletal classes showed that it was statistically insignificant (P=0.123). The details of mean, standard deviation, 95% confident interval are given in table II.

Table I: Comparison of age, SN-FH angle, NFH (mm), SFH (mm) and difference of SFH-NFH between genders.

Sagittal class			Mean ± SD	Mean diff	95% CI	P-value
I	Age (years)	Male	18.80±2.62	0.667	-.68, 2.01	0.33
		Female	18.13±2.61			
	SN-FH angle(⁰)	Male	6.07±2.61	-1.5	-2.8, -.11	**0.03***
		Female	7.57± 2.74			
	NFH (mm)	Male	25.47±2.42	-0.93	-2.3, .46	0.19
		Female	26.40±2.96			
	SFH (mm)	Male	12.13±4.10	-2.4	-4.3, -.46	**0.02***
		Female	14.53±3.36			
	SFH-NFH (Δ) (mm)	Male	5.30±3.83	-2.57	-4.3, -.74	**0.01***
		Female	7.87±3.18			
II	Age (years)	Male	21.53±4.45	0.1	-2.1, 2.3	0.93
		Female	21.43±4.01			
	SN-FH angle(⁰)	Male	7.03±1.90	-0.13	-1.3, 1.1	0.83
		Female	7.17±2.70			
	NFH (mm)	Male	25.70±1.91	0.8	-.47, 2.1	0.21
		Female	24.90±2.89			
	SFH (mm)	Male	18.03±3.17	0.9	-.84, 2.6	0.31
		Female	17.13±3.56			
	SFH-NFH (Δ) (mm)	Male	7.23±2.41	-0.5	-2.04, 1.04	0.52
		Female	7.73±3.49			
III	Age (years)	Male	18.43±1.35	0.267	-.42, .95	0.44
		Female	18.17±1.31			
	SN-FH angle(⁰)	Male	7.43±2.22	-0.57	-1.71, .59	0.33
		Female	8.00±2.26			
	NFH (mm)	Male	26.53±3.32	1.033	-.74, 2.81	0.25
		Female	25.50±3.54			
	SFH (mm)	Male	17.67±1.75	0.933	-.074, 1.941	0.07
		Female	16.73±2.132			
	SFH-NFH (Δ) (mm)	Male	8.33±3.089	-0.1	-1.74, 1.55	0.90
		Female	8.43±3.287			

*significant

Table II: Comparison of overall SN-FH angle in different skeletal classes.

Skeletal class	N	Overall SN-FH angle		P-value
		Mean ± SD	95% CI for Mean	
I	60	6.82±2.75	6.10, 7.53	0.123
II	60	7.10±2.31	6.50, 7.70	
III	60	7.72±2.24	7.14, 8.30	
Total	180	7.21±2.46	6.85, 7.57	

*ANOVA test; P<0.05 was significant level

Discussion

The present study was aimed to compare the SN-FH angle, and the closest distance from the FH to the S (SFH), and the difference between the NFH and SFH (Δ) among genders in three sagittal classes of malocclusion. Our findings showed that SN-FH angle, SFH and the difference of SFH-NFH were statistically significant among genders.

The SN and FH lines are commonly used in cephalometric as a reference planes for growth assessment and quantification of changes associated with orthodontic treatment. Previous study showed the anterior cranial base finished growth after 6 to 7 years of age.[12] Literature is evident that cranial base length and inclination are the controlling factors for sagittal growth of maxilla and mandible.[13,14] It has been documented that FH line can a good replacement of SN plane for assessment of jaw growth.[15]

Some studies have reported that the average value of SN-FH is 7 degrees with no statistically significant difference among skeletal class of malocclusion and genders[6, 16] while on other hand many studies have shown that SN-FH varies among skeletal class of malocclusion and genders.[5,17,18]

Alves et al[5] conducted a study based on pre- and post-treatment changes in the sella-nasion and frankfort-horizontal plane angle in orthognathic cases. Wu et al[8] performed an investigation in Class II division 1 malocclusion on the FH-SN angle in different vertical growth patterns. However, a study in Indian population based on sexual dimorphism of angle between FH-SN planes in different sagittal classes of malocclusion reported significant (P value 0.002) sexual dimorphism in class I malocclusion only.[9]

Our results showed that SN-FH angle in skeletal class I was different statistically significantly between males and females. The mean SN-FH angle was little higher in females than males. Higher value in female may be due to genetic reason. A study on sexual dimorphism of angle between FH and SN planes in various sagittal classes of malocclusions in Indian population by Reddy et al.[9] reported that the mean SN-FH angle was higher in females than males and results were statistically significant. These results are consistent to our study. Similarly Huh et al.[7] on Korean and Giri *et al*.[19] on Nepalese Population also reported that the mean SN-FH angle was higher in females than males.

Similarly, in skeletal class I the SFH, and difference of NFH-SFH between males and females differed statistically significantly. However NFH was different among genders. The reasons may be due to the fact that that the change of the position of Nasion (N) were insignificant in both genders and similar results were also reported by Reddy et al.[9]

In skeletal class II and III these parameters (SN-FH angle, NFH, SFH, difference of SFH-NFH) were not different between males and females. Similar results were found by Reddy et al.[9]

In our study the value of SN-FH angle was approximately equal in class II and III and difference was insignificant. Our results are almost similar to study by Reddy et al[9] in which SN-FH angle was higher in class II than III but differences were insignificant. On the other hand, results of a study carried out in Brazilian population by Alves et al.[20] showed that SN-FH angle was higher in class II than III, and was statistically significant. The difference in results may be due to genetic, ethnic and environmental variations.

Conclusions

There is statistically significant sexual dimorphism in SN-FH angle in skeletal class I

but not in class II and III. In the sample used for this research, females were found to have steeper SN-FH angle in all three classes of malocclusion.

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