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A Cephalometric Evaluation of Anterior Cranial Base Slope in Patients with Different Skeletal Malocclusions

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ABSTRACT

Objective: To assess the correlation in the anterior cranial base (SNA, SNB angles) and among the three different skeletal malocclusions. **Study Design:** Descriptive cross-sectional study. **Study setting:** Orthodontic Department KRL Hospital G-9, Islamabad, from March to August 2024. **Methodology:** The data included lateral cephalograms of people undergoing orthodontic treatment. By simple consecutive non-random sampling technique, a total sample size of 120 patients was selected. IBM SPSS version 23.0 was used for the data analysis. Quantitative data like age, SNA, SNB and ACB slope was expressed in mean (SD) as descriptive statistics. Pearson correlation coefficient was used to evaluate the relationship between the anterior cranial base and the skeletal malocclusions. A p-value ≤ 0.05 was considered statistically significant. **Results:** Out of 120 patients evaluated in this study, the distribution across the three skeletal malocclusions was as follows: 10% were classified as skeletal class I, 65% as skeletal class II, and 25% as skeletal class III. A significant correlation was observed between the anterior cranial base slope and the type of skeletal malocclusion ($p < 0.05$). The patients with Class II malocclusion, the SNA angle was notably higher while in Class III malocclusion patients, the SNB angle was significantly increased. Additionally, the SN-FH angle demonstrated a steeper slope in Class III patients compared to those with Class I and Class II malocclusions. There was no significant difference in anterior cranial base length (BA-S) across the malocclusion groups. The correlation analysis between SNA, SNB, and the anterior cranial base slope indicated that the steepness of the cranial base plays a role in the manifestation of the skeletal malocclusions. **Conclusion:** This research study underscores the significance of the anterior cranial base in the development of skeletal malocclusions. The findings suggest that patients with Class II malocclusion exhibit a steeper anterior cranial base slope, whereas Class III patients tend to have a flatter cranial base slope. These variations in anterior cranial base morphology can serve as effective diagnostic tools in the assessment, evaluation, and treatment planning of skeletal malocclusions. The study also highlights the complex interplay between cranial base morphology and skeletal relationships, indicating the need for comprehensive analysis in orthodontic assessment and treatment strategies.

INTRODUCTION

Malocclusion can be skeletal or dental, which can lead to distortion of normal growth and development [10]. Various angular and linear measurements have been included in numerous cephalometric analyses for the characterization of the patient's craniofacial skeleton. These aid clinicians in diagnosing skeletal and dental discrepancies contributing towards presenting malocclusions and determining the limitations of tooth movement in particular cases [2, 13].

Cephalometric analysis has long been a decisive factor in orthodontic treatment planning [6]. Measurements performed based on dentofacial structures rely on specific reference planes, one of which is the anterior cranial base (ACB) [7]. The ACB may be influenced by the direction and degree of craniofacial growth, with studies revealing its angular slope or length's role in the development of skeletal malocclusions [1, 11]. The slope varies across populations and ages, which can affect the outcomes of cephalometric analyses [14, 15].

The stability of the ACB throughout craniofacial growth makes it ideal for superimposing cephalometric radiographs [5]. Despite this, its significance in malocclusion has been debated. Some studies propose cranial base inclination affects malocclusion severity [4, 9], while others argue that its role is secondary to broader craniofacial morphology factors [8, 12].

MATERIAL

Subjects

Approval for this descriptive cross-sectional study was obtained on 2nd March 2024 and the study was conducted after approval from the Ethical Review Board of KRL General Hospital, Islamabad at the Orthodontic Department. A total of 120 patients between the ages of 07 and 40, undergoing orthodontic treatment, were selected using a consecutive non-random sampling technique. Patients included in the study had permanent dentition and no history of orthodontic treatment. Exclusion criteria comprised patients with craniofacial anomalies, syndromes, systemic diseases affecting craniofacial growth, and any previous orthodontic interventions.

Apparatus

Data collection was carried out using lateral cephalograms of the selected patients between March and August 2024. Cephalometric radiographs were obtained using a standardized technique. The angular and linear measurements of the anterior cranial base were assessed, focusing on the SN-FH angle (the angle between the anterior cranial base and the Frankfort horizontal plane), the BA-S/FH angle (the angle between the posterior cranial base and Frankfort horizontal plane), the BA-S length (distance between basion and sella), and the S- FH length (perpendicular distance from sella to the Frankfort horizontal plane).

The different skeletal malocclusions (Skeletal Class I, Class II, and Class III) were identified based on SNA and SNB angles. The SNA angle measured the intersection of the sella-nasion and nasion-A lines, while the SNB angle measured the intersection of sella-nasion and nasion-

B lines. Both angular measurements were crucial in classifying the type of skeletal malocclusion.

METHOD

All data were analyzed using SPSS version 23.0. A set of cephalometric radiographs that were taken using a standardized technique was used, and the anterior cranial base slope [NSL-NV (Nason-Sella line to V-ert) angle; in degrees] as well as linear measurement associated with it. The angle of the SN-FH (angle between anterior cranial base and Frankfort horizontal plane) and BA-S/FH (angular measurement related to posterior cranial planes). Linear measurements: Linear variables such as BA-S length (distance from the basion to sella) and S-FH length (perpendicular distance of sella to Frankfort horizontal plane). Two angular measurements (SNA and SNB) were used to correlate these with the different skeletal malocclusions. Descriptive statistics were calculated for quantitative variables such as age, slope SNA, SNB measurements of the anterior cranial base. Qualitative variables like gender, and skeletal class were measured in the term of frequency and percentage. All patients had complete permanent dentition and no prior history of orthodontic treatment. A p-value of ≤ 0.05 was considered statistically significant.

RESULT

The total number of patients in the study was 120 (53 males and 67 females). The mean age was 16.60 years,ranging from 07- 40 years. Twelve patients belonged to skeletal class I (10%), seventy-eight were skeletal class II (65%) and thirty were skeletal III (25%).

Table 1
Relationship between SNA and SNB with ACB with malocclusion

	SNA	SNB	SLOPE SN
SNA Pearson Correlation	1	.618**	.105
Sig. (2-tailed)		.000	.252
n	120	120	120
SNB Pearson Correlation	.618**	1	.136
Sig. (2-tailed)	.000		.139
n	120	120	120
SLOPE SN Pearson Correlation	.105	.136	1
Sig. (2-tailed)	.252	.139	
n	120	120	120

*Note. n=120, Pearson correlation test, p-value 0.05 **. Correlation is significant at the 0.01 level (2-tailed).*

Table I shows the relationship between SNA and SNB with anterior cranial base with malocclusion by using Pearson correlation coefficient. These two angles have a significant relationship, according to the SNA-SNB correlation. However, neither of these angles exhibit any significant correlation with the anterior cranial base slope (SLOPE SN), indicating that it may not be a significant factor influencing sagittal jaw discrepancies, at least not in this sample. Correlations with SLOPE SN are not statistically significant, which suggests that the variations in the slope of the anterior cranial base are not supportive and they do not substantially affect the skeletal relationships reflected by the SNA and SNB angles.

Table 2
Independent t-test analysis

	t-test for Equality of Means			
	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
				Lower
SNA Equal variances	.064	-1.628	.871	-3.352
assumed	.065	-1.628	.874	-3.360
Equal variances not	.221	-.920	.748	-2.401
assumed	.227	-.920	.757	-2.421
SNB Equal variances assumed	.998	.00045	.15328	-.30395
Equal variances not assumed	.998	.00045	.15293	-.30335

Note. $p^{**} < 0.01$, $p^{*} < 0.05$

Table II shows the independent t-tests results between variables. The independent samples t- test results reveal no statistically significant differences in SNA, SNB, or SLOPE SN between the two groups. For SNA, there is a marginal trend toward significance ($p = 0.064$), suggesting a possible difference that might become significant with a larger sample size. However, both SNB ($p = 0.221$) and SLOPE SN ($p = 0.998$) show no significant differences, indicating similar values across groups. Overall, these findings suggest that the craniofacial angles, including the anterior cranial base slope, are consistent between the groups in this dataset.

Table 3
ANOVA test analysis

		(*n* = 120)				
Variable	**Gender**	**M**	**SD**	***t***	***p***	***df***
SNA	Male	79.92	4.823	-1.869		118
	Female	81.55	4.669	-1.862	0.064	110.026
SNB	Male	77.17	4.304	-1.230		118
	Female	78.09	3.872	-1.215	0.221	105.739
SLOPE SN	Male	1.5581	.73363	.003		93
	Female	1.5577	.75182	.003	0.998	90.448

Note. M= mean; SD=standard deviation; p = significance level; df = degree of freedom

In Table. III the ANOVA test was conducted to see if the anterior cranial base slopes and SLOPE SN differ across the different groups based on gender. This analysis found no statistically significant differences between groups male and female in the variables SNA, SNB, and SLOPE SN. Although SNA showed a slight trend ($p = 0.064$) towards a difference, it did not reach significance, indicating that SNA angles are largely similar across groups. Both SNB ($p = 0.221$) and SLOPE SN ($p = 0.998$) also showed no significant differences, suggesting that craniofacial angles and cranial base slope are consistent across the groups in this study.

The findings of this study highlighted thr role of the anterior cranial base slope, in influencing the craniofacial relationships, with implications for occlusal plane orientation and mandibular alignment across the different skeletal malocclusion types. It is recommended to conduct further comparisons across all three sagittal classifications in larger, more diverse populations to enhance our understanding of the role of cranial base structure in clinical populations.

DISCUSSION

This study assessed the relationship between the slope of the anterior cranial base (ACB) and sagittal jaw alignment using the SNA and SNB angles. The findings revealed no statistically significant correlation between the ACB slope and either the SNA or SNB angles, suggesting that the ACB slope may not be a critical factor in skeletal discrepancies across malocclusion classes.

The results align with previous findings indicating that cranial base morphology influences jaw positioning but may not universally impact malocclusion severity [1, 7]. For instance, Gong et al. [11] reported that cranial base points, particularly points N, A, and B, affect the SNA and SNB angles but that sagittal positioning of other points has minimal influence. Similarly, Dhopatkar et al. [9] noted that the ACB slope's effect on malocclusion was minor compared to broader craniofacial factors.

Differences in findings may be attributed to varying sample demographics and methodologies. For example, Bhattacharya et al. [6] observed population-specific variations in cranial base morphology, emphasizing that craniofacial growth patterns differ regionally and racially. Wu et al. [15] further highlighted age-specific changes in cranial base angulation, reinforcing the need for population-based norms.

This study's broader population scope, which included malocclusion types I, II, and III, contrasts with prior research focusing predominantly on single classifications [10]. Future studies should explore larger, more diverse populations to better understand cranial base morphology's role in skeletal relationships.

CONCLUSION

This study examined the relationship between the anterior cranial base (ACB) slope and sagittal jaw alignment, using the angles SNA and SNB, across patients with different skeletal malocclusions. The results indicate no statistically significant correlation between the ACB slope and SNA or SNB angles, suggesting that the ACB slope may not be a primary factor influencing skeletal discrepancies in this study. While cranial base morphology has been shown in past studies to influence jaw positioning, this study suggests that ACB slope alone does not consistently affect sagittal jaw relationships across different malocclusion types i.e, I, II and III. These results emphasize the importance of a comprehensive analysis of multiple craniofacial structures in orthodontic diagnosis and treatment planning. Further studies are recommended to explore these relationships in diverse populations.

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