ORIGINAL ARTICLE

ANTERO POSTERIOR POSITION OF MAXILLARY CENTRAL INCISORS IN RELATION TO THE FOREHEAD IN PAKISTANI POPULATION

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Background: Facial aesthetics, particularly profile aesthetics, are not just a single intention for many patients to seek orthodontic treatment, but they also serve as a crucial objective in dental and aesthetic treatment. Objective was to determine the anteroposterior (AP) position of maxillary central incisors in relation to the forehead and examine the potential correlation between the AP positioning of maxillary central incisors and the inclination of the forehead in a cohort representing the Pakistani population. **Methods:** A total of 100 orthodontic patients aged 13 years and older, without regard to gender of Pakistani descent, were enrolled in this cross section study. Exclusions comprised individuals with absent or impacted maxillary central incisors, history of orthodontic treatment, craniofacial trauma, prior cosmetic dental procedures, or anterior prostheses/restorations. Participants' demographic data including age and gender were recorded. Forehead inclination and position of maxillary central incisor were assessed from smiling photographs. Pearson's correlation coefficient was used to evaluate the correlation between the anteroposterior (AP) positioning of maxillary central incisors and the angle of forehead inclination. Differences in the AP positioning of maxillary central incisors based on age and gender were analyzed using t-tests and ANOVA. **Results:** Males were 44 (44%) and females were 56 (56%). The mean age was 26.47±6.46 years. The mean value of incisor position in males (2.86±1.73 mm) was a little higher than in females (2.55±2.03 mm) but not statistically significant (p=0.416). The correlation between incisor position and forehead inclination was moderately high (r = 0.672), and it was very highly statistically significant (p<0.001). **Conclusions:** The average values for maxillary incisor sagittal position and forehead inclination were determined. A moderately strong and highly statistically significant correlation was observed between incisor position and forehead inclination. No gender differences were identified, although variations were noted among different age groups.

Keywords: Anteroposterior; Forehead; Incisor; Orthodontics

Citation: Hussain M, Malik F, Noman M, Ali MM, Hashmi G, Sikandar S. Antero posterior position of maxillary central incisors in relation to the forehead in Pakistani population. J Ayub Med Coll Abbottabad 2025;37(3):286–90.

DOI: 10.55519/JAMC-03-13618

INTRODUCTION

Facial aesthetics, particularly profile aesthetics, are not just a single intention for many patients to seek orthodontic treatment, but they also serve as a crucial objective in dental and aesthetic treatment.[1,2] As orthodontic treatment evolves from simply aligning crooked teeth to enhancing facial aesthetics, patients increasingly aim to improve their overall facial appearance. It is widely accepted that a balanced face plays a critical role in how others and themselves perceive individuals in society.[2] The position of the maxillary incisors, especially when viewed in profile while smiling, is of significant concern to many people.[3] This concern highlights the importance of adequately placing maxillary incisor teeth in the sagittal position, which substantially affects oral and facial harmony in both frontal and profile views, with the latter being particularly important during diagnostic assessments when patients smile.[4] Schlosser *et al*. confirmed a significant difference in aesthetic assessment and perception for every millimeter change in maxillary incisors' anteroposterior (AP) position in a smiling profile. Cao *et al*.[1] validated the importance of maintaining an ideal AP incisor position in the sagittal view, noting that change in this positioning highly influences both smiling profile aesthetics and overall facial balance.[5]

Additionally, variations in the position of maxillary incisors and their effect on the upper lip are essential for treatment planning.[6] To accurately assess a patient's facial appearance or aesthetics, orthodontists must include an evaluation of the profile face as part of diagnostic records.[7] Over the years, various methods have been suggested in the

literature for evaluating the facial profile, including traditional cephalometric studies and repose soft tissue analysis.[4] Traditional cephalometric techniques rely mainly on internal bony landmarks and are questionable due to identification errors and individual landmark position variability.[8]

Previous research has yet to explore the relationship between maxillary central incisors and other external facial landmarks in a profile view while showing a central incisor. According to Andrew's six elements of orofacial harmony,[9] the forehead has been utilized as a reference point to assess the AP position of maxillary central incisors in profile.[10] Recent studies have evaluated the AP position of maxillary central incisors and their relationship to the forehead. The AP position of the maxillary central incisors and forehead inclination (FI) were measured in relation to a vertical line through the Glabella (GV) parallel to the true vertical. One study found an average maxillary central incisor antero-posteriorly positioned at 2.5±1.94.

This study explores the correlation between the AP positioning of maxillary central incisors and the angle of forehead inclination within the Pakistani population. Considering the changing global trends in facial aesthetics, with a paradigm shift from flatter to fuller-looking profiles, this study will help establish aesthetic norms for the Pakistani population. The current literature shows a great deal of ethnic variability in the optimal AP position of the maxillary central incisor with reference to forehead landmarks. Therefore, this study will be a valuable addition to the Pakistani database of ethnic dentofacial norms. Furthermore, it will help suggest a guideline for diagnosis and treatment planning in orthodontics and orthognathic surgery.

MATERIAL AND METHODS

This cross-sectional study was conducted in the Department of Orthodontics at Sharif Medical and Dental College Lahore after obtaining ethical approval from the Sharif Medical Research Centre and the Ethical Committee. The inclusion criteria were orthodontic patients presenting in the OPD at age 13 years and above, irrespective of gender. Exclusion criteria were patients with missing or impacted central incisors and a previous history of orthodontics treatment or any history of trauma or deformity. Written informed consent was obtained from every patient. Using the non-probability consecutive sampling method, 100 patients were selected with the help of WHO sample size determination software, with 95% CI and absolute precision of 0.05 and taking the mean central incisors anteroposterior position (CIAPP) value of 2.5±1.9.[4] Each participant's extraoral profile photograph was captured while smiling using a Nikon D-5300 camera. These photographs were taken with the subject's forehead and maxillary incisors visible from a fixed distance of 6 feet from the mid-sagittal plane of the patient. Subjects were seated against a blue background while maintaining a natural head position.

A vertical chain hanging in a plumb line was also placed close to the subject to represent the true vertical line (TVL). Each photograph was imported into Adobe Photoshop (CC2019-20.0.5 Version). The image was then rotated upright and resized with an estimated life-size. Upon completing this, landmarks and lines were drawn for evaluation, as shown in Figures 1.

Landmark points on the forehead were identified and marked in each image as described by Andrews II, including the trichion, superion, glabella, and FFA point, as illustrated in Figure 1. The most superior aspect of the forehead when the forehead is of relatively flat contour is trichion point and if the forehead is either round or angular it will be called as superion. FFA point is the midpoint between trichion and glabella for forehead with flat contour or the midpoint between superion and glabella for forehead with rounded or angular contour. Glabella is the most inferior aspect of the forehead.[7] The landmark for the maxillary central incisors was the facial axis (FA) point, located on the facial axis that bisects the occlusal and gingival halves of the clinical crown. These points were all positioned on the midsagittal plane of the head. Three reference lines were drawn as vertical lines, as shown in Figure 1. Line 1 passed through the FA point on the maxillary central incisor, Line 2 through the glabella point, and Line 3 through the FFA point on the forehead. A fourth reference line was drawn connecting the glabella to either the superion or trichion, the uppermost point on the forehead, to assess the inclination of the forehead (shown in Figure 2). The AP position of the maxillary central incisors relative to the forehead was measured as the linear distance between the FA point (Line 1) and the glabella vertical line (GVL, Line 2), using a metric ruler accurate to 0.5 mm. The inclination of the forehead was measured with a protractor to the nearest 0.5°, as the angle between Line 3 and Line 4.

Data was entered and analyzed in SPSS version 25. Continuous variables such as age, CIAPP and forehead inclination (FI) were reported as mean and standard deviation. Categorical variables such as gender were reported as frequency and percentage. Data was stratified for age and

gender. Post-stratification, Pearson's correlation coefficient was applied to determine the correlation between the AP position of maxillary central incisors and forehead inclination. The significance of gender and age difference for the AP position of the maxillary central incisor was determined using a t-test. *p*-value<0.05 was considered as significant.

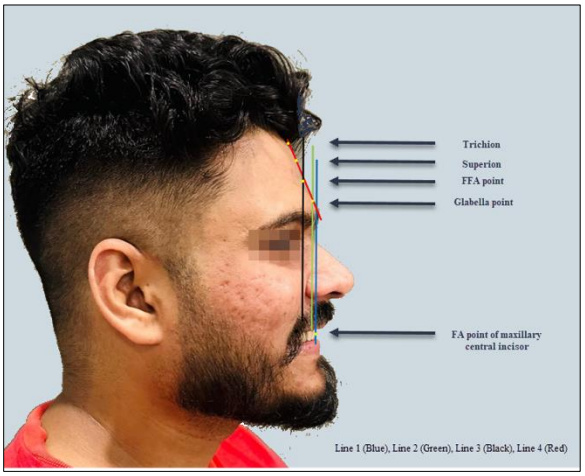

Figure-1: Landmark points and Reference lines

RESULTS

The males were 44 (44%) and females were 56 (56%). The mean age was 26.47±6.46 years, with a range from 15 to 38 years. The mean maxillary incisor position was 2.68±1.89mm with a range from -1.68 to -6.76, and the mean forehead inclination was 19.71±5.51 degrees, with a range from 10.29 to 36.27.

The most common age group was 15–23 years, with 38 (38%), followed by age groups 24–30 and 31-38 years, each having 31 (31%) participants. The mean value of incisor position in males (2.86±1.73 mm) was a little higher than in females (2.55±2.03 mm) but not statistically significant (*p*=0.45) (Table-1).

The highest mean incisor position was found in the age group 24-30 years (3.52±1.53 mm), followed by the age group 15–23 years (2.68±1.85 mm), and the least was in the age group 31-38 years (1.86±1.95 mm). The difference was statistically significant (*p*=0.002) (Table-2).

The scatter plots show a positive high correlation between incisor position and forehead inclination and coefficient of determination (r2 = 0.45) (Figure-2).

The correlation between incisor position and forehead inclination was moderately high (r = 0.67), and it was highly statistically significant (*p*<0.001). In males, the correlation between the position of the central incisor and the inclination of the forehead was high (r = 0.74), and it was greatly statistically significant (*p*<0.001). In females, the correlation between the position of the incisor and the inclination of the forehead was moderate (r = 0.64) and highly statistically significant (*p*<0.001) (Table-3).

The correlation between incisor position and forehead inclination stratified by age groups shows that it was highest in the age group 15–23 years (r = 0.83), followed by age group 31–38 years (r = 0.51), and least in the age group 24–30 years (r = 0.50). All the correlations were statistically significant (*p*<0.01) (Table-4).

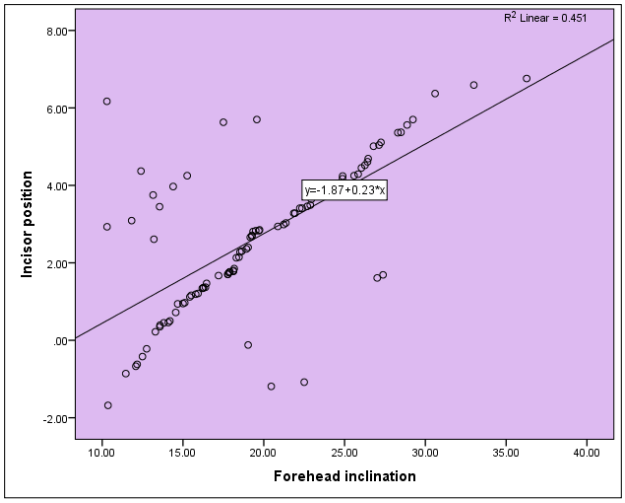

Figure-2: Scatter plot for incisor position and forehead inclination

Table-1: Comparison of incisor position between genders

		Mean±SD	95% CI	*p*-value*
Incisor position (mm)	**Male**	2.86±1.73	-0.44,1.07	0.45
	Female	2.55±2.025		

*Independent t test

Table-2: Comparison of incisor position among age groups

Age group	Mean±SD (mm)	95% CI	*p*-value*
15-23	2.68±1.85	2.076, 3.29	0.002
24-30	3.52±1.53	2.95, 4.08	
31-38	1.86±1.95	1.14, 2.57	

*One way ANOVA

Table-3: Correlation between position of central incisor and inclination of forehead stratified by gender

	Gender		Forehead inclination
Incisor position	**Male**	**Pearson Correlation**	0.74**
		***p*-Value**	< 0.001
	Female	**Pearson Correlation**	. 64**
		***p*-Value**	< 0.001
	Total sample	**Pearson Correlation**	.672**
		***p*-Value**	<0.001

Table-4: Correlation between position of central incisor and inclination of forehead stratified by age groups

	Age category		Forehead inclination
Incisor position	15-23	Pearson Correlation	0.83*
		p-Value	< 0.001
	24-30	Pearson Correlation	0.51*
		p-Value	0.004
	31-38	Pearson Correlation	0.51*
		p-Value	0.003

DISCUSSION

This study determined the anteroposterior position of the maxillary central incisors in relation to the forehead. It examined the relationship between the positioning of these teeth and the forehead angle in a Pakistani cohort. The results indicated that the average position of the upper central incisors was 2.68±1.89 mm, with the average angle of the forehead being 19.71±5.51 degrees. There was a moderately strong correlation (r = 0.672) between the position of the incisors and the tilt of the forehead, which was found to be highly significant statistically (p<0.001).

Physical attractiveness has become increasingly important in modern society, with enhancing facial aesthetics being a key motivator for individuals pursuing orthodontic procedures.[11,12] The impact of physical attractiveness extends into areas such as career advancement, financial success, and interpersonal relationships. The aesthetics of one's smile and the contour of one's facial profile are critical components of overall facial appeal.[13,14]

Therefore, orthodontists must focus on enhancing the smile's aesthetics and improving the facial profile's overall attractiveness as a primary treatment goal.[15] Several factors, such as lip shape and length, the extent of the buccal corridor, visibility of the gums during smiling, and the smile's width and type, must be considered when crafting an appealing smile.[16,17] The alignment and appearance of the upper front teeth play a significant role in the smile's aesthetics and overall facial profile. Consequently, orthodontists strive to achieve a beautiful smile in harmony with correct bite and functional relationships, ensuring durability over time. Some scholars have argued that the side view of the face holds more diagnostic value than the frontal view, suggesting that orthodontists should consider the profile perspective.[18] Techniques such as traditional cephalometric X-rays and analysis of the soft facial tissues are commonly used.[19]

If the maxillary upper incisors are regarded as an integral part of facial aesthetics, then orthodontists must assess the facial profile considering the visibility of these teeth. To accurately determine their placement in the profile view, it is necessary to identify facial landmarks beyond the usual lips, nose, and chin, especially when these teeth are shown. The outcomes of this study suggest that the forehead serves as an appropriate landmark for this purpose. Employing the forehead as a critical reference point for the AP positioning of the upper central incisors circumvents the limitations associated with cephalometric analysis or analysis of the soft tissue at rest.[20,21]

The positioning of the upper central incisors was found to have a strong relationship with the forehead landmarks identified in this investigation. It was also strongly linked to the forehead angle in adult Caucasian females exhibiting optimal facial balance (reference group). These results support the observations made by Andrews[4] and Adams[22].

Gidaly and colleagues[23] identified the ideal anteroposterior positioning of the upper central incisors and their association with the forehead in adult African American women. Earlier research found a significant relationship between the angle of the forehead and the anteroposterior position of the upper incisors in relation to the GVL, noting that an 18-degree increase in the forehead angle corresponded to a 0.31 mm forward movement of the incisors .[24] Adams and co-authors observed a link between the anteroposterior location of the upper incisors and the forehead angle, highlighting the forehead angle as a crucial reference for their proper positioning.[22] Resnick and team discussed the relevance of the forehead in evaluating the sagittal maxilla position for orthognathic surgery, suggesting the forehead as a critical reference in determining the anteroposterior positioning of the upper incisors during a full smile.[23] Kim found a notable association between the upper incisors' anteroposterior position and the forehead angle, underscoring the forehead's importance as a landmark in this context.[24]

Additionally, Resnick and others tested the effectiveness of Andrews's analysis in identifying the ideal sagittal maxilla position for orthognathic surgery,

finding it remarkably accurate for females, thereby supporting our observations.[25] He and his team in China also verified the significant correlation between the upper incisors' sagittal position and the forehead angle.[10] The collective findings of these studies endorse the optimal positioning of the upper incisors more to the front with an increase in the forehead angle. Given the variance in forehead shapes and the acceptable incisor positions across different races, it becomes essential to conduct such evaluations across diverse racial groups.[19]

CONCLUSION

Within the limitation of this study, it can be concluded that the average maxillary incisor position was 2.68±1.89mm and average forehead inclination was 19.71±5.51 degrees. The correlation between position of central incisor and inclination of forehead was moderately high and it was very highly statistically significant. No difference was found for genders. However, variations among age groups were found.

AUTHORS' CONTRIBUTION

MH: Study conception and design, data collection, drafting. Analysis and interpretation. FM: Analysis and interpretation of results, critical review. MN: Data collection, draft the manuscript, proof reading. MMA: Interpretation of results, proof reading. GH: Data collection. SS: Data collection, proof reading.

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Submitted: July 19, 2024	*Revised: November 19, 2024*	*Accepted: April 15, 2025*

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