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Antero-Posterior Relationship of Maxillary Central Incisors to The Forehead in Jharkhand Population

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ABSTRACT

Background: Facial aesthetics play a crucial role in an individual's social, professional, and personal life, making orthodontic treatment a popular choice for enhancing facial appearance. The maxillary central incisors significantly contribute to smile aesthetics, and their anteroposterior (AP) positioning relative to facial landmarks is a critical aspect of orthodontic diagnosis and treatment planning. This study evaluates the AP location of maxillary central incisors in adult African females relative to the forehead, assessing its reliability as a reference marker.

Methods: A total of 100 participants (50 cases and 50 controls) were analyzed using digital imaging. The AP location of the maxillary mid-incisors relative to the forehead and forehead angulation was determined using a metric ruler and protractor. The correlation between the maxillary central incisors and the forehead was assessed using statistical analysis.

Results: In the study group, 68% of subjects had their maxillary central incisors positioned ahead of the glabella, while 26% had them positioned between the forehead facial axis (FFA) point and the glabella. In contrast, in the control group, only 26% had their incisors ahead of the glabella, while 46% had them between the FFA point and glabella. The forehead angulation was significantly different between the study and control groups ($p = 0.00$), and the AP location of the maxillary incisors relative to the forehead FFA point varied significantly ($p = 0.001$). The regression analysis showed a strong correlation between the maxillary mid-incisors' AP position and the forehead ($r^2 = 0.310$ in the control group), but a weaker correlation with forehead angulation ($r^2 = 0.185$ in the study group).

Conclusion: The study confirms that the maxillary central incisors' AP positioning is significantly associated with the forehead, making it a reliable reference point for orthodontic evaluation in adult females. However, the correlation between incisor position and forehead angulation is weak. The study also found that females in the research model had a more rounded forehead, while males exhibited a flatter forehead. Considering the forehead as a reference marker can aid in treatment planning, and for Indian patients, achieving a harmonious AP relationship between the maxillary incisors and the forehead should be a therapeutic objective to enhance facial balance and aesthetics.

Keywords: *Maxillary central incisors, Forehead angulation, Facial aesthetics, Orthodontic diagnosis, Anteroposterior positioning, Smile aesthetics, Indian patients.*

1. INTRODUCTION

Facial aesthetics play a significant role in an individual's decision to seek orthodontic treatment.[1] A comprehensive orthodontic diagnosis involves a lateral assessment of the face, using both conventional cephalometry and soft tissue analysis to evaluate facial characteristics. Traditional cephalometry relies on internal skeletal landmarks to determine the anteroposterior (AP) position of the jaw and incisors.[2] However, soft tissue structures also significantly impact the final facial profile, making their evaluation crucial in orthodontic treatment planning.

One of the primary goals of orthodontics, apart from achieving occlusal perfection, is to ensure facial harmony. Studies have shown that orthodontic treatment influences both hard and soft tissues, leading to changes in lip position and overall facial aesthetics.[3-5] Several cephalometric analyses have been developed to establish ideal relationships between teeth, bones, and soft tissues to guide treatment. Early research by Riedel (1950) highlighted the relationship between soft tissue profile changes and orthodontic treatment, while later studies by Burston and Rickett emphasized the significance of lip position in treatment planning.[6-8] Research has demonstrated that upper incisor retraction influences lip thickness and position, affecting the nasolabial angle and overall facial profile.[9]

Despite the importance of cephalometric analyses, soft tissue evaluation alone does not always provide accurate predictions of skeletal changes. The AP position of the upper incisors significantly affects facial aesthetics, but discrepancies exist between cephalometric measurements and actual soft tissue responses. Furthermore, individual variations in lip thickness and pressure influence how lips respond to incisor retraction, making treatment outcomes unpredictable.[10] Some researchers suggest using external facial markers, such as the forehead, to guide orthodontic treatment.[11]

This study aims to determine the AP position of the maxillary central incisors in relation to the forehead, as the forehead remains a stable anatomical landmark over time. By comparing a control group with a randomly selected group of orthodontic patients from Jharkhand, this study seeks to evaluate whether the forehead can serve as a reliable guide for incisor positioning.

This study will contribute to the understanding of how maxillary incisor positioning affects facial aesthetics and explore the forehead as a stable reference point for orthodontic diagnosis and treatment planning.

2. MATERIALS & METHODOLOGY

This study was conducted in the Department of Orthodontics at Awadh Dental College & Hospital, Jamshedpur, with a sample of 100 female subjects divided into two groups: a study group of 50 orthodontic patients and a control group of 50 images of adult Indian women sourced from fashion magazines, advertisements, and online platforms. The control group was presumed to have ideal facial symmetry, while the study group comprised randomly selected orthodontic patients without considering attractiveness as a selection criterion.

Data Collection

Data were obtained from the Outpatient Department of the institution, with ethical approval secured and informed consent obtained from participants or their parents. The study population consisted of individuals from Jharkhand, defined as those with at least three generations of ancestry in the region. Inclusion criteria ensured that profile images had complete coverage of maxillary central incisors and the forehead, without congenital or neurological conditions. Individuals who had previously undergone orthodontic treatment, had congenital defects, or had undergone facial or orthognathic surgery were excluded.

Cephalometric Analysis

Cephalometric analysis was performed using a standardized lateral cephalogram technique. The head was positioned in a "natural head position" (NHP) with lips relaxed, and cephalograms were captured using Sirona XG 3 OPG digital imaging equipment. The film-to-source distance was 5 feet, and image processing was performed using EzDent-i and FilmPlus software. Manual tracing was conducted on acetate matt tracing paper.

Cephalometric analysis followed the Bradbent standard method. Landmark points, such as the trichion and glabella, were marked on images using PowerPoint's drawing tool. A reference line system was established to assess the anteroposterior (AP) positioning of maxillary incisors relative to the forehead. A metric ruler was used to measure the distance between the incisor position and the forehead landmarks, while a protractor determined forehead inclination.

Photography Procedure

Participants maintained a relaxed facial posture while sitting in NHP. Standardized lighting and camera settings were used, with a Canon EOS 700 DSLR camera mounted on a tripod at a fixed 5-foot distance from the subject. The interpupillary line was aligned parallel to the horizontal plane to avoid head tilting. Facial images were processed digitally, ensuring uniform magnification and quality.

Statistical Analysis

The collected data were processed using the Statistical Package for the Social Sciences (SPSS). Mean values, standard

deviations, and incisor position ranges were computed. A two-tailed T-test was applied to compare the two sample means, while second-order regression analysis was used to determine the relationship between maxillary incisor placement and forehead curvature.

This methodology ensured accurate and standardized data collection, allowing for reliable comparisons of maxillary incisor positioning in the study and control groups.

3. RESULTS

The study evaluated the anteroposterior relationship of maxillary central incisors to the forehead in the Jharkhand population by analyzing photographs of 100 individuals, divided into 50 cases and 50 controls. Measurements included the relative position of the maxillary incisors to the forehead using a metric ruler (precision: 0.5 mm) and forehead inclination (precision: 0.5°) using a protractor. When the maxillary central incisors (line 3) are in front of the FFA point of the forehead (line 1), it is given a positive score and when it is posterior, a negative value. The angle formed by line 4 and line 1 is measured with a protractor up to the nearest 0.5 to determine the forehead inclination.

Detailed and comparative statistical analyses were performed using the Microsoft Excel 2019 and SES programs. For comparing the mean of each specimen, a two-tailed t-test was used. Significant differences are indicated by P values of 0.05 or less. The analysis revealed significant differences between the study and control groups. In the study group, 68% of participants had their maxillary central incisors positioned ahead of the forehead's FFA point, whereas only 28% of the control group exhibited this placement. The mean anteroposterior location of maxillary incisors in the study group was 8.5 mm, compared to 2.94 mm in the control group, indicating a significant forward positioning (P = 0.001) (Table 5). Similarly, forehead inclination was markedly higher in the study group, with a mean of 16.84° compared to 9.12° in controls (P = 0.00), suggesting a steeper forehead profile in cases (Table 5). Furthermore, regression analysis demonstrated a stronger correlation between incisor positioning and forehead curvature in the control group ($r^2 = 0.310$) than in the study group ($r^2 = 0.185$), indicating that while forehead inclination influences incisor placement in both groups, the relationship is less pronounced in cases (Table 7). Additionally, variations in incisor position relative to the glabella further distinguished the two groups, with a mean of 2.82 mm in the study group and -2.34 mm in the control group (Table 6). These findings suggest that individuals in the study group exhibit a more pronounced forward positioning of maxillary incisors along with a greater forehead inclination compared to the control group, highlighting distinct skeletal and dental characteristics in the population studied.

Table 1: 50 subject control records

Sample	Incisor position relative to forehead (mm)	Incisor position relative to glabella (mm)	Forehead inclination (degree)
1	7	-2	12
2	3	0	5
3	0	-2	4
4	8	0	11
5	0	-1	5
6	2	0	1
7	-2	-8	11
8	14	8	16
9	-4	-10	11
10	-12	-10	6
11	-19	-15	5
12	-8	-10	4
13	0	-4	11
14	-8	-10	2
15	-12	-8	3

16	-5	-7	3
17	2	-2	8
18	-6	-12	6
19	0	-2	1
20	12	2	22
21	-4	-4	3
22	6	2	13
23	-12	-13	4
24	10	4	6
25	5	0	8
26	6	-2	8
27	13	6	18
28	7	4	11
29	3	-4	12
30	6	-2	8
31	9	8	1
32	0	-4	16
33	12	-2	14
34	10	-2	11
35	8	2	8
36	18	8	20
37	0	-5	8
38	3	-7	17
39	13	-4	21
40	0	0	4
41	8	1	9
42	6	6	8
43	-2	-4	7
44	17	6	9
45	-4	-8	14
46	-12	-5	8
47	12	-1	12
48	8	1	8
49	17	-6	11
50	12	1	12

In the Control category, 14 members (28%) had maxillary central incisors before the glabella, 13 subjects (26%) had

maxillary central incisors behind the FFA point on the forehead, and 23 subjects (46%) had maxillary incisors placed between the Glabella and FFA Point (Fig. 8).

Table 2: 50 subject cases records

Sample	Incisor position relative to forehead (mm)	Incisor position relative to glabella (mm)	Forehead inclination (degree)
1	11	7	16
2	13	6	24
3	11	8	21
4	19	6	29
5	8	7	8
6	6	-3	13
7	3	-2	11
8	1	6	23
9	0	6	22
10	6	3	13
11	6	7	12
12	2	-1	17
13	24	11	31
14	0	-2	12
15	7	4	24
16	8	-2	31
17	4	-3	15
18	17	6	22
19	20	11	20
20	9	1	17
21	-3	2	13
22	11	5	23
23	9	3	15
24	5	2	11
25	7	-2	14
26	6	3	11
27	9	-3	29
28	10	-2	18
29	19	11	17
30	7	2	23

31	3	2	11
32	13	8	14
33	15	9	13
34	21	16	17
35	15	13	8
36	2	-3	17
37	18	9	12
38	4	-2	15
39	21	11	25
40	-9	-12	11
41	-11	-15	9
42	2	-2	11
43	12	-2	19
44	11	3	20
45	6	-3	15
46	14	4	19
47	9	1	14
48	7	2	12
49	9	2	15
50	8	3	10

In the Study category, three patients (6%) placed their upper central incisors behind the FFA point on the forehead. The upper central incisors of 34 participants (68%) were placed ahead of the FFA point. Only 13 (26%) of participants had upper central incisors between FFA and Glabella points.

Table 3: The mean and standard deviation of the forehead to the AP location of the maxillary central incisors are shown.

	Mean	Standard deviation	Minimum	Maximum
Control Sample	2.94	8.57	-19	18
Study sample	8.5	7.23	-11	24

In the control category, the AP location of the maxillary central incisors relative to the FFA point on the forehead varies between -19 to 18 mm, with a mean of 2.94 mm and a standard deviation of 8.57 mm. In the study category, the AP location of maxillary central incisors relative to the forehead FFA point ranges from -11 to 24 mm, with a standard variation of 7.23 mm. & a mean of 8.5 mm.

Graph 1:

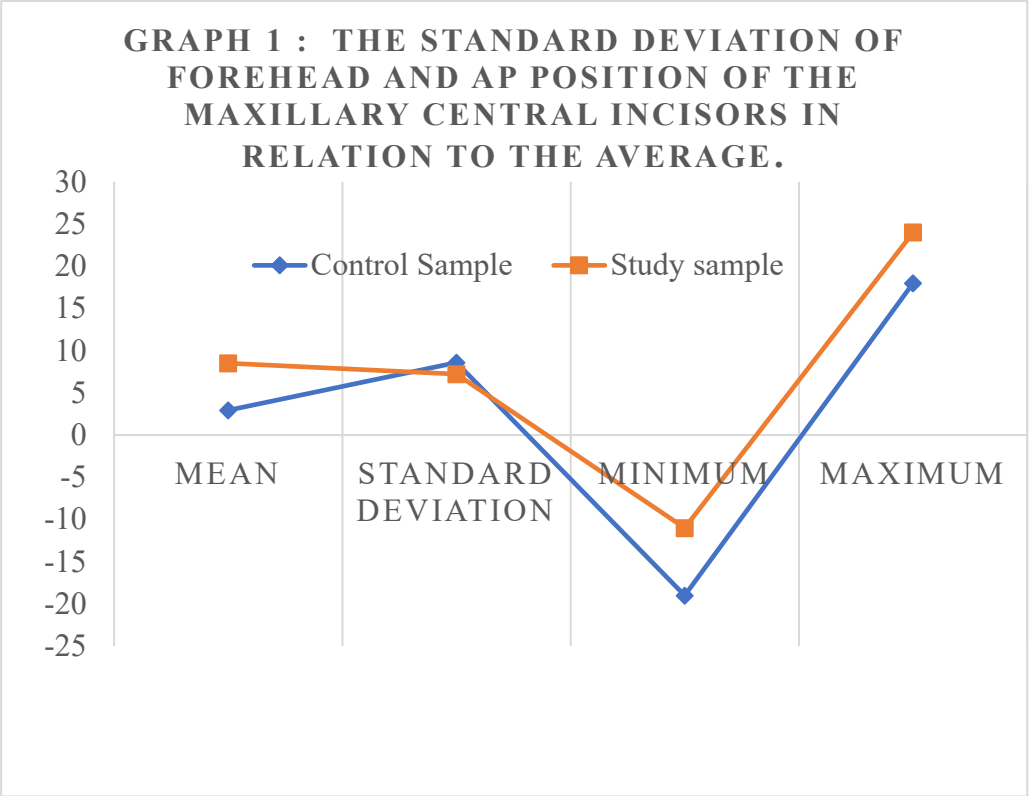


Table 4: Changes in forehead inclination between control and study models.

	Mean	Standard deviation	Minimum	Maximum
Control Sample	9.12	5.24	1	22
Study sample	16.84	5.97	8	31

The forehead inclination of the control category varies from 1 to 22, with a standard deviation of 5.24 and a mean of 9.12 In the study category, the inclination of the forehead spans from 8 to 31, with a mean of 16.84 and a standard deviation of 5.97.

Graph 2:

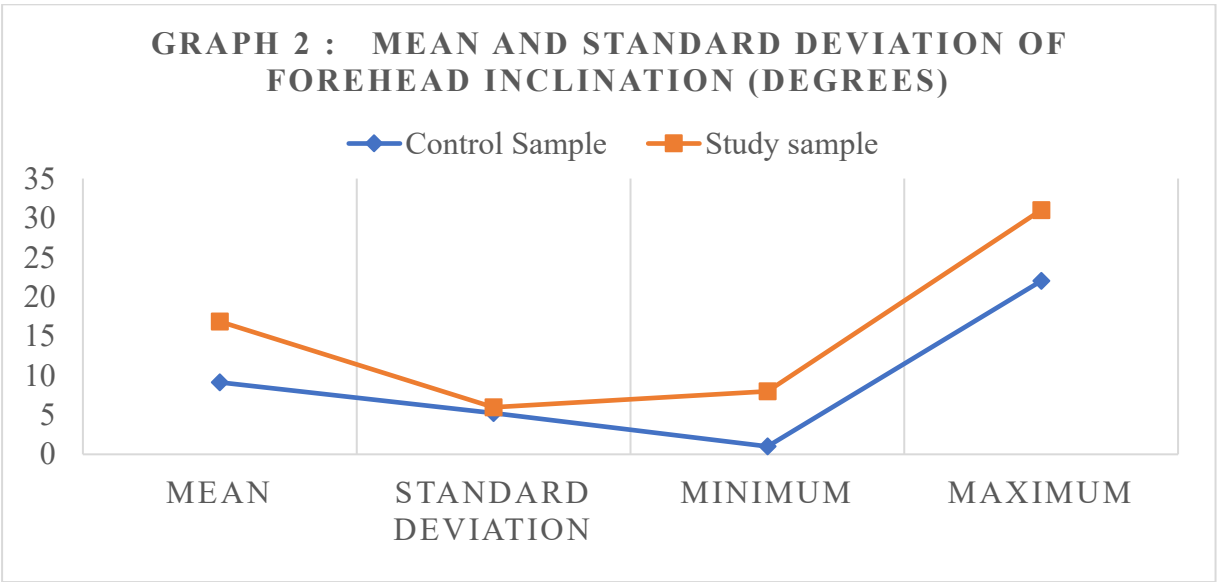


Table 5 shows the variations in maxillary central incisors location and forehead inclination between the control and study category.

	Control	Study	t-value	p-value
Position, mm	2.94	8.5	1.9853	0.000699
Forehead inclination, mm	9.12	16.84	1.9850	6.21E-10

The maxillary central incisor location relative to the forehead FFA point varies significantly between control and study models (P = 0.001). There is also a statistically significant difference (P = 0.00) in the forehead inclination between the study models and the control models. The difference in forehead inclination between the control and research samples was extremely significant.

Graph 3:

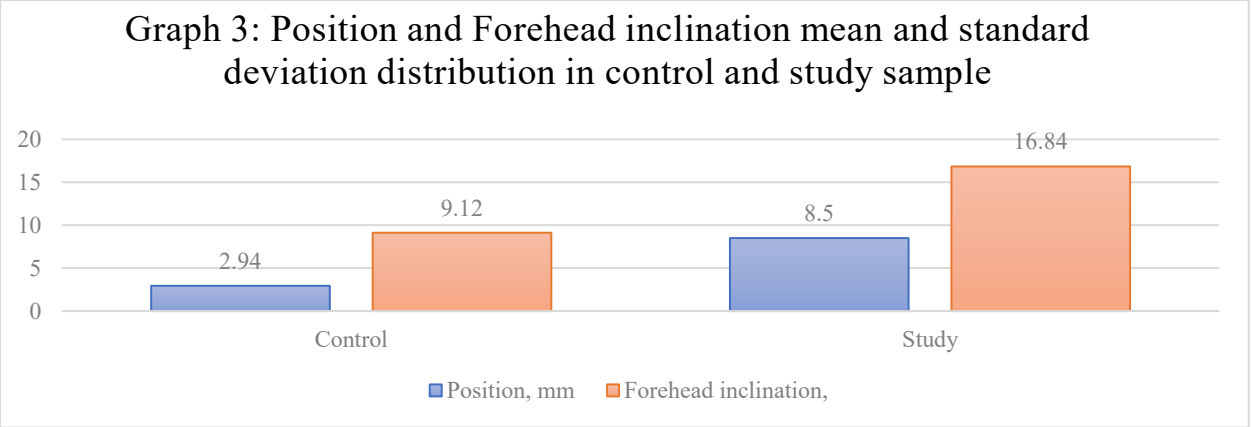


Table 6 shows the changes in incisor position relative to the glabella (mm) between the control and study models.

	Mean	Standard deviation	Minimum	Maximum
Control Sample	-2.34	5.56	-15	8
Study sample	2.82	5.90	-15	16

Graph 4:

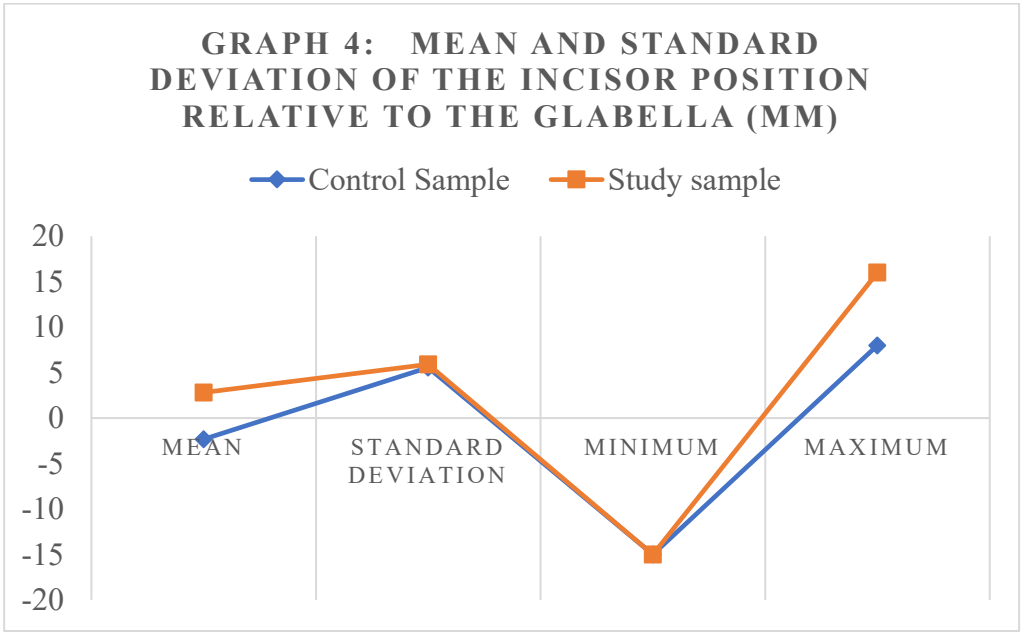
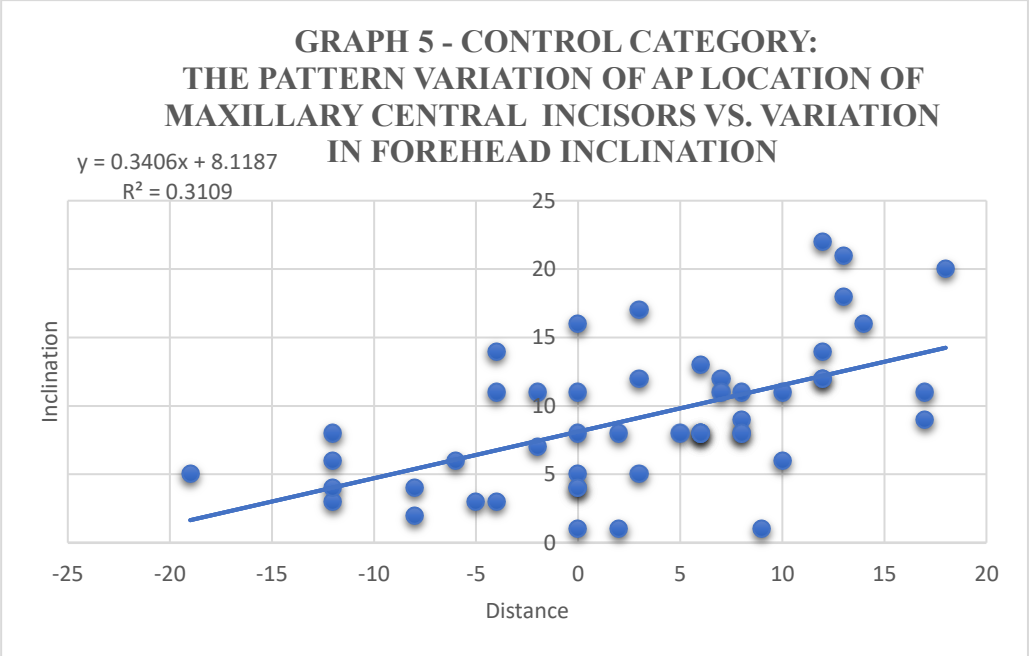


Table 7 illustrates the AP location of the upper central incisor, as well as the regression analysis between the two groups' forehead inclination.

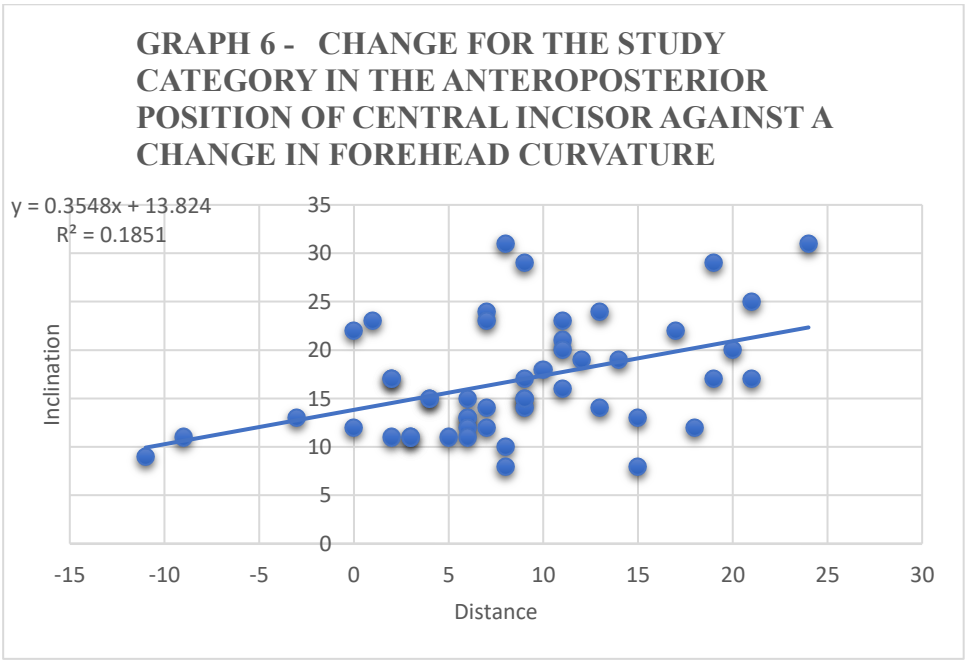
	Position	Forehead inclination	r^2
Control sample	2.94	9.12	0.310934
Study sample	8.5	16.84	0.185078

In the control group, AP locations of maxillary central incisors were substantially linked with the forehead curve (r2 = 0.310). In the study group, the AP locations of the maxillary central incisors were less linked with forehead orientation (r2 = 0.185).

Graph 5 shows the change in the AP location of maxillary central incisors against the change in forehead inclination for the control category. For every degree of inclination of the forehead greater than 8^0, incisors are 2 mm ahead of the forehead FFA point.



Graph 6: For the study category, shows the change in anterior posterior central incisor position against a change in forehead inclination.



The AP locations of the maxillary incisors are weakly correlated with the anterior curvature, with each change in the 1 mm position resulting in a 14 ° forehead inclination.

4. DISCUSSION

In modern society, physical attractiveness plays a significant role in financial and career success, as well as social relationships. Consequently, improving facial aesthetics has become a primary motivation for seeking orthodontic treatment. Since a beautiful smile significantly influences facial attractiveness, orthodontists must consider both smile aesthetics and facial profile harmony when planning treatment.[1,12,13] Key factors in smile design include lip shape and length, buccal corridor width, incisal gum display, smile index, and smile style. Among these, the symmetry of the upper incisors plays a crucial role in enhancing facial aesthetics.[3] Thus, orthodontic treatment aims not only to achieve a functionally stable occlusion but also to create an attractive smile that maintains long-term stability.

Research suggests that lateral profile views provide more valuable diagnostic information than frontal views, emphasizing the need for conventional radiography and soft tissue analysis in orthodontic evaluation.[5] We found that in our Study Group, 6% (3 individuals) had their maxillary central incisors positioned behind the FFA point. 68% (34 individuals) had their maxillary central incisors positioned anterior to the glabella. 26% (13 individuals) had their incisors located between the FFA point and the glabella. Whereas, in the Control Group, 28% (14 individuals) had their maxillary central incisors behind the FFA point. 26% (13 individuals) had their maxillary central incisors ahead of the glabella. 46% (23 individuals) had their incisors positioned between the glabella and the FFA point. In the control group, forehead angulation ranged from 1° to 22°, with a mean of 9.12° and a standard deviation of 5.24°. In the study group, forehead angulation ranged from 8° to 31°, with a mean of 16.84° and a standard deviation of 5.97°.

A significant difference was observed in the maxillary central incisors' AP location relative to the forehead's FFA point between the study and control groups (P = 0.001). Additionally, forehead angulation differences between the two groups were statistically significant (**P = 0.00**). Regression analysis revealed that in the control group, the AP position of the maxillary central incisors was significantly correlated with forehead angulation (**r^2 = 0.310**). In the study group, the AP position of the maxillary central incisors showed a weaker correlation with forehead orientation (**r^2 = 0.185**).

The study conducted by Gidali et al., focused on analyzing the anteroposterior (AP) positioning of the upper central incisors relative to the forehead in adult African females.[14] The study compared test and control groups and found a significant difference in the AP positioning of the maxillary incisors relative to the glabella vertical (GV) line. Though similar trends were observed in female subjects in the present study, the difference was not statistically significant, possibly due to racial and methodological variations. African individuals exhibited more prominent teeth compared to African and Iranian populations, which may influence aesthetic assessment and treatment planning.[14]

A major strength of this study was the use of digital software for precise and direct measurements. Unlike previous studies, this research employed digitizer software, which improved analytical accuracy, reduced human error and ensured reliability and reproducibility.

Since facial attractiveness significantly influences individuals' desire for orthodontic treatment, this study focused on analyzing facial profiles using conventional cephalometry and soft tissue assessments. The forehead was examined as a key reference point for determining the AP position of the maxillary central incisors. Using the forehead as a landmark helps overcome limitations associated with cephalometric and soft tissue analyses.

This study highlights the importance of the forehead as a key anatomical landmark for determining the AP positioning of the maxillary central incisors. The findings suggest that forehead angulation and incisor positioning are significantly different between the study and control groups, emphasizing the need for orthodontists to consider these factors when planning treatment. The use of digital measurement tools enhances precision and reliability in orthodontic analysis. By incorporating forehead-based evaluations, orthodontists can improve treatment planning and aesthetic outcomes while reducing reliance on cephalometric and soft tissue analyses alone.

5. CONCLUSION

The findings of this study indicate that the maxillary central incisors' anteroposterior (AP) locations are significantly correlated with the forehead, making it a reliable marker for assessing facial aesthetics in adult females. However, the placement of maxillary central incisors shows a weak correlation with forehead angulation, suggesting that forehead inclination alone may not be a definitive reference for determining incisor positioning. Additionally, the study observed that females in the research model exhibited a more rounded forehead shape, whereas males had a relatively flatter forehead. This variation in forehead morphology highlights the importance of gender-specific considerations in orthodontic diagnosis and treatment planning.

Given its strong association with the AP positioning of the maxillary central incisors, the forehead serves as an effective landmark for evaluating facial aesthetics in adult females. For Indian patients, achieving a harmonious AP relationship

between the maxillary central incisors and the forehead should be considered a therapeutic goal in orthodontic treatment planning. Integrating this approach can enhance both functional and aesthetic outcomes, ensuring a balanced and naturally appealing facial profile.

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