# Evaluation of The Anteroposterior Relationship of Maxillary Central Incisors to The Forehead In Profile

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**Abstract**

**Objective :** Evaluate the anterior-posterior relationship of maxillary central incisors to the forehead in young adults.

**Materials and Method:** The sample consisted of 146 lateral profile photographs of young adults with good facial harmony (control group) and 135 lateral profile photographs of young adult patients seeking orthodontic treatment (study group). The photographs were taken under standard conditions with the subjects in posed smile and the maxillary incisors clearly visible. The images were resized and the measurements were made using Image Tool version 3. The A-P position of the maxillary central incisors relative to the forehead was measured and the data subjected to statistical analysis.

**Results :** 90.4% of young adults in the control group had maxillary central incisors positioned ahead of FFA point of forehead and only 9.6% had maxillary central incisors positioned behind the FFA point whereas in the study group, 71.3% of young adults had maxillary central incisors positioned ahead of FFA point and 28.7% had maxillary central incisors positioned behind FFA point of forehead.

**Conclusion:** The FFA point of the forehead is a useful landmark in assessing the position of the maxillary central incisors in young adult patients seeking improved facial harmony.

**Key Words :** Profile Analysis, FFA, Maxillary Incisors

## Introduction

Facial esthetics is one of the main goals of orthodontic treatment and increased emphasis has been placed on it in recent years by both the patients and the orthodontists. Evaluating the face in profile is an integral part of a complete orthodontic diagnosis. Studies of facial esthetics in orthodontic literature have concentrated on the profile aspect of the face, especially on the profile outline as traced from photographs or cephalometric radiographs.

With the advent of improved orthodontic and surgical techniques, emphasis has shifted more towards envisioning an ideal position of upper incisors as the starting point in treatment planning. Treatment mechanics can then be planned to position the incisors ideally and subsequently to fit all the other teeth around this ideal position.[1]

The maxillary incisors, when displayed, should be considered a part of the face both from the frontal and lateral perspectives.

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Contemporary orthodontic diagnosis includes assessing the display of the maxillary incisor teeth from the frontal perspective. In profile however, the maxillary incisors are not routinely assessed with regard to how they directly relate to the face. Instead, the soft tissue drape is relied on to reflect indirectly their positions, despite the potential unreliability of that method.

Andrews[2] has advocated the use of the forehead as a landmark for assessing the anteroposterior position of the maxillary central incisors in profile. Andrews defined forehead landmarks and observed a relation between the forehead's prominence and inclination and the position of the maxillary central incisors in individuals with a good facial profile. Schlosser et al[3] found that Andrew's method of profile assessment was a useful method to evaluate attractiveness relative to the maxillary incisor position.

Andrews [4] compared the anteroposterior relationship of the maxillary central incisors to the forehead in adult white females and found that their position was strongly correlated with forehead inclination. He concluded that treatment goals should include a harmonious anteroposterior relationship between the maxillary central incisors and the forehead.

The purpose of this study was to evaluate the anteroposterior position of the maxillary incisors in relation to the forehead in profile photographs of young adults and determine its usefulness as landmark for assessing the position of maxillary incisors.

**Materials and Method**

The study sample was derived from two different sources. The control group was selected from the students of I.T.S college campus (Muradnagar) and the study group was selected from the patients reporting for orthodontic treatment to the dental institution of the same campus. A written consent was obtained from the subjects after explaining the purpose of the study. Only those subjects willing to participate in the study were included. The subjects selected had all maxillary incisors present with no history of previous orthodontic treatment and no history of trauma or restorations in the maxillary anterior teeth. All the selected subjects were within the age group of 18-25 years.

A total of 415 subjects with class 1 occlusion and good facial esthetics were randomly selected for the study. Profile photographs of all the subjects were taken in the natural head position under standardized conditions with a Sony DSC-H50 Camera (9.1 Megapixel). All the subjects were photographed with a posed smile next to an inverted- L scale.

The control sample for the study was selected by a panel comprising of an orthodontist, an oral and maxillofacial surgeon, a plastic surgeon, a cosmetologist, a jury member of a local beauty pageant and two members from the peer population (a boy and a girl of a nearby engineering college were selected randomly).

The photographs were given to the members of the panel for the final sample selection. The panel was asked to choose photographs of patients with good facial harmony and a generally pleasing appearance of the maxillary incisors. Only those subjects were selected for the study who received a unanimous decision from all the members of the panel.

1. Control group – Out of the 415 photographs given to the panel 146 (65 males and 81 females) subjects were found to have a good facial harmony and a generally pleasing

appearance of the maxillary incisors by all the members of the panel. These 146 subjects were used as control group for the study.

2. Study group – 135 young adults seeking orthodontic treatment (59 males and 76 females) were used as the study group. Profile photographs of the study subjects were taken in the same manner as described for the control group.

All photographs were digitalized in life size with the help of the software Image Tool Version 3, according to the calibration scale so that measurements could be made.

The following landmarks and vertical reference lines (Figure 1) were constructed using Adobe photoshop CS4 version 9, parallel to the vertical scale:

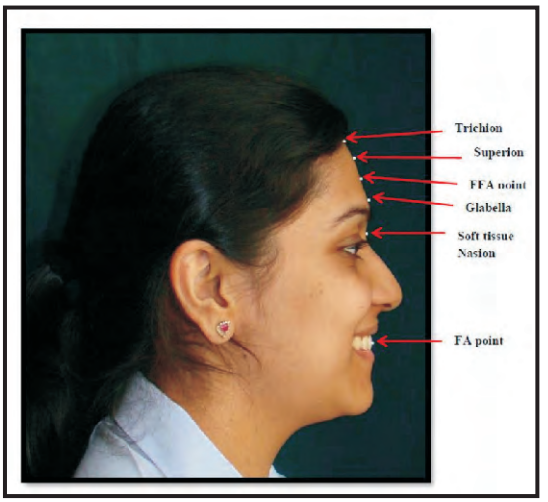


**Figure1. Landmarks**

a) Line 1 - through the FFA point. The FFA point is defined as the midpoint between trichion and glabella for foreheads with flat contour or the midpoint between superion and glabella for foreheads with rounded or angular contour.

b) Line 2 - through glabella.

c) Line 3- through the FA point of most prominent maxillary central incisor.

d) Line 4- (for assessing forehead inclination) was constructed by connecting glabella to the uppermost point of the clinical forehead (superion point or trichion) as described by Andrews.[4]

The following measurements were recorded using **Image Tool Version 3**:

1) Anteroposterior relation of the maxillary incisors to the forehead (FA – FFA) -measured as the distance between line 1 and line 3. A positive value was assigned when the maxillary incisors (line 3) were anterior to the forehead's FFA point (line 1) and negative when posterior.

2) Forehead inclination- measured as the angle between line 4 and line 1.

**Results**

The statistical analysis for the control group and study group was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The means, standard deviations, and ranges were calculated and compared using a paired two-tailed t-test. This was followed by qualitative analysis to check for the percentage of values falling in a particular range. For this the mean value ± 1 S.D. for control group for males and females was set as a benchmark and the percentage of sample falling in this range was checked for both the study group and the control group. The percentages obtained were again evaluated statistically to check for significance.

All measurements were repeated at an interval of 1 month by the same examiner on a random sample of 50 subjects (25 from the study sample and 25 from the control sample). The systematic error between the first and second measurements was calculated using a paired t-test, for $P < 0.05$. No statistically significant difference was seen between the two sets of measurements for any of the groups, showing good reproducibility of the measurements.

Table 1 shows the mean values for forehead inclination in the control and study groups. For the overall sample, the mean value for forehead inclination was 17.97°±6.05° in the control group and 17.01°±6.46° in the study group. On comparing the data statistically, no significant difference was observed between the two groups (p>0.05). Among males, the forehead inclination had a mean value of 21.91°±5.50° in the control and 20.98°±6.25° in the study group. On comparing the data statistically, no significant difference was observed between the two groups (p>0.05).Among females, the forehead inclination had a mean value of 15.44°±4.95° in the control and 14.46°±5.21° in the study group. On comparing the data statistically, no significant difference was observed between the two groups (p>0.05).

Thus comparison of forehead inclination showed no significant difference in the control and study groups, both in males and females.

Table 1 also shows comparison of forehead inclination in males and females. Females had a significantly lower mean value in both the control and study groups (p<0.001) as compared to males.

**Table 1: Assessment of Forehead inclination (angle between line 1 and line 4)**

| S.N | | Control Group | | | Study Group | | | Statistical analysis | |
|---|---|---|---|---|---|---|---|---|---|
| | | n | Mean (in degrees) | S.D. | n | Mean (in degrees) | S.D. | "t" | "p" |
| 1. | Overall | 146 | 17.97 | 6.05 | 135 | 17.01 | 6.46 | 1.164 | 0.246 |
| 2. | Males | 65 | 21.91 | 5.50 | 59 | 20.98 | 6.25 | 0.747 | 0.457 |
| 3. | Females | 81 | 15.44 | 4.95 | 76 | 14.46 | 5.21 | 1.143 | 0.255 |
| Statistics | | | t =6.550 p < 0.001 | | | t =6.059 p < 0.001 | | | |

* p <0.05Significant, p <0.01Highly significant, p <0.001Very highly significant, NS-not significant

Table 2 shows the values for the anteroposterior (AP) position of the maxillary incisors relative to the forehead (FA-FFA). For the overall sample, the AP position of the maxillary incisors relative to the forehead showed a mean value of 2.74 ± 2.01 mm for the control group and 1.95±3.0 mm for the study group. There was a statistically significant difference between the two groups (p <0.05) with the incisors positioned more forward relative to the forehead in the control group as compared to the study group. In the males, the AP position of the maxillary incisors relative to the forehead showed a mean value of 3.69 ±1.96 mm for the control group and 2.80 ±3.27 mm for the study group. There was no statistically significant difference between the two groups (p>0.05).

In the females, the AP position of the maxillary incisors relative to the forehead showed a mean value of 2.13 ±1.80 mm for the control group and 1.4 ±2.7 mm for the study group. There was no statistically significant difference between the two groups (p>0.05).

Table 2 also shows the comparison of anteroposterior position of the maxillary incisors relative to the forehead in males and females. There was a statistically significant difference between males and females in both the control and study groups, with the males showing higher mean values indicating a more forward position of the maxillary incisors as compared to females, (p <0.001 for control and p <0.05for study group).

**Table 2: Antero-posterior Position of the Maxillary incisors relative to the forehead (FA - FFA)**

| S.N | | Control Group | | | Study Group | | | Statistical analysis | |
|---|---|---|---|---|---|---|---|---|---|
| | | n | Mean (in mm) | S.D. | n | Mean (in mm) | S.D. | "t" | "p" |
| 1. | Overall | 146 | 2.74 | 2.01 | 135 | 1.95 | 3.00 | 2.365 | 0.019 |
| 2. | Males | 65 | 3.69 | 1.96 | 59 | 2.80 | 3.27 | 1.565 | 0.121 |
| 3. | Females | 81 | 2.13 | 1.80 | 76 | 1.40 | 2.70 | 1.899 | 0.060 |
| Statistics | | | t =4.367 p< 0.001 | | | t =2.506 p= 0.014 | | | |

* p <0.05Significant, p <0.01Highly significant, p <0.001Very highly significant, NS-not significant

Table 3 (a,b,c) shows the qualitative assessment of the location of the maxillary central incisors relative to forehead in the control and study groups. In the overall sample, a significantly higher proportion of subjects had location of maxillary incisors ahead of glabella in the control group (64.4%) as compared to the study group (43.6%). This difference was statistically significant (p <0.01). The same difference was seen in the females (p<0.01) as well as males (p<0.05) with a higher proportion of subjects showing maxillary incisors ahead of glabella in the control group(63% in females, 66.2% in males) compared to the study group(40.8% in females, 45.8% in males). In the study group, a significantly higher percentage of subjects had maxillary incisors located behind FFA point of forehead in the overall sample (28.2%), as well as in males (25.4%) and females (30.3%) as compared to the control group (9.6% in the overall sample, 4.6% in the male and 12.3% in the female sample). The difference was statistically significant (p<0.001 for overall, p<0.01for males and females).

**Table 3: Qualitative assessment of location of maxillary incisors relative to the forehead**
**a) Overall sample-**

| S.N | Location of maxillary incisors | Control Group (n=146) | | Study Group (n=135) | | Statistical Analysis | |
|---|---|---|---|---|---|---|---|
| | | No. | % | No. | % | $X^2$ | p |
| 1. | Ahead of glabella | 94 | 64.4 | 59 | 43.6 | 10.92 | 0.001 |
| 2. | Between glabella and FFA | 38 | 26.0 | 38 | 28.2 | 0.197 | 0.657 |
| 3. | Behind FFA | 14 | 9.6 | 38 | 28.2 | 13.60 | <0.001 |

*p <0.05 Significant, ** p <0.01 very significant, *** p <0.001 most significant, NS-not significant

**b) Males-**

| S.N | Location of maxillary incisors | Control Group (n=65) | | Study Group (n=59) | | Statistical Analysis | |
|---|---|---|---|---|---|---|---|
| | | No. | % | No. | % | $X^2$ | p |
| 1. | Ahead of glabella | 43 | 66.2 | 27 | 45.8 | 3.665 | 0.046 |
| 2. | Between glabella and FFA | 19 | 29.2 | 17 | 28.8 | 0 | 1 |
| 3. | Behind FFA | 3 | 4.6 | 15 | 25.4 | 7.283 | 0.007 |

*p <0.05 Significant, ** p <0.01 very significant, *** p <0.001 most significant, NS-not significant

**c) Females-**

| S.N | Location of maxillary incisors | Control Group (n=81) | | Study Group (n=76) | | Statistical Analysis | |
|---|---|---|---|---|---|---|---|
| | | No. | % | No. | % | $X^2$ | p |
| 1. | Ahead of glabella | 51 | 63.0 | 31 | 40.8 | 7.320 | 0.002 |
| 2. | Between glabella and FFA | 20 | 24.7 | 22 | 28.9 | 0.331 | 0.565 |
| 3. | Behind FFA | 10 | 12.3 | 23 | 30.3 | 7.002 | 0.008 |

*p <0.05 Significant, ** p <0.01 very significant, *** p <0.001 most significant, NS-not significant

On comparing the location of maxillary central incisors relative to the forehead in males and females (Table 4), no statistically significant difference was observed between the two genders for any of the three locations in either control or study groups (p>0.05).

**Table 4: Comparison of qualitative assessment of location of maxillary incisors relative to forehead in males and females**

| S.N | Location of maxillary incisors | Control Group Male vs Female | | Inference | Study Group (n=59) | | Inference |
|---|---|---|---|---|---|---|---|
| | | $X^2$ | p | | $X^2$ | p | |
| 1. | Ahead of glabella | 0.173 | 0.677 | NS | 0.498 | 0.480 | NS |
| 2. | Between glabella and FFA | 0.301 | 0.583 | NS | 0.001 | 0.971 | NS |
| 3. | Behind FFA | 2.241 | 0.134 | NS | 0.653 | 0.419 | NS |

*p <0.05 Significant, ** p <0.01 very significant, *** p <0.001 most significant, NS-not significant

**Discussion**

Contemporary orthodontic diagnosis includes assessing the display of the maxillary incisor teeth from the frontal perspective. There is enough literature and consensus regarding the vertical position of the upper incisor in relation to the upper lip both at rest and during smile. Also there are several guidelines regarding the saggittal position of the upper incisor related to various skeletal landmarks. The use of skeletal landmarks and intra-cranial reference lines however, can be unreliable because of errors in identification, angulation and variability in their positions between

individuals. In addition, good facial harmony can exist within a wide range of cephalometric values and positioning the upper incisors according to skeletal guidelines may not necessarily result in a pleasing soft tissue profile.[4-7]

Soft tissue landmarks such as the nose, lips and chin may not accurately reflect the position of the maxillary incisors. Using the forehead as a primary landmark for anteroposterior (AP) incisor positioning avoids the potential pitfalls of relying on hard and soft tissue cephalometric analyses. The rationale for using the forehead to determine the goal for the maxillary incisors includes the concept that, in persons with facial harmony, there is a correlation between the prominence and the inclination of the forehead and the AP positions of the teeth and jaws. Andrews also favored the forehead as a stable landmark because, unlike internal radiographic landmarks, it is a part of the face, and its relationship to the incisors is predictable and repeatable.

The results of this study show that the forehead inclination was not different in control and study groups. This finding agrees with Andrews[4] study of adult white females. Males had a more posteriorly inclined forehead than females, which agrees with the study by Hwang et al[8] who found that Korean and European- American men had a larger slope of forehead than women.

The maxillary incisors were positioned anteriorly in relation to the forehead's FFA point, more often in the control than in the study group, whereas a greater number of study subjects had maxillary incisors positioned behind FFA as compared to controls. This finding agrees with that of Andrews[4], who also found that the maxillary incisors were anterior to the forehead's FFA point in adult white females with harmonious profiles and behind this point in females seeking orthodontic treatment.

The position of maxillary incisors in relation to the forehead's FFA point was more anterior in males as compared to females in this study. Conversely, other analyses such as Burstone[9] and Arnett[10] in which the maxillary incisor position has been related to landmarks other than the forehead show that the incisors are positioned more forward in females than in males. This may have been due to a difference in the study samples.

In this study, 64.4% subjects in the control and 43.6% subjects in the study group had maxillary incisors positioned ahead of glabella as compared to only 3% in the control and 15% in the study group of Andrews study in adult white females. This finding indicates that the maxillary incisors were generally positioned more anteriorly in our sample compared to Andrew's sample, which reflects racial differences. This agrees with the study of Kalha et al[11], who also found that that the incisors were more proclined in the Indian population as compared to a white population.

The maxillary incisor position related strongly with forehead inclination in the control group but moderately in the study group, for the overall sample as well as males and females. This is in contrast to Andrews[4] study, in which the incisor positions were strongly related to the forehead inclination in adult white females with good facial harmony but a poor correlation was seen in the study sample.

**Conclusion**

The results of the study led to the following conclusions:

1. Females showed a more upright forehead than males while the maxillary central

incisors were found to be more anterior relative to the forehead in males.

2. Most of the subjects (90%) having good facial harmony and a pleasing appearance of the maxillary incisors in profile had maxillary central incisors positioned ahead of the FFA point of the forehead.
3. The forehead's FFA point is useful in assessing the position of the maxillary central incisors in young adult patients seeking improved facial harmony.

The limitations of our study were a small sample size and some subjectivity involved in classifying aesthetic and harmonious profiles. Further studies with a much larger sample size classified by age, sex and race are needed in order to arrive at numerical normative data.

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