Assessing the AP Position of Maxillary Central Incisor using Forehead: A Smiling Profile Photographic Study

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ABSTRACT

**Aim**: To evaluate and compare the anteroposterior position of permanent maxillary central incisor in profile in relation to the forehead inclination and prominence in adult (18-25 years) females of Maharashtra population.

**Materials and methods**: The control sample (N = 100) consisted of adult females (18-25 years of age) with optimum facial balance showing a pleasing profile compared with study sample (100 adult female patients of 18-25 years) seeking orthodontic treatment. All smiling profile images had the maxillary central incisors and the forehead in full view. The images were adjusted and rotated to the upright head position. Reference lines were drawn to measure the anteroposterior positions of the maxillary central incisors as well as forehead inclinations.

**Results**: Strong correlation exists between positions of maxillary central incisor relative to forehead inclination in control group. In study group it is insignificant. It means that if position of maxillary central incisor relative to ‘forehead’s facial axis (FFA) point’ changes the forehead inclination also changes. The most esthetic maxillary central incisor position between FFA point and glabella was highest in the control sample (94%).

**Conclusion**: The forehead is a useful landmark for assessing the facial profile for adult Maharashtra females as it relates to A-P maxillary central incisor position. Smiling profile photograph can be useful additional diagnostic tool for determining esthetic position of maxillary central incisors in the face.

**Keywords**: Forehead inclination, Facial profile, Maxillary central incisor position.


INTRODUCTION

Humans have been aware of ‘facial esthetics’ from prehistoric times. An ‘esthetically pleasing face’ is regarded as one in which various facial features are well proportioned and balanced from both ‘frontal and profile’ view. Evaluating the face in profile is an integral part of a complete orthodontic diagnosis. The labiolingual inclination and anteroposterior (AP) position of maxillary central incisors have a key effect on the appearance of the smiling profile. To improve the prediction of the most proper position of the maxillary incisors, and for evaluating the facial profile many cephalometric and profilometric measurements have been suggested.

Contemporary orthodontic diagnosis includes assessing the display of maxillary incisor teeth from frontal perspective.

Recently, smiling esthetics, especially ‘frontal smiling esthetics’, has been frequently studied. In profile, however the maxillary incisors are not typically 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.

AIMS AND OBJECTIVES

The purpose of this study is to evaluate and compare the AP position of permanent maxillary central incisor in profile to the inclination and prominence of the forehead in adult (18-25 years) females with harmonious profiles and to compare the same parameters with adult females seeking orthodontic treatment. To provide the guidelines for orthodontic diagnosis and treatment planning for patients seeking improved facial harmony. To draw ‘regression equations’ for the obtained correlations between maxillary central incisor position with inclination and prominence of forehead.

MATERIALS AND METHODS

A study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, Rural Dental College of Pravara Institute of Medical Sciences, Loni (Ahmednagar, Maharashtra) from June 2009 to October 2010.
The control sample (N = 100) consisted of adult females (18-25 years of age) with optimum facial balance showing a pleasing profile with competent lips and normal soft tissue features of the face. For this purpose, a routine orthodontic clinical case record sheet was used to record the extraoral and intraoral features of the subject. Control sample was subjected to the panel of three judges. Extraoral frontal and profile photographs were taken on which soft tissue analysis was done to determine optimum facial balance. A neutral (Angle’s Class I) molar and canine relationship and an incisor relationship (without need for either deep bite or open bite correction).

The study sample consisted of 100 adult female patients (age group of 18-25 years) seeking orthodontic treatment from the OPD of Department of Orthodontics and Dentofacial Orthopedics. No specific skeletal, dental or facial characteristics were used to select the sample. With all the photographic standardization, images were taken in profile with the maxillary central incisors and forehead fully visible for both the sample groups.

**ARMAMENTARIUM**

1. Digital camera (Canon SX 10 IS powerShot, 10.1 Megapixels, 20× optical zoom)
2. A photographic Tripod (Sony, handycam shooting gear, VCT-R640, Tokyo, Japan)
3. An image processing program (CorelDRAW Graphics Suite 13, USA).

All the photographs were taken by one clinician. A distance of 56.0 cm between the digital camera lens and the tip of the nose was established by the use of measuring tape and maintained while taking all the photographs. The subject was asked to sit on a stool looking into the vertical mirror, approximately 110 cm away from the subject.

In order to take the records in NHP, the subjects were asked to walk a few steps, stand at rest and sit on a stool looking into their eyes in the mirror, and place their arms at their side. The final upright head position was confirmed by two independent observers. The first image was taken with a neutral facial expression for use in a definitive profilometric assessment. The second image was taken under the same standard conditions with full smiling expressions showing maxillary central incisors and fully bared forehead in profile view (Fig. 1).

Each photographic image was then transferred to a computer (Compaq Presario C700). The image was then enlarged to approximate life size. Approximate life size was determined using the average vertical distance from trichion (hairline) to the incisal edge of the maxillary central incisors measured on the pretreatment lateral cephalograms of a randomly selected sample of 10 adult female patients. The 10 subjects all had the trichion marked with barium paste prior to taking the head film. This distance was 142 mm. An image processing program was used (CorelDRAW Graphic Suite 13, USA) to make the accurate landmarks and measurements up to two decimal points.

Landmark points for the forehead were identified as described by Dr. Andrews16 as (trichion, superion, glabella and the forehead’s facial axis point, i.e. FFA point) and marked on each image using the ‘ellipse tool’ in the CorelDRAW Software as:

- **Trichion**: It is defined as the hairline and is the most superior aspect of the forehead when the forehead is of relatively flat contour.
- **Glabella**: It is defined as the most inferior aspect of the forehead.
- **Superion**: It is defined as the most superior aspect of the forehead when the forehead is either rounded or angular in contour.
- **The FFA Point**: It is defined as the midpoint between trichion and glabella for foreheads with flat contour or the midpoint between superion and glabella for the foreheads with rounded or angular contour. All of these points lie on the midsagittal plane of the head. After identifying the landmark points, three vertical lines were drawn using ‘Bezier tool’ in the software as follows (Fig. 2).

  - **Line 1**: Through the FFA point.
  - **Line 2**: Through glabella.
  - **Line 3**: Through the maxillary central incisor facial axis point.
  - **Line 4**: For assessing forehead inclination was constructed by connecting glabella to the uppermost point of the clinical forehead (superion point or trichion).

Forehead inclination was defined as the angle between Line 1 and 4.

The photographic image was then deleted, leaving only the constructed reference points and lines for measurements (Fig. 3). The AP relationship of the maxillary central incisors to the forehead was measured as the distance between Lines 1 and 3 up to two decimal points. A positive sign was assigned when the maxillary central incisors (Line 3) were anterior to...
the foreheads’ FFA point (Line 1) and negative when posterior. Forehead inclination was measured as the angle between Lines 4 and 1.

RESULTS

The correlation between position of maxillary central incisor relative to FFA point and forehead inclination in control group is significant; and in study group it is insignificant. It means that if position of maxillary central incisor relative to FFA point changes the forehead inclination also changes in control group only.

For the control sample, the AP position of the maxillary central incisors relative to the forehead’s FFA point ranged from –4.5 to 8.5 mm, with a mean of 2.348 mm and standard deviation of 2.391 mm. For the study sample, the AP position of the maxillary central incisors relative to the forehead’s FFA point ranged from –7.5 to 6.0 mm, with a mean of –0.135 mm and a standard deviation of 3.291 mm.

Table 1: Comparison of mean values of position of maxillary central incisor relative to FFA point (mm) and forehead inclination (in degree) in control and study group

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control sample (n = 100)</th>
<th>Study sample (n = 100)</th>
<th>Z-value</th>
<th>p-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position of maxillary central incisor relative to FFA point (mm)</td>
<td>2.348 ± 2.391</td>
<td>–0.135 ± 3.291</td>
<td>6.11</td>
<td>p &lt; 0.01</td>
<td>Highly significant</td>
</tr>
<tr>
<td>Forehead inclination in (degree)</td>
<td>12.963 ± 3.244</td>
<td>12.5925 ± 2.294</td>
<td>0.93</td>
<td>p &gt; 0.05</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

Table 1 describes the comparison of mean values of position of maxillary central incisor relative to FFA point (mm) and forehead inclination (in degrees) in control and study group. For the control sample, the forehead’s inclination ranged from 7 to 19, with a mean of 12.96 and standard deviation of 3.24. For the study sample, the forehead’s inclination ranged from 7.2 to 19, with a mean of 12.59 and standard deviation of 2.29. Forehead inclination between the control sample and the study sample was not significantly different.

Table 2: Distribution of AP maxillary central incisor positions relative to forehead for the control and study sample

<table>
<thead>
<tr>
<th>Position of maxillary central incisor</th>
<th>Control sample no. (%)</th>
<th>Study sample no. (%)</th>
<th>Z’ test value</th>
<th>p-value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior to the forehead’s FFA point</td>
<td>8 (8)</td>
<td>63 (63)</td>
<td>9.94</td>
<td>p &lt; 0.01</td>
<td>Highly significant</td>
</tr>
<tr>
<td>Anterior to glabella</td>
<td>5 (5)</td>
<td>12 (12)</td>
<td>2.15</td>
<td>p &lt; 0.01</td>
<td>Highly significant</td>
</tr>
<tr>
<td>Somewhere at or between the FFA point and glabella</td>
<td>87 (87)</td>
<td>25 (25)</td>
<td>11.31</td>
<td>p &lt; 0.01</td>
<td>Highly significant</td>
</tr>
</tbody>
</table>

Table 2 describes the distribution of AP maxillary central incisor positions relative to forehead for the control and study sample. By applying ‘Z’ test of difference between two sample means; there is a highly significant difference between mean values of position of maxillary incisor to FFA point in control and study group comparison (i.e. p < 0.01). And there is no significant difference between mean values of forehead inclination in control and study group comparison (i.e. p > 0.05). By applying ‘Z’ test of difference between two.

p < 0.001: Highly significant; p > 0.05: Not significant
proportions, there is a highly significant difference between proportions of maxillary central incisor positions relative to forehead for the control and study sample (i.e., \( p < 0.01 \)).

In the control sample, eight subjects (8%) had maxillary central incisors positioned posterior to the forehead’s FFA point, five subjects (5%) had maxillary central incisors positioned anterior to glabella and 87 subjects (87%) had maxillary central incisors positioned somewhere at or between the FFA point and glabella.

In the study sample, 63 subjects (63%) had maxillary central incisors positioned posterior to the forehead’s FFA point. Twelve subjects (12%) had maxillary central incisors positioned anterior to glabella. Only 25 subjects (25%) had maxillary central incisors positioned somewhere at or between the FFA point and glabella.

**REGRESSION EQUATIONS**

**For Control Group**

Line of regression of position of maxillary central incisor relative to FFA point (X) on forehead inclination (Y) in control group is as follows:

\[
(X - \bar{X}) = b_{XY} (Y - \bar{Y})
\]

Where,  
\( X \) = required position of maxillary central incisor relative to FFA point.  
\( \bar{X} \) = mean value of position of maxillary central incisor relative to FFA point in control sample.  
\( Y \) = forehead inclination.  
\( \bar{Y} \) = mean value of forehead inclination in control sample.  
\( b_{XY} \) = regression coefficient of x on y calculated as,  
\( b_{XY} = r \times SD_x \times SD_y \) \( (SD = \text{standard deviation}) \)

Hence,  
\( (X - 2.348) = 0.0988(Y - 12.59) \)

\( X^\wedge \) (estimate) = 0.0988Y – 1.1091

**For Study Group**

\( X^\wedge \) (estimate) = 0.0480X + 12.59

**DISCUSSION**

Contemporary orthodontic diagnosis includes frontal photographic examination with lip relaxed and while smiling. But profile photographic examination includes evaluating the face with lips relaxed only. If the maxillary incisors are considered a part of the face, then orthodontists should evaluate the facial profile with the maxillary incisors bared. Facial landmarks other than the lips, nose and chin are needed for assessing their position in profile when those teeth are displayed. The rationale for using the forehead to determine the goal for the maxillary incisors include the concept that, in persons with facial harmony, there is a correlation between the prominence and the inclination of forehead and the AP positions of the teeth and jaws.

Schlosser,17 Dr LF Andrews18 also favors 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. They concluded that people, trained or untrained, are sensitive to the incorrect AP relationship of the maxillary incisors to the forehead and that this is the method that society unconsciously uses in determining profile acceptance.

In the present study, the mean values of position of maxillary central incisor relative to FFA point in control sample was 2.348 mm and for study sample it was –0.135 mm with the range from –4.50 to 8.50 mm for control sample and from –7.50 to 6.0 mm for study sample. While the mean values for forehead inclination were statistically insignificant in both control and study samples.

By applying ‘Z’ test of difference between two sample means there is a highly significant difference between mean values of position of maxillary central incisor to FFA point in control and study group comparison (i.e. \( p < 0.01 \)). And there is no significant difference between mean values of forehead inclination in control and study group comparison (i.e. \( p > 0.05 \)).

The AP positions of the maxillary central incisors were strongly associated with the forehead landmarks used in this study and strongly correlated with forehead inclination in adult females with good facial harmony (control sample). In looking at the correlation of AP incisor position relative to FFA point and forehead inclination, only the control group exhibited a strong correlation while it was weak in the study sample, despite the fact that forehead inclination was not found to be statistically different between the control sample and study sample.

The results of this study indicate that the forehead can be used as a landmark to estimate the ideal position of maxillary central incisor in profile view, as there is a strong correlation between forehead inclination and the position of maxillary central incisor relative to FFA point on forehead in control sample. Using the forehead as a primary landmark for AP incisor positioning avoids the potential pitfalls of relying on cephalometric analysis or reposition soft tissue analysis.
CLINICAL SIGNIFICANCE OF THE STUDY

The findings from this study not only reaffirm Andrews’ findings, but can be incorporated into routine orthodontic record taking, diagnosis and treatment planning.

The inclusion of a smiling profile photograph with the forehead and maxillary incisors fully visible to the set of diagnostic records as well as clinical evaluation of the smiling facial profile will allow the orthodontist to document orientation of the patients’ maxillary central incisors to the forehead and to achieve ideal position of maxillary central incisors in the face.

The analysis is unique because treatment goals are based on the patient’s existing features, and therefore treatment is directed at maximizing each individuals esthetic potential by creating a balance and harmony within all areas of the face.

It is a quick and simple way to analyze a critical soft tissue landmark (forehead) and hard tissue landmark (maxillary central incisor). Generic norms are not created and specified to a patient but contrastingly each individual patient is assessed and given an ideal norm specific to them. Additional studies that would be needed to extend these findings would be to look at other races, specific age groups as well as gender groups.

CONCLUSION

The forehead is a useful landmark for assessing the facial profile for adult Maharashtrian females as it relates to AP maxillary central incisor position. Treatment goals should include a harmonious AP relationship between the maxillary central incisors and the forehead for adult female patients of given population. This study in particular, makes clear the usefulness of including a lateral smiling photo for diagnostic purposes.

Addition of new diagnostic tool ‘smiling profile photograph’ will really be useful in clinical practices. Using the obtained ‘regression equations’ we can determine the ideal position of maxillary central incisor in profile view in adult females to provide optimum facial esthetics at the end of the orthodontic treatment.

REFERENCES