Anteroposterior relationship of the maxillary central incisors to the forehead in adult white males

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Aim: To evaluate and compare the anteroposterior relationship of the maxillary central incisors to the forehead in white male adults with harmonious profiles and white male adult orthodontic patients. Methods: Photographs of 101 white male adults with good facial harmony (control sample) were compared with photographs of 97 white male adults seeking orthodontic treatment (study sample). All were profile images with the maxillary central incisors and foreheads in full view. The images were imported into an image editing software program, resized, and rotated to the upright head position. Reference lines were constructed to assess the anteroposterior positions of the maxillary central incisors and forehead inclinations. Results: In the control sample, the maxillary central incisors were positioned between the forehead facial axis (FFA) point and glabella in 91%, posterior to the FFA point in 8%, and anterior to the glabella in <1%. The position of the maxillary central incisors was moderately correlated with forehead inclination ($r^2 = 0.37$). In the study sample, the maxillary central incisors were positioned between the FFA point and glabella in 34%, posterior to the FFA point in 59%, and anterior to the glabella in 7%. Maxillary central incisor position and forehead inclination were strongly correlated ($r^2 = 0.53$). The anteroposterior maxillary incisor position relative to the forehead between the control and study groups was significantly different ($P < .0001$). In addition, the forehead inclination between the control and study group was significantly different ($P < .05$). Conclusion: The forehead is an important landmark for anteroposterior maxillary incisor positioning for adult white male patients seeking improved facial harmony. Orthodontics (Chic) 2013;14:e2–e9. doi: 10.11607/ortho.906

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With the emphasis in orthodontic therapy expanding from the teeth to include facial esthetics, patients often seek treatment to improve their facial appearance. Dion et al1 found that attractive individuals are more likely to get better jobs, have more successful marriages, and to experience a happier, more fulfilling life. Berscheld and Gangestad stated, “the
social psychological effects of physical attractiveness are pervasive, strong, and generally uniform in nature. The physically attractive, whether male or female, old or young, black or white, or of high or low socioeconomic status, receive preferential treatment in virtually every social situation examined thus far. Overall physical appearance, specifically facial balance and symmetry, is an indicator of how people are perceived by themselves and others. Giddon suggested various physical, psychological, and social factors that affect perceptual judgments and relate to the development and maintenance of self-image and concept. In order to evaluate a patient’s facial appearance or facial esthetics, the orthodontist must evaluate the face in profile as part of a complete orthodontic diagnosis. Many methods for evaluating profiles have been proposed in the literature, including traditional cephalometric repose soft tissue analyses and, recently, L. F. Andrews’ Six Elements of Orofacial Harmony.

Traditional cephalometrics uses internal landmarks to define points, lines, and planes to quantify anteroposterior jaw and incisor positions. These landmarks can be unreliable due to errors in landmark identification as well as variability in landmark positions among individuals. Also, facial esthetics may suffer in patients treated using specified traditional cephalometric normative values. Cephalometric norms are potentially unreliable since the hard tissue structures are not consistently related to the soft tissues of the face.

Repose soft tissue analyses use external soft tissue landmarks to define points, lines, and planes from which measurements are made to define norms. As with traditional cephalometrics, soft tissue measurements vary greatly among individuals.

Andrews’ Six Elements of Orofacial Harmony use the forehead as a landmark for assessing the anteroposterior position of maxillary central incisors. Schlosser et al found that Andrews’ method of profile assessment was useful for evaluating attractiveness relative to the maxillary incisor position. Andrews defined forehead landmarks and observed the correlation between the forehead’s prominence and inclination and the position of the maxillary central incisors in individuals with good facial smile profiles (Fig 1). W. A. Andrews published a study on the AP relationship of the maxillary incisors to the forehead in adult white females. The author concluded that the forehead could be used as a landmark for treatment planning as it relates to maxillary incisor position. The objective of this study was to evaluate and compare the anteroposterior relationship of the maxillary central incisors to the forehead in a sample of white male adult patients seeking orthodontic treatment to a control sample of white male adults with good facial harmony. The null hypotheses are (1) there is no significant difference in the position of the maxillary central incisors with reference to the forehead facial axis (FFA) point between white male patients seeking orthodontic treatment compared with a control group of white male adults with harmonious facial profiles, and (2) there is no significant difference in the correlation of the maxillary central incisors with the inclination of the forehead between adult white male patients seeking orthodontic treatment compared with a control group of white male adults with harmonious facial profiles.

MATERIALS AND METHODS

The control sample consisted of 101 lateral smiling facial photographs of white male adults collected from various Internet sites. The criteria for inclusion were maxillary central incisors and foreheads being fully exposed and a generally pleasing facial appearance. A panel of three orthodontists examined the photographs to select pleasing profiles. Two of the three evaluators had to agree on the profile judgment of a subject for inclusion.
The study sample consisted of 97 lateral smiling facial profile photographs of white male adults seeking orthodontic treatment at either West Virginia University or at one of three private orthodontic practices. Photographs were randomly selected from the private offices after institutional review board approval from West Virginia University. The photographs were selected regardless of a pleasing or unpleasing profile appearance. Also, no specific skeletal, dental, or facial characteristics were included in the criteria to select the subjects. The maxillary central incisors and foreheads were fully exposed in all images.

Each image was imported into Adobe Photoshop CS3 (Adobe Systems). The images were resized to approximate life size and rotated to an estimated upright head position with patient looking outward into the horizon. The final upright head position was confirmed by the investigator and one independent practicing orthodontist from the orthodontic clinic. The approximate life size was determined by using the average vertical distance from trichion (hairline) to the incisal edge of the maxillary central incisors (128 mm) measured on the pretreatment lateral cephalograms of a randomly selected sample of ten adult
white male patients. Trichion was marked with barium paste prior to taking the head film. All the images were changed to a black and white format. Three independent orthodontists then screened the control sample for good facial harmony. A facial image was excluded if two of the three orthodontists agreed it did not have good facial harmony. Two investigators determined the natural head position of the images by rotating them in Adobe Photoshop. The images were printed, landmarks and lines were drawn, and the images were evaluated.

Landmark points, all of which were on the head’s midsagittal plane, were marked on each image (see Fig 1). The landmark for the maxillary central incisors was the facial axis (FA) point, which is the point on the facial axis that separates the gingival half of the clinical crown from the occlusal half. Trichion is defined as the hairline, and is the most superior aspect of the forehead when the forehead is of relatively flat contour. Glabella is the most inferior aspect of the forehead. Superion is the most superior aspect of the forehead when the forehead is either rounded or angular in contour. The FFA point is 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. Three vertical reference lines were constructed: line 1 through the FFA point, line 2 through glabella, and line 3 through the maxillary central incisor’s FA point. A fourth reference line (line 4) for assessing forehead inclination connected glabella to the uppermost point of the clinical forehead (superion or trichion).

The pictures were printed on 8½ × 11–inch standard white paper. All measurements were made by one examiner. The AP relationship of the maxillary central incisors to the forehead was measured as the distance between line 1 and line 3 using a metric ruler to the closest 0.5 mm. A positive value was assigned when the maxillary central incisors (line 3) were anterior to the FFA point (line 1); when the incisors were posterior to the FFA point a negative value was given. Forehead inclination was measured as the angle between line 4 and line 1 using a protractor to the closest 0.5 degrees.

Statistical analysis
Descriptive and comparative statistical analyses were performed using JMP computer software (SAS Institute). The means, standard deviations, and ranges were calculated for maxillary central incisor position relative to the forehead and for forehead inclination in both samples. The means for both samples were compared using a two-sample t test. A simple linear regression analysis was performed between the maxillary central incisor position and forehead inclination for both samples. Confidence intervals were set at 95%.

Error analysis
All measurements were repeated by the same examiner on a random sample of 10 subjects (5 from the study sample, 5 from the control sample). The systematic error between the first and second measurements was calculated using the intraclass correlation coefficient of reliability (R).9

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R = \frac{(MSA - MSE)}{MSA + [(k - 1) MSE]}
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where MSA is the mean square among the patients, MSE is the mean square within the patients, and k is the number of repeated measurements. When k = 2, the correlation coefficient of reliability is equal to the correlation coefficient between the first and second readings. All types of measurements showed reliability greater than 0.90.
RESULTS

Table 1 shows the mean, standard deviation (SD), and $R$ values for the incisor position and forehead inclination. The $R$ values for both area measurements were greater than 0.90, indicating high reliability.

Table 2 shows the AP position of the maxillary central incisors relative to the FFA point for the control and study groups. Significant differences were found between the two groups ($P < .001$). For the control sample, the AP position of the maxillary incisors relative to the FFA point ranged from $-6$ to $12$ mm, with a mean of $3.22 \pm 3.17$ mm. For the study sample, the AP position of the maxillary central incisors relative to the FFA point ranged from $-24$ to $13$ mm with a mean of $-0.31 \pm 6.52$ mm. Figures 2 and 3 show where the incisors were located in relationship to the external landmarks. In the control sample, 8 subjects (8%) had maxillary central incisors positioned posterior to the FFA point, 1 subject (<1%) had maxillary central incisors positioned anterior to glabella, and 92 subjects (91%) had maxillary central incisors positioned somewhere at or between the FFA point and glabella. In the study sample, 57 subjects (59%) had maxillary central incisors positioned posterior to the FFA point. Seven subjects (7%) had maxillary central incisors positioned anterior to glabella. Thirty-three subjects (34%) had maxillary central incisors positioned somewhere at or between the FFA point and glabella.

Table 3 shows the forehead inclinations for the control and study samples. Significant differences were found between the two groups ($P < .05$). For the control sample, the forehead’s inclination ranged from $8$ to $30$ degrees, with a mean of $19.04$ degrees and a standard deviation of $4.58$ degrees. For the study sample, the forehead’s inclination ranged from $5$ to $29$ degrees, with a mean of $17.45$ degrees and standard deviation of $6.09$ degrees.
Figures 4 and 5 show the results of the regression analysis between the anteroposterior maxillary central incisor position and forehead inclination for both samples. In the control sample, the anteroposterior positions of the maxillary central incisors were moderately correlated with the inclinations of the forehead ($r^2 = 0.37$), and in the study sample they were more closely correlated ($r^2 = 0.53$). This study found that for the control group 16.21 degrees is the predicted value of the inclination of the forehead when the FFA point and FA point coincide, and for the study group 17.71 degrees is the predicted value.
of the inclination of the forehead when the FFA point and FA point coincide. It can be inferred that in the control group a 0.88-degree change in forehead inclination is correlated with a correspondingly positive or negative change of 1 mm in the anteroposterior position of the maxillary incisor's FA point. For the study sample, it can be inferred that in the control group a 0.68-degree change in forehead inclination is correlated with a correspondingly positive or negative change of 1 mm in the anteroposterior position of the maxillary incisor's FA point.

DISCUSSION

The difference in the anteroposterior position of the maxillary central incisors relative to the forehead was found to be statistically significant between the control and study groups. On average the FA point of the maxillary central incisors in the control group was located 3.22 mm anterior to the FFA point, whereas in the study group the FA point was located on average 0.31 mm posterior to the FFA point. This indicates that the men considered to be attractive had maxillary central incisors positioned not just more anteriorly than the study group, but also anterior to the FFA point by a significant amount. This 3.53-mm difference between the means is also clinically significant. This finding agrees with results reported by Andrews with white female adults. In Andrews' study the FA point of the maxillary central incisors in the control group was located 2.5 mm anterior to the FFA point on average, whereas in the study group the FA point was located 1.2 mm posterior to the FFA point on average. The findings of this study are also consistent with the findings by Schlosser et al, in which a panel of orthodontists and nonorthodontists found that Andrews' method provides a useful method to evaluate attractiveness relative to the maxillary incisor position. The results are also applicable to Asian female young adults. In a study by Cao et al, the smiling profile with the highest score judged by both orthodontists and nonorthodontists was the one with a 5-degree lingual inclination of the incisors with FA on the Goal Anterior Limit Line (GALL). Agostino et al found that the perception of the tooth anterior limit line is not influenced by the protrusion of the nose and chin. The authors found that the judgment of the tooth anterior limit line was independent of the protrusion of the nose and chin and they were not able to pinpoint a correlation between the protrusion or retraction of nose and chin and the changes of the ideal position of the maxillary incisor.

According to Andrews' study, treatment goals for white female adults should include a maxillary central incisor position somewhere at or between the FFA point and glabella. This study confirms that this is also true for white male adults since 92 subjects (91%) in the control group had maxillary central incisors with FA points located between the FFA point and glabella, whereas only 33 subjects (34%) had maxillary central incisors with the FA points located between the FFA point and glabella.

Forehead inclination was found to be significantly different between the control and study groups in this study. This agrees with Andrews' findings on white female adults. However, unlike Andrews' study, in which the anteroposterior position of the maxillary central incisors was strongly correlated ($r^2 = 0.64$) with forehead inclination in the control group, this study showed only moderate correlation between the anteroposterior position of the maxillary central incisors and forehead inclination ($r^2 = 0.37$) and greater correlation for the study group ($r^2 = 0.53$). The fact that the forehead inclination is not highly correlated with the anteroposterior maxillary incisor position could be due to greater variations in the inclinations and amount of frontal bossing in
men. The glabella tends to be more anterior in men. It could be due also to limitations of the study, which included mass media bias for characteristics contributing to facial beauty and harmony. Lastly, resizing the control sample photographs to life size could have introduced variability.

The results of this study support Andrews’ Six Elements of Orofacial Harmony, which use the forehead as a landmark for assessing the anteroposterior position of the maxillary central incisors. These can be used as guidelines for clinical orthodontists when developing treatment goals for patients that will undergo significant anteroposterior changes in maxillary incisor position. Attention should be given to ensuring that the final position of the maxillary incisors should be neither posterior to the FFA point nor anterior to the glabella.

CONCLUSIONS

The majority (91%) of the white male adults with good facial harmony examined in this study had maxillary central incisors positioned at or between the FFA point and glabella. Comparatively fewer (34%) white male adults seeking orthodontic treatment had maxillary central incisors positioned at or between the FFA point and glabella. Most (59%) of the study sample had maxillary central incisors positioned posterior to the FFA point (compared with only 8% of the control sample). Therefore, when viewing facial profiles of white male adults the forehead is a useful landmark for assessing the anteroposterior maxillary central incisor position.

REFERENCES


To learn how to construct the Goal Anterior Limit Line (GALL), go to http://www.slideshare.net/rafiromano/906-ngan