A Study to compare and correlate the Relationship between Computer-assisted Facial Midline and Four Different clinically assessed Facial Midlines on Dentate Subjects in Dakshina Kannada

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ABSTRACT

Aim: The purpose of this study is to determine the facial anatomic landmarks closest to the midline of the face as well as midline of the mouth in Dakshina Kannada population.

Materials and methods: Three commonly used anatomic landmarks, nasion, tip of the nose, and tip of the philtrum were marked clinically on 250 subjects (age range: 20–35 years) who met all the inclusion criteria. Frontal full-face digital images of the subjects in smile were then made under standardized conditions. Upon applying the exclusion criteria, all the 250 images were used for midline analysis using a computer-assisted technique. Deviations from the midlines of the face and mouth were measured for the three clinical landmarks marked; the existing dental midline was considered as the fourth landmark. The entire process of midline analysis was done by a single observer. One sample t tests were conducted at an α value of 0.001.

Results: The results indicated that each of the four landmarks deviated uniquely and significantly (p < 0.001) from the midlines of the face as well as the mouth.

Conclusion: The anatomic landmarks closest to the midline of the face in smile are as follows: The midline of the oral commissures, natural dental midline, tip of philtrum, tip of the nose, and nasion. The anatomic landmarks closest to the midline of the oral commissures were natural dental midline, tip of philtrum, tip of the nose, and nasion.

Keywords: Dental midline, Esthetic frame, Facial midline.

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To compare Computer-assisted Facial Midline and Four Different clinically assessed Facial Midlines on Dentate Subjects

overall symmetry of the face was used to create a framework using a computer software. The bisection of this framework is taken as the actual midline of the face. This computer-generated midline was used to compare the proximity of the anatomical landmarks to it. The study concluded that the hierarchy of anatomical landmarks closest to the midline of the face in smile followed by the midline of the oral commissures, natural dental midline, tip of philtrum, nasion, tip of the nose, and to the midline of the oral commissures was: Natural dental midline, tip of philtrum, tip of the nose, and nasion. This study suggested that similar studies on different samples in different races are needed to confirm the results. The present clinical study is undertaken to validate this results among Dakshina Kannada population.

AIMS AND OBJECTIVES

The objectives of this study are to define:
- The facial anatomical landmarks closest to the midline of the face
- The facial anatomical landmarks closest to the midline of the oral commissures (mouth) and
- The relationship between the midline of the oral commissures and the facial midline.

The facial anatomical landmarks analyzed were those traditionally used in clinical practice, such as nasion: A point in the midline of both the nasal root and nasofrontal suture, tip of the nose, tip of philtrum, a vertical groove on the median line of the upper lip, and dental midline.

MATERIALS AND METHODS

For the purpose of correlating computer-assisted facial midline to four different clinically assessed facial midlines, it was decided to conduct the study on 250 subjects, selected among the patients, students, and employees of Yenepoya University, Mangaluru, Karnataka, India. Ethical clearance was obtained from the ethical committee of the institute, and informed consent from patients was taken.

Selection of the Subjects

A total of 250 subjects in the age range of 20 to 35 years were selected randomly. The subjects having prosthetic or missing maxillary and mandibular anterior teeth, any history of facial or dental trauma, midline diastema, or any craniofacial anomaly were excluded.

Clinically Marking Three Anatomic Landmarks

A mark is placed on the nasion, tip of the nose, and tip of the philtrum of all the subjects. Standardization in application of all anatomic marks is maintained throughout the course of this study.

Obtaining the Photographic Data

A digital SLR camera (Canon EOS D500 digital camera, 16 Megapixel; Canon USA, Lake Success, NY) with a 105 mm lens and a point flash with two additional flashes in 3 and 9 o’clock positions is used for this study. A camera with an aperture setting of F 4.5 is mounted on a tripod, with a standardized focus at a standardized distance of 5 feet (1.5 m) from the subject. The lighting conditions are the same for all the photographs. The subjects were made to sit upright and the head of the subjects was positioned in such a way that Frankfort horizontal plane remained parallel to the surface of the floor, and subjects were asked to direct their sight in the distance. The height of the lens of the camera is adjusted on the tripod to match the eye level of the subject when seated upright with shoulders and head held straight and facing forward. Full-face digital images of all subjects in smile are made, with the subject in this position. Prior to making images, careful attention is given to ensure that the subjects do not rotate their heads, especially along the vertical axis.

Analysis of the Digital Photograph for Different Clinical Midlines and comparing them with the Computer-aided Facial Midline

All photographs are analyzed using an image analyzing software (AutoCADCS2, Autodesk Inc. San Jose, CA, USA) on a thin-film transistor (TFT) monitor calibrated with the following settings: Screen resolution: 1024 x 768 at 62 dpi, Refresh rate: 60 Hz, Phosphors: HDTV (CCIR 709), Gamma: 2.20, Hardware White Point: 6500K (Daylight).

Relative facial midline value (RFV) and relative commissural midline value (RCV) are two operational tools used to quantify the relationships of the anatomic landmarks to the respective midlines. To obtain RFV and RCV two parallel lines are drawn perpendicular from the exocanthion, a point on the outer commissure of the eye fissure of each eye. Facial midline is established by bisecting the distance between these two lines. Three vertical lines are then drawn along each of the anatomic points, which is marked clinically. The fourth line is drawn along the subject’s existing dental midline, which is defined as the vertical line passing through the tip of the incisal embrasure between the two maxillary central incisors.

The RFV value is defined as the relative closeness of an anatomic landmark to the facial midline. The measured distance from the line drawn from the exocanthion of each eye to facial midline is considered a constant called “F” and to nasion is “n.” The RFV is then obtained by dividing n by F. Similarly, the RFVs are obtained for three other anatomic landmarks: Tip of the nose (t), tip of philtrum (p), and dental midline (d) by dividing them by F.
Numerical values for \( n/F, t/F, p/F, \) and \( d/F \) are thus obtained (Fig. 1).

The midline of the oral commissures is defined as a line bisecting the distance between the cheilions, a point located on each labial commissures of the subject in smiling posture. The RCV value is defined as the relative closeness of an anatomic landmark to the midline of the oral commissures (center of the mouth). The measured distance from the midpoint of the intercommisural line to the right/left cheilion is considered a constant term “C.” The measured distances (variables) are: From the nasion – \( nx \), from the tip of the nose – \( tx \), from the tip of philtrum – \( px \), and from the dental midline – \( dx \). The RCV is then obtained by dividing \( nx/C, tx/C, px/C, \) and \( dx/C \) (Fig. 2). The measured distance from the two parallel lines are drawn perpendicular from the exocanthion to the midpoint of the commissures and is described as a variable called “C\( x \).” Thus, the relationship between the midline of the commissures and the midline of the face is obtained by dividing \( Cx/F \). Hence

RFV1 and RCV1: Relativity of nasion to midline of the face and commissures;
RFV2 and RCV2: Relativity of tip of the nose to midline of the face and commissures;
RFV3 and RCV3: Relativity of tip of philtrum to midline of the face and commissures;
RFV4 and RCV4: Relativity of dental midline to midline of the face and commissures; and
RFV5: Relativity of the midline of the commissures with the midline of the face.

In perfect symmetry, all five of the RFVs and all four of the RCVs would be equal to each other and to the numeral 1. If a line drawn along one anatomic landmark coincided with any of the other landmarks, the same RFV or RCV value is recorded for both. If an anatomic landmark was coincident with the facial or the commissural midline, then it is assigned a RFV or RCV value of 1. A total of nine values are recorded per subject. To determine whether the selected landmarks significantly differed from the midline of the face and mouth, a series of one-sample t tests are conducted with an \( \alpha \) value of 0.001.

RESULTS

A total of 250 subjects were included in this study. The results of this study support rejection of the null hypothesis that there would be no difference between the chosen facial anatomic landmarks and the midlines of the face and oral commissures, i.e., all the midline anatomical structures considered like the midline of oral commissures, the dental midline, the philtrum, the tip of the nose, and the nasion do not align with the facial midline considered. Two sets of one-sample t tests were conducted. One set of t tests was conducted to test the null hypothesis that the mean ratios of the five specified anatomic measures did not differ from 1 for the entire population considered (whether they all lined up with the facial midline). The analysis indicated that the difference between the mean ratio of each anatomic landmark and the midline of the face was statistically significant (\( p < 0.001 \)). The midline of the commissures was the closest, followed by the dental midline, the tip of philtrum, the tip of nose, and the nasion (Table 1, Graph 1). Another set of t tests was conducted to test the null hypothesis that the mean ratios of the four specified anatomic measures did not differ from 1 for the entire population. In line with the previous analysis, the results indicated that the difference between the mean ratio of each anatomic landmark and the midline of the commissures was statistically significant (\( p < 0.001 \)). The natural dental midline was the closest, followed by the tip of philtrum, tip of the nose, and the nasion (Table 2, Graph 2).
DISCUSSION

Esthetics is enhanced when anterior tooth midline coincides with midline of the face. Dental authors recommend that the midline of the anterior teeth be placed precisely in the facial median line or the middle of the mouth using landmarks as the incisive papilla and the labial frenum to establish it. Currently, there are no verifiable guidelines that direct the choice of specific anatomic landmark to determine the midline of the face or midline of the mouth. This clinical problem is the purpose of conducting this study.

The purpose of this study was to determine the facial anatomic landmarks closest to the midline of the mouth as well as the facial midline in Dakshina Kannada population. There is no standard definition for facial midline in the literature. Therefore, a method for obtaining facial midline using a computer-assisted technique is used as suggested by Bidra et al.8 The smiling image of the subject was chosen for all purposes of analysis, as it is a standard for esthetic analysis, and it revealed the dental midline as well. The markings for each anatomic landmark were made clinically. The landmarks clinically marked were on the nasion, tip of the nose, and the midpoint of philtrum. On the image in the computer, lines were drawn along these landmarks.

In this selected population of Dakshina Kannada, the midline of oral commissures ranked closest to the facial midline in comparison to all of the landmarks analyzed. This result was consistent with the study conducted by Bidra et al. The dental midline in the Dakshin Kannada population was ranked second in closeness to the midline of the face. The dental midline ranked closest to the midline of the commissures. This was in concurrence with the study conducted by Bidra et al.8 Thus, it can be inferred that the incisive papilla, usually found in between the two maxillary central incisors, may be an acceptable landmark for the determination of midlines, as reported by authors in the past.9-12 This indicates that dental midline in this population is in fact consistent with the facial midline. So, when fabricating a prosthesis, dental midline has to be consistent with the facial midline for optimal esthetics. The tip of the philtrum was ranked third in this study. The philtrum or tip of the vermilion border has been assumed by several studies in the past to represent the facial midline. The present study reinforces the credibility of the tip of the philtrum as a reliable landmark in the determination of the midlines of the face and mouth. Nasion was the most deviated landmark with regard to the facial midline, followed by the tip of nose. Based on the current study, soft tissue nasion may not be an adequate clinical landmark to

<p>| Table 1: Difference between the mean ratio of each anatomic landmark and the midline of the face |</p>
<table>
<thead>
<tr>
<th>Landmark</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midline of commissure (RFV5)</td>
<td>0.983</td>
<td>0.03</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dental midline (RFV4)</td>
<td>0.976</td>
<td>0.02</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tip of philtrum (RFV3)</td>
<td>0.973</td>
<td>0.02</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tip of nose (RFV2)</td>
<td>0.962</td>
<td>0.03</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nasion (RFV1)</td>
<td>0.951</td>
<td>0.03</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

<p>| Table 2: Difference between the mean ratio of each anatomic landmark and the midline of the commissures |</p>
<table>
<thead>
<tr>
<th>Landmark</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental midline (RFV4)</td>
<td>0.973</td>
<td>0.02</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tip of philtrum (RFV3)</td>
<td>0.971</td>
<td>0.02</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tip of nose (RFV2)</td>
<td>0.959</td>
<td>0.01</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nasion (RFV1)</td>
<td>0.942</td>
<td>0.03</td>
<td>&lt;0.001</td>
</tr>
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</table>
determine either of the midlines mouth. The second part of the study evaluated the proximity of these anatomical landmarks namely the dental midline, soft tissue nasion, tip of nose, and tip of philtrum to the midline of mouth (commissures). The result showed that dental midline ranked highest, followed by philtrum, tip of nose, and soft tissue nasion when compared to the midline of mouth. For most clinical situations, the ranking of the 1st three anatomic landmarks, namely, tip of philtrum, dental midline, and the midline of the commissures, appears to be more relevant. This was consistent with the results of Bidra et al. 8

The result of this study provides only baseline information about the relationships of various facial anatomic landmarks to the midlines of face and mouth. Similar studies in different geographical areas and larger populations are required to confirm these results.

REFERENCES