

Angular photogrammetric analysis of soft tissue facial profile of dental students at Bhavnagar, Gujarat: A cross-sectional study

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ABSTRACT

Background: Facial aesthetics play a crucial role in orthodontic diagnosis and treatment planning. A harmonious facial profile contributes to an individual's self-esteem and social acceptance. Photogrammetric analysis has emerged as a valuable tool for evaluating facial aesthetics, offering advantages such as cost-effectiveness, ease of use, and the ability to capture subtle nuances in soft tissues. This study focuses on angular photogrammetric analysis of the soft tissue facial profile of dental students at Bhavnagar, Gujarat.

Materials and Methods: This study investigates the soft-tissue facial profiles of dental students in Bhavnagar, Gujarat, using angular photogrammetric analysis. This method, which involves capturing and analysing photographs, offers a cost-effective and accessible way to assess facial aesthetics compared to traditional methods like cephalometric radiography or 3D scanning.

Results: The study included 62 dental students (31 male and 31 female) with specific inclusion criteria such as Class 1 malocclusion, no previous orthodontic treatment, and facial symmetry. The study found significant gender differences in several angles, including nasofrontal angle, nasal angle, nasal dorsum angle, cervico-mental angle, and angle of inferior third.

Conclusion: These findings contribute to establishing soft-tissue norms for the Gujarati population, aiding in orthodontic diagnosis and treatment planning. The study highlights the importance of considering ethnic variations in facial aesthetics and the practicality of photogrammetric analysis in routine orthodontic practice..

Keywords: Angular photogrammetric analysis, facial profile, soft tissue, orthodontics.

INTRODUCTION

Evaluation of the patient's soft tissue profile is most important components of orthodontic diagnosis and treatment planning^[1]. Social acceptance, psychological well-being, and the self-esteem of an individual are related to physical appearance. It has been established that self esteem is strongly dependent on facial appearance. On the other hand, some special treatments (orthognathic and plastic surgery, orthodontics, prostheses) can change the face. Therefore, facia

l therapists need to understand facial beauty standards to guide patient aesthetic goals^[2].

Perceptions of facial attractiveness are important; Race, age, gender, culture, and personality are related to facial attractiveness^[3]. Various different methods have been used to evaluate facial characteristics such as craniofacial anthropometry, photogrammetry, cephalometric radiography, stereo-photogrammetry, computed tomography and laser scanning^[4].

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The variability and beautifulness of the face are expressed in different sizes and shapes of an individual which features parts of the face and different facial angles [5].

Photographic evaluation of orthodontic patient has assumed considerable importance as an essential aid in treatment planning since it depicts a very close representation of the appearance of the person [6].

One of the main reasons why all patients seek dental treatment is to make their face more beautiful and satisfying. Photographic evaluation of orthodontic patient has assumed considerable importance as an essential aid in treatment planning since it depicts a very close representation of the appearance of the person [7].

Thus, there is need to develop norms pertaining to Gujarati populations. This study is to develop angular photogrammetric standards of soft tissue profile for Gujarati population both male and female and also compare the sexual dimorphism between them.

MATERIALS AND METHODS

The subjects were dental students at the college of dental science, Amargadh, Bhavnagar. A random sample of total 62 students (31 males and 31 females) was obtained. A brief questionnaire was completed for all individuals that included name, age, origin, previous orthodontic treatment, and maxillo-mandibular relationship. For the purposes of this study, the study sample met the following inclusion criteria: Individual with Gujarati grandparents, Age between 18 to 30 years, Class 1 malocclusion with minor or no crowding, Normal growth and development, Well-aligned maxillary and mandibular dental arch Full complements of permanent teeth irrespective of third molar status, good facial symmetry, determined clinically and radiographically, no significant medical history, no history of trauma, no previous orthodontic or prosthodontic treatment, and no maxillofacial or plastic surgery.

Photographic Setup

The method described by Riveiro *et al.* (2003) [8] for the photographic set-up and record taking was used. The photographic set-up consisted of a tripod (Digitek DTR 550 LW) that held a camera (Canon

EOS 1500D DSLR). This ensured a correct horizontal position of the optical axis of the lens (Macro Canon lens 100 mm; Tokyo). Flash was not used; natural light was used as a source of light for image capture.

Records

The camera was used in its manual position, the shutter speed was 1/125 per second, and the opening of the aperture f/11. The subject was positioned on a line marked on the floor; the dots are placed on lines marked on the ground and follow a vertical scale divided into 5 cm slices. Hanging from the scale is a tube held by a thick black line that indicates the true vertical (TV). The scale allowed measurements at life size (1:1).

A vertical mirror is placed off scale and outside the frame, approximately 110 cm away from the subject. To record in natural head position, subjects were asked to take a few steps, look at the camera, and stand still next to the scale, looking at the scale. Lips should be relaxed and feel a place. In the past, during registration, workers were required to remove their glasses and ensure that the patient's forehead, neck, and ears were clearly visible.

Digitalization

The photographic records, 35 mm slide format, were digitized and analyzed using the Photoshop CS3 extended software program for the Windows operating system.

Analysis

The software calculated all measurements once they were identified on each landmark record which had previously been digitized and scaled to life size. All the manual procedures were undertaken by the same operator (AD).

Statistical Analysis

Sexual dimorphism was assessed by Student's t test. The intrarater reliability of this method was analyzed using Dahlberg's standard error (ME) = $\sqrt{\sum (x_1 - x_2)^2 / 2n}$ to determine the difference between 2 measurements taken at least one month apart.

RESULTS

Descriptive statistics data including mean and standard deviations for photogrammetric angular measurements are shown in Tables 1 and Student's *t*-test comparing male and female measurements are shown in Table 2. Method error assessment are shown in Table 3.

Nasofrontal angle, Nasal angle and Nasal dorsum angle showed statistically significant gender difference ($P < 0.05$). Nasolabial angle (Male = $100.48^\circ \pm 7.103^\circ$ and Female = $103.97^\circ \pm 11.712^\circ$) and Mentolabial angle (Male = $130.16^\circ \pm 13.072^\circ$ and Female = $136.71^\circ \pm 14.889^\circ$) showed large variability in maximum and minimum values in both male and female. Both angles were wider in female than in male.

Cervico-mental angle and angle of inferior third showed statistically significant gender difference ($P < 0.05$). Cervico-metal angle was more acute in female ($93.94^\circ \pm 6.480^\circ$) than in male ($98.00^\circ \pm 7.483^\circ$). While angle of middle facial third showed no significant gender difference ($P > 0.05$).

Angle of inferior third was larger (Male = $36.10^\circ \pm 2.902^\circ$ and Female = $34.55^\circ \pm 2.514^\circ$) than middle third (Male = $25.42^\circ \pm 2.997^\circ$ and Female = $29.03^\circ \pm 9.786^\circ$). Angle of head position showed statistically significant gender difference (Male = $7.94^\circ \pm 5.961^\circ$ and Female = $80.81^\circ \pm 4.969^\circ$).

Vertical nasal angle, angle of facial convexity and angle of total facial convexity showed no statistically significant gender difference ($P > 0.05$).

DISCUSSION

The main goal of this investigation was to determine the average soft-tissue facial profile parameters specific to dental students at the college of dental science, Amargadh, Bhavnagar. Various factors, such as ethnicity, can influence the characteristics of the soft-tissue profile. To establish norms, only individuals with Class I malocclusion were included in the study. The inclusion criteria and methodology were designed to identify standard values that can aid in the diagnosis and treatment planning for individuals seeking orthodontic treatment or orthognathic surgery. However, it is important to note that participants with Class I molar relationship can still exhibit skeletal variations. Previous research has shown that cephalometric values in individuals with

normal occlusions can deviate significantly from the mean values commonly used in treatment planning. Therefore, in this study, participants were also assessed for well-balanced facial features in addition to their occlusion status.

To ensure a representative sample of normal dental students at the college of dental science, Amargadh, Bhavnagar, this study excluded patients who had previously undergone orthodontic or facial surgical treatment. The aim was to distinguish between normal and aesthetically pleasing profiles, as difficulties in applying supernormal cephalometric data have been associated with racial differences. Therefore, the main criterion for subject selection in this study was normal occlusion, which may not necessarily align with perceptions of beauty. This approach was supported by previous research conducted by Peerlings et al. in 1995^[9].

The clinical interest in natural head position (NHP) stems from its correlations with craniofacial morphology, growth trends, and respiratory needs. It has been argued that NHP provides a logical reference and orientation position for craniofacial analysis and the publication of illustrations. Lateral cephalometric radiographs taken in NHP would be more valuable for clinicians, as they present individuals as they appear in real life. Similarly, routinely capturing lateral profile photographs in NHP would have greater clinical significance, as highlighted by the study conducted by Malkoc et al. in 2005^[10-11].

Several anthropometrical investigations have been conducted to determine acceptable facial profiles, such as those by Merrifield (1966), Holdaway (1983), Paul et al. (1994), and Ferrario et al. (1998). However, these studies are not easily applicable in clinical settings due to their reliance on expensive machinery and complex procedures. Additionally, these studies tend to focus on specific aspects of the facial profile, rather than considering it as a balanced and harmonized structure composed of multiple aesthetic^[12-15].

In addition to direct anthropometry, various facial analysis systems and landmarks have been developed, such as those introduced by Neger (1959), Epker (1992), Arnett and Bergman (1993a, b), Burger et al. (1994), Peck and Peck (1995), Auger and Turley (1999), and Riveiro et al. (2003).

However, many of these systems, with the exception of photographically based ones, require expensive equipment and complex procedures. Furthermore, the data provided by these systems are often difficult to evaluate. Arnett and Bergman (1993a, b) presented a clinical facial analysis based on previous studies and their surgical experience. For the facial examination, the G – Sn – Pg angle was used to assess the convexity/concavity of the profile. According to those authors, a Class I profile presented an angle range of 165 – 175 degrees, a Class II profile less than 165 degrees, and a Class III greater than 175 degrees [16-21].

There is a consensus regarding the overall reliability of cephalometric analysis. However, it is important to note that a desirable skeletal pattern does not necessarily imply desirable facial aesthetics, and vice versa. This point was emphasized in the study conducted by Park et al. in 2004[22]. In daily practice, orthodontists often perform soft tissue analysis in a subconscious and unstructured manner. However, the present study aimed to establish soft tissue facial measurements through photogrammetric analysis to enable orthodontists to engage in more quantitative evaluation and make disciplined decisions.

Photogrammetric analysis provides several advantages for human profile analysis. First, angular measurements in photogrammetric analysis are unaffected by photographic enlargement, unlike in cephalometric analysis. This allows for clinical use in both pre-treatment planning and evaluation of post-operative results for patients. Secondly, with the use of cephalometric software programs, every profile fiducial point can be freely adjusted on a computer monitor to determine the most appropriate profile points. Additionally, photogrammetric profile analysis does not require expensive equipment or complex procedures, and it offers digitized results that are easily evaluated. Moreover, the collected data can be organized in unified charts for convenient reference. These advantages make photogrammetric analysis a valuable tool for facial profile assessment.

Lines et al. (1978) provided a mean range of 60 – 80 degrees for the angle of the intersection of the nasal dorsum and a tangent to columella [23]. The present results are different from the findings of Riveiro et al. (2003) who reported considerable gender

differences in these angles. The relationship between the nasal base (columella) and the upper lip, analyzed by the nasolabial angle (Cm – Sn – Ls), is one of the facial profile parameters with greater clinical uncertainty. In the present sample, this angle showed statistically insignificant difference between males and females. Burstone (1967) reported a nasolabial angle of 74 ± 8 degrees (range 60 – 90 degrees) in a Caucasian adolescent sample with a normal facial appearance [24].

Likewise, McNamara et al. (1992) reported a nasolabial angle of 102.2 ± 8 degrees for males and 102.4 ± 8 degrees for females in a study on lateral cephalograms of adult Caucasians with pleasing facial aesthetics [25].

Yuen and Hiranaka (1989) reported an angle of 102.7 ± 11 degrees for males and 101.6 ± 11 degrees for females in a study of Asian adolescents on standardized photographic records. The mentolabial angle (Li – Sm – Pg) was significantly wider in females than in males. Similar results of $133 - 134 \pm 10$ degrees also found by McNamara et al. (1992). The cervicomental angle (C – Me/G – Pg) was significantly more acute in females than in males. These results differ from those of Riveiro et al. (2003). Yuen and Hiranaka (1989) reported for their Asian adolescent sample on photographic records, a G – Sn – Pg angle of 162 ± 5 degrees in females and 161 ± 6 degrees in males. The G – Prn – Pg angle was 142.35 ± 5.36 degrees in males and 142.57 ± 5.29 degrees in females. No sexual dimorphism was found. In the present study, the facial and total facial convexity angles were similar. G – Sn – Pg: 168.32 ± 5.87 degrees males and 168.03 ± 4.99 degrees females [26].

The lower profile orientation was analyzed by the line Sn – Sm and the true horizontal or the angle of head position but statistically significant gender differences were found. Likewise, Riveiro et al. (2003) reported 74.5 ± 5 degrees for males and 76.1 ± 5 degrees for females.

Peck and Peck (1970) investigated standardized cephalometric and photographic records of Caucasians with pleasing faces. They assessed the facial angle of the soft tissue facial profile [27].

They analyzed vertical height by means of angles such as total vertical (N – T – Pg), nasal (N – T –

Prn), maxillary (Prn – T – Ls), and mandibular (Ls – T – Pg) angles. In this study, the middle and inferior facial thirds were evaluated by the N – Trg – Sn and Sn – Trg – Me angles. The middle third was smaller than the inferior third. Epker (1992) also founded that linear lower face height (Sn – Me) was larger than the upper (G – Sn) in relation to total face height in Caucasian subjects [28].

CONCLUSION

Establishing soft-tissue norms for dental students at the college of dental science, Amargadh, Bhavnagar using angular photogrammetric analysis is an important step in orthodontic diagnosis and treatment planning. By comparing participants with similar characteristics to the established mean values, orthodontists can better understand and address the unique needs of their patients. This can lead to more accurate and effective treatment outcomes.

The following conclusions were drawn from the study:

1. Results of the present study showed statistically significant gender difference in nasofrontal angle, Nasal angle and Nasal dorsum angle.
2. Nasolabial angle and Mentolabial angle were wider in female than in male.
3. Cervico-mental angle and angle of inferior third showed statistically significant gender difference ($P < 0.05$). Cervico-metal angle was more acute in female than in male.
4. Angle of inferior third was larger than middle third.

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