Photographic facial soft tissue analysis of healthy Iranian young adults: anthropometric and angular measurements

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Abstract

Background: Soft tissue profile can be widely different in various populations. Furthermore, this profile can be also continues to change throughout life. However, there are few studies that quantitatively evaluate the soft tissue profile in Iranian population. In order to determine normal reference values of facial parts in our populations, we aimed to measure standards for facial soft tissue parameters in Iranian young population.

Methods: The study samples included 155 medical students at the Firouzgar hospital in winter 2011. The soft tissue facial profiles were digitally analyzed using linear measurements and angles made with standardized photographic records, taken in a natural head position, to determine the average soft tissue facial profile for males and females.

Results: There was a statistically significant difference between males and females in 21 of our 26 measurements. The most prominent differences between the genders were observed in the measurements taken from the face region. Minimum frontal breadth and supraorbital breadth were larger in males than in females. Except for middle face height measurement, other horizontal and vertical measurements for the face were larger in males than in females, indicating wider and higher faces in men than in women. Some measurements of facial angles are discrepant between the two genders.

Conclusion: Due to the specific features of Iranian facial soft tissue values and also observable differences in facial measurements and angles between men and women, the Iranian standard values on facial measurements and angles should be given more attention, especially by plastic and cosmetic surgeons.

Keywords: Anthropometry, Measurements, Face, Analysis, Iranian.

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Introduction

The analysis of the human face is a science and an art, utilizing both aesthetic and anthropologic tools. The appearance of the face is influenced by age, sex, race, and ethnicity (1). In addition, the quantitative measurements of the face can be widely changes following growth as well as after surgical procedures (2). Furthermore, facial measurements are also an integral part of the evaluation of dimorphism. Therefore, planning a surgery on the face with the aim
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of restoration of facial components or maintaining the beauty should be performed by considering each of these factors (3). On the other hand, due to the increasing scrutiny placed upon the facial appearance at the completion of maxillofacial and cosmetic surgeries, a great deal of research has been conducted to determine what factors contribute to facial esthetics naturally through growth as well as through treatment (4). Consequently, the assessment of the soft tissue profile is an important part of diagnosis and treatment plan those in need of these types of surgeries (5,6). Photogrammetry has been introduced as an alternative to direct measurements to obtain angles and distances between facial landmarks. Obtaining measurements from photographs is less intrusive to the patient and more cost-effective, it provides a permanent record of the face that can be accessed at a later time (6,7,8).

There are numerous studies which demonstrated that the soft tissue profile can be widely different in various populations. Furthermore, this profile can also be continued to change throughout life from childhood into adulthood. However, there are few studies that quantitatively evaluate the soft tissue profile in Iranian population. In order to determine normal reference values of facial parts in our populations, we aimed to measure standards for facial soft tissue parameters in Iranian young population.

Methods

This analytical cross sectional study samples included 155 medical students at the Firouzgar hospital who had an appropriate health condition and enrolled in the hospital in winter 2011. All participants were explained how to implement the project and then they all had written consent to participate in the study. A brief questionnaire for all baseline characteristics including age, gender, and race was completed and inclusion criteria were checked by an ENT resident. Dental class I occlusion (the mesiobuccal groove of the maxillary first molar sitting within the mesiobuccal groove of the mandibular first molar (9)) was performed for all subjects that the normal state considered as inclusion criterion. History of orthodontic treatment was also considered as exclusion criterion. Other exclusion criteria were history of trauma to the face and facial fractures, facial cosmetic surgery, or any significant deformity in the nose or face.

Photography devices included a camera (canon D 5 35mm) and a tripod that used to prevent vibration and considering the height of subject for setting up horizontal axis of the camera lens. To avoid red eye in the picture, the camera flash the mode set for red eye effect. The primary flash was attached to the tripod by a lateral arm, at a distance of 27 cm from the optic axis to avoid the “red-eye effect” on the records. A secondary flash was placed behind the subject to enlight the background and eliminate undesirable shadows from the contours of the facial profile. The primary and secondary flashes were synchronized to improve the image. Distance between the camera and subject fixed at 2m and the visual axis was parallel to the floor. To get the actual size of the frontal and lateral views, a one-centimeter benchmark in the middle of the forehead and in the cheek was considered respectively. Before taking the picture if the person had to wear glasses, the glass was removed. Standardized facial photographs were obtained: with a fully opened eye, no smile, and gently closed lips, and with visible forehead and neck. For each subject, a single operator located the standard anthropometric landmarks on digital photographic images. All data were obtained from standardized digital photographic images using the standard anthropometric measuring method. After locating a total of 19 soft tissue facial landmarks on frontal view (Fig. 1) and 15 landmarks on lateral view (Fig. 2), angles (26 measurements on frontal view and 9 angles on lateral view) were measured using AutoCAD 2008 software and recorded in the checklists. Anthropometric landmarks used in this study are presented in Table 1 and Fig-

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ures 1 & 2, and 26 standard anthropometric measurements on right and left side of the face are shown in Table 2.

Results were presented as mean/SD for quantitative variables and compared using t test or Mann-Whitney U test if required. Statistical significance was determined at a p value of ≤ 0.05. All statistical analysis was performed using SPSS software (version 16.0, SPSS Inc., Chicago, Illinois).

Results

The results of the craniofacial anthropometric measurements for all 155 subjects (72 men with the mean age of 22.19/2.42 years and 83 women with the mean age of 23.38/3.24 years) were summarized by gender in Table 3. All measurements were given in millimeters. Craniofacial measurements were compared between males and females. A statistically significant difference existed between males and females in 21 of our 26 measurements. The most prominent differences between the genders were observed in the measurements taken from the face region. In this study, 19 facial landmarks were marked by the same investigator. After one month, this same investigator marked the landmarks on the 40 frontal and lateral images (10 male, 10 female) that were selected randomly from the study population. Analysis was performed to obtain a G reliability coefficient. As a result, the analysis of the rate indicated good repeatability for both female and male subjects (G = 0.91).

Cranial: Four measurements were performed, two vertical (tr-n, tr-g) and two horizontal (ft-ft, fz-fz). Comparison of the measurement of cranial region showed that minimum frontal breadth and supraorbital breadth were larger in males than in females. Also, vertical measurements of
Table 1. Anthropometric landmarks used in the study

| Landmarks       | Region                      | Definition                                                                 |
|-----------------|-----------------------------|-----------------------------------------------------------------------------|
| tr-trichion     | Cranial                     | Midpoint of the hairline                                                    |
| g-glabella      | Cranial                     | The most prominent point in the median sagittal plane between the supraorbital ridges |
| n-nasion        | Face                        | The midpoint of the nasofrontal suture                                       |
| mf-maxillofrontale | Nose                  | The anterior lacrimal crest of the maxilla at the frontomaxillary suture     |
| pr-pronasale    | Nose                        | The most protruded point of the nasal tip                                   |
| al-alare        | Nose                        | The most lateral point on the nasal ala                                      |
| sbal-subalare   | Nose                        | The point on the lower margin of the base of the nasal ala where the ala disappears into the upper lip skin |
| sn-subnasale    | Face                        | The junction between the lower border of the nasal septum, the partition that divides the nostrils, and the cutaneous portion of the upper lip in the midline |
| cph-crista philter | Orolabial   | The point on the crest of the philtrum, the vertical groove in the median portion of the upper lip, just above the vermilion border |
| ls-labialesuperius | Orolabial | The midpoint of the vermilion border of the upper lip                        |
| ch-cheilion     | Orolabial                    | The outer corner of the mouth where the outer edges of the upper and lower vermilions meet |
| sto-stomion     | Face                        | The midpoint of the labial fissure when the lips are closed naturally       |
| li-labialeinferius | Orolabial | The midpoint of the vermilion border of the lower lip                       |
| sl-sublabiale   | Face                        | The midpoint of the labiomental sulcus                                       |
| Me-menton       | Face                        | The lowest point in the midline on the lower border of the chin             |
| zy-zygion       | Face                        | The most lateral point on the zygomatic arch                                |
| go-gonion       | Face                        | The most lateral point at the angle of the mandible                         |
| ft-frontotemporale | Cranial   | The most medial point on the temporal crest of the frontal bone             |
| fz-frontozygomaticus | Cranial   | The most lateral point on the frontozygomatic suture                        |

Table 2. Standard anthropometric measurements

| Region       | Measurement name       | Plane                  | Landmarks                                      |
|--------------|------------------------|------------------------|------------------------------------------------|
| Cranial      | Minimum frontal breadth | Horizontal line        | frontotemporale-frontotemporale               |
|              | Supraorbital breadth   | Horizontal line        | frontozygomaticus-frontozygomaticus           |
|              | Forehead height I      | Vertical line          | trichion-glabella                             |
|              | Forehead height II     | Vertical line          | trichion-nasion                               |
| Facial       | Middle face height     | Vertical line          | glabella-subnasale                            |
|              | Maximum facial breadth | Horizontal line        | zygion-zygion                                 |
|              | Bignonial breadth      | Horizontal line        | gonion-gonion                                 |
|              | Physiognomic face height | Vertical line       | trichion-Me(menton)                           |
|              | Morphologic face height | Vertical line          | nasion-nathion                                |
|              | Upper face height      | Vertical line          | nasion-stomion                                |
|              | Anterior mandibular height | Vertical line     | stromion-Me(menton)                           |
|              | Chin height            | Vertical line          | sublabiale-gnathion                           |
|              | Lower face height      | Vertical line          | subnasale-gnathion                            |
| Nasal        | Nose height            | Vertical line          | nasion-subnasale                              |
|              | Nasal bridge length    | Vertical line          | nasion-pronasale                              |
|              | Nose width             | Horizontal line        | alare-alare                                   |
|              | Nasal root width       | Horizontal line        | maxillofrontale-maxillofrontale              |
|              | Nostril floor width    | Horizontal line        | subalare-subnasale                            |
| Oral-labial  | Philtrum width         | Horizontal line        | crista philtre-crista philtre                |
|              | Labial fissure width   | Horizontal line        | cheilion-cheilion                             |
|              | Philtrum length        | Vertical line          | subnasale-labialesuperius                    |
|              | Upper vermilion height | Vertical line          | labialesuperius-stomion                      |
|              | Upper lip height       | Vertical line          | subnasale-stomion                             |
|              | Lower lip height       | Vertical line          | stromion-sublabiale                           |
|              | Cutaneous lower lip height | Vertical line | labialesuperius-sublabiale                   |
|              | Lower vermilion height | Vertical line          | labialesuperius-stomion                      |

forehead height (tr - g, tr – n) were discrepant between the two genders.

Face: Seven vertical (g-sn, tr-gn, n-gn, n-sto, sto-gn, sl-gn, sn-gn) and two horizontal (zy-zy, go-go) measurements were performed. Except for middle face height measurement, other measurements (including maximum facial breadth, bignonial breadth, physiognomic face height, morphologic face height, upper face height, anterior mandibular height, chin height, lower face height) were larger in males than females. Measurements of the face showed that males had wider and higher faces.
Table 3. Standard craniofacial anthropometric measurements in Iranian population in men and women

| Facial measurements             | Male (mean) | SD (SEM) | Female (mean) | SD (SEM) | Total (mean) | SD (SEM) | p-value |
|--------------------------------|-------------|----------|---------------|----------|--------------|----------|---------|
| Minimum frontal breadth        | 107.433     | 7.5873   | 94.564        | 7.1996   | 100.542      | 9.7778   | < 0.001 |
| Supra-orbital breadth          | 129.108     | 6.7111   | 115.102       | 5.6665   | 121.608      | 9.3260   | < 0.001 |
| Nasal root width               | 21.383      | 1.3058   | 20.054        | 1.7883   | 20.672       | 1.7121   | < 0.001 |
| Maximum facial breadth         | 138.050     | 9.6521   | 124.698       | 6.8680   | 130.900      | 10.5541  | < 0.001 |
| Nose width                     | 39.771      | 2.6555   | 35.022        | 2.2258   | 37.228       | 3.3964   | < 0.001 |
| Nostril floor width            | 14.183      | 2.3627   | 12.167        | 1.6870   | 13.104       | 2.2597   | < 0.001 |
| Philtrum width                 | 15.737      | 2.7116   | 12.790        | 2.1680   | 14.159       | 2.8403   | < 0.001 |
| Labial fissure width           | 53.133      | 4.7927   | 48.057        | 6.3020   | 50.415       | 6.1798   | < 0.001 |
| Bigonal breadth                | 127.229     | 10.9665  | 105.960       | 7.4428   | 115.840      | 14.0782  | < 0.001 |
| Forehead height I              | 58.933      | 6.1150   | 55.751        | 6.9009   | 57.229       | 6.7181   | 0.003   |
| Forehead height II             | 68.500      | 5.7529   | 65.113        | 7.2194   | 66.686       | 6.7736   | 0.001   |
| Nasal bridge length            | 40.350      | 6.7173   | 41.498        | 4.6480   | 40.965       | 5.7128   | 0.213   |
| Philtrum length                | 17.567      | 2.5546   | 14.243        | 3.9960   | 15.787       | 3.7784   | < 0.001 |
| Upper vermilion height         | 6.025       | 1.6215   | 6.312         | 1.1496   | 6.179        | 1.3916   | 0.212   |
| Lower vermilion height         | 9.600       | 2.6691   | 9.820         | 1.6889   | 9.718        | 2.1944   | 0.534   |
| Cutaneous lower lip height     | 10.967      | 3.3117   | 8.025         | 2.0247   | 9.392        | 3.0667   | < 0.001 |
| Chin height                    | 31.754      | 3.6766   | 28.302        | 2.4955   | 28.299       | 4.4687   | < 0.001 |
| Lower lip height               | 20.5667     | 3.02115  | 17.8458       | 2.28331  | 19.1097      | 2.9729   | < 0.001 |
| Anterior mandibular height     | 52.3208     | 4.63711  | 43.1482       | 3.65203  | 47.4090      | 6.16238  | < 0.001 |
| Midface height                 | 76.029      | 5.9889   | 73.770        | 5.3207   | 74.819       | 5.7334   | 0.115   |
| Morphological face height      | 128.350     | 8.9877   | 116.918       | 7.4709   | 122.228      | 9.9840   | < 0.001 |
| Physiognomical face height     | 196.850     | 12.8803  | 182.031       | 11.5016  | 189.915      | 14.2092  | < 0.001 |
| Middle face height             | 62.004      | 5.1380   | 62.577        | 4.2623   | 62.311       | 4.6826   | 0.455   |
| Upper lip height               | 23.592      | 1.8256   | 20.555        | 3.9837   | 21.966       | 3.5064   | < 0.001 |
| Lower face height              | 75.912      | 5.4588   | 63.704        | 6.1768   | 69.375       | 8.4488   | < 0.001 |
| Nose height                    | 52.437      | 5.0226   | 53.214        | 3.5721   | 52.854       | 4.3100   | 0.276   |

Nasal: Five measurements were made for the nasal region. Although nose width and nostril floor width show statistically significant differences between males and females, nose height, nasal bridge length, and nasal root width were not different.

Orofacial: Comparing anthropometric measurements from the orofacial region, we found that all measurements were larger in males than in females, except for the upper and lower vermilion heights.

Angles: Descriptive measurements of angles are summarized in Table 4 and compared between the two genders.

Nose: There was significant difference in the angles of nasal (N-Prn-Sn), nasal dorsum, (N-Mn-Prn), and nasofrontal (G–N – Prn) between men and women, while no differences was detected in vertical nasal (N–Pn/N–Ort) angle between them.

Nasal Base and upper lip: This region was assessed by measuring Nasolabial (Prn–Sn–Ls) angle that ranged 85 to 123 degree in men and 79 to 120 degree in women. Mentolabial (Li–Sl–Pg) angle were not different between men and women. The average of cervicomental (G-Pg/C-Me) angle was 101.41/6.95 degree in men and 91.94/7.23 degree in women with a significant difference. The measurements of other
Facial convexity was assessed using facial convexity (G-Sn-Pg) angle with the mean of 167.67/4.19. Also, total facial convexity was measured by Total Facial (G – Prn – Pg) angle with the average of 138.86/7.20 degree.

Discussion

Many studies have been performed for better understanding of how growth and development could affects the skeleton, dentition, and the soft tissue profile in children and adolescence (10). It has been recently presented statistical significance in the interethnic variability of the neoclassical facial measurements with a 95 percent confidence level, allowing classification of the facial measurements into five distinct levels of variability including least variable, less variable intermediate, intermediate, more variable intermediate, and most variable (11).

Comparison of our facial measurements with the findings of other studies among different populations especially among Asians showed major similarities in different landmarks and facial angles. Similar to studies on Turkish people, in our observation, the most prominent differences between the sexes were observed in the angles were not meaningful between the two genders.

Fig.3. Schematic figures of young Iranian adults of soft facial tissue (With respect to the results of anthropometric and angular measurements)
measurements taken from the face region (1,12). In our study, all four measurements of skull including two vertical and two horizontal were discrepant between men and women. Also, in facial measurement, except for middle face height measurement, other measurements including maximum facial breadth, bigonial breadth, physiognomic face height, morphologic face height, upper face height, anterior mandibular height, chin height, lower face height) for the face were larger in males than females. Gender differences were also present in the mentolabial and cervicomental angles. However, when this was compared to Chinese adults, most of the measured angles in our analysis were similar in the two genders, while all the linear measurements in Chinese peoples were larger in men than women, but all the angular measurements were smaller in men than women (13). Also, in some studies on both eastern and western European nations, most of the facial angles including nasofrontal, nasolabial, mentolabial, and nasal tip angle were larger in women than men (14,15). In Croatian people, almost all vertical variables were larger in the males, except the length of the nasal tip, which was larger in females (16).

With respect to the results of anthropometric and angular measurements, we decided to propound schematic figures of young Iranian adults in soft facial tissue (Fig. 3).

**Conclusion**

Our study revealed a highly significant sex dimorphism in the soft tissue profile, presenting that form for both size and shape differ between male and female soft tissue profiles that was similarly shown in some other populations especially neighboring countries of Iran. Due to the specific features of Iranian facial soft tissue values and also observable differences in facial measurements and angles between men and women, the Iranian standard values on facial measurements and angles should be given more attention, especially by plastic and cosmetic surgeons.

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