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Proportional and Angular Photogrammetric Analysis of the Soft Tissue Facial Frontal View of 16-30 Year Olds in Shiraz, Iran.

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ABSTRACT

Facial beauty is becoming more and more important worldwide. This is defined as being close to what is advertised as attractiveness (for example by media) and is determined mainly by golden proportions. This study aimed to observe the soft tissue facial angular and proportional norms of South Iranian population attending Shiraz Dental School's clinic.Methods and material: Seventy subjects (34 males and 36 females; 16-30 years of age) with Persian origin who had a skeletal class 1 pattern and almost well-aligned maxillary and mandibular dental arches who participate in this cross-sectional study were selected from patients attending Shiraz Dental School's orthodontic clinic in 2013. Standardized frontal facial view digital photographs were taken from subjects and traced. Four angular and eight proportional facial variables were analyzed by using Autocad software. For statistical evaluation a Student's t -test was used and the reliability of the method was assessed by using Intraclass Correlation Coefficient within a four week interval.Results: Men had a higher facial asymmetry, a higher Facial Index, a higher proportion of the distance between inner canthus of the eyes divided by the mean of the width of the right and left eyes, and a lower facial aperture modified angle average than females. Conclusion: The average measurements of most facial variables of this study's population deviated from the ideal values suggested in texts and from those of the Brazilian Caucasian population.

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Introduction

Considering the fact that physical appearance and facial beauty play significant roles in the life of individuals in the contemporary world, one of the orthodontists' assignments is to improve the patients' facial beauty by their demands. Orthodontic treatments that solely focus on dentoskeletal complex without concerning the overlying soft tissue is no longer acceptable (1). Many factors such as sex, race, genetic and age can affect facial soft tissue features. However, in all cases facial attractiveness deeply depends on the facial proportions (2, 3).

Soft tissue facial analysis can be conducted using a variety of extra-oral radiographs. However, there are limitations on the precision of soft tissue findings on radiographs, especially in analyzing frontal View. The measuring could be done on the patients' actual face too. However, using photographs as means of soft tissue analysis has proved both more convenient and more reliable. The digital phenomenon has made the soft tissue photogrammetric assessment easy and accurate, and as a result the first choice for studying facial variables (4).

Ricketts et al. conducted a comprehensive study on details of face that lead to facial beauty in early 1980s, and they defined some important soft tissue facial measurements as "divine proportions" (2, 5).

Several other researchers followed their work to assess the most popular facial measurements in other populations and some ideal range for facial variables were set and globally accepted by both researchers and clinicians and were cited in text books. These ideal values or ranges have only had minor changes through last decade (6, 7).

There have been agreements in what ideal or golden details of face of western population are, Such as the "facial one fifth proportions" in horizontal dimension and the third proportions of vertical dimension (7,8,9).

Morosini et al. (2008) worked on face pleasantness by means of facial analysis of standardized frontal and lateral facial photographs. From their findings, it could be concluded that the angular and proportional measurements are much more crucial in establishment of attractiveness than the linear measurements (10).

The relationship between facial esthetics and so-called "the golden proportions" was assessed in a recent Indian study. Sunilkumar et al. (2013) analyzed the facial proportions of 300 North Maharashtrian young adults by photogrammetric analysis. their subjects showed a shorter lower anterior facial height and smaller mouth and nose compared to what is mostly reported in western white populations (11).

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Although most facial proportional and angular variables seem to have common normative ranges among races, some differences are also reported (12). Ukoha et al. (2012) reported some differences between African and western populations. Their findings revealed that the middle face of Igbo Nigerian adult men was shorter than their lower face. They also had a moderate glabella, but a more protruded nose and a less protruding chin compared to white populations (13).

Few studies have assessed the facial soft tissue on Iranian population. The only published comprehensive study was conducted by Sepehr et al. (2012) on 107 volunteer 18 to 40 year old Persian women. They compared the normative quantitative ranges of anthropometric measurements of the subjects' face with those reported for North American white women. Surprisingly, statistically significant differences were seen in 18 out of 26 assessed anthropometric measurements between Persian women (PW) and North American white women (NAWW)(14).

Although there have been several studies assessing proportional facial analysis, many controversies in facial soft tissue relationships among different ethnic clusters (15). This is partially because studying the soft tissue facial variables is a relatively new science when compared to the hard tissue study. However, one main reason for the variations in findings of studies is the natural variations that exist in different ethnics and populations. Therefore, more studies should be carried out on different populations to collect sufficient data to understand the norms and normal variations (16).

No previous data was available on the soft tissue norms in Iranian population at the time this study was conducted. Also the effects of sex on these angular and proportional measurements have not been evaluated. Therefore, the purpose of this study was to measure angular and proportional photogrammetric normal range of soft tissue facial frontal variables of Iranian males and females with normal skeletal feature attended Shiraz Dental School, Iran in 2013.

Material and Methods

A cross sectional study was designed. Ethical permission was obtained from the international branch of Shiraz University of Medical Sciences (ID: 8693075).

70 Patients (34 males and 36 females) was selected among those who had attended Shiraz Dental School's orthodontic clinic in 2013 for minor dental corrections. Four hundred lateral chephalograms were chosen in a convenient method. The radiographs were scanned with Fujitsu scanner (output resolution: up to 600 dpi, speed: 200 or 300 dpi, grayscale and monochrome). Each assessed bv chephalograms was two calibrated orthodontists for selection of appropriate subjects. Cephalometric tracing for detecting skeletal class I cases was done by Onyx Ceph image software in different dimensions.

A unique ID number was allocated to each chephalogram that was recognized appropriate. A simple randomized method was used to draw 70 ID numbers. Those selected patients were consented and assured of the confidentiality of their information and their privacy. Those who were not from Persian origin, or had a history of trauma to face and jaws, prior orthodontic treatments, or maxillofacial or plastic surgeries were also

excluded from the study and replaced by new subjects drawn randomly.

Standard frontal photographs were taken from subjects by a professional photographer. All photographs were obtained by one camera and in the same condition: Canon 60D digital camera with a 100-mm macro canon f/9,ISO=200,shutter lens. speed=60. Subject-camera distance was fixed at two meters. The camera was secured on a tripod. The subjects were asked to stand on a line marked on the floor two meters away from the camera's tripod. They were also asked to remove their glasses and hats and hold their heads in natural head position (NHP) facing the camera so that their hairline, forehead, neck, and ear were all clearly visible from the frontal view.

Two main flash lamps (430EX) with soft boxes were used at 45 degree to the subject for an evenly distributed illumination without shadows.

Facial analysis

Photometric tracing was performed on frontal view by AUTOCAD image software (Autodesk American company, version:13).Twenty reference points were marked on each photograph (Figure 1). Twelve soft tissue variables (four angular and eight proportional measurements) derived from previous studies (12) were assessed. They are shown and briefly defined in Table 1 and shown in Figure 2,3,4,5.The measurements were made by a final year dental students. To have the method error marking the landmarks on each photograph and measuring of variable for each individual were conducted twice two weeks apart.



Figure 1. PhotometricPoints: Gl' – soft tissue glabella; N' - soft tissue nasion; Exd – rightexternal corner ofthe eye; Exe – left external corner of the eye; End – right internal corner of the eye; Ene – left internal corner of the eye; V – Point V; Sn – subnasale; Ald – right alar point; Ale – left alar point; F- lower philtrum; Ls- upper philtrum; Li- lower lip; Abdright mouth angle; Abe – left mouth corner; Esstomium; Zid – right zigion; God'- right gonion; Goe'- left gonion; Me'- Menton.



Figure 2. Angular measures 1 and 2: 1) Facial symmetry angle - angle formed between facial midline (N'-F) and Sn'Me' line .2) Symmetrybetween left and right side of the face - the difference between left and right angle measurements formed by intersection of Zi'-Go' and Ex-Go' lines.



Figure 3. Angular measures 3 and 4: 3) V Angle angle formed by lines extending from V to God' point and from V to Goe'; 4) Facial aperture modified angle - angle formed by right and left lines extending from Exd to Exe to Me' point.



Figure 4. Proportional measures – Facial Index: Proportion between upper facial height and facial width; Facial Height Proportion: Proportion between middle face height and lower face height; upper lip proportion: The proportion between Sn-Es and Sn-Me.



Figure 5. Proportional measures- 4)distance between inner canthus of the eyes/ Mean of the width of the

right and left eyes; 5)widths of the right outer canthus to right zygoma(right outer 5th)/ Width of the right eye; 6)widths of the left outer canthus to right zygoma(left outer 5th)/Width of the left eye; 7) width of the inter commissural/ Width of the inter iris of botheyes;8)width of the inter alar/Width of distance between innercanthus.

Statistical analysis

The Statistical Package for the Social Sciences SPSS 20.0.0.0 (SPSS Inc, Chicago, IL) software for windows was used for data analyzing. A test-retest reliability assessment within a 4 week interval showed that the Cronbach's alpha of the two measurements of the assessed variables was between 0.91 and 1.00. The p-value of the intra-class correlation test of the two measuring occasions for all variables was, of course, less than 0.001. Although the two sets of measurements were very close to each other, their average values for each variable was used for each subject.

The main objectives of this study were fulfilled by descriptive statistics and independant t-test was used to compare the differences between the male and female subjects. Also one sample t-test was used to compare the proportional values with the divine proportions described in the literature for vertical and transverse dimensions (Table 1).

Results

Data derived from 34 males (48.6%) and 36 females (51.4%) were used in the final analysis. The average values of the assessed angular and proportional facial variables are given in Table 2. The mean age of sample was 22.91 ± 4.61 , with no significant difference between males (22.21 ± 4.34) and females (23.58 ± 4.81).

Comparing the average facial measurements between males and females, the greatest difference was seen in the *facial symmetry angle*, where males possessed an average value (1.64 ± 0.92) of about 2.5 than females (0.66 ± 0.61) . The difference showed that male participants were more likely to have higher natural facial asymmetry (p<0.001). Another significant difference in angular facial variables was found in the average of the *facial aperture modified angle* which was significantly lower in males (43.67 \pm 2.86) than in females (46.77 \pm 3.72) (p<0.001).

There was no significant difference between males and females in terms of the other two assessed angular variables: the *symmetry between left and right of the face* (p=0.209) and the *V-angle* (p=0.256).

Significant differences were seen between males and females in two out of the eight assessed proportional facial variables. The average values of both the Facial Index (p<0.001) and the distance between inner canthus of the eyes divided by the mean of the width of the right and left eyes (p=0.011) were higher in males than in females. The average values of the *Width of inter alar divided by the distance between inner canthus of eyes* was almost the same between males and females (p=0.965).

The ideal values for the five out of eight assessed proportional soft tissue facial variables are suggested as 1.0 in the literature (7). As presented in Table 2, the difference from the ideal proportional value was statistically significant in four variables (p<0.001 for all four variables). The average of the present study's three variables: the width of the right outer canthus to right zygoma divided by the width of the right eye, the width of the left outer canthus to left zygoma divided by the width of the left, and the proportion of the width of the inter commissural to the width of the inter iris of both eyes was lower than the ideal. However, the proportion of the width of the inter alar to the distance between inner canthus of eyes obtained in the current study was significantly higher than the ideal 1, despite it was clinically close.

Table 2. Comparison of five proportional soft tissue facial variables between this study and the suggested ideal values of 1.0.

	Variable	Average	Suggested	p-value
		±SD	ideal value	
8	Distance between	$1.02 \pm$	1.00	0.103
	inner canthus of the	0.11		
	eyes/			
	mean of the width of			
	the right and left			
	eyes			
9	Width of the right	$0.68 \pm$	1.00	< 0.001*
	outer canthus to right	0.10		
	zygoma/			
	width of the right			
	eye			
10	Width of the left	$0.65 \pm$	1.00	< 0.001*
	outer canthus to left	0.10		
	zygoma/			
	width of the left eye			
11	Width of the inter	$0.82 \pm$	1.00	< 0.001*
	commissural/	0.07		
	width of the inter			
	iris of both eyes			
12	Width of the inter	$1.11 \pm$	1.00	< 0.001*
	alar/	0.09		
	distance between			
	inner canthus of eyes			

*Significant at 0.001 level.

Table 1. Brief definitions and the average (±SD) values of angular (1 to 4) and proportional (5 to 12) facial variables assessed in this study.

	Variable	Brief definition	Average	Gender	Average+SD	p-value
			±SD		in gender	P
1	Facial symmetry angle	Formed between facial midline (N'-F)and Sn'Me'	1.05 ± 0.84	Male	1.64 ± 0.92	< 0.001*
		line		Female	0.66 ± 0.61	
2	Symmetry between left and	The difference between left and right angles	0.89 ± 0.99	Male	1.04 ± 1.06	0.209
	right of the face	formed by intersection of Zi'-Go' and Ex-Go'		Female	$0.74~\pm~0.92$	
		lines				
3	V angle	Formed by lines extending from V to God point	71.01 ±5.33	Male	71.8 ± 4.46	0.256
		and from V to Goe		Female	70.30 ± 6.02	
4	Facial aperture modified	Formed by right and left lines extending from	45.26 ±3.65	Male	43.67 ± 2.86	<0.001*
	angle	Exd to Exe to Me' point		Female	46.77 ± 3.72	
5	Facial Index	Facial height (N'-Me') /	90.20 ±5.89	Male	93.30 ± 4.85	< 0.001*
		upper facial width (Zid'-Zie')		Female	87.28 ± 5.31	
6	Lower Facial Height	Middle facial height (Gl'-Sn) / lower facial height	2.42 ±11.47	Male	1.03 ± 0.13	0.327
	Proportion	(Sn-Me')		Female	3.73 ± 15.99	
7	Upper lip proportion	Sn-Es /	0.32 ± 0.04	Male	0.32 ± 0.04	0.134
		Sn-Me		Female	0.33 ± 0.04	
8	Distance between inner	End to Ene/	$1.02 ~\pm~ 0.11$	Male	1.05 ± 0.11	0.011**
	canthus of the eyes/	Mean of the width of Exd to End and Exe to		Female	0.99 ± 0.10	
	mean of the width of the	Ene				
-	right and left eyes		0.40.0.40	3.6.1	0.50 0.10	0.4.40
9	Width of the right outer	Exd to Zid/	0.68 ± 0.10	Male	0.70 ± 0.13	0.160
	canthus to right zygoma/	Exd to End		Female	0.66 ± 0.07	
10	Width of the right eye		0.65 . 0.10	N. 1	0.66 + 0.11	0.625
10	width of the left outer	Exe to Zie/	0.65 ± 0.10	Male	0.66 ± 0.11	0.625
	width of the left ave	Exe to Ene		Female	$0.65~\pm~0.09$	
11	Width of the inter	Abd to Aba/	0.82 ± 0.07	Mala	0.82 ± 0.08	0.802
11	commissural/	Abu to Abe/ Distance between inter iris of eves	0.82 ± 0.07	Famala	0.82 ± 0.08	0.602
	width of the inter iris of	Distance between inter ins or eyes		remaie	0.82 ± 0.03	
	both eves					
12	Width of the inter alar/	Ald to Ale/	1.11 + 0.09	Male	1.11 + 0.11	0.965
12	distance between inner	End to Ene	0.07	Female	1.11 ± 0.07	5.205
	canthus of eyes			- cillate	0.07	
L			1			

*Significant at 0.001 level.

**Significant at 0.05 level.

The proportion of the distance between inner canthus of the eyes to the mean of the width of the right and left eyes obtained in this study (1.02 ± 0.11) was not statistically different from the ideal 1.0 (p=0.103). However, as the average of this variable was significantly different between males and females of the study, the one-sample t-test was repeated for the males and females separately. The results showed that males with an average of 1.05 ± 0.11 were significantly different from the ideal 1.0 (p=0.007), while females with an average of 0.99 ± 0.10 were not (p=0.541).

Discussion

Although beauty perceptions are considered subjective, the concept of "normality" as a guide during orthodontic treatment planning is the safe margin. This study, in the absence of a study reporting the norms for South Iranian population, was conducted to assess the average of the proportional and angular soft tissue facial frontal measurements of a group of patients attended the Dental School Clinic for minor Shiraz dental malocclusion correction. Defining the normative measurements of Iranian population and their differences with those of western white population would definitely help the regional orthodontists, surgeons, and all other health professionals that work on facial aesthetics to make the best decisions when suggesting a treatment plan to the patients. This is especially important to those patients willing to maintain their ethnic originality after their aesthetic treatment.

As shown in Table 2, the proportional variables of the Iranian population in this study were significantly different, in average, from the suggested ideal proportions in the western population. Apart from ethnic differences, some researchers claim that the facial proportions might be in close relationship with body height (17). On the other hand, the average height of Iranian youth has showed a decrease during the past decades and is lower than the norms of western countries that are published in, for example, CDC 2000 (18, 19). Therefore, the difference of facial proportional variables of Iranian subjects from western population could be justified by the difference in average height of Iranian subjects from western norms.

Morosini et al. (2012) used a similar methodology to assess the facial measurements of 85 Brazilian Caucasian women (10). They have reported linear and angular facial measurements. Current study was conducted in a way the results were comparable to this study.

The proportional facial variable, *Facial Index* in Brazilian women was reported as 85.03 ± 3.85 in their study. In the current study, Iranian women had longer facial height or lower facial width than the Brazilian ones, However the Facial aperture modified angle was much lower in the Brazilian woman than the Iranian woman in this study.

Dawei et al. (1997) in a study of chinese adults reported that the nose width corresponded to one-quarter of the face width significantly was seen more frequently in the Chinese participants (51.5%) than in the Caucasian adults (36.9%). The nose was narrower than one-quarter of the face width in 38.8% of North American Caucasians and in 21.8% of Chinese; this difference was also statistically significant (20). Also in the current study the width of the nose was more than the proportion defined for the North American caucasions (7).

Porter et al. (2004) determine the average facial proportions of the African American man and compared the results with the neoclassical canons of facial proportions and the standard for the North American white man. Proportional facial relationships of the African American man differed significantly from those of the North American white man and from neoclassical standards. African American men vary primarily in the midface from their white counterparts. The most dramatic differences in the African American man were shorter nasal length \cdot wider alare width. In this study the width of the inter alar to the distance between inner canthus of eyes was significantly higher than the ideal 1, despite it was clinically close (21).

In the study of Sepehr et al. (2012) on the average, in the upper third, Persian women (PW) had a shorter forehead (trichion to glabella), a smaller eye fissure height, a smaller eye fissure width, and a smaller antimongoloid slant to the eyes. A shorter columella, a wider nose, a wider nasal base, and a thinner alar were observed in the middle third of PW compared to North American White women. In the lower third: PW were found to have a smaller lower face height, a thinner upper vermilion, and a narrower mouth (14). In the current study the proportion of the width of the inter commissural to the width of the inter iris of both eyes was lower than the ideal 1 and lower facial height was not significantly different between males and females.

The use of highly standardized photographs, along with appropriate digital software and reliable measuring methods warrants the accuracy of the average measurements obtained in this study. Although being single-centered with a limited sample size the averages and ranges reported in this study could not be generalized to the whole South Iranian population, they provide a vital insight for both researchers and clinicians. Relative to surgical planning for cosmetic procedures and treatment of facial disorders, we believe our results can be used to re-assess the norms used by clinicians and improve the natural appearance for young Iranian subjects. These results confirm that a database for facial patterns used by clinicians in facial surgery for young Iranian subjects should be racially sensitive, if the goal is to attain a 'natural' facial appearance that is consistent with Iranian norms. The differences in our results with benchmark studies of other ethnic groups further validate the need for racial-ethnically tailored cosmetic treatment plans. Further future studies on the subjects from other neighboring cities, probably on field derived samples (not attending patients) could be used for better understanding of the norms of the facial variables of this population and the differences between this population and others. Conclusion

A few differences were observed between men and women in terms of the angular and proportional measurements of their face. The average measurements of most facial variables of this study's population deviated from the ideal values suggested in texts and from those of the Brazilian Caucasian population. These differences should be considered when planning orthodontic or other esthetic treatment plans for the South Iranian population. Acknowledgements

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