

Angular Photogrammetric Analysis of the Soft Tissue Facial Profile and Sexual Dimorphism in Young Adults in Zanjan

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Abstract

Background and Aim: Facial features are different depending on gender and race. These features are usually studied in profile view. Angular evaluation of the facial soft tissue profile is important in males and females of different races for correct diagnosis and treatment planning. For this reason, in the present study, we measured the facial profile angles in young adults in Zanjan.

Materials and Methods: In this descriptive cross-sectional study, the photographs of 35 males and 35 females between 16 to 30 years were studied. The patients had class I malocclusion without a history of trauma, plastic surgery, or previous orthodontic treatment. Using AutoCAD software (version 2015), 12 angles were measured on the facial profile view photographs. Student t-test was used for statistical analysis.

Results: There were significant differences between males and females in four angles namely the nasal angle, angle of the nasal dorsum, angle of the inferior facial third, and angle of facial convexity ($P < 0.05$). The nasal angle in females was larger than that in males, but the angle of the nasal dorsum, angle of the inferior facial third, and angle of facial convexity were wider in males. Other angles did not show any significant difference between males and females.

Conclusion: In the present study, soft tissue facial measurements were performed by means of photogrammetric analysis to help orthodontists carry out quantitative evaluations and make disciplined decisions. The mean values obtained can also be used for studies comparing the records of participants with the same characteristics in other ethnicities.

Key Words: Photogrammetry, Face, Sex Characteristics, Analysis

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Received: 16 April 2020

Accepted: 26 Aug 2020

➤ **Cite this article as:** Nourian A, Hemmati F, Motamed N, Farzan A. Angular Photogrammetric Analysis of the Soft Tissue Facial Profile and Sexual Dimorphism in Young Adults in Zanjan. J Islam Dent Assoc Iran. 2020; 32(3-4):59-66. DOI: 10.30699/jidai.32.3.4.59

Introduction

Face is the most attractive and diverse part of the human body. Facial attractiveness is influenced by the facial angles, and shape and size of different parts of the face (1). Facial appearance affects the well-being and self-esteem of individuals (2). Harmony of the

facial ratios and balanced relation of facial features and their symmetry are important factors in this respect (3,4). Facial balance has been investigated by nasal length, lip protrusion, and chin development. Researchers found that the facial feature balance ultimately creates facial harmony (5). What is considered

as a beautiful appearance in a culture may be different compared with other cultures (6). Specialists including orthodontists, oral and maxillofacial surgeons, and prosthodontists can change the facial features (7). Orthodontists help patients to have a beautiful appearance by refining dental, jaw, and facial abnormalities. Among the goals of orthodontic treatment, the priority is to restore the function and stability of occlusion (8). One of the most important components of orthodontic diagnosis and treatment planning is evaluation of soft tissue profile (9). Obtaining the size of facial soft tissue is important to achieve normal and beautiful face indicators (6,10-12). Human facial analysis is a combination of science and art, and is performed by using anthropological instruments (13). A person's appearance is affected by the structure of the soft and hard tissues of the face (8). In longitudinal studies, it has been shown that the soft tissue profile does not necessarily follow the hard tissue. Thus, analysis of the facial soft tissue is required due to the differences in the soft tissue thickness of different individuals (8,14).

Clinical examination is the standard diagnostic method in orthodontic treatment. Also, diagnostic records of patients are required for treatment planning. Photography is among the commonly used diagnostic records. Analysis of the facial soft tissue by photography is referred to as photogrammetry. This method is commonly used for diagnosis, treatment, and evaluation of treatment results, and provides information about the normal values of different facial parameters in a specific population (1,13). Angular photogrammetric analysis provides a method to identify the problems of different parts of the face. In addition, this measurement is helpful to study the changes in growth and development, changes caused by treatment, and craniofacial abnormalities (15). Moreover, photogrammetry is a less technique-sensitive and inexpensive method that provides an evaluation of the balanced relation between the external craniofacial structures, which are affected by the muscles and the covering tissues (16). This method was first used by Stoner to compare the

profile before and after treatment and is a reliable, non-invasive and simple method. Also, it is a permanent and actual record of a person's appearance that decreases the chair time and saves time (1,8).

Cephalogram is another diagnostic orthodontic record by which the face is evaluated by angular and linear measurements (17). However, cephalometry has some limitations. The most important limitation is its radiation exposure. Today, due to increase in cases of cancer related to X-ray radiation, it is necessary to avoid excessive radiation. Also, patients are not familiar with observing and understanding cephalometric tracings; thus, photogrammetry is a preferred method for this purpose. In other words, understanding a photography is easier than a cephalogram for patients (16). As mentioned earlier, various specialists are able to change the facial features. In addition to orthodontists, plastic surgeons and oral and maxillofacial surgeons can change the facial features (7). Due to the recent development in surgical techniques, the harmony of the face has become a major goal of treatment. In other words, ongoing research on the facial appearance and the maxillofacial complex has established a number of variables related to facial esthetics for use by surgeons (9,14,18). Beugre et al. (2016) evaluated 57 Ivorian individuals aged 18-25 years and reported a significant gender difference in nasofrontal angle, mentolabial angle, and cervicomental angle (8). Ajami et al (2014) conducted a study on 71 Iranian young adults and showed that there was a significant gender difference in facial angles (19). Moshkelgosha et al. (2013) reported a significant gender difference in nasofrontal angle, nasal angle, vertical nasal angle, angle of the nasal dorsum, mentolabial angle, and cervicomental angle in a sample of 240 Iranian young adults aged 16 to 18 years (4). Since the beauty of the face is affected by several factors such as age, gender, race, personality, and culture, it is emphasized to pay attention to gender and ethnicity characteristics (6,10,20,21,22). Facial soft tissue measurements determine the normal values in different populations and reveal the differences

in the dentofacial relationships between different racial and ethnic groups. Therefore, developing some standards is necessary for different populations. Since few studies have been conducted on the Iranian young adults, and also no research has been conducted on the native population of Zanjan city as a sample of the Iranian population, the aim of the present study was to conduct angular photogrammetric analysis of the soft tissue facial profile of young adults in Zanjan.

Materials and Methods

The cross-sectional descriptive study was assessed by the National Biomedical Information System and approved by the Ethic Committee of Zanjan University of Medical Sciences (IR. ZUMS. REC. 1396.318). Seventy adults (35 females and 35 males) referred to the special clinic of the school of dentistry and a private clinic in Zanjan city, who met the inclusion criteria of the study signed informed consent forms to participate in the study. The inclusion criteria were age between 16-30 years with a mean age of 23 years (to minimize the effect of age on facial dimensions), patients with native father or grandfather from Zanjan city, dental and skeletal class I relation, mild to moderate dental crowding, absence of obvious asymmetry in the face in the clinical view, and no history of facial trauma, plastic surgery or orthodontic treatment.

The method of photography was the same for all patients. Canon SX6 HS digital camera was used and fixed on a tripod adjusted based on the patient's height. To avoid the fisheye image and to preserve the facial proportions of the image, the red eye effect was prevented by the tuning button of the camera during image acquisition. The Color Match was used to adjust the color of the images. To avoid the undesired shadow on the image background, a secondary flash was used behind the patient to brighten the background. All images were obtained in the natural head position. To adjust the patient's head in the standard natural head position, a mirror was used in front of the patients at a distance of 120 cm, and the patients were asked to look at their image in the mirror. If the

patient wore glasses, he/she had to take it off during photography. Also, the lips had to be in the resting position. On all photographs, the ear, neck, and forehead had to be clearly visible. Fifteen landmarks were specified on the patients' photographs using AutoCAD software (version 2015). Then, 12 angles namely the nasolabial angle, mentolabial angle, cervicomental angle, angle of the inferior facial third, angle of the head position, angle of facial convexity, angle of total facial convexity, nasofrontal angle, nasal angle, vertical nasal angle, angle of the nasal dorsum, and angle of the middle facial third were measured and recorded by drawing lines through the marked points on the photographs (Table 1, Figures 1 and 2). To assess the reliability and reproducibility of the method, one orthodontist measured and recorded the landmarks on 20 randomly selected samples. after 4 weeks, the same landmarks were marked by the same orthodontist and then intra-class correlation coefficient (ICC) was calculated. ICC revealed excellent consistency between the first and second observations (Table 2).

The Student t-test was used to analyze sexual dimorphism. The results were analyzed using SPSS version 25 considering $\alpha=0.05$.

Results

The four angles of nasal, nasal dorsum, inferior facial third, and angle of facial convexity showed significant differences by gender. From these four angles, the amount of nasal angle was greater in females than males ($P=0.036$). The angle of the inferior facial third ($P=0.018$), angle of the nasal dorsum ($P=0.036$), and angle of facial convexity ($P=0.008$) were greater in males than females (Table 3). Angle of the inferior facial third of the females' face was larger than their middle facial third (facial middle third was 30.57° and facial lower third of the face was 36°). The lower third of the males' face was larger than their middle third of the face (middle third of the face was 29.91° and lower third of the face was 37.68°). Generally, in all males and females, the middle third of the face was smaller than the inferior third of the face. The angle of facial convexity and the angle

Table 1. Landmarks and parameters used in the facial profile analysis

Landmarks	Description	Parameters	Description
G, Glabella	The most anterior point on the middle line of the forehead	G-N-Prn	Nasofrontal angle
N, Nasion	The deepest point in the middle in the frontonasal curve	Cm-Sn/N-Prn	Nasal angle
Mn, midnasal	The midpoint on the dorsum of the nose between its root and tip	N-Prn/Tv(N)	Vertical nasal angle
Prn, pronasal	The most prominent point on the apex of the nose	N-Mn-Prn	Angle of the nasal dorsum
Cm, columella	The most anterior and inferior point on the apex of the nose	Cm-Sn-Ls	Nasolabial angle
Sn, subnasal	The deepest point in the nasolabial curvature	Li-Sm-Pg	Mentolabial angle
Ls, labial superior	The upper lip vermillion border	C-Me/G-Pg	Cervicomental angle
Li, labial inferior	The lower lip vermillion border	N-Trg-Sn	Angle of the medium facial third
Sm, supramental	The deepest point in the inferior sublabial concavity	Sn-Trg-Me	Angle of the inferior facial third
	The most anterior point of the chin	Sn-Sm/TH	Angle of the head position
Me, menton	The most inferior point on the inferior edge of the chin	G-Sn-Pg	Angle of facial convexity
C, cervical	The deepest point at the angle of the chin and neck	G-Prn-pg	Angle of total facial convexity
Trg, tragus	The most posterior point of the auricular tragus	-	-
TV(N), true vertical line	A straight line through nasion parallel to the TV line	-	-
TH, true horizontal line	A straight line through tragus perpendicular to the TV line	-	-

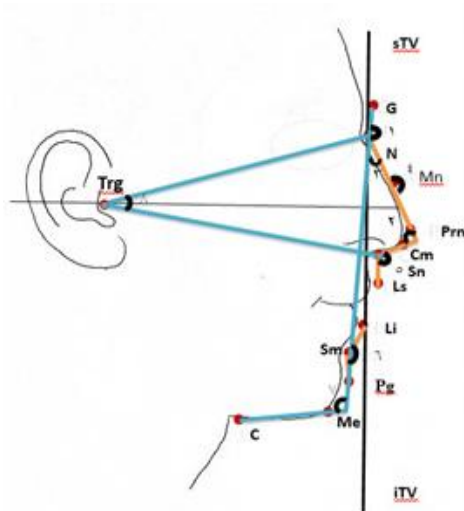


Figure 1. 1, N-G-Prn, nasofrontal angle; 2, Cm-Sn/N-Prn, nasal angle; 3, N- Prn/TV; vertical nasal angle; 4, N-Mn- Prn; angle of the nasal dorsum; 5, Cm- Sn - Ls, nasolabial angle; 6, Li - Sm- Pg, mentolabial angle; 7, C-Me/G-Pg; cervicomental angle; 8, N- Trg- Sn; angle of the medium facial third

G, glabella; N, nasion; Mn, midnasal; Prn, pronasal; Cm, columella; Sn, subnasal;

Ls, labial superior; Li, labial inferior; Sm, supramental; Pg, pogonion; Me, menton; C, cervical; Trg, tragus; sTV, superior point of true vertical; iTV, inferior point of true vertical; Reference lines: sTV-iTV, true vertical; parallel to TV through nasion, true vertical in nasion, true horizontal (TH)

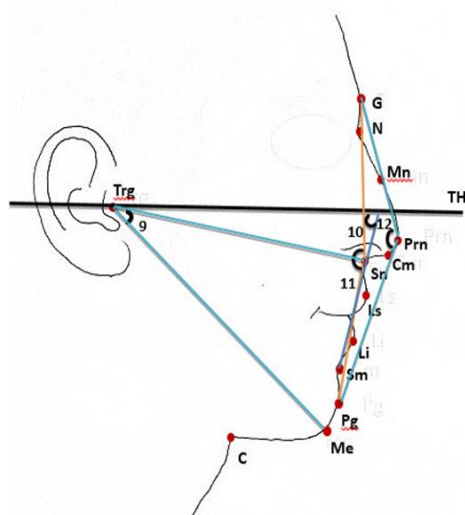


Figure 2. 9, Sn-Trg -Me, angle of the inferior facial third; 10, Sn-Sm/TH; angle of the head position; 11, G-Sn-Pg; angle of facial convexity; 12, G-Prn-Pg; angle of total facial convexity

of total facial convexity were larger in males than females. This means that the facial profile of Zanjani males was more convex than Zanjani females (Table 3).

Table 2. Intraclass correlation coefficients (ICCs)

Parameters	ICC
G-N-Prn	0.994
Cm-Sn-N-Prn	0.980
N-Prn-Tv(N)	0.998
N-Mn-Prn	0.980
Cm-Sn-Ls	0.997
Li-Sm-Pg	0.989
C-Me-G-Pg	0.939
N-Trg-Sn	0.953
Sn-Trg-Me	0.989
Sn-Sm-TH	0.963
G-Sn-Pg	0.976
G-Prn-Pg	0.988

Discussion

The results of this study can be summarized as follows: The nasofrontal angle, nasal angle, and angle of medium third were larger in females than males. The vertical nasal angle, angle of the nasal dorsum, nasolabial angle, mentolabial angle, cervicomental angle, lower third, angle of the head position, angle of facial convexity, and angle of facial convexity were larger in males than females. In the present study, the nasal angle, angle of the nasal dorsum, angle of the inferior facial third, and angle of facial convexity showed a significant gender difference. The nasal angle in females was larger than that in males, but the angle of the nasal dorsum, angle of inferior facial third, and angle of facial convexity in males were larger than in females. Different studies have investigated the facial profile angles and compared these angles between males and females (1,4,7,13,19-23). Soft tissue facial analysis on photographic records is referred to as photogrammetry. Photogrammetric analysis is a common method for diagnosis, treatment planning and evaluation of treatment outcome, and provides useful data about different normal facial

Table 3. Descriptive statistical data and application of student's t-test in relation to gender

Parameters	Gender	Minimum	Maximum	Mean	Std. deviation
G-N-Prn	F ^a	122	158	139.02	9.29
	M ^b	115	160	135.68	11.28
Cm-Sn-N-Prn	F	70	95	80.45	6.22
	M	62	93	76.80	7.95
N-Prn-Tv(N)	F	18	41	29.85	5.47
	M	20	40	31.14	4.57
N-Mn-Prn	F	165	198	183.02	5.87
	M	180	198	186.02	5.88
Cm-Sn-Ls	F	90	118	103.51	6.95
	M	81	126	103.60	11.66
Li-Sm-Pg	F	114	159	131.88	10.99
	M	110	166	137.14	12.84
C-Me-G-Pg	F	83	113	97.14	7.68
	M	89	123	99.74	6.89
N-Trg-Sn	F	27	37	30.57	2.09
	M	25	37	29.91	2.38
Sn-Trg-Me	F	31	43	36	2.93
	M	30	42	37.68	2.88
Sn-Sm-TH	F	61	87	76.11	6.56
	M	70	93	77.42	5.65
G-Sn-Pg	F	156	172	165.05	3.86
	M	160	179	168.31	5.76
G-Prn-Pg	F	130	147	137.02	3.80
	M	128	152	138.85	5.32

* P<0.05 Significant aFemale, n =35 bMale, n=35

parameters in different population groups (1,13).

Beugre et al. (2016) evaluated 57 Ivorian people aged 18-25 years, and reported a significant difference in nasofrontal angle, mentolabial angle, and cervicomental angle (8). Their results were different from ours since there was no significant difference between males and females in these parameters in our study. Ajami et al. (2014) conducted a study on 71 Iranian young adults and showed that there

was a significant gender difference in the nasofrontal angle, nasal angle, and vertical nasal angle (19). These results are similar to those of the present study only in the nasal angle. Similar to our study, the nasal angle of males was larger than that of females. The reason for this difference in the results of the two studies can be related to the effects of ethnicity on the appearance of people. Also, the impact of gender and difference in age is influential on the results (22). Moshkelgosha et al. (2013)

reported a significant gender difference in the nasofrontal angle, nasal angle, vertical nasal angle, angle of the nasal dorsum, mentolabial angle, and cervicomentale angle in a sample of 240 Iranian young adults aged 16 to 18 years (4). The results of this study on the nasal angle and angle of the nasal dorsum were similar to the present study, but were different regarding other facial angles.

Ferdousi et al, (2013) in the study on 100 Bangladeshi Garo people aged 25-45 years showed that there was a significant gender difference in the nasofrontal angle, angle of facial convexity, and angle of total facial convexity (1). The results regarding the angle of facial convexity were the same as our study. Unlike the present study, angle of facial convexity in females was larger than that in males. Fernandez-Riveiro et al, (2003) in their study on 212 Spanish people aged 18-20 years reported significant gender differences in the nasofrontal angle, nasal angle, vertical nasal angle, angle of nasal dorsum, and cervicomentale angle (7). Their study was similar to the present study in the nasal angle and angle of nasal dorsum. Moreover, similar to our study, the nasal angle in females was larger than that in males, but angle of the nasal dorsum in males was larger than that in females. Filipović et al. (2019) compared the differences in angular photogrammetric soft tissue facial characteristics of parents and their offspring. Similar to our study, they studied the same 12 angles and the data suggested that there were much more similarities between the facial soft tissue angles of fathers and their offspring. This study confirms the effect of genetics and sexual dimorphism on angular soft tissue facial characteristics (20). Pandian et al, (2018) in their study on 300 Indian people aged 18-25 years showed statistically significant gender differences in 5 parameters out of 12 including the nasofrontal angle, nasolabial angle, mentolabial angle, cervicomentale angle, and angle of medium facial third. The results were different from our study as there were no significant differences between males and females in these parameters in our study (21).

The reason for the difference between the results of studies conducted in other countries and studies conducted in Iran is probably the ethnic differences and their impact on the appearance of people (22). The authors recommend similar studies in different cities and on both genders to recognize the differences among different ethnic groups in Iran.

Conclusion

Facial features are affected by age, gender, and ethnicity. Iran consists of different ethnicities. This study investigated the angular analysis of facial soft tissue profile in young adults in Zanjan. There was a significant gender difference in the facial profile angles of young adults in Zanjan. A number of facial soft tissue angles in Zanjan males were different from those in females. In the present study, soft tissue facial measurements were established by means of photogrammetric analysis to help orthodontists carry out more quantitative evaluations and make disciplined decisions. The mean values obtained can also be used for studies comparing the records of participants with the same characteristics in different ethnicities.

Acknowledgement

This study was derived from a thesis with the approval code A-11-1061-3. The authors would like to thank the Research Deputy of Zanjan University of Medical Sciences for funding this project.

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