Three-dimensional facial analyses of Indian and Malaysian women

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Abstract

Context: Facial measurements serve as a valuable tool in the treatment planning of maxillofacial rehabilitation, orthodontic treatment, and orthognathic surgeries. The esthetic guidelines of face are still based on neoclassical canons, which were used in the ancient art. These canons are considered to be highly subjective, and there is ample evidence in the literature, which raises such questions as whether or not these canons can be applied for the modern population. **Aims:** This study was carried out to analyze the facial features of Indian and Malaysian women by using three-dimensional (3D) scanner and thus determine the prevalence of neoclassical facial esthetic canons in both the groups. **Subjects and Methods:** The study was carried out on 60 women in the age range of 18–25 years, out of whom 30 were Indian and 30 Malaysian. As many as 16 facial measurements were taken by using a noncontact 3D scanner. **Statistical Analysis Used:** Unpaired *t*-test was used for comparison of facial measurements between Indian and Malaysian females. Two-tailed Fisher exact test was used to determine the prevalence of neoclassical canons. **Results:** Orbital Canon was prevalent in 80% of Malaysian women; the same was found only in 16% of Indian women ($P = 0.00013$). About 43% of Malaysian women exhibited orbitonasal canon ($P = 0.0470$) whereas nasoaural canon was prevalent in 73% of Malaysian and 33% of Indian women ($P = 0.0068$). **Conclusions:** Orbital, orbitonasal, and nasoaural canon were more prevalent in Malaysian women. Facial profile canon, nasooral, and nasofacial canons were not seen in either group. Though some canons provide guidelines in esthetic analyses of face, complete reliance on these canons is not justifiable.

Keywords: Facial analyses, facial measurements, neoclassical canons, three-dimensional scanner

Introduction

The face symbolizes identity of a person. Right from the birth of an individual, the face plays an important role in social interaction. The uniqueness of face helps in determining the person's origin and race. The facial features and proportions differ with race.[1] The concepts of harmony, symmetry, equality, and proportion of face have been studied from ages by various artists and surgeons. Facial proportions have been idealized in ancient art.[2-4] The study of beauty became a formal discipline in 15th century BC. In the prerenaissance era, many body proportions were used by the artists to achieve esthetics in their work. It was in the renaissance period that more importance was given to facial proportions.[5,6] Renaissance artists emphasized that facial beauty is rooted in symmetric and balanced proportions.[7] Polycleitus, a Greek sculptor, was the first to define canons as rules to be followed in the artwork.[3,5] Leonardo Da Vinci, Vitruvius, Bergmuller, and Albrecht Durer extensively reported on canons and have applied these canons in their art.[2-6,8-10] However, these canons were more objective and do not establish standard values for the specific population.[11-13] The most commonly used canons are listed in Table 1.

Facial parameters are an indispensable tool for maxillofacial rehabilitation, pre- and post-treatment evaluation in orthognathic surgeries and orthodontic treatment.[6,7,12,13] Qualitative and quantitative information of the face is useful in diagnosis and treatment planning of patients.[14]

Quantitative analysis of face can be done by anthropometry in which direct facial measurements are taken using calipers or indirect ones such as two-dimensional photographs and three-dimensional (3D) scanning systems, which include laser scanning, cone beam computed tomography, and 3D stereo photogrammetry.[14-16] In the recent times, noninvasive 3D scanning has become more popular and reliable method of analyzing craniofacial complex.[14-20]

A 3D scanner is a device, which works on the basis of conversion of a real object into digital form. First, the scanner

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acquires data of the shape and dimensions of the scanned object with the aid of different technologies.[21] The data are then processed and used in prosthetics and orthotics.

This study was carried out to analyze the facial features of Indian and Malaysian women between the age group of 18 and 25 years, and to determine the prevalence of neoclassical canons in both the groups. A 3D scanner was used to take the facial measurements. The study aimed at establishing realistic values of facial measurements in Indian and Malaysian women so that they can be used beneficially in various treatment procedures.

Subjects and Methods

The study was carried out on 60 women in the age range of 18–25 years out of whom 30 were Indian and 30 Malaysian. A total of 16 facial measurements were carried out 12 linear and 4 horizontal [Figures 1 and 2].

All of the participants had class I skeletal relationship with no history of trauma and injury to the face, no gross facial asymmetry, no history of orthodontic treatment. Demographic data including age, place of birth, and ancestral origin were obtained along with informed patient consent to participate in the study.

Data acquisition

Comet light emitting diode (LED) 3D scanner (Steinbichler Optotechnik GmbH, Germany), which works on photographic principle was used to scan the subjects. It is a noncontact optical scanner with camera resolution (dpi) of 1600 × 1200, measuring field 400 mm, measuring volume 400 × 300 × 250 mm, and point-to-point distance 259 μm. The object was scanned from several angles and the scans were subsequently combined to create a digitized 3D image of the subject. During scanning, the position of the patient head was standardized and the basic parameters of the surroundings namely temperature, humidity, and lighting were kept unchanged.

Data processing

The data were analyzed using Steinbichler Comet plus software (Steinbichler Optotechnik GmbH, Germany). The facial landmark identification was performed by an orthodontist.

Results

Sixteen facial measurements of Indian and Malaysian women were compared. Significant differences were seen in all the facial measurements. The statistical values are presented in Table 2. The prevalence of neoclassical canons is presented in Table 3.

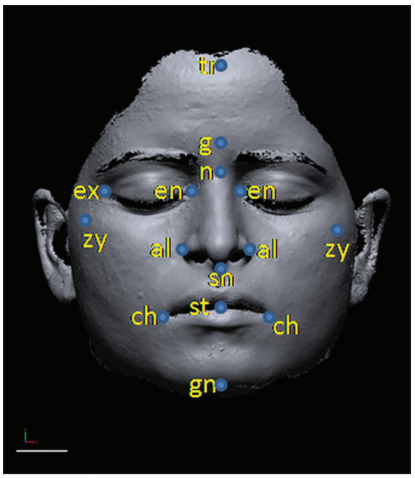

Figure 1: Frontal view-abbreviations: Tr-trichion, g-glabella, n-nasion, en-endocanthion, ex–exocanthion, zy-zygion, sn-subnasale, al-alare, ch-cheilion, st-stomion, gn-gnathion

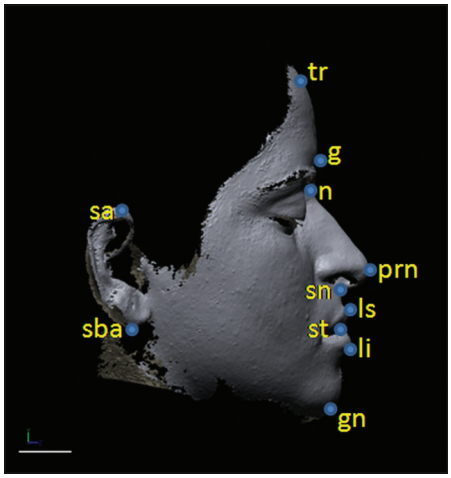

Figure 2: Lateral view-abbreviations: Prn-pronasale, ls-labrale superioris, li-labrale inferioris, sa–superaurale, sba-subaurale

Table 1: Neoclassical canons

Name of the canon	Equation	Description
Facial profile canon	tr-n=n-sn=sn-gn	The face can be divided into equal thirds, with the nose occupying the middle third
Orbital canon	en-en=ex-en	The distance between the eyes is equal to the width of each eye
Orbitonasal canon	en-en=al-al	The distance between the eyes is equal to the width of the nose
Nasooral canon	ch-ch=1.5 (al-al)	The width of the mouth is one and one-half times the width of the nose
Nasofacial canon	al-al=1/4 (zy-zy)	The width of the nose is one-fourth the width of the face
Nasoaural canon	n-sn=sa-sba	The length of the nose is equal to the length of the ear

Table 2: Comparison of facial measurements between Indian and Malaysian women

Facial measurements	Indian		Malaysian		Mean difference	*P*
	Mean	SD	Mean	SD		
Face height (tr-gn)	167.73	6.88	175.18	4.40	7.44	0.00001*
Forehead height 1 (tr-g)	50.22	5.01	56.23	3.46	6.01	0.00001*
Forehead height 2 (tr-n)	58.83	4.36	63.39	4.79	4.55	0.0003*
Nose length (n-prn)	40.56	2.14	45.15	3.21	4.59	0.00001*
Mid face height (n-sn)	47.13	3.18	51.51	3.95	4.38	0.00001*
Lower face height (sn-gn)	45.82	5.49	49.85	4.51	4.03	0.0029*
Upper lip length (sn-ls)	12.15	1.31	15.01	1.92	2.86	0.00001*
Upper lip thickness (ls-st)	6.54	0.70	7.88	1.03	1.34	0.0001*
Lower lip thickness (st-li)	8.78	1.36	11.11	1.24	2.33	0.00001*
Total lip thickness (ls-li)	15.72	1.34	18.99	1.63	3.28	0.00001*
Mouth width (ch-ch)	45.63	4.42	51.84	2.97	6.21	0.00001*
Face width (zy-zy)	121.87	5.96	130.32	7.80	8.45	0.00001*
Eye fissure width (ex-en)	36.02	2.81	34.07	3.19	1.95	0.015*
Inter fissure width (en-en)	28.62	2.23	34.76	4.97	6.14	0.00001*
Nasal width (al-al)	32.76	2.84	35.52	3.58	2.76	0.0016*
Ear length (sa-sba)	51.91	5.19	48.29	5.29	−3.62	0.0097*

*P<0.05; P values based on unpaired t-test. SD: Standard deviation

Facial profile canon

The facial profile canon was not valid in both Malaysian as well as Indian women. The forehead height was found to be greater than mid face height (tr-n>n-sn) in all Malaysian women, whereas the same was found to be true in 96% of Indian women. The forehead height was also greater than lower face height (tr-n>sn-gn) in both the groups. Midface height (n-sn>sn-gn) was found to be greater than lower face height in 56% women of both groups.

Orbital canon

The orbital canon was prevalent in 80% of Malaysian women whereas it was seen in only 16% of Indian women with $P = 0.00013$.

Orbitonasal canon

The orbitonasal canon was prevalent in 43% of Malaysian population with $P = 0.0470$ but not found in Indian women at all. The interfissure width was lesser than nasal width (en-en<al-al) in all Indian women.

Nasooral canon

The nasooral canon was not seen in either women group.

Nasofacial canon

The nasofacial canon too was not seen in either women group.

Nasoaural canon

The nasoaural canon was prevalent in 73% of Malaysian and 33% of Indian women with $P = 0.0068$.

Discussion

Facial features change with origin, ethnicity, and culture. Many anthropometric studies have been carried out in various ethnic groups to analyze and measure the facial proportions. Farkas *et al*. conducted an anthropometric study of facial morphology across 25 countries among various ethnic groups where the North American women population was used as the reference group. More similarities were found between European Caucasians and North Americans and between Asians and Africans.[1]

In the present study, facial analyses of Indian and Malaysian women were carried out. The total face height and forehead height was found to be more in Malaysian women. The nose was slightly longer and broader and lips thicker in Malaysian women. The inter fissure width was significantly more in Malaysian women than in Indian women. The eyes and ears were smaller and face wider in Malaysian women as compared to Indian women.

Husein *et al*. carried out anthropometric and esthetic analyses on Indian American women (IAW) and North American white women (NAWW). The study revealed that facial measurements in IAW were much different from NAWW with larger and wider set eyes, a smaller midface, and a smaller nose with greater tip rotation, smaller ears, and a larger mouth. Attractive IAW displayed many measurements typical of average IAW and several measurements that reflect average NAWW values.[7]

Table 3: Prevalence of neoclassical canons

Neoclassical canons	Indians	Percentage	Malaysians	Percentage	*P*
Facial profile canon					
tr-n=n-sn=sn-gn	0	0.00	0	0.00	
tr-n=n-sn	0	0.00	0	0.00	0.2361
tr-n>n-sn	29	96.67	30	100.00	
tr-n<n-sn	1	3.33	0	0.00	
n-sn=sn-gn	1	3.33	0	0.00	0.5945
n-sn>sn-gn	17	56.67	17	56.67	
n-sn<sn-gn	12	40.00	13	43.33	
tr-n=sn-gn	0	0.00	0	0.00	1.0000
tr-n>sn-gn	30	100.00	30	100.00	
tr-n<sn-gn	0	0.00	0	0.00	
Orbital canon					
en-en=ex-en	5	16.66	24	80.00	0.00013*
en-en>ex-en	2	6.00	5	16.66	
en-en<ex-en	23	76.66	1	3.00	
Orbitonasal canon					
en-en=al-al	0	0.00	13	43.33	0.0470*
en-en>al-al	0	0.00	3	10.00	
en-en<al-al	30	100.00	14	46.66	
Nasooral canon					
ch-ch=1.5(al-al)	0	0.00	0	0.00	0.2789
ch-ch>1.5(al-al)	13	43.33	8	26.67	
ch-ch<1.5(al-al)	17	56.67	22	73.33	
Nasofacial canon					
al-al=1/4(zy-zy)	0	0.00	0	0.00	1.0000
al-al>1/4(zy-zy)	22	73.33	22	73.33	
al-al<1/4(zy-zy)	8	26.67	8	26.67	
Nasoaural canon					
n-sn=sa-sba	10	33.33	22	73.33	0.0068*
n-sn>sa-sba	1	3.33	0	0.00	
n-sn<sa-sba	19	63.33	8	26.67	

*$P<0.05$. *P* values based on two-tailed Fisher exact test

Choe *et al*. carried out anthropometric analysis on Korean American women's face (KAW). The study concluded that KAW facial anthropometric measurements were very different from NAWW, but the attractive KAW facial features reflected many similar features of NAWW face, and it was also found that neoclassical canons were not valid in KAW population.[12]

The neoclassical canons dominated the Western art during the renaissance era. In the 20th century, anthropometrist Farkas, *et al.* challenged the classical canons by measuring the facial proportions of 200 North American Caucasians women. The study concluded that some of the canons are nothing more than artistic idealizations.[4,10] However, the esthetic guidelines are still based on these canons.[12]

In this study, the prevalence of neoclassical canon was assessed for Indian and Malaysian women. However, neither Indian nor Malaysian women exhibited facial profile canon. Orbital canon was observed in 80% of Malaysian women, whereas only 16% of Indian women showed this feature. The variant of orbital canon en-en < ex-en was observed in 76% of Indian women. Orbitonasal Canon was seen in 43% Malaysian women, however, it was not found in a single Indian woman. The variant of orbitonasal canon en-en < al-al was observed in all the Indian women.

The nasooral canon was found neither in Indian nor Malaysian women. The variant of nasooral canon ch-ch < 1.5 (al-al) was observed in 56% of Indian women and 73% of Malaysian women. Nasofacial canon was not witnessed in both the

population. The variant of nasofacial canon al-al >¼ (zy-zy) was observed in 73% of both the females.

Nasoaural canon was prevalent in 73% of Malaysian women. The variant of nasoaural canon (n-sn<sa-sba) was observed in 63% of Indian women.

Wang *et al*. compared the validity of neoclassical canons of facial proportion in Chinese and North American Caucasians population. The study revealed that horizontal measurements were significantly greater in Chinese population with wider intercanthal distance, short palpebral fissure, wider nose, and a small mouth width; and forehead height greater than the lower face.[2]

Steinbichler Comet LED 3D scanner was used in this study for scanning subjects. It is a noninvasive, safe procedure and does not require physical contact with the subjects. Toth and Zivcak compared outputs of the Steinbichler Comet LED 3D optical scanner and the creaform EXAscan laser scanner; and concluded that the scanners using white light (Comet, Atos) have greater accuracy than other types of 3D scanners.[21]

In the present study, the realistic values of face that could be beneficially used in orthodontic, orthognathic, and reconstructive surgeries of face were established successfully. The validity of the five facial canons was assessed in both Indian and Malaysian women. Only two out of the six canons were prevalent in Malaysian women whereas the Indian women exhibited none of them.

Conclusions

The study showed variation in all the facial measurements in Indian and Malaysian women. The realistic values for facial measurements of both the groups were successfully established. The same can be used in diagnosis and treatment planning in various dental procedures. The prevalence of orbital, orbitonasal, and nasoaural canons was more in Malaysian women. Though some of these canons provide valuable guidelines in the esthetic analysis of face, complete reliance on these canons is not justifiable. Neoclassical canons are more of an artistic idealizations rather than realistic values.

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