

Orbitofacial assessment of Indian Americans and its significance—an anthropometric study

Abstract

Background: For the perception of facial attractiveness, the orbital region in the face acts as a key determinant factor. The Orbitofacial measurements vary with sex and race. Orbital region in the face is one of the most important regions in plastic, reconstructive and ophthalmic surgery and anthropometric evaluation. There are no reports available on the Orbitofacial anthropometry in Indian American population.

Objectives: The objectives of the study were to determine the normal average values of linear measurements of the orbital and eyebrow regions and to determine any significant sex differences that exist in the Indian American students of American University of Antigua (AUA), Antigua.

Methods: The direct orbitofacial anthropometric measurements (orbital and eyebrow linear measurements, height of the orbit to the length of the eye fissure ratio and canthal index) were carried out using digital caliper in 100 men and 100 women Indian American students (18 to 30 years) of AUA, Antigua and compared between sexes.

Results: The orbital and eyebrow linear measurements of Indian American men showed higher value when compared to women. Outer canthal distance, inner canthal distance and thickness of the eyebrow showed statistically significant sexual difference. The palpebral fissure width, height of the orbit and inter eyebrow distance showed no statistical significant sexual difference. Height of the orbit to length of the eye fissure ratio and Canthal index were calculated and showed higher value in men when compared to women.

Conclusion: The Orbitofacial anthropometric data obtained in the present study can be used as a reference value for Indian Americans and can be made use in diagnostic procedures, designing of products like optical spectacle frames and lenses, surgical procedures and also in studies involving facial attractiveness.

Keywords: orbitofacial, anthropometry, palpebral fissure, eyebrow, digital calliper

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Abbreviations: AUA, american university of antigua; USA, united states of america; LCD, liquid crystal display; EX, exocanthion; EN, endocanthion; OR, orbitale; OS, orbitale superius; ME, medial end of the eyebrow; PFW, palpebral fissure width (en-ex); OCD, outercanthal (biorbital) distance (ex-ex); ICD, intercanthal distance (en-en); IB, interbrow distance; TE, eyebrow thickness

Introduction

The facial birth defects, injuries or any disorders can affect the facial dimensions. Anthropometry technique is widely used to analyze facial morphology in the field of medicine. The challenge for surgeons is to maintain appropriate ethnic facial features. For the perception of the facial attractiveness, the orbital region in the face acts as a key determinant factor. In the field of facial anthropometry, Farkas¹ has done the research extensively in many ethnic groups.¹ Facial morphometry is well discussed in Caucasians¹ and African Americans² but, only a limited number of studies exist for Asian Americans.³ The Orbitofacial measurements and contours vary with sex and race.⁴⁻⁶ Results of the studies conducted in certain ethnic groups or regions may not be applicable to the populations elsewhere.⁷ Therefore there is a need for systematic study for each ethnic groups or region. There are very few anthropometric studies that have dealt with different migrant ethnic groups in the United States of America (USA). Indian Americans are the second-fastest growing ethnic group in the USA. Most of the studies on Orbitofacial anthropometric

measurements in the USA have been done in Caucasians and therefore may not be applicable for Indian Americans. Therefore, in recent years, anthropometric studies have been conducted in different racial/ethnic groups to establish a normative database.⁵ Orbital anthropometric data specific to Indian Americans will be useful if in case they need to undergo orbitofacial surgeries. It is desirable that studies should be carried out in different ethnic groups to establish normal reference values on different anthropometric measurements. A few studies have been conducted on orbitofacial anthropometry in Indian populations within India.⁸⁻¹⁵ But, the available literature search shows a study performed by Husein et al.¹⁶ dealing only with 100 Indian American Women face by using photographs. However, there are no reports available on the orbitofacial anthropometry in Indian American population. Orbital region in the face is one of the most important regions in plastic, reconstructive and ophthalmic surgery and anthropometric evaluation. Hence, the aim of the present study was to determine the normal average values of orbital and eyebrow liner measurements in Indian Americans, and if there are any significant differences existing in the measurements among the sexes.

Materials and methods

Subjects

The study group consisted of 100 Indian American students of American University of Antigua (AUA), Antigua, with equal number

of males and females. The age of the subjects ranged from 18-30 years. This study was approved by AUA ethics committee. The subjects with previous history of developmental and neurological defects of orbito-facial region, cosmetic treatment of orbito-facial region, cranio-facial trauma, surgery and bi-racial ethnic origins were excluded in this study. This study was funded by School of Medicine, AUA, Antigua. The study was explained and the standard informed consent was obtained from the participants prior to the study. The anthropometric landmarks were identified on the subjects with careful inspection and then marked on the face with black liquid eye liner (Table 1) (Figure 1).

Table 1 Anthropometric landmarks

Anthropometric landmarks		
en	endocanthion	Internal commissura of the eye fissure
ex	exocanthion	external commissura of the eye fissure
or	orbitale	the lowest point on the lower edge of the cranial orbit
os	orbitale superius	highest point on the lower border of the eyebrow
ME		medial end of the eyebrow

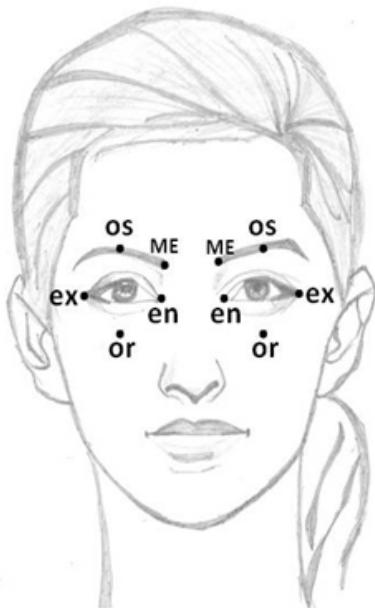


Figure 1 Photograph shows the orbital anthropometric landmarks. ex, exocanthion; en, endocanthion; or, orbitale; os, orbitale superius; ME, medial end of the eyebrow.

Landmarks (orbital & eyebrow): ex, exocanthion; en, endocanthion; or, orbitale; os, orbitale superius; ME, medial end of the eyebrow (Table 1) (Figure 1).

Position of the subjects: Subjects were asked to sit in an upright relaxed position "natural and normal" erect posture of head and shoulders, with both arms hanging free beside the trunk for the linear measurements of the face.¹

Anthropometric measurements: manual measurement (Direct method)⁸⁻¹⁰

The following measurements were done up to 0.5 degree and 0.5mm accuracy on the subjects with maximum care and comfort by using Neiko 01407A stainless steel digital caliper with extra-large LCD (liquid crystal

display) screen and instant SAE-metric (Society of Automotive Engineers) conversion, New York, USA. Every measurement was obtained thrice by the same observer. A third reading was taken if the initial two measurements showed a large discrepancy, and the two closer readings were used (Figure 2).



Figure 2 Photograph shows the sample orbital linear measurement by using digital caliper.

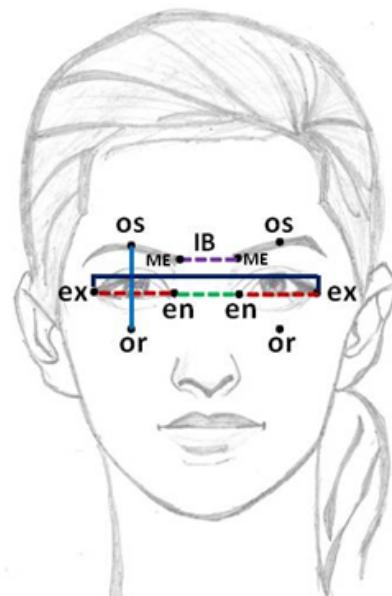


Figure 3 Photograph shows the anthropometric orbital linear measurements. Palpebral fissure width (PFW) (en-ex); Height of the orbit (os-or); Outercanthal (biorbital) distance (OCD) (ex-ex); Intercanthal distance (ICD) (en-en); Interbrow distance (IB); Eyebrow thickness (TE).

Linear distances (unit:mm): The following measurements were taken bilaterally and compared (right & left side) (Figure 3).

Orbital linear distances (unit:mm):

a. Palpebral fissure measurements

- Palpebral fissure width (PFW) → (en-ex)
- Height of the orbit (os-or)

b. Canthal (medial and lateral) distances

- Outercanthal (biorbital) distance (OCD) → (ex-ex)
- Intercanthal distance (ICD) → (en-en)

c. Ratios (unit: percentage)

- Height of the orbit to length of the eye fissure ratio (os-or/en-ex $\times 100$);
- Canthal index was calculated as ICD/OCD $\times 100$.

Eyebrow linear distances (unit:mm): Interbrow distance (IB) Eyebrow thickness (TE) (bilateral).

Statistical analysis

Data was collected and analyzed in accordance with the current law about personal data and privacy. The statistical analysis was performed using “Graph pad instat” (Version 3.06, Graph pad Software Inc.), San Diego, CA. The orbital and eyebrow linear distances were presented

as range, mean and standard mean of error (SEM). Right and left side mean linear distances were compared by using “paired *t*-test”. The orbital and eyebrow linear distances were compared between sexes by using “Independent *t* test”. Values of $p < 0.05$ were considered as significant.

Results

The range, mean and standard error of mean (SEM) of left and right orbital and eyebrow linear anthropometric measurements of Indian Americans are shown in Table 2 & 3. In this study, the difference between the right and left side measurements were not significant; hence the mean values of right and left were taken together and compared between the sexes by using “independent *t* test” shown in Table 4.

Table 2 Comparison of orbital measurements in men (mm) (n=100)

No	Measurements	Right		Left		Average	p value
		Range	Mean(SEM)	Range	Mean(SEM)		
1	Palpebral Fissure Width(en-ex)	29.5 - 44	36.16(0.329)	29 - 44	36.01(0.334)	36.08	0.0015*
2	Height of the Orbit(os-or)	33 - 59	45.93(0.607)	32 - 59	45.96(0.609)	45.95	0.665
3	Ratio -(os-or/en-ex) $\times 100$	97.73 - 166.7	127.4(1.616)	100 - 166.7	128(1.600)	127.7	0.0394*
4	Eyebrow Thickness(TE)	15-Jul	12.36(0.315)	15-Jul	12.40(0.312)	12.38	0.407

(os-or/en-ex) $\times 100$ - Height of the orbit to length of the eye fissure ratio; SEM - standard error of mean; *- significant; $p < 0.05$ were considered as significant

Table 3 Comparison of orbital measurements in women (mm) (n=100)

No	Measurements	Right		Left		Average	p value
		Range	Mean(SEM)	Range	Mean(SEM)		
1	Palpebral Fissure Width(en-ex)	30 - 47	35.59(0.345)	29 - 47	35.45(0.358)	35.52	0.0443*
2	Height of the Orbit(os-or)	35 - 55	44.13(0.495)	34.50 - 54	44.08(0.468)	44.1	0.6462
3	Ratio -(os-or/en-ex) $\times 100$	100 - 171.9	124.7(1.584)	100 - 163.6	125.3(1.594)	125	0.3117
4	Eyebrow Thickness(TE)	4.5 - 14	8.68(0.212)	3.5 - 14	8.665(0.213)	8.67	0.626

(os-or/en-ex) $\times 100$ - Height of the orbit to length of the eye fissure ratio; SEM - standard error of mean; *- significant; $p < 0.05$ were considered as significant

Table 4 Descriptive statistics of orbital measurements in sexes (mm) (n=100)

No	Measurements	Men		Women			
		Range	Mean(SEM)	Range	Mean(SEM)		
1	outer Canthal Distance(ex-ex)	89 - 117	102.9(0.545)	85 - 111	99.84(0.580)		
2	inter Canthal Distance(en-en)	25 - 39	32.74(0.407)	22.5 - 40	31.33(0.309)		
3	Canthal Index -(en-en/ex-ex) $\times 100$	26.18 - 37.14	31.77(0.260)	26.47 - 37	31.35(0.208)		
4	Inter Eyebrow Distance(IB)	Aug-32	19.28(0.527)	11.50 - 29	19.26(0.358)		

(en-en/ex-ex) $\times 100$ - canthal Index; SEM-standard error of mean

Comparison of palpebral fissure by sex

The palpebral fissure width (en-ex) ($p=0.4034$) and height of the orbit (os-or) ($p=0.506$) in the Indian Americans showed no statistical significant sexual difference. Height of the orbit to length of the eye fissure ratio (os-or/en-ex $\times 100$) was calculated and showed higher value in men when compared to women.

Comparison of canthal distances by sex

The outer canthal distance (ex-ex) ($p=0.0006$) and inner canthal distance (en-en) ($p=0.0040$) in the Indian Americans showed statistically significant sexual difference in this study. Canthal index

was calculated (en-en/ex-ex $\times 100$) and showed higher value in men when compared to women.

Comparison of eyebrow measurements by sex

The thickness of the eyebrow (TE) ($P=0.0001$) in Indian Americans showed statistically significant sexual difference, whereas the inter eyebrow distance (IB) ($p=0.9812$) was not statistically significant.

Discussion

The Orbitofacial anthropometric study plays important role in clinical practice for evaluation and surgical treatment of cranio-facial

deformities. It has been reported that anthropometric measurements may vary based on gender, race, dietary habits, climates and the surrounding environments.⁴ The normal morphological and functional values of the periorbital features are varied according to sex and race.^{5,6} Kunjur et al.⁵ suggested that the aesthetic standards of a particular group may not suit other patients belonging to diverse racial and ethnic background.⁵ In the present study, palpebral fissure, canthal distances, eyebrow thickness and inter eyebrow distances were evaluated and compared between the sexes. We also compared our data with Caucasians and Indian American Woman's studies revealed variations and similarities in certain key parameters. The compilation of orbital measurements in Indians, Indian Americans and Caucasians

are summarized in Table 5 & 6. In the present study, Indian American men have higher values when compared with women in orbital and eyebrow measurements. In the present study, Palpebral fissure width in Indian Americans did not show statistical significant sexual difference (males: 36.08mm; females: 35.52mm). Present study's palpebral fissure width was higher in both sexes when compared with previous reports of Indian and Caucasian population (Table 6).^{1,5,9-11,16,20-22} Husein et al.¹⁶ photographic measurement on Palpebral fissure width in female Indian American (30.6mm) and North American Caucasian (31.3) showed lower value when compared with present direct anthropometric study (35.52).

Table 5 Comparison of orbital measurements by sex using "independent t test"

S. no	Measurements	Average	Right side	Left side
		p value	p value	p value
1	Palpebral Fissure Width(en-ex)	0.4034	0.2326	0.254
2	Height of the Orbit(os-or)	0.506	0.0226*	0.0156*
3	Outer Canthal Distance(ex-ex)	0.0006*		
4	Inter Canthal Distance(en-en)	0.0040*		
5	Eyebrow Thickness(TE)	0.0001*	0.0001*	0.0001*
6	Inter Eyebrow Distance(IB)	0.9812		

* - significant; p<0.05 were considered as significant

Table 6 Compilation of orbital measurements in Indians, Indian Americans and Caucasians(mm)

Authors	Population	(en-ex)		(en-ex)		(en-en)	
		M	F	M	F	M	F
Farkas et al. ¹	Indians	30.2	31.3	98.8	97.5	34.1	30.9
Kunjur et al. ⁵	Indians	30.3	28.2			31.4	31.1
Kunjur et al. ⁵	Caucasians	27.6	27.5			32.7	33.3
Packiriswamy et al. ⁹	Malaysian Indians	30.91	29.62	97.15	91.78	34.1	32.77
Vasanthakumar et al. ¹⁰	South Indians	31.08	29.9	95.55	92.44	34.27	33.41
Agrawal et al. ¹¹	Indians			96.89	94.49	32.2	31.9
Husein et al. ¹⁶	Indian American Woman			30.6			31.2
Farkas et al. ¹⁷	Caucasians	31.2	30.7	89.4	86.8	32.9	31.6
Price et al. ¹⁸	Caucasians	26.7	27.2				
Jagdish Chandra et al. ¹⁹	Indians			101.1	99.12	33.16	32.08
Present study	Indian Americans	36.08	35.5	103	99.8	32.7	31.33

Palpebral fissure width (PFW) (en-ex); Outercanthal (biorbital) distance (OCD) (ex-ex); Intercanthal distance (ICD) (en-en); M, male; F, female

Bashour²³ stated that eyebrows are the most important features of the face for sexual dimorphism and facial recognition.²³ In the present study, eyebrow thickness showed statistical significant sexual difference (men: 12.38mm; women: 8.67mm). Packiriswamy et al.⁹ study (men: 7.85mm; women: 6.37mm) on Indians and Sclafani and Jung²⁴ study on Caucasians showed lower value when compared with present study on Indian Americans (men: 12.38mm; women: 8.67mm). Men with thick and flat eyebrows are linked to perception of dominance and sexual dimorphic feature.²⁵ But, there was no significant sexual differences found in inter eyebrow distance (men: 19.28mm; women: 19.26mm). In the present study, height of the orbit in Indian Americans did not show statistical significant sexual difference (males: 45.95mm; females: 44.1mm). We could not find the studies on Indian and Indian American population for the comparison.

Studies using direct anthropometry and photogrammetric analyses in Caucasian and Asian populations found variations in Orbitofacial features, with the width of the eyes often being either less than or greater than the Intercanthal distance.^{26,27} In the present study, Outercanthal and Intercanthal distances were higher in men (102.9mm; 32.74mm) when compared with women (99.84mm; 31.33mm). Outercanthal and Intercanthal distances of the present study are similar to the studies conducted on Indian population.^{1,5,9-11,16,20-22} Outercanthal and Intercanthal distances are used in assessment of hypertelorism. In the present study, mean value of Intercanthal distance in both sexes follows Caucasians norm. We also calculated the height of the orbit to length of the eye fissure ratio and canthal index. This method is time consuming and it necessitates very well trained and experienced examiners. It is very demanding for both the clinician and the patient.

Conclusion

The present study's Orbitofacial anthropometric data can be used as a reference value for Indian American which can be made use of if they need to undergo Orbitofacial surgeries. The Orbitofacial anthropometric data on Indian Americans would be useful for wide range of fields like ophthalmology, plastic and reconstructive surgical procedures (ocular prosthetics, Blepharoplasty), diagnostic procedures, designing of products like optical spectacle frames and lenses, and studies involving facial attractiveness.

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Conflict of interest

Author declares that there is no conflict of interest.

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