Research Article
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Facial proportions of Indian Americans and its clinical applications

Abstract

Introduction: All humans have same features in the face. But, their proportions and relationships vary one face from another even within the group or race. The balance and harmony of various facial features are essential to the surgeon who requires facial analysis in the diagnosis and treatment planning. Facial proportions are well discussed in western populations, but only a limited number of studies exist for Asian Americans.

Objectives: To determine the normal average horizontal facial proportions, to determine the proportions of lowerface height and to determine any significant sex differences that exist in the Indian American students of American University of Antigua (AUA), Antigua.

Methods: The direct anthropometric measurements (horizontal thirds of the face and proportions of lowerface height) were carried out using digital caliper in 100 men and 100 women Indian American students (18-30years) of AUA, Antigua and compared between sexes.

Results: The Midface height and lowerface height were higher in men than women whereas the forehead height was higher in women compared to men. The Midface height was higher than the lowerface and forehead heights in both sexes. The forehead, Midface and lowerface heights showed statistically significant sexual difference. The upper one third and the lower two third of the lowerface height proportions were significant sexual difference.

Conclusion: Facial proportions are considered as ideal silhouette to facilitate the surgeon with facial analysis and add a quantifiable dimension to perioperative assessment in surgical facial treatments. The facial proportions data obtained in the present study can be used as a reference value for Indian Americans which can be made use of if they need to undergo facial surgeries in the United States of America (USA).

Keywords: facial anthropometry, facial proportion, forehead height, midface height, lower face height

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Abbreviations: USA, unites states of america; AUA, american university of antigua; LCD, liquid crystal display; SAE, society of automotive engineers; CA, california; SEM, standard error of mEAN; ANOVA, one-way analysis of variance; M, male; F, female

Introduction

Humans grasp the spatial relationship of the face in memory more readily than the individual features. The most important factor for likeness and individuality, thus leading to facial recognition, is proportion. Proportion means the relationship of one part to another or to the whole.[1] We all have same features in the face. But, their proportions and relationships vary from one face to another within the group or race.[2] Proportion of the facial height is observable where hairline to the eyebrows, eyebrows to base of the nose, base of the nose to below chin are equal. Lower facial height is further divided into upper one-third and lowers two-thirds.[3–5] Facial thirds of Leonardo are simple and adequate for evaluation of many patients.[6] In the available literature survey, the study on Caucasians face shows the lower third is greater than the middle and upper thirds, the upper third is more than the middle third.[7] In East Asians, the middle third is greater than the upper third and equal to the lower third.[8] In Indian population lower third of face is greater than middle third.[9] It is desirable that studies should be carried out in different ethnic groups to establish normal reference values on different anthropometric measurements. There are very few anthropometric studies that have dealt with different migrant ethnic groups in the USA. Indian Americans are the second-fastest growing ethnic group in the United States. The balance and harmony of various facial features are essential to facilitate the surgeon who requires facial analysis in the diagnosis and treatment planning. Most of the studies on anthropometric measurements in the USA have been done in Caucasians and therefore may not be applicable for Indian Americans. Anthropometric data specific to Indian Americans will be useful if in case they need to undergo facial surgeries. Various researches shows contradicting result and hence the aim of the present study was to determine the normal average horizontal facial proportions, to determine the proportion of lowerface height and to determine any significant sex differences that exist in the Indian American students of American University of Antigua (AUA), Antigua.

Materials and methods

Subjects

The study group consisted of 200 Indian American students of American University of Antigua (AUA), Antigua, which included 100 men and 100 women. 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 facial region, cosmetic treatment of 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 forms were collected 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 (Table1) (Figure 1).

Table 1 Anthropometric land marks

tr	trichion	on the hairline in the middle of the forehead
g	glabella	the most prominent midline point between the eyebrows
sn	subnasale	midpoint at the union of the lower border of the nasal
		septum and the upper lip
st	stomion	midpoint of the horizontal labial fissure
gn	gnathion	lowest median point on the lower border of the mandible

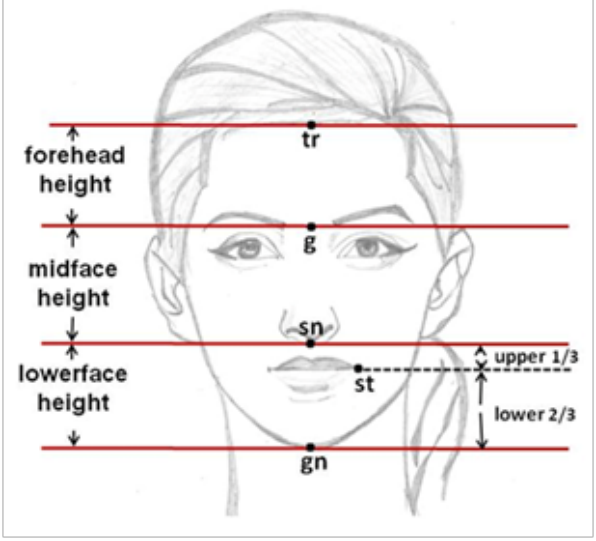

Figure 1 Photograph shows the anthropometric landmarks, facial height proportions and lowerface height proportions. Tr, trichion; g, glabella; sn, subnasale; st, stomion; gn, gnathion.

A. Facial height proportions: Forehead height (tr-g); Midface height (g-sn); Lower face height (sn-gn).

B. Lowerface height proportions: Lower face height (upper 1/3) (sn-st); Lowerface height (lower 2/3) (st-gn).

Position of the subjects10

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

Anthropometric measurements Manual measurement (Direct method)11

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).

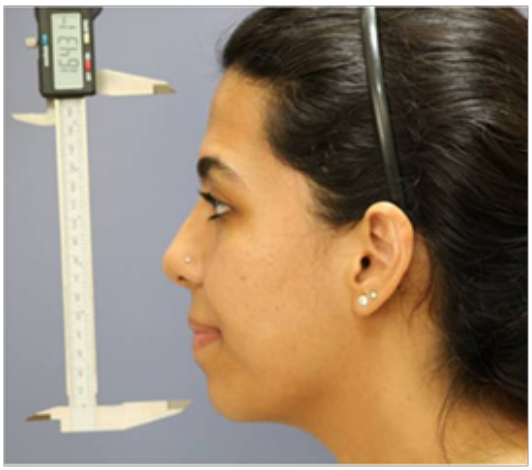

Figure 2 Photograph shows the sample facial linear measurement by using digital caliper.

Linear distances (unit:mm):

The following linear distances were measured and compared.

i. The horizontal thirds of the face (Figure 1)

ii. Upper third (forehead height (tr-g))

iii. Middle third (midface height (g-sn))

iv. Lower third (lowerface height (sn-gn))

v. The proportion of lowerface heights were measured and compared (Figure 1)

vi. Upper one third of lowerface height (sn-st)

vii. Lower two third of lowerface height (st-gn)

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. Descriptive statistics of facial proportions were presented as range, mean and standard mean of error (SEM). For comparison of horizontal thirds of the face, One-way analysis of variance (ANOVA) followed by "post hoc test", e.g. Bonferroni's test was used. Facial proportions were compared between sexes by using "Independent *t* test". Values of $p<0.05$ were considered as significant.

Results

Descriptive statistics of the face horizontal thirds

The horizontal thirds of the face and proportion of the lower face heights were shown in Figure 1. Upper third (forehead height (tr-g)), middle third (Midface height (g-sn)) and lower third (lower face height (sn-gn)) were obtained during the study. The range, mean and SEM was calculated and compared (Table 2). The midface height and lowerface height were higher in men than women whereas the forehead height was higher in women compared to men. The midface height was higher than lowerface height and forehead height in both sexes. The forehead height was lower than lowerface height and midface in both sexes (Table 2).

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Table 2 Descriptive statistics of the face horizontal thirds in Indian Americans

Measurements in millimetre(mm)	Number		Men			Women		
	Men	Women	Mean(SEM)*	Min.	Max.	Mean(SEM)	Min.	Max.
Forehead height(tr-g)	100	100	51.95(0.792)	36	66	54.23(0.758)	38	73
Midface height(g-sn)	100	100	65.67(0.394)	55	76	61.33(0.411)	51	70
Lower face height(sn-gn)	100	100	63.83(0.592)	50	77	56.72(0.485)	46	71

SEM, standard error of mean; Min, minimum; Max, maximum

Comparison of the face horizontal thirds within men and women

The face horizontal thirds of Indian American men were compared using ANOVA followed by "post hoc test" (Bonferroni's multiple comparison test). In men, forehead height and midface height ($p<0.001$), forehead height and lowerface height ($p<0.001$) showed statistically significant difference. Midface height and lowerface height ($p>0.05$) showed no significant difference (Table 3). The face horizontal thirds of Indian American women were compared using ANOVA followed by "post hoc test" (Bonferroni's multiple comparison test). In women, forehead height and midface height ($p<0.001$), forehead height and lowerface height ($p<0.001$), midface height and lowerface height ($p<0.001$) showed statistically significant difference (Table 4).

Table 3 Indian American men face horizontal thirds comparison using ANOVA followed by "post hoc test" (Bonferroni's multiple comparison test)

No	Group(A)	Group(B)	Mean difference(A-B)	p-value
1	FHH	MFH	-13.72*	p<0.001
2	FHH	LFH	-11.88*	p<0.001
3	MFH	LFH	1.85	p>0.05

Comparison of the face horizontal thirds between sexes

Indian Americans (men and women) face horizontal thirds were compared by using Independent t test. The forehead height, midface height and lowerface height showed statistically significant sexual difference ($p<0.001$) (Table 5).

Table 4 Indian American women face horizontal thirds comparison using ANOVA followed by "post hoc test" (Bonferroni's multiple comparison test)

No	Group(A)	Group(B)	Mean difference(A-B)	p-value
1	FHH	MFH	-7.12*	p<0.001
2	FHH	LFH	-2.49*	p<0.01
3	MFH	LFH	4.61*	p<0.001

*Significance; FHH, forehead height; MFH, mid face height; LFH, lower face height

Descriptive statistics of the lowerface height proportion

The proportions of the lowerface height are shown in Figure 1. Upper one third of the lowerface height (sn-st) and lower two third of the lowerface height (st-gn) were obtained during the study. The range, mean and SEM were calculated and compared. The upper one third of the lowerface height and the lower two third of the lowerface height were higher in men than women (Table 6).

Table 5 Comparison of face horizontal thirds in Indian Americans by sexes using "Independent t test"

Measurements in millimetre(mm)	Number		p value	95% CI	
	Male	Female		lower	upper
Forehead height(FHH)	100	100	p<0.05	0.131	4.429
Midface height(MFH)	100	100	p<0.0001	-5.455	-3.225
Lowerface height(LFH)	100	100	p<0.0001	-8.605	-5.605

CI–confidence interval

Comparison of the lowerface height proportion between sexes

The upper one third of the lowerface height and the lower two third of the lowerface height were compared using Independent t test which showed statistically significant sexual difference ($p<0.001$) (Table 6).

Table 6 Comparison of lowerfacial height (LFH) proportion in Indian Americans by sexes using "Independent t test"

(mm)	Lowerfacial height upper 1/3(sn-st)		Lowerfacial height lower 2/3(st-gn)	
	Men	Women	Men	Women
p value	p<0.0001		p<0.0001	
mean difference	2.225*		4.88*	
Mean	21.42	19.19	42.41	37.53
SEM	0.346	0.304	0.432	0.469
Minimum	14	13.5	33	27.5
Maximum	27	25.5	54.5	52
Lower 95% CI	20.73	18.59	41.55	36.6
Upper 95% CI	22.1	19.79	43.27	38.49
Number	100	100	100	100

*Significance; SEM, standard error of mean; CI, confidence interval

Discussion

Comparison of the present study with other studies on Indian population revealed variations and similarities in the facial measurement. The facial proportions and contours vary with sex and race. Lombardi emphasized the importance of the facial proportion.[12] Variations in the facial morphology arise through number of factors which include sex, race, dietary, climate, and environment where we live.[13] Results of the studies conducted in certain ethnic groups or regions may not be applicable to the populations elsewhere. Therefore

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there is a need for systematic study for each ethnic groups or region.[14] In our study, the forehead height is greater in women (54.23) than men (51.95). Husein et al.[15] photographic study on forehead height in Indian American women (54.2) and Farkas et al.[10] study on North American Caucasian women (52.7) were similar to the present study. Persons look in a face depends on the correctness of the proportions of the features within the midface area.[2] In our study, the midface height in men (65.67) is higher than the women (61.3). Husein et al.[15] photographic study on the midface height of Indian American women (58.1) showed lower value and Farkas et al.[10] study showed higher value in North American Caucasian women (63.1) compared to the present study. In East Asians, the midface height was greater than the forehead height and equal to the lowerface height.[8] Jain et al.[9] study on Indian population showed midface height was lower than lowerface height. According to Mack[16] the facial appearance is significantly influenced by the lowerface height. Lowerface height and lowerface height proportions (upper 1/3 and lower 2/3) of the Indians and Indian Americans are summarized in Table 7.[15,17–21] In our study, the lowerface height in men (63.83) is higher than the women (56.72). The studies performed by Farkas et al.[10] showed similar values for both Indian men (62.7) and women (57.2) and higher values for both North American Caucasian men (71.9) and women (65.5). In the available literature survey, the study on Caucasians face showed the lowerface height was higher than the mid and forehead heights, the forehead height was higher than the midface height.[7] In contrast, the two studies performed by Sinojiya et al.[18] on Indian women (55.13) and Husein et al.[15] study on Indian American women 957.8) showed similar values compared to the present study (57.2).

Table 7 Compilation of lower 1/3rd of the face and it's proportions in Indian American population.

Study	Population	LFH		LFH–upper1/3rd		LFH-lower2/3rd	
		Men	Women	Men	Women	Men	Women
Husein et al.[15]	Indian American		57.8				
Abraham et al.[17]	South Indian	69.23	62.82				
Sinojiya et al.[18]	South Indian	58.88	55.13	17.83	16.93	39.87	37.6
Upadhyay et al.[19]	North Indian	73.31	66.5	22.75	20.78	50.63	45.79
Jagadish Chandra et al.[20]	South Indian	54.54	59.12				
Kalha AS et al.[21]	South Indian	72.4	63.13				
Present study	**Indian American**	**63.83**	**56.72**	**21.42**	**19.19**	**42.41**	**37.53**

LFH-lower face height

Jain et al.[9] study on Indian population showed lowerface height was greater than midface height. Whereas, In the present study, Indian American men have higher values compared to women. Also, the midface height is higher than the lower and forehead height; the lowerface height is higher than the forehead height. This facial proportions variation may be due to the effect of climate, dietary, and environment changes in USA compared to India. According to Reyneke study,[22] in the well-balanced lower third of the face, the upper lip makes up one-third, whereas the lower lip and chin comprises the lower two-thirds. These distances and divisions in the lower third of the face are one of the most important in the evaluation of facial beauty. In our study, the upper one third of lowerface height and lower two third of lower facial height proportions were higher in men (21.42 and 42.41) than women (19.19 and 37.53). A study on upper one third of lowerface height proportions performed by Upadhyay et al.[19] showed similar values for both Indian men (22.75) and women (20.78) where as Sinojiya et al.[18] showed lower values for both Indian men (17.83) and women (16.93) compared to the present study. A study on lower two third of lower facial height proportions performed by Upadhyay et al.[19] showed higher values for both Indian men (50.63) and women (45.79) whereas Sinojiya et al.[18] showed similar value for Indian women (37.60) and higher value for Indian men (45.79) compared to the present study. The significant difference in facial proportions between men and women might be indications to increase or decrease face height during surgical procedures.[17] Analysis of facial proportions is necessary in the fields of medicine and dentistry, especially specialists like plastic surgeons, facial surgeons, and orthodontists.[23] The facial proportions presented thus far are adequate evaluation of many patients. The advent of digital techniques (indirect anthropometry) for the imaging of the facial skeleton can be combined with direct anthropometry. When a more detailed analysis of facial contour is required surgeon can proceed to hard-tissue cephalometrics, soft-tissue cephalometrics and 3-dimentional method.

Conclusion

The aesthetic surgeons must know the average and ideal facial proportions when they apply to the Indian American patients so that surgical procedures can be performed with the goal in mind of achieving an attractive and harmonious appearance. With this information, the surgeon should educate the patient on the role of facial proportions in aesthetics, discuss the most appropriate measures, and tailor a plan to achieve the best results. Once there is an understanding of the importance of proportion in facial aesthetics, the proposed surgical plan is usually more acceptable, even if it deviates from the patient's initial requests. The facial proportions data obtained in the present study can be used as a reference value for Indian Americans which can be made use of if they need to undergo facial surgeries in the USA.

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Conflict of interest

Author declares that there is no conflict of interest.

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