Original Article

Vertical and horizontal proportions of the face and their correlation to phi among Indians in Moradabad population: A survey

Shruti Anand, Siddhi Tripathi[1], Anubhav Chopra[2], Karan Khaneja[3], Swatantra Agarwal[4]

B.D.S, M.D.S (Prosthodontics and Implantology), Delhi, [1]Senior Lecturer, Department of Prosthodontics and Crown and Bridge, Kothiwal Dental College and Research Centre, Moradabad, Uttar Pradesh, [2]B.D.S, M.D.S (Prosthodontics and Implantology), Delhi, [3]Senior Lecturer, Department of Conservative Dentistry and Endodontics, I.T.S Dental College, Hospital and Research Centre, Greater Noida, Uttar Pradesh, [4]HOD and Principal, Department of Prosthodontics and Crown and Bridge, Kothiwal Dental College and Research Centre, Moradabad, Uttar Pradesh, India

Abstract

Purpose: The purpose was to examine the existence of divine proportions among the Indian faces in Moradabad population.

Materials and Methods: Totally, 100 patients (50 males; 50 females) aged 25-45 years were selected for the study. All facial photographs were analyzed based on the method of Ricketts assessing the divine proportions in vertical and transverse facial planes. Six horizontal and seven vertical ratios were determined, which were then compared with the phi ratio.

Results: The horizontal ratio results showed that three male and female ratios were not significantly different from each other ($P > 0.05$), and interchilion/nose width ratio was highly significant ($P < 0.001$). The horizontal mean ratios for females as well as males were highly significant from the phi ratio ($P < 0.001$) except for interchilion/interdacryon ratio, which was significant ($P < 0.05$) for females and not significant ($P > 0.05$) for males. The vertical ratio results showed that there was a highly significant difference ($P < 0.001$) for forehead height/stomion-soft menton ratio and no significant difference for two ratios between the mean ratios of males and females. All the vertical mean ratios for both the groups were highly significant ($P < 0.001$), except for the intereye-soft menton/intereye-stomion ratio, which was significant ($P < 0.05$) for female group and not significant ($P > 0.05$) for the male group.

Conclusion: Although, the golden proportion is a prominent and recurring theme in esthetics, it should not be embraced as the only method by which human beauty is measured to the exclusion of others factors.

Key Words: Dentofacial esthetics, esthetics, facial attractiveness, golden proportion, phi, Ricketts facial proportions

Address for correspondence:
Dr. Shruti Anand, D-29, Lajpat Nagar-I, New Delhi - 110 024, India. E-mail: shruti.anand19@yahoo.com
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INTRODUCTION

The face is the most important individual factor determining the physical appearance of the individuals.[1] The importance of physical and facial attractiveness, in which the smile arguably plays a major role, has been extensively reviewed and related to job recruitment decisions, initial impressions, susceptibility to peer pressure, voting and juror decisions,

and social interactions including dating decisions.[2] The esthetic outcome is also critical for patient satisfaction and, therefore, essential to the overall treatment objectives. Beauty and facial attractiveness are easy to identify but difficult to quantify. Despite its subjective nature, an attempt can be made to define, measure and explain the captivating phenomenon of beauty by describing it numerically and geometrically.[3]

The golden ratio, also known as the divine proportion, is considered by many to be the mystery of esthetics, attraction and human beauty.[4] It is denoted by the symbol **Φ** (phi) and is an irrational number of the order of 1.618033988.[4,5]

Ricketts devised a golden proportion caliper to establish and evaluate the ratios between various elements of the attractive face.[6] In 1982, he claimed to have found a large number of golden proportions after examining lateral and frontal cephalograms that were considered ideal. He also found, after examining photos of models, a number of divine ratios within the face. Ricketts therefore advocated the use of these divine proportion ratios as guides for planning orthognathic surgery. Lombardi was the first to propose the application of the golden proportion in dentistry, but he also stated, "It has proved too strong for dental use."[7] Snow stated that the concept of the golden percentage is a useful application in the diagnosis and development of symmetry, dominance, and the proportion for an esthetically pleasing smile.[8]

The theory that the phi ratio is the associated proportion that describes ideal facial beauty has been proposed at least since the age of Phidias. Although there are supporters of this theory, there are limited research studies correlating phi and ideal facial beauty.[9-11] Conflicting research outcomes have been reported for the occurrence of phi in the facial view of maxillary teeth.[12-15] Few authors stated that the occurrence of the phi ratio does not decisively determine the attractiveness through color photographs, and neither was a statistically significant golden ratio or any other continuous proportion found for the anterior teeth as a whole.[14,15]

However, in a study of 229 participants, that evaluated the proportion between the inner canthal distance and the maxillary incisor width, the phi ratio was evident.[16]

Several studies have shown the existence of the correlation between attractiveness and proportions in face measurements that approach the Golden Ratio. According to these reports, faces that have features with ratios close to the Golden Ratio are thought to be esthetically pleasing. To determine the validity of this claim, the present study was designed to verify the existence of divine proportions among the Indian faces in Moradabad population.

The null hypothesis to be tested was that there was no correlation between phi ratio and different horizontal and vertical facial reference points defined by Ricketts among Indians in Moradabad population.

MATERIALS AND METHODS

The study was conducted in Kothiwal Dental College and Research Centre, Moradabad. 100 patients (50 males and 50 females) aged 25-45 years were selected for the study. The inclusion criteria included: Orthognathic profile, a full complement of teeth in both the arches and absence of craniofacial anomalies or other pathologies and no significant skeletal asymmetry. The exclusion criteria included: Subjects with trauma, any maxillofacial surgery; apparent loss of tooth structure due to attrition, fracture, caries, or restorations; and obvious problems that could disfigure or otherwise affect the face and dentition.

Each subject was seated in a dental chair with the head upright, supported by the headrest. The individual's head was fixed in a cephalostat so that the Frankfort horizontal plane was parallel to the floor, and the midsagittal plane was aligned with the center of the camera lens. Standardized frontal view of each subject was taken using a Canon EF 85 mm f / 1.2 L II USM Lens SLR camera (Canon U.S.A., Inc., Lake Success, NY). The camera was stabilized with the help of a tripod, at a fixed distance of 36 inches.

The photographs were then cropped and adjusted to a standardized image size (5" ×4"). All photographs were made by the same investigator to ensure standardization of the procedure.

All facial photographs were analyzed based on the method of Ricketts assessing the divine proportions in vertical and transverse facial planes. The following 7 facial reference points were used [Figures 1 and 2]:

1. The lateral canthi of the eyes, located at the extreme lateral commissures of the eyelids
2. The supraorbital foramen, located at the height of the eyebrows
3. The dacryons, located at the medial commissures of the eyes and representing the junctions of the maxillary, lacrimal and frontal bones
4. The soft tissue border of the temporal, located at the most lateral points of the face
5. The lateral alae, located at the most lateral points on the rims of the wings of the nose
6. The chilions, located at the extreme lateral points at the angles of the mouth
7. The soft tissue menton (soft menton), located at the most inferior point of the face.

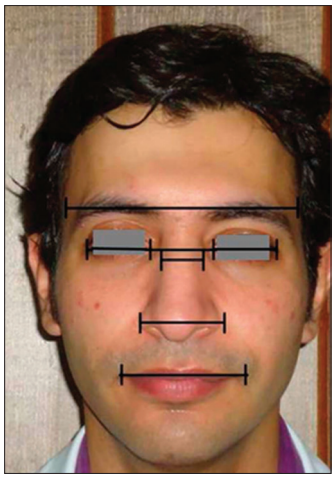

Figure 1: Landmarks and measurements for facial width analysis

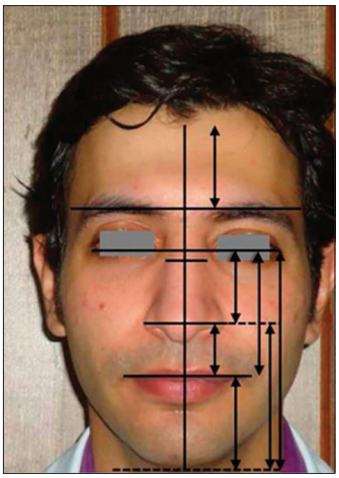

Figure 2: Landmarks and measurements for facial height analysis

Six horizontal measurements were made [Figure 1]:

1. Intercanthal: The horizontal measurement from the left lateral canthus of the left eye to the right lateral canthus of the right eye. The midpoint of the measurement was the intereye point
2. Interdacryon: The horizontal measurement between the eyes from the left dacryon to the right dacryon
3. Interalae: The horizontal measurement between the left lateral rims of the ala of the nose to the right lateral rim of the ala of the nose. The ala point was the midpoint of the line
4. Interchilion: The horizontal measurement from the left chilion to the right chilion of the mouth. The stomion was the midpoint of the line
5. Intertemporal: The horizontal measurement from the soft tissue lateral border of the left temple to the soft tissue lateral border of the right temple measured along a line that passed through the estimated location of the supraorbital foramen of the of the head
6. Nose width: The horizontal measurement of the bridge of the nose.

Ricketts' index point, the beginning of the hairline or the junction of facial and skull fascia, trichion, was considered for the vertical measurements.

Seven vertical measurements were made along the facial bisecting vertical line [Figure 2]:

1. Forehead height: Trichion to the line bisecting the intertemporal plane
2. Intereye point to soft menton
3. Intereye point to stomion
4. Intereye point to the ala point
5. Ala point to stomion
6. Ala point to soft menton
7. Stomion to soft menton.

Adobe Photoshop CS5.1 software was used for all the measurements.

Using the aforementioned measurements, different ratios were calculated in the horizontal and vertical planes, which allowed direct comparisons with the phi ratio. Intertemporal/intercanthal; intercanthal/interchillion; interalae/interdacryon; interalae/nose width; interchilion/interdacryon; interchilion/interalea ratios, and forehead height/intereye-interalae; forehead height/stomion-soft menton; ala-soft menton/stomion-soft menton; intereye-interalae/interalae-stomion; intereye-soft menton/interalae-soft menton; intereye-soft menton/intereye-stomion ratios were calculated in horizontal and vertical planes respectively.

SPSS Statistics for Windows, Version 21.0. (Armonk, NY: IBM Corp. Released 2012) was used to perform various statistical tests and calculate different measures. The Kolmogorov-Smirnov test was first performed to check for normality of the distribution of data for the different ratios in the males and females, followed by Mann-Whitney test.

RESULTS

The results showed that in case of interchilion/nose width ($P < 0.001$) and forehead height/stomion-soft menton ($P < 0.001$), a highly significant difference were noted between the mean ratios of males and females [Table 1].

Male *t*-test

It was seen that in all the ratios except interchilion/interdacryon the tests return to significant *P* values [Table 2].

Female *t*-test

As far as females were concerned it was seen that intereye-soft menton/intereye-stomion was the only ratio which returned a nonsignificant *P* value and as such could be considered to

be not significantly different from the value of phi =1.6180. In the rest of the ratios the *P* values were highly significant [Table 2].

DISCUSSION

The null hypothesis that Ricketts horizontal facial proportion would not include phi was accepted in the female group and was rejected only for one of the six male horizontal proportions. For the vertical facial proportions, the null hypothesis was accepted in the female group and was rejected only for one of the six male vertical proportions.

From the era of ancient Greeks, through the Renaissance, and the present day, mathematicians, scientists, architects, artists, and cosmetic surgeons have been intrigued by the ubiquitous nature of the divine proportion and its correlation with esthetics. Ricketts showed that the proportions in a face generally perceived as being beautiful are intimately related to the golden ratio.[6,17-19]

The face is divided into horizontal thirds. The upper third extends from the hairline to the glabella, the middle third from the glabella to the subnasale and the lower third from the subnasale to the menton. These facial thirds are rarely equal. In Caucasians, the middle third is often less than the upper third, and the middle and upper thirds are less than the lower third.[20] In East Asians, the middle third of the face if often greater than the upper third and equal to the lower third, and the upper third is less than the lower third.[21] The lower third is further divided into its own thirds, defining the upper lip, lower lip and the chin. Anic-Milosevic *et al.*[22] compared the proportions of the lower facial third segments in males and females. The chin represented the largest segment and the lower lip height the smallest in both the sexes. The width of the lips should be about 40% of the width of the lower face, and usually equal to the distance between the medial limbi. The width to height ratio of the face is typically 3:4, with an oval shaped face being the esthetic ideal.

In the present study, phi was examined as a potential feature of the judgment of beauty. The horizontal ratio results showed that the three male and female ratios were not significantly different from each other ($P > 0.05$) except for the interchilion/nose width ratio, which was highly significant ($P < 0.001$), interalae/interdacryon and interchilion/interalae ratios which were significant ($P < 0.05$). The horizontal mean ratios for females were highly significant from the phi ratio ($P < 0.001$) except for interchilion/interdacryon ratio ($P < 0.05$) which was significant. The horizontal mean ratios for males were highly significant from the phi ratio ($P < 0.001$) except for the interchilion/interdacryon ratio ($P > 0.05$) which was not significant [Tables 1 and 2].

Table 1: Mean horizontal and vertical ratios and mean difference of the male and female groups

	Mean difference	*P*
Horizontal ratios		
Intertemporal/intercanthal	−0.017	0.548
Intercanthal/interchilion	−0.007	0.783
Interalae/interdacryon	0.082	0.021
Interchilion/nose width	0.441	0.000
Interchilion/interdacryon	0.101	0.056
Interchilion/interalae	−0.085	0.050
Vertical ratios		
Forehead height/intereye-interalae	−0.120	0.009
Forehead height/stomion-soft menton	−0.180	0.000
Ala-soft menton/stomion-soft menton	−0.053	0.010
Intereye-interalae/interalae-stomion	0.015	0.687
Intereye-soft menton/interalae-soft menton	−0.046	0.013
Intereye-soft menton/intereye-stomion	0.015	0.448

Table 2: Comparison between phi and mean horizontal and vertical ratios for male and female groups

	Females		Males	
	Mean difference	*P*	Mean difference	*P*
Horizontal ratios				
Intertemporal/intercanthal	−0.251	0.000	−0.268	0.000
Intercanthal/interchilion	0.173	0.000	0.166	0.000
Interalae/interdacryon	−0.478	0.000	−0.396	0.000
Interalae/nose width	0.577	0.000	1.019	0.000
Interchilion/interdacryon	−0.138	0.003	−0.037	0.122
Interchilion/interalae	−0.239	0.000	−0.324	0.000
Vertical ratios				
Forehead height/intereye-interalae	−0.101	0.001	−0.221	0.000
Forehead height/stomion-soft menton	−0.303	0.000	−0.483	0.000
Ala-soft menton/stomion-soft menton	0.139	0.000	0.086	0.000
Intereye-interalae/interalae-stomion	−0.463	0.000	−0.448	0.000
Intereye-soft menton/interalae-soft menton	−0.098	0.000	−0.143	0.000
Intereye-soft menton/intereye-stomion	0.024	0.169	0.039	0.007

These horizontal preferences have been reported in contemporary studies utilizing photographs.[12,23,24]

The neoclassical canon of facial proportions divides the face vertically into fifths, with the width of each eye, the intercanthal distance, and the nasal width all measuring one-fifth. However, studies using direct anthropometry and photogrammetric analyses in white and Asian subjects found variations in these proportions, with the width of the eyes and the nasal widths often being either less than or greater that the intercanthal distance.[20,21,25]

The vertical ratio results showed that there was a significant difference ($P < 0.05$) between the mean ratios of males and females for forehead height/intereye-interalae, ala-soft menton/stomion-soft menton and intereye-soft menton/interalae-soft menton ratios and a highly significant difference

($P < 0.001$) for forehead height/stomion-soft menton ratio. The remaining two ratios showed no significant difference between the mean ratios of males and females [Table 1]. All the vertical mean ratios for both the groups were highly significant ($P < 0.001$), except for the intereye-soft menton/intereye-stomion ratio, which was significant for female group and not significant for the male group [Table 2].

These results are contradictory to the findings of the previous studies, in which attractive females and cover models had Ricketts facial ratios closer to phi than the unattractive females.[9,12,18]

Few studies have suggested that, in general, there are no concrete evidences to consider the Golden Proportion as the ideal esthetic standard to rehabilitate either a human face or the anterior dental segment.[26-28] Recent observations of 81 Brazilian undergraduate students (37 females and 44 males), with a mean age of 21 years old, showed that facial architecture was not significantly dimensioned according to Divine Proportion. The lack of Divine Proportion among dental and facial structures are also stated in recent literature attesting this proportion as an unsuitable method to relate dentofacial dimensions with natural or even "attractive" appearance during rehabilitation treatments.[23,29,30]

Such proportions are only guidelines, as ideal proportions change over time, and the ideal result varies with patient expectations. The horizontal facial proportions can be used in orthodontic surgeries to alter the shape of the jaws to improve dental occlusion stability, improve temporomandibular joint function (corrective jaw surgery) and in the correction of bilateral asymmetries to improve the patient's facial proportions.

Patients often are specific on their requests for facial rejuvenation procedures: Nose reduction, nose tip elevation, lip enhancement, brow lift, or chin augmentation. Creating the esthetic ideal relies less on site specific reduction, augmentation or straightening of facial features and more on a holistic approach, considering each feature as it relates to the rest of the face. Hence, one must consider the (n) number of various measurements that can be made in an area as anatomically complicated as human skull and further study relative to this mathematical relationship is needed before ascertaining its clinical implications as an important parameter for achieving esthetic harmony.

Further research can be carried out amongst various other age groups and racial parameters. Dentate and edentate population can be compared as well, with larger sample size.

CONCLUSION

In the assessment of dentofacial esthetics, art and science must act in unison. Although the golden proportion is certainly a prominent and recurring theme in esthetics, it should not be embraced as the only method by which human beauty is measured to the exclusion of others factors.

It should be kept in mind that divine proportions are not absolute determinants of facial attractiveness. It is the individual esthetic character of facial features, not just their proportions that significantly influence the assessment of facial beauty and attractiveness. If the divine proportions are to be used in orthodontic/orthognathic surgical planning, they should be used only as general guidelines alongside other well-established treatment planning methods.

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