An analysis of maxillary anterior teeth dimensions for the existence of golden proportion in the representative North Indian population

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Abstract

Context: Esthetic appearance of the face is a major concern in self-image among the majority of the population. The dimensions, anatomy, and arrangement of maxillary anterior are the key factors in the esthetic appearance of the face.

Aim: The present study aimed to measure the mesiodistal dimensions of maxillary anterior teeth and analyzing the golden proportion in the representative North Indian population.

Materials and Methods: Subjects were seated in the upright position in a dental clinical chair. A digital Vernier caliper was used to record the mesiodistal dimensions of central incisors (CIs), lateral incisor (LI), and canine (C) teeth in maximum smile position. A total of three sets of recordings were made by a single observer to avoid the measurement bias of both left and right sides of teeth. Digital images were also captured. Obtained measurements were used for the calculation of ratios and statistical analysis was done.

Results: The prevalence of golden ratio between right CI/LI was observed in 3.1% males and 3.2% females. The calculated median ratio was 1.2 for males and 1.3 for females which differs significantly ($P > 0.05$) from the golden ratio. The divine proportion between visible portion of right C/LI was seen in 39.5% males and 32.3% females with calculated median value for males being 0.6 and that for females was 0.7.

Conclusion: The prevalence of golden proportion between the CI/LI in esthetically pleasing smiles was too small (mean-3.9 in males and 2.75 in females) while the golden ratio of 0.6 was found in the majority of the population irrespective of the gender.

Keywords: Divine proportion; esthetics; golden mean; golden proportion; golden ratio

INTRODUCTION

The dimensions, anatomy, and arrangement of maxillary anterior teeth are the key factors in the esthetic appearance of the face. Achieving a cordial fraction between the widths of maxillary anterior teeth is one of the key factors in esthetics while rehabilitating smile.

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The notion of "golden proportion" is considered as a keystone of smile rehabilitation theory.[1] It was described by the Pythagoreans during sixth century followed by the Greek geometrician Euclid but was introduced in dentistry by Lombardi. A golden proportion or golden mean is ideal, perfect, and desirable which determines the dominance, symmetry, and proportion in the dentition. Levin observed the application of golden mean theory suggesting that mesiodistal measurements of the central incisor (CI) should be in golden fraction to that of lateral incisor (LI) and the width of LI should be in golden fraction to that of Canine (C), while observing from

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the front profile.[1] Furthermore, Preston reported the absence of the golden mean in the majority of examined cases.[2]

The existence of different segments could be correlated to sex and study population and mean measurements of the maxillary anterior teeth were highly variable.[3-5] However, various studies[5-9] reported the absence of any association between the morphology of teeth and sex.

Hence, analysis of front dentition among populations, ethnicity, and gender is important to fabricate treatment plans. The current study aimed to evaluate golden proportion by calculating the mesiodistal dimensions of maxillary front teeth in representative North Indian population. The null hypotheses tested were as follows:
1. The fraction among maxillary anterior teeth in the right and left sides of the face will be similar
2. The proportions between maxillary anterior teeth will be similar among both the sex.

MATERIALS AND METHODS

The research included 2200 volunteers out of which 448 corroborated with the defined exclusion and inclusion criteria and were selected for the present study.

Selection criteria
1. Age of 21–30 years
2. Patients containing all natural teeth
3. Patients without any discrepancy in teeth size or shape
4. Patients without any history of orthodontic treatment
5. Patient should be satisfied from her appearance.

Exclusion criteria
1. Patients with any previous history of trauma, restorations, or maxillofacial surgery in relation to anterior teeth
2. Patients with any rotation, spacing or crowding of anterior teeth
3. Patients with obvious asymmetries or severe dentofacial deformities.

The procedure was explained and written consent was taken from 448 volunteers which included 228 males and 220 females as depicted in Figure 1. Patients were assessed in upright sitting position in dental chair and a digital caliper was used for measuring the widths of the maxillary front teeth: CI, LI, and C in maximum smiling position by a single operator to reduce the observer bias and estimation error.

For reducing error, each measurement was repeated thrice and the mean of three was taken as the final value. The width of the CI and LI were computed at the start to end contact point of the teeth and the width of the C was measured from the start contact point to the end most visible area from the frontal view.

The golden or divine proportion was calculated by measuring the width of CIs, cuspids, and LIs from the frontal aspect and then obtained value was fragmented by the measured mesiodistal dimensions of the LI. The resultant data were statistically analyzed using the paired *t*-test.

RESULTS

The mean mesiodistal dimensions in males of right and left CI, LIs, and Cs were - 7.93 mm and 7.98 mm, 6.10 and 6.08, 4.28 and 4.29, respectively [Table 1]. The mean CI/LI value was 1.2 and the mean C/LI was 0.6. In females, the mean mesiodistal dimensions of right and left CI, LIs, and Cs were - 7.96 and 7.97, 6.09 and 6.22, 4.46 and 4.37, respectively, and the mean CI/LI value was 1.2 and that of C/LI was 0.6 [Table 2].

The prevalence of golden ratio of 1.6 between right CI/LI was seen in 3.1% males and 3.2% females and calculated median ratio was 1.2 for males and 1.3 for females [Table 3].

Table 1: Male descriptive statistics

Particulars	Male			
	Count	Mean	±SD	Median
Age	228	23.34	1.96	23.00
Right_CI	228	7.93	0.69	7.86
Right_LI	228	6.10	0.70	6.16
Right_C	228	4.28	0.38	4.30
Right_GP_CI/LI	228	1.25	0.13	1.20
Right_GP_C/LI	228	0.66	0.09	0.60
Left_CI	228	7.98	0.60	8.10
Left_LI	228	6.08	0.67	6.36
Left_C	228	4.29	0.37	4.23
Left_GP_CI/LI	228	1.27	0.12	1.30
Left_GP_C/LI	228	0.66	0.10	0.60

SD: Standard deviation, CI: Central incisors, LI: Lateral incisor, GP: Golden proportion, C: Canine

Table 2: Female descriptive statistics

Particulars	Female			
	Count	Mean	±SD	Median
Age	220	21.99	2.08	22.00
Right_CI	220	7.96	0.64	7.90
Right_LI	220	6.09	0.58	6.23
Right_C	220	4.46	0.44	4.43
Right_GP_CI/LI	220	1.26	0.12	1.30
Right_GP_C/LI	220	0.69	0.09	0.70
Left_CI	220	7.99	0.60	8.06
Left_LI	220	6.22	0.56	6.36
Left_C	220	4.37	0.40	4.33
Left_GP_CI/LI	220	1.24	0.11	1.30
Left_GP_C/LI	220	0.65	0.08	0.60

SD: Standard deviation, CI: Central incisors, LI: Lateral incisor, GP: Golden proportion, C: Canine

The golden ratio of 0.6 between visible portion of right C/LI was present in 39.5% males and 32.3% females. The calculated median values were 0.6 and 0.7, respectively [Table 4].

For the left side, the divine ratio of 1.6 (CI/LI) existed in 4.8% males and 2.3% females with calculated median value of 1.3 irrespective of the gender [Table 5]; whereas the golden ratio of 0.6 was prevalent in 60.1% and 57.3% males and females, respectively [Table 6]. The calculated median value was 0.6 in both the genders.

Table 3: Prevalence of golden proportion in right side-central incisors/lateral incisor

	GP (CI/LI)	
Particulars	Male, frequency (%)	Female, frequency (%)
1	13 (5.7)	3 (1.4)
1.1	33 (14.5)	42 (19.1)
1.2	86 (37.7)	61 (27.7)
1.3	45 (19.7)	62 (28.2)
1.4	38 (16.7)	45 (20.5)
1.5	6 (2.6)	0
1.6	7 (3.1)	7 (3.2)
n (total)	228 (100.0)	220 (100.0)
Mean	1.247	1.260
Median	1.200	1.300
Mode	1.200	1.300
P*	0.000	0.000

CI: Central incisors, LI: Lateral incisor, GP: Golden proportion, *P< 0.05

Table 4: Prevalence of golden proportion in right side canine/lateral incisor

	GP (C/LI)	
Particulars	Male, frequency (%)	Female, frequency (%)
0.5	25 (11.0)	10 (4.5)
0.6	90 (39.5)	71 (32.3)
0.7	66 (28.9)	82 (37.3)
0.8	47 (20.6)	53 (24.1)
0.9	0	4 (1.8)
n (total)	228 (100.0)	220 (100.0)
Mean	0.659	0.686
Median	0.600	0.700
Mode	0.600	0.700
P*	0.000	0.025

LI: Lateral incisor, GP: Golden proportion, C: Canine, *P< 0.05

Table 5: Prevalence of golden proportion in left side central incisors/lateral incisor

	GP (CI/LI)	
Particulars	Male, frequency (%)	Female, frequency (%)
1	0	8 (3.6)
1.1	34 (14.9)	43 (19.5)
1.2	61 (26.8)	57 (25.9)
1.3	94 (41.2)	90 (40.9)
1.4	22 (9.6)	16 (7.3)
1.5	6 (2.6)	1 (0.5)
1.6	11 (4.8)	5 (2.3)
n (total)	228 (100.0)	220 (100.0)
Mean	1.273	1.239
Median	1.300	1.300
Mode	1.300	1.300
P*	0.001	0.000

CI: Central incisors, LI: Lateral incisor, GP: Golden proportion, *P< 0.05

DISCUSSION

The principle of golden proportion is to achieve a proportion of (1.6:1:0.6) among the CIs, LIs, and cuspids for achieving suitable esthetics and establishing a symmetrical relation among the anterior teeth is critical to achieve esthetic results.

Levin[1] identified and proposed the application of golden mean between the width of CI, LI, and the C. Golden mean arithmetically decides the correlation between a larger and shorter length.[10] Anterior teeth dimensions are the key factors for achieving a balanced esthetically pleasing smile.[11]

This study was conducted in 448 volunteers with esthetically pleasing smile, 220 being female and 228 male subjects. Results of the present study displayed statistically significant ($P < 0.05$) between the calculated ratios and the golden ratios irrespective of the gender, and hence, the null hypothesis was rejected.

The mean value of right and left CI/LI in males and females was found to be 1.2 which differs significantly ($P < 0.05$) from the golden correlation of 1.6 which is in accordance with various studies.[12-16]

The golden ratio of 0.6 between right C/LI was found to be prevalent in the studied population and the difference was statistically significant ($P = 0.000$) as observed in 39.5% males which corroborated with the findings of Murthy and Ramani.[17] Similar trends were seen in females in the study population.

The calculated median ratio was 1.3 which correspond to the observations of Chander *et al*.[16] and varies statistically
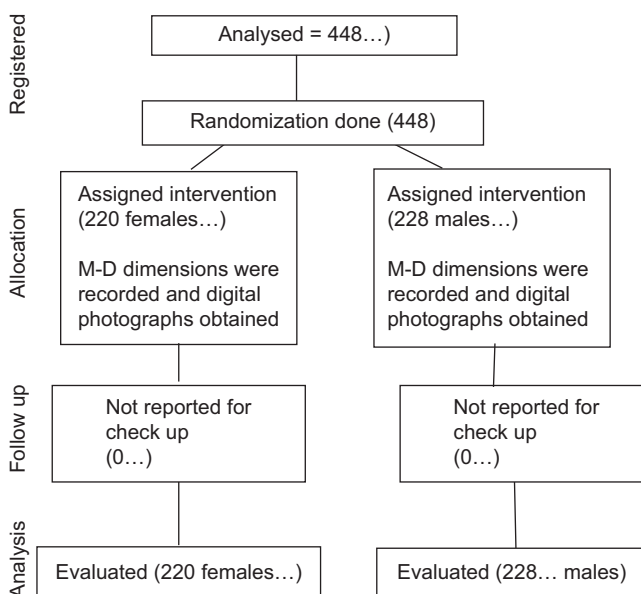

Figure 1: Consort diagram

Table 6: Prevalence of golden proportion in left side canine/ lateral incisor

	GP (C/LI)	
Particulars	Male, frequency (%)	Female, frequency (%)
0.5	5 (2.2)	9 (4.1)
0.6	137 (60.1)	126 (57.3)
0.7	41 (18.0)	67 (30.5)
0.8	28 (12.3)	10 (4.5)
0.9	17 (7.5)	8 (3.6)
n (total)	228 (100.0)	220 (100.0)
Mean	0.665	0.648
Median	0.600	0.600
Mode	0.600	0.600
*P**	0.000	0.000

LI: Lateral incisor, GP: Golden proportion, C: Canine, *$P < 0.05$

significantly ($P < 0.05$) from the golden ratios. Gillen *et al*.[3] also noted a poor association between tooth size and the golden fraction. The calculated mean value of ratio between CI/LI was 1.2 irrespective of the gender which is in accordance to other studies.[16,18-22]

Furthermore, the prevalence of golden ratio of 0.6 between left C/LI was seen in 60.1% males and 57.3% females with calculated mean and median values of 0.6 irrespective of the gender which is in contrary to various studies,[3,14] as this prevalence was not observed.

In context to the theory of divine fraction, the best consequences were observed in relation to ratio of perceived left C width with left LI width. The calculated median ratio was 0.6 in males and left side of females with the maximum incidence in the left side in males was in accordance to the results of Kanaparthy *et al*.[21] but was in contrary to that of Mahshid *et al*.[14] This difference might be due to the method of measurement and dissimilarity in the sample size.

The prevalence of golden mean was more in the left quadrant opposed to the right quadrant and was found to exist more in males than their female counterparts in the study. In general, it was seen that the mesiodistal dimensions of CIs were narrower, whereas that of cuspids were wider than those indicated by the golden fraction theory. Arch curvature may be a key factor in establishing the esthetics with the constricted arch forms simulating the golden fraction more than broader arch forms.[10] Smile esthetics are related to the form, texture, color, and alignment of the anterior teeth.[23]

These variations in the analysis may be attributed to paucity of the homogenized protocol for the analysis of golden fraction, although the observations were in esthetically acceptable limits in this study. Variations in the ethnicity can also be an influential factor. The perception of attractiveness of smile is also influenced by the social background and cultural differences.[24]

Within the limitations of the study, it was witnessed that the volunteers that participated and were selected majorly belonged to a circumscribed region and displayed appealing smile and hence, these findings cannot be generalized to the entire north Indian population.

Moreover, evaluation of different populations between specific age groups should be done to further authenticate that the desired proportion vary according to the population. Encompassing a large stratum of population across the nation/nations can be done to elucidate the significance of esthetics in maxillary anterior region and to establish the significance of golden proportion on population grounds rather than just being a formula or ratio. Furthermore, using the golden proportion in future innovations such as AI, digital software will further enhance the treatment precision and outcome.

CONCLUSION

The median ratio of 1.2 was observed in both genders. Excluding the gender difference, the golden ratio of 0.6 was found in the majority of the population. The existence of golden proportion was observed to be higher in the left quadrant in contrast to the right quadrant and was higher in males in contrast to females in our study population.

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Conflicts of interest
There are no conflicts of interest.

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