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Prevalence of dental esthetic proportions and its correlation with Dentogenics in Maharashtrian population- A cross sectional study

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ABSTRACT

Background: Artistic and scientific principles play a vital role in esthetic smile designing. These principles can be established through data collected from patients, diagnostic models, dental research, scientific measurements and basic artistic concepts of beauty in nature. Various proportions have been identified by many authors and attempts have been made to apply those proportions in smile designing to improve the esthetic outcome of rehabilitation. This study aims to ascertain the most prevalent dental proportion existing in natural dentition based on photographic data, to be utilized in clinical application.

Objectives: 1. To investigate and compare the existence of Golden proportion, Recurring Esthetic Dental, Preston proportion and Golden Percentage in maxillary anterior teeth in dentate population using digital photographs and software analysis; 2. Correlation of the dental esthetic proportions with dentogenic concept.

Materials and Methods: Fifty dentate individuals with full complement of maxillary anterior teeth were selected for the study. Digital photographs (frontal) were taken from a standardized distance. Mesiodistal width of individual tooth was taken at incisal contact with adjacent tooth and readings were tabulated. Ratio of adjacent teeth was calculated for evaluation of dental esthetic proportions. The width of each tooth was used to calculate the golden percentage and results obtained were subjected to statistical analysis.

Results: For Golden proportion, distribution of mean delta (difference between observed and reference data) for all parameters differs significantly from the reference standard (p-value<0.001 for all). For RED proportion, Preston proportion and Golden percentages, distribution of mean delta for the parameters did not differ significantly from the reference standard (p-value>0.05 for all). Mean overall absolute delta value for standards such as Golden percentage, RED proportion, Preston proportion and Golden proportion is 1.62, 7.42, 9.00 and 10.54 respectively. Distribution of mean overall delta for either ratios did not differ significantly across three demographic variables studied in the study group (p-value>0.05).

Conclusion: Based on results, it was found that golden percentage was most prevalent for all age groups, irrespective of gender and difference in personality types. Other commonly occurring standards (in ascending order) based on delta value after Golden percentage are RED proportion, Preston proportion and Golden proportion respectively.

1. Introduction

Esthetics is the study of beauty and emotional responses to it.[1] With the increased life span and high esthetic demands, cosmetic rehabilitation therapy is gaining popularity over conventional restorative procedures. Esthetic dentistry

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derives its concepts from various proportions existing in nature. Understanding of these esthetic principles and scientific analysis of beautiful smiles has shown that repeatable, measurable objective principles can be systematically applied to enhance esthetics and predictable results can be achieved.[2,3]

Esthetic smile comprises of balanced, symmetrical facial esthetics with proportionate soft and hard dental tissues. Various esthetic principles utilized in smile designing include smile line placement, minimum negative space, axial inclination graduation, incisor embrasure gradation and others.[4]Degree of symmetry across the midline differentiates an esthetically pleasing smile from an unesthetic one. Earlier works done by Lombardi demonstrates 'unity with variety' as the most dynamic correlation and basic principles of dominance, symmetry and maintenance of proportions, keys to esthetic rehabilitation.[5]Due to the size, form and visibility of maxillary anteriors, they often form the basis for calculation of esthetic dental proportions.[6]

Golden proportion was introduced in dentistry by Lombardi. According to Levin, the ratio of visibility decreases by a constant ratio when viewed from frontal aspect. However, it was considered 'too strong', and not widely popularized as a tool to determine tooth size.[5,7]

Ward recommended use of recurring esthetic dental (RED) proportion as a range for successive width of maxillary anterior teeth which remains constant.[8]

Preston observed that this proportion was 66% for the lateral incisor/central incisor and 84% for the canine/lateral incisor among his study group.[8,9] Snow proposed a proportional width based on total width of all maxillary anteriors and implementation of same to achieve desired esthetics.[10]

This study aims to ascertain the most commonly occurring dental proportions in dentulous population and its correlation with the components of dentogenic concept ie Sex, Personality & Age.

2. Materials and Methods

Fifty dentate individuals who reported to Department of Dental Surgery were selected based on inclusion and exclusion criteria.

2.1. Inclusion criteria

Patients in the age group of 20-45 years, with full complement of maxillary anterior teeth.

2.2. Exclusion criteria

History of orthodontic treatment, Malaligned or fractured maxillary anterior teeth, Congenital or developmental anomalies leading to alteration in tooth position, size or shape.

2.3. Procedure

The methodology comprised of two components: Data acquisition and proportion calculations

2.3.1. Data acquisition

Demographics of patients; age, sex and personality were recorded. Each patient was categorized based on personality as delicate, medium or vigorous.[11] The personality traits were identified independently by two observers. Figure 1a shows a 30 year old male with moderate personality trait and Figure 1b shows a 29 year old female with delicate personality trait.

Patients were seated comfortably on a chair with back supported and natural head position(NHP) with eyes focused on a point in the distance at eye level, which implies that the visual axis is horizontal.[12] NIKON DSLR camera was stabilized on a tripod and adjusted at a standardized imaging distance of 60 cm to obtain a sharp image.(Figure 1c) At this position, patient was asked to smile and standardized frontal images from tip of the nose to tip of chin were captured (Figure 1d). Only sharp, focused centralized images with equal visibility bilaterally were selected and others were discarded. Approved images were transferred to the personal computer and measurements made using Adobe Photoshop.

2.3.2. Measurement and calculations

Mesiodistal width of maxillary canines, lateral incisors and central incisors was measured bilaterally using the ruler scale option in Adobe Photoshop (Adobe Creative Cloud Photoshop CC 2015) to a precision of second decimal point (Figure 1e)**.**

The demographics as well as all the dental measurements were made by two independent observers. Data collected was tabulated in Microsoft excel sheet as shown below.

2.4. Demographics and dental measurements

2.4.1. Abbreviations

RWCA-Width of canine (right side) in centimeter;

RWLI- Width of lateral incisor (right side) in centimeter;

RWCI- Width of central incisor (right side) in centimeter;

LWCI- Width of canine (left side) in centimeter;

LWLI- Width of lateral incisor (left side) in centimeter;

LWCA- Width of central incisor (left side) in centimeter;

T- Total width of Right Canine, lateral incisor, central incisor and Left Canine, lateral incisor, central incisor).

Dental ratios were calculated by dividing mesiodistal width of distal tooth by the mesiodistal width of tooth mesial to it. For example, dividing the mesiodistal width of canine by that of lateral incisor and width of lateral incisor by central incisor. The values obtained were multiplied by 100 to derive a percentage.

2.5. Dental ratio calculations

The ratios obtained were correlated with standard ratios given in the literature.

According to Golden proportion, mesiodistal width of Canine/ mesiodistal width of lateral incisor multiplied by 100 (RWCA/RWLI x 100) and that of width of lateral incisor/ width of central incisor multiplied by 100 (RWLI/RWCI x 100) should be a constant. Golden proportion mathematically describes the ratio between a larger and a smaller length. This proportion is unique as the ratio remains constant at 61.8 %.

According to Recurrent esthetic dental (RED) proportion, this ratio is in the range between 62 to 80 percent.

According to Preston proportion, the width of average maxillary lateral incisor was about 66% of the width of maxillary central incisor and the width of maxillary canine was about 84% of the width of lateral incisor.

2.6. Calculation of golden percentage

RT3- percentage for maxillary canine right side

RT2- percentage for maxillary lateral incisor right side

RT1- percentage for maxillary central incisor right side

LT3- percentage for maxillary canine left side

LT2- percentage for maxillary lateral incisor left side

LT1- percentage for maxillary central incisor left side

For Evaluation of golden percentage, the width of individual tooth is divided by the total mesiodistal width of all six maxillary anterior teeth and multiplying the results by 100. For example:

Width of Canine (WCA) / Total width of anteriors (T) x 100

Width of Lateral Incisor (WLI) / Total width of anteriors (T) x 100

Width of Central Incisor (WCI) / Total width of anteriors (T) x 100

According to Snow the golden percentage should be 10% for canines, 15% for lateral incisors and 25% for central incisors.

The results thus obtained were evaluated in terms of most commonly occurring dental proportion and their association with the demographics to derive a correlation with the dentogenics. The data obtained was subjected to statistical analysis. Data on continuous variables was presented as Mean and Standard deviation (SD). The inter-group statistical comparison of means of continuous variables was done using independent sample t test for two groups and by analysis of variance (ANOVA) for more than two groups. Mean overall absolute delta was used as a statistical measure of the most commonly occurring standard in the study group. The entire data was statistically analyzed using Statistical Package for Social Sciences (SPSS ver 22.0, IBM Corporation, USA) for MS Windows.

3. Results

hows the distribution of mean delta (i.e. observed and reference data) along with statistical significance of difference from the reference value for each type of standard.

Distribution of mean delta (difference between observed and reference data) along with statistical significance of difference from the reference value. (Table 2) Figure 2 a, Table 2 .

3.1. For golden proportion

Distribution of mean delta (difference between observed and reference data) for all parameters such as RWCA/RWLI, RWLI/RWCI, LWLI/LWCI and LWCA/LWLI differs significantly from the reference standard (i.e. 62) (p-value<0.001 for all).

3.2. For RED proportion

Distribution of mean delta (difference between observed and reference data) for the parameters such as RWCA/RWLI and LWCA/LWLI differs significantly from the reference standard (70) (p-value<0.001 for all). Distribution of mean delta (difference between observed and reference data) for the parameters such as RWLI/RWCI and LWLI/LWCI did not differ significantly from the reference standard (i.e. 70) (p-value>0.05 for all).

3.3. For preston proportion

Distribution of mean delta (difference between observed and reference data) for all parameters differs significantly from the reference standard (i.e. 66 and 84 respectively). Distribution of mean delta (difference between observed and reference data) for the parameter such as RWLI/RWCI did not differ significantly from the reference standard (i.e. 66) (P-value>0.05).

3.4. For golden percentages

Distribution of mean delta (difference between observed and reference data) for all parameters such as RT3, RT1, LT1, LT2 and LT3 differs significantly from the reference standard (i.e. 10, 25, 25, 15 and 10 respectively) (p-value<0.05 for all) (Table 2). Distribution of mean delta (difference between observed and reference data) for all parameters such as RT2 did not differ significantly from the reference standard (i.e. 15) (p-value>0.05).

3.5. Distribution of mean overall absolute delta (difference between observed and reference data)

Mean overall absolute delta value for standards such as Golden percentage, RED proportion, Preston proportion and Golden proportion is 1.62, 7.42, 9.00 and 10.54 respectively.

Lower mean overall absolute delta value indicates the most commonly occurring standard in the study group. Mean delta value for Golden percentage is lower as compared to other standards (proportions), hence the Golden percentage is the most commonly occurring standard in the given study group. The other commonly occurring standards (in ascending order) based on delta value after Golden percentage are RED proportion, Preston proportion and Golden proportion respectively. (Figure 2b)

3.6. Distribution of mean overall delta (difference between observed and reference data) for each type of standard according to age, sex and personality

Distribution of mean overall delta for either ratios did not differ significantly across three demographic variables studied in the study group (P-value>0.05). However, based on results, it was found that golden percentage was most prevalent for all age groups, irrespective of sex and difference in personality types. (Tables 3, 4 and 5 & Figure 3 a,b,c)

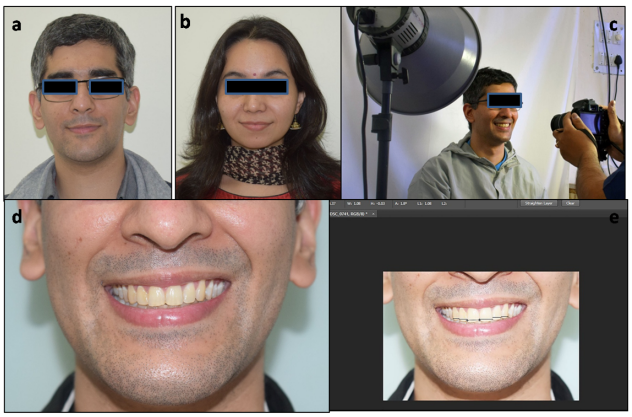

Fig. 1: a: A 30 yrs old male with moderate personality trait; **b:** A 29 yrs old female with delicate personality trait; **c:** Imaging set-up; **d:** Image obtained from tip of nose to chin; **e:** Measurements using software.

4. Discussion

Beauty and esthetic parameters are easy to identify but difficult to quantify. Despite its subjective nature, attempts have been made to define, measure and explain this phenomenon by describing it numerically and geometrically in terms of ratios and proportions. These ratios are unanimous and present everywhere around us in nature. Since the time of Pythagoras, mathematical ratios have been found in nature and have evolved ever since due to unfolding of knowledge and inquisitiveness of human brain.

The golden proportion, also known as the divine proportion, is considered the key to mystery of aesthetics, attraction and human beauty. Introduced in dentistry by

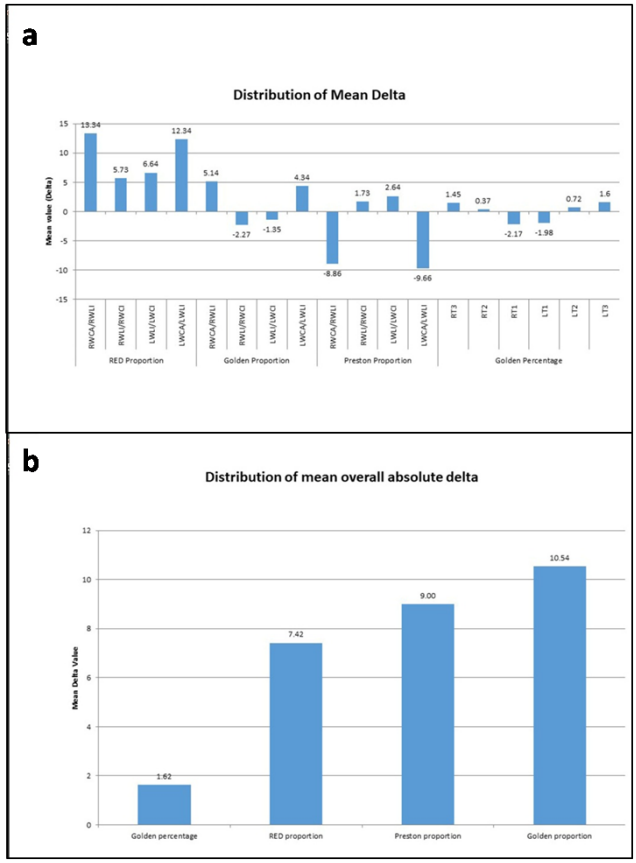

Fig. 2: Distribution of mean delta (difference between observed and reference data) with statistical significance of difference from the reference value; **b:** Distribution of mean overall delta among various proportions.

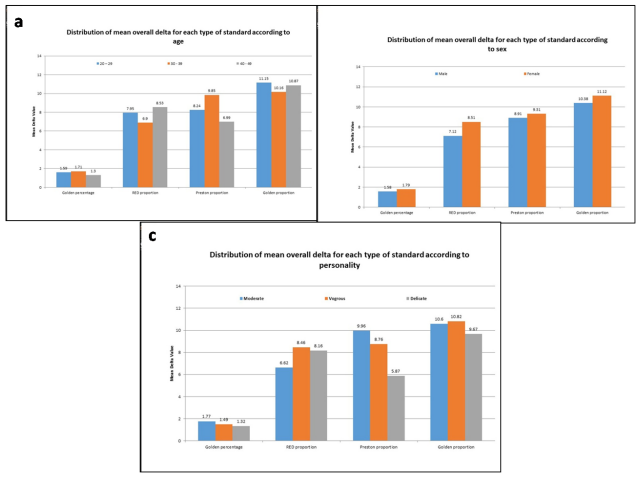

Fig. 3: Distribution of mean overall delta amongst various age groups; **b:** Distribution of mean overall delta amongst different genders; **c:** Distribution of mean overall delta amongst different personalities

Table 1: Distribution of mean delta (i.e. observed and reference data) with statistical significance of difference from the reference value for each type of standard.

	Data (n=50)			Delta	95% CI of Delta	T-Test Value	P-value
Golden Proportion	**Mean**	**SD**					
RWCA/RWLI	75.14	8.66	62	13.34	10.67 to 15.60	10.72	0.001^{***}
RWLI/RWCI	67.73	9.17	62	5.73	3.13 to 8.34	4.42	0.001^{***}
LWLI/LWCI	68.64	7.82	62	6.64	4.42 to 8.87	6.01	0.001^{***}
LWCA/LWLI	74.34	8.77	62	12.34	9.85 to 14.83	9.95	0.001^{***}
RED Proportion							
RWCA/RWLI	75.14	8.66	70	5.14	2.67 to 7.60	4.19	0.001^{***}
RWLI/RWCI	67.73	9.17	70	-2.27	-4.87 to 0.34	-1.75	0.087^{NS}
LWLI/LWCI	68.64	7.82	70	-1.35	-3.58 to 0.87	-1.22	0.226^{NS}
LWCA/LWLI	74.34	8.77	70	4.34	1.85 to 6.83	3.50	0.001^{***}
Preston Proportion							
RWCA/RWLI	75.14	8.66	84	-8.86	-11.32 to -6.40	-7.23	0.001^{***}
RWLI/RWCI	67.73	9.17	66	1.73	-0.87 to 4.34	1.34	0.187^{NS}
LWLI/LWCI	68.64	7.82	66	2.64	0.42 to 4.47	2.39	0.021^{*}
LWCA/LWLI	74.34	8.77	84	-9.66	-12.15 to -7.17	-7.79	0.001^{***}
Golden Percentage							
RT3	11.45	0.83	10	1.45	1.21 to -1.68	12.29	0.001^{***}
RT2	15.37	1.43	15	0.37	-0.04 to -0.78	1.83	0.074^{NS}
RT1	22.83	1.25	25	-2.17	-2.52 to -1.82	-12.31	0.001^{***}
LT1	23.02	1.27	25	-1.98	-2.34 to -1.62	-11.06	0.001^{***}
LT2	15.72	1.27	15	0.72	0.36 to -1.08	4.04	0.001^{***}
LT3	11.60	0.83	10	1.60	1.36 to -1.84	13.64	0.001^{***}

P-value by one-sample t test. P-value<0.05 is considered to be statistically significant from the reference standard value. *P-value<0.05, ***P-value<0.001, NS – Statistically non-significant.

Table 2: Distribution of mean overall absolute delta (difference between observed and reference data) for each type of standard.

	Delta (Absolute)	
Standard	**Mean**	**SD**
Golden percentage	1.62	0.59
RED proportion	7.42	4.35
Preston proportion	9.00	4.49
Golden proportion	10.54	3.76

Table 3: Distribution of mean overall delta (difference between observed and reference data) for each type of standard according to age.

	Age Group (years)						
	20 – 29 (n=14)		30 – 39 (n=29)		40 – 49 (n=7)		p-value
Standard	**Mean**	**SEM**	**Mean**	**SEM**	**Mean**	**SEM**	
Golden percentage	1.59	0.16	1.71	0.12	1.30	0.09	0.253^{NS}
RED proportion	7.95	1.46	6.90	0.60	8.53	2.34	0.594^{NS}
Preston proportion	8.24	1.14	9.85	0.90	6.99	0.87	0.246^{NS}
Golden proportion	11.15	1.23	10.16	0.60	10.87	1.65	0.707^{NS}

P-value by ANOVA. P-value<0.05 is considered to be statistically significant from the reference standard value. NS – Statistically non-significant.

Table 4: Distribution of mean overall delta (difference between observed and reference data) for each type of standard according to gender.

	Gender				
	Male (n=39)		Female (n=11)		P-value
Standard	Mean	SEM	Mean	SEM	
Golden percentage	1.58	0.09	1.79	0.19	0.286^{NS}
RED proportion	7.12	0.74	8.51	0.96	0.355^{NS}
Preston proportion	8.91	0.60	9.31	1.99	0.797^{NS}
Golden proportion	10.38	0.65	11.12	0.77	0.566^{NS}

P-value by independent sample t test. P-value<0.05 is considered to be statistically significant from the reference standard value. NS – Statistically non-significant.

Table 5: Distribution of mean overall delta (difference between observed and reference data) for each type of standard according to personality.

	Personality						
	Moderate (n=27)		Vigrous (n=16)		Delicate (n=7)		p-value
Standard	Mean	SEM	Mean	SEM	Mean	SEM	
Golden percentage	1.77	0.11	1.49	0.15	1.32	0.16	0.102^{NS}
RED proportion	6.62	0.73	8.46	1.42	8.16	0.81	0.371^{NS}
Preston proportion	9.96	0.83	8.76	1.17	5.87	1.40	0.094^{NS}
Golden proportion	10.60	0.67	10.82	1.21	9.67	0.64	0.799^{NS}

p-value by ANOVA. P-value<0.05 is considered to be statistically significant from the reference standard value. NS – Statistically non-significant.

Levin, successive width of anterior teeth should follow a golden proportion of 0.618 or approximately 62% when viewed from front. However, use of this proportion created a very narrow appearing lateral incisor. Preston reported that only 17% of study population followed golden proportion which was less for it to be taken as an esthetic norm.[9]

Preston observed that the average tooth to tooth width proportion of front teeth among dental students of North American was 66% for the lateral incisor/central incisor and 84% for the canine/lateral incisor. Forster and colleagues reported this measurement to be 62% for the lateral incisor/central incisor and 84% for the canine/lateral incisor.

The Recurrent Esthetic dental (RED) proportion proposed by Ward, states that the proportion of the successive widths of the teeth as viewed from the front should remain constant as one moves distally. In this ratio, height of the tooth was also included, based on which the average range has been suggested is between 62-80%. An average of 70% was proposed for individuals with normal height as considered in this study. Advantage of using this proportion is that it provides flexibility for design of the size of tooth and decide the constant ratio based on patient's facial and body type.

Golden percentage as given by Stephen Snow in which golden proportion has been applied to the canine to canine width to form the golden percentage: 10%:15%:25%: 25%:15%:10%. Golden percentage serves as a useful tool in analysing esthetic proportions of the smile. It takes the symmetry, dominance, proportion of entire anterior segment into consideration.

Results of the present study, it was concluded that golden percentage is a rather recurring esthetic proportion seen in natural dentition. It was also a commonly occurring esthetic ratio irrespective of demographics. Mean value for golden percentage in males for central incisors, lateral incisors and canine were 22.96, 15.57, 11.45 and for females were 22.63, 15.74, 11.63 respectively. Mean value for age groups of 20-29 yrs were 22.92, 15.30, 11.77, for 30-39 yrs were 22.66, 15.84, 11.47 and for 40-49 yrs were 23.74, 14.77, 11.47. The mean values for vigorous personality were 22.29, 15.22, 11.48, for moderate personality were 22.58, 15.87, 11.53 and for delicate personality were 23.37, 15.01, 11.59.

Various authors have attempted to evaluate the existence of esthetic proportions in natural dentition. Golden proportion which is considered to be the most prevalent in nature was not commonly found in natural dentition in many studies.[13–15] This observation was in coherence with our study as well. Correlation of esthetics with RED proportion was also incoherent.[16]Golden percentage was however most commonly found and a rather constant parameter in dentate individuals.[17–19]

5. Conclusion

This cross-sectional study was conducted to establish definitive guidelines bridging the gap between esthetic principles in completely edentulous and partially dentate individuals. Based on the results obtained, it is recommended that golden percentage is one single most prevalent esthetic proportion commonly found in patients. Based on dentogenic concept as well, golden percentage emerged as a most commonly occurring esthetic proportion

based on demographics including age, sex and personality. This will allow utilization of this proportion for smile designing in patients and also teeth arrangement based on the principles of golden percentage i.e. 25% for Central Incisor, 15% for lateral incisor and 10% for canines when viewed from frontal plane.

6. Source of Funding

None.

7. Conflict of Interest

None.

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