Relevance of Recurring Esthetic Dental (RED) proportion and golden proportion among patients attending a tertiary care center at Kochi, Kerala

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A B S T R A C T

Background: Smile plays an essential part in facial esthetics. There have been some mathematical and geometric theories regarding smile designing in literature. The purpose of the study was to assess RED proportion and golden proportion among patients attending a tertiary care centre at Kochi, Kerala.

Methods: Standardised frontal images of 106 subjects, 50 male and 56 females, were captured in the age bracket of 18–25 years. Pictures of the patients were obtained using a DSLR camera (CANON EOS-60D) and then digitally analysed. Measurements of each maxillary anterior tooth was recorded and then the theories of RED and golden proportion were employed and the figures recorded were statistically analysed.

Results: The RED proportion was observed to be inconsistent, while progressing distally, Golden proportion was observed to be in 6–29% of the existing subject population.

Conclusion: Within the limited sample size of the study, RED (Recurring Esthetic Dental) proportion and golden proportion failed to exist in Keralites.

1. Introduction

The smile is the most significant aspect of the face that influences the physical appearance of a person. It is a reflection of the person and helps to communicate emotions to the people around us and it is unique to each individual person. Smile designing refers to some artistic and scientific principles that when applied together can construct a beautiful smile.

Every individuals' perception of beauty is different as noted in the saying: "Beauty lies in the eye of the beholder". That view may also be affected by ethnic, racial, or cultural notions of beauty and may vary from the standards established in the western dental community.

The designing of smile can be divided into 4 different types of esthetics: facial, macro, gingival and micro. The esthetics of the face includes curvature of the soft tissue and lips while talking, smiling and laughing. Gingival health, existence or absence of black triangles, form and contour of the interdental papilla are the parameters of gingival esthetics. Microesthetic traits include the anterior teeth anatomy, characterization, incisal translucency and lobe development. Macroesthetic features include dimensions and structure of the teeth and the midline of the face.[1]

Microesthetics includes various proportions that are explained in the literature for the dimensions of maxillary anterior sextant. Recurring

Esthetic Dental proportion and Golden proportion are some principles that introduce geometric calculations to associate with the progressive width of maxillary anterior teeth in this field.

Recurring Esthetic Dental (RED) proportion, given by Ward declares that when viewing maxillary teeth from front and progressing distally, the proportion of their successive widths should remain constant.[2] Smile designing with this principle means that when observed from the front, each individual tooth's mesio-distal width reduces by the same percentage as we move distally. The width of central and lateral incisor and canine reduces proportionately when moved distally. The 70–80% RED proportion has been suggested for the anterior teeth of normal length whereas for excessively tall tooth, 62% RED was considered appropriate. 70% RED denotes that the widest mesio-distal dimension of the maxillary lateral incisor is 70% of the central incisor width the canine has its width 70% that of the lateral incisor.

Golden proportion, given by Lombardi and Levin says that there is a an association between the beauty that exists in nature and in mathematics.[3,4] It is a mathematically constant ratio (1.618: 1.0) that defines the dimensions between two different lengths. This particular relationship is distinct, precise, idyllic, and suitable. It is based on the theory that when viewed from front, the maxillary lateral incisor width, should be in a particular ratio to the maxillary central incisor width. Consequently, the maxillary lateral incisor width should be 62% the maxillary

central incisor width and the maxillary canine width should be 62% the resulting lateral incisor width.

When viewed from front, the shape, size and arrangement of maxillary anterior teeth is the most significant aspect for a pleasant appearance.[5] In accordance with Bannister's classification of upper facial index; males have long (leptene) to round faces (mesene) and females have broad (euryene) to long faces in south India.[6] There have been several proportions which serve as a guide to restore the esthetics. However, the decision to select the most appropriate one is perplexing. Golden Proportion has been found to be the most harmonious ratio that occurs repeatedly as a tooth-to-tooth ratio more constantly in aesthetically pleasing smiles and is used as an esthetic guideline for rehabilitating maxillary anterior teeth. In North America. RED proportion is preferred by the dentists to create esthetic smiles as they can select a constant proportion themselves.[5] RED proportion has been applied as a treatment option for closure of midline diastema in maxillary anterior teeth using conservative direct composite resin restoration.[7] These proportions aid in smile designing and act like a guideline for the dentist to follow.

A clinical study conducted in Chhattisgarh observed high significant difference between males and females. It evidenced more number of males with Golden proportion in comparison to females. There has been a lot of literature stating the relevance of RED and Golden Proportion.[8–10] However, these studies have not taken race and ethnicity into consideration. No studies have been conducted to check its applicability in Kerala population. The rationale of this study was thus to address this limitation and to identify how the proportion varies with the race, ethnicity and gender of the given population.

2. Methodology

A total of 106 subjects were selected, 50 male and 56 females according to the inclusion and exclusion criteria. The inclusion criteria being the subjects should be of Kerala origin; having well-aligned anterior dentition, in angle's Class I occlusion and of 18–25 years of age. Subjects with following conditions were excluded such as tooth structure loss due to caries, abrasion, attrition, or erosion; Facial disfigurement or gross asymmetry in dentition; a history of orthodontic treatment; presence of midline diastema and maligned anterior teeth.

Each subject was selected based on above mentioned inclusion criteria and their smile evaluated. A short description of the study was given to the subjects and an informed consent was attained from them written in English/Malayalam. A digital camera DSLR CANON EOS-60D, 18 megapixels, 7.5 X zoom with 18–135 mm (29–216 mm eq.) lens was used to capture images. The camera was mounted on a tripod and positioned directly infront of the subject under constant lighting conditions. Marks were made on the floor at the position of the tripod and the photographer for standardisation. A working distance of 90 cm was taken as a fixed reference point to capture all the pictures. A plain black cloth was used as the background. The subjects were made to sit upright in a natural head position with them looking straight ahead. Interpupillary line was used as an orientation guide. The subjects were asked to smile in their maximum smiling position. A full-face frontal image was captured 90° to the facial midline from the front. The second image was captured by guiding the subject to give a full smile. The incisal plane of the upper teeth was made the horizontal midline of the image. The image was captured from the same standardised position in front of the subject.

The captured images were then downloaded and evaluated using Adobe Photoshop software (Adobe Photoshop CS2 9.0.1 for Windows). An image was taken with a millimetre scale placed next to the subject as a reference for the software program. The mesio-distal dimensions were measured in the widest area on the tooth and analysed using this
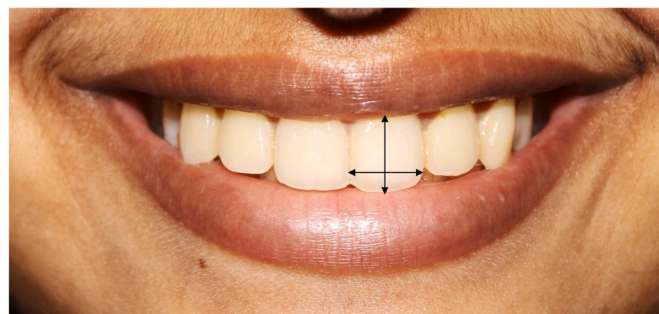

Fig. 1. Measuring cervico-incisal height and mesio-distal width for a subject in maximum smiling position.

software (Fig. 1). An intraoperator reliability was confirmed by measuring the images twice by two separate observers. An average of the two were determined incase of a discrepancy.

Statistical analysis was accomplished using IBM SPSS version 20.0 software. Numerical variables were expressed by using mean and standard deviation. Categorical variables were represented by frequency and percentage. The statistical significance of the difference in the mean values of golden proportion of central incisor, lateral incisor, canine and RED proportion of central incisor was tested. One sample *t*-test was applied. A p value of <0.05 was deemed to be statistically significant.

3. Results

This study involved a total of 106 subjects between the age group of 18–35 with an esthetic smile. All of them were analysed for the suitability of Golden Proportion and Recurrent Esthetic Dental (RED) Proportion.

The mesio-distal width of all the esthetic smiles were then evaluated for RED proportion. Table 1 depicts the mean RED proportion for the central incisor and lateral incisor which was accounted to be $84.7\% \pm 8.74$. Table 2 represents the mean RED proportion for lateral incisor and canine which was $106.5\% \pm 12.3$. Although, both the values obtained, were statistically significant ($p < 0.001$) they were not within the ideal range as proposed by Ward (60%–80%).

The images were assessed for Golden Proportion. This proportion was seen only in 6.7% of the population between central and lateral incisor (Table 3). Its existence between canine and lateral incisor was found to be in 29% of the respondents (Table 4). It was present in 3% of the population between central incisor, lateral incisor and canine.

The gender variation of RED and G.P was analysed amongst the males and females. Table 5 depicts that the RED proportion existed as 84.7 ± 8.4 for males and 83.4 ± 7.8 for females when observed between the C.I and L.I. The proportion when analysed for L.I and Canine, it was found that it was 106.5 ± 11.6 for males and 105 ± 11.5. This signifies that the values obtained for RED was in close approximation with the ideal values (60 %–80%) when checked for the females.

Similarly, the gender variation was observed for the males and females to check for G.P. The existence of G.P was more valid in the females (43%) than males showing (38%)

Table 1
Red proportion of central incisor (C.I) and lateral incisor (L.I).

T test One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
RED C. I and L.I	105	84.71168	8.749141	.853829
RED L. I and Canine	105	106.50437	12.383905	1.208545

Table 2
Red proportion of lateral incisor (L.I) and canine (C).

T test One-Sample Test						
	Test Value = 66					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
RED C. I and L.I	21.915	104	<0.001	18.711680	17.01851	20.40485
RED L. I And Canine	33.515	104	<0.001	40.504370	38.10778	42.90096

Table 3
Frequency of Golden proportion between Central Incisor and Lateral Incisor.

		Frequency	Percent	Valid Percent	Cumulative Percent
Validity	Not valid	98	93.3	93.3	93.3
	Valid between C.I and L.I	7	6.7	6.7	100.0
	Total	105	100.0	100.0	

Table 4
Frequency of Golden proportion between Lateral Incisor and Canine.

		Frequency	Percent	Valid Percent	Cumulative Percent
Validity	Not valid	70	66.7	66.7	66.7
	Valid between L.I and Canine	31	29.5	29.5	96.2
	G.P exists in the anterior sextant	4	3.8	3.8	100.0
	Total	105	100.0	100.0	

Table 5
Gender distribution of RED and G.P

Gender	RED C.I and L.I	RED L.I and Canine
Females(56)	83.4 ± 7.8	105 ± 11.5
Males(50)	84.7 ± 8.4	106.5 ± 11.6
TOTAL (106)		
Gender	GP valid in the anterior dentition	GP invalid in the anterior dentition
Females(56)	43%	57%
Males(50)	38%	62%
Total (106)	100%	100%

4. Discussion

In order to attain an esthetic restorative result, it is essential to establish a scientific or statistical relationship between teeth.[11] The artistic guidelines and norms to transform smiles have proven to have some discrepancies evident in the population due to a varying racial origin.

This study was performed on 106 subjects, 50 male and 56 female subjects. The exclusion criteria removed patients with any maligned teeth like crowding, spacing and rotation as it can be detrimental in the measurement of an individual tooth. The age group of 18–25 was selected as at that age esthetics is the prime concern more than occlusion.[12] Orthodontic treatment and cosmetic surgeries were another exclusion factor as facial profile could have been altered during the treatment process. The photography section was standardised with marking and measuring the distance between the tripod and subject. The angulation of the camera was kept straight at 90° to the subject, guided by the spirit level on the tripod and the interpupillary line on the subject. The source of light was kept constant throughout the study period.

Images captured of the subject were stored on one desktop and could be reviewed when required. This improved their availability and accessibility to verify measurements. The fundamental factor in obtaining a superior quality image lies in the use of a high-quality camera with adequate lighting and a proper depth of field and no distortion.

The objective assessment of the samples was recorded for RED and Golden proportion. In our present study, the results obtained by measuring the RED proportion differed from the ideal values as proposed by Ward.

The values obtained for RED proportion denotes that it varied significantly from what was suggested ideal by Ward (60–80%). These figures of the Height/Width ratio of central incisor were similar to the ones reported by Shetty et al.[1] Hence, no conclusive data was reported in this study to back the RED proportion theory when applied to natural esthetic smile.

The inconclusive data could be because of the variation of ethnicity not being taken into consideration in the ideal values given by Ward.

Literature has reported conflicting views about the use of various proportions for evaluating smiles.[13] Fayyad et al.[14] from his study inferred that Golden Proportion failed to exist in the anterior dentition as it was found in only 38.2% of the population. No particular proportion in their study could satisfy all the rules of geometry in nature.[15]

The result of the present study is also analogous to the previously reported ones.

The values for Golden Proportion also exhibited that it was disproportionate for 50.5% for the samples. This result could be accredited to the point that a harmonious smile need not always follow a constant ratio. Golden proportion was not found to be practical in the assessed width of the maxillary anterior dentition of our present study. No Proportion should be blindly followed during anterior dental restorations as it may lead to displeasing results. Anterior teeth should be rehabilitated with distinctive and rational proportions based on the individual's cultural characteristics and definite measurements rather than following a general rule. However, we can slightly modify these percentages and adopt them keeping in mind racial differences of the subjects in this study.

Total population in Kochi is 3,462,920,[16] out of which we have taken a very small sample size of 106 subjects aged 18–25. This is the biggest limitation to the study; more extensive research is needed to confirm the presence of these proportions.

5. Conclusion

The aim of the present research was to compare and review the relevance of golden proportions and RED proportions in Keralites.

From the results obtained in our study, following conclusions can be highlighted:

- 1. The ratio of the height and width of the anterior sextant emphasized that the values recorded were not within the same range as proposed by Ward. It was noted that there is no fixed proportion when moving distally from the central incisor as the range varied from 65% to 115%. However, on classifying the teeth separately as: tall, medium or short, the application of RED may prove beneficial. Thus, a desired RED proportion could be designated with varying tooth height as substantiated by Rosensteil et al.[17]
- 2. The analysis of Golden Proportion, denoted that it was invalid for more than half of the subjects included in the study. Hence, the use of golden proportion failed to be used as a criteria to restore the anterior dentition.

Therefore, it can be concluded that the use of RED and Golden Proportion are not reliable mathematical ratios for designing smiles. A new proportion inclusive of the various facial and racial parameters is of utmost importance to recreate smiles in Keralites. The major limitation of the study was the small sample size, further extensive research needs to be carried out to understand these proportions.

Declaration of competing interest

Acknowledgments

References

1　Shetty S, Pitti V, Satish Babu C, Surendra Kumar G, Jnanadev K. To evaluate the validity of Recurring Esthetic Dental proportion in natural dentition. *J Conserv Dent JCD*. 2011;14(3):314–317.

2　Ward DH. Proportional smile design using the recurring esthetic dental (red) proportion. *Dent Clin North Am*. 2001;45(1):143–154.

3　Levin EI. Dental esthetics and the golden proportion. *J Prosthet Dent*. 1978;40(3): 244–252.

4　Meshramkar R, Patankar A, Lekha K, Nadiger R. A study to evaluate the prevalence of golden proportion and RED proportion in aesthetically pleasing smiles. *Eur J Prosthodont Restor Dent*. 2013;21(1):29–33.

5　Ward DH. A study of dentists' preferred maxillary anterior tooth width proportions: comparing the recurring esthetic dental proportion to other mathematical and naturally occurring proportions. *J Esthet Restor Dent Off Publ Am Acad Esthet Dent Al*. 2007;19(6):324–337. ; discussion 338-339.

6　LC P, S B, AS D, H M, RH T, KS S. Facial indices of North and South Indian adults: reliability in stature estimation and sexual dimorphism. *J Clin Diagn Res JCDR*. 2013; 7(8):1540–1542.

7　Ward DH. Proportional Smile Design: Using the Recurring Esthetic Dental Proportion to Correlate the Widths and Lengths of the Maxillary Anterior Teeth with the Size of the Face. *Dent Clin North Am*. 2015 Jul;59(3):623–638. https://doi.org/10.1016/j. cden.2015.03.006. PMID: 26140969.

8　Shankari, et al. *Smile Design Using Recurring Esthetic Dental Propo.pdf*. 2018.

9　Levin EI. *The Updated Application of the Golden Proportion to Dental Aesthetics*. vol. 5. 2011:6, 3.

10　Murthy BS, Ramani N. Evaluation of natural smile: golden proportion, RED or Golden percentage. *J Conserv Dent*. 2008;11(1):16.

11　Rupesh S, Rakesh S, Winnier JJ, et al. The Role of Divine Proportion in the Perception of Beauty: A Cross Sectional Study. :6.

12　Soares GP, Valentino TA. Esthetic Analysis of the Smile. :8.

13　Maharjan A, Joshi S. Clinical evaluation of maxillary anterior teeth in relation to golden proportion, red proportion and golden percentage. *J Nepal Health Res Counc*. 2018;16:11.

14　Fayyad MA, Jamani KD, Aqrabawi J. Geometric and mathematical proportions and their relations to maxillary anterior teeth. *J Contemp Dent Pract*. 2006;7(5):62–70.

15　Johnston CD, Burden DJ, Stevenson MR. The influence of dental to facial midline discrepancies on dental attractiveness ratings. *Eur J Orthod*. 1999;21(5):517–522.

16　Population Ernakulam. *District Taluks List, Kerala* [Internet]. [cited 2022 Apr 2]; Available from:; 2021/2022. https://www.indiagrowing.com/Kerala/Ernakulam.

17　Rosenstiel SF, Ward DH, Rashid RG. Dentists' preferences of anterior tooth proportion–a web-based study. *J Prosthodont Off J Am Coll Prosthodont*. 2000;9(3): 123–136.