

A Study to Evaluate the Prevalence of Golden Proportion and RED Proportion in Aesthetically Pleasing Smiles

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Abstract - A beautiful smile is the most striking feature in the face. However, beauty is not absolute and is extremely subjective. The aim of this study is to determine the prevalence of 'Golden proportion and Recurring aesthetic dental proportion' in individuals presenting attractive smiles. 214 smile photographs of students of SDM Dental College aged 18-25 years with natural dentition were analysed for their attractiveness based on 6 predetermined criteria. Further, smiles were digitally analysed to evaluate the prevalence of Golden Proportion and Recurring Aesthetic dental proportion (RED) and obtained data was statistically analysed. RED proportion was present in 6.6% of population as opposed to golden proportion which was found in 0.6% of population. It was found that 70% RED was more prevalent than Golden Proportion in attractive as well as unattractive smiles..

KEY WORDS: Golden proportion, Recurring aesthetic dental proportion, aesthetics, smile, smile design, attractive smile

INTRODUCTION

A beautiful smile is perhaps the most striking feature in the face. It is an expression which conveys various emotions like pleasure, happiness or amusement. The smile is a means of communicating emotions throughout the world and is a uniquely human gesture.

According to Tjan *et al* 1984, the smile type (high, average or low), parallelism of maxillary incisal curve relative to touching the lower lip & number of teeth displayed in a smile are the factors governing whether a smile is pleasing or not¹. Usually obvious asymmetries, unpleasant dental alignment such as crowding, spacing, malformations & discolouration of the dentition create a visual tension and does not constitute an aesthetic smile². "Smile designing" is one of most important aspects of aesthetic dentistry. Aesthetics have become increasingly important in the practice of modern dentistry & are synonymous with a natural harmonious appearance. But aesthetics are not absolute and are extremely subjective. A large number of individuals seek dental care for aesthetic reasons, and wish to look more attractive by improving their smiles³.

Smile designing has long been considered a subjective art. Most of the aesthetic disciplines have prescribed proportions & ratios to improve aesthetics. Scientific analysis of beautiful smiles have shown that repeatable, measurable & objective principles can be systematically applied to evaluate & improve aesthetics in a predictable way. One of the most important tasks in smile designing lies in creation of harmonious proportions between widths of maxillary anterior teeth. Different ratios can be used depending upon the cervico-incisal length and mesio-distal width of teeth⁴.

Several tooth proportion theories have been advocated that relate the relative widths of maxillary anterior teeth. Amongst these, the 'Golden Proportion' is said to be the cornerstone of smile designing. The golden proportion was described by Pythagoras in 6th century B.C. and later by Greek geometrician Euclid⁵. It has also been called different names: the divine proportion by Pacilio a mentor of Leonardo Da Vinci, sacred geometry, magic numbers and the golden cut. It is found in art, architecture and anatomy. These proportion seem to display maximum beauty and ultimate efficiency in function. This ratio is approximately 1.61803: 1 that is the smaller section is about 62% the size of larger. The uniqueness of this ratio is that the ratio of smaller part to larger part is the same as the ratio of larger part to the whole. The application of golden proportion to dentistry was first proposed by Lombardi⁶. Levin discovered that from frontal aspect the width of maxillary lateral incisor is in golden proportion to width of maxillary central incisor and so is the width of maxillary canine to lateral incisor⁷. Snow proposed the 'Golden Percentage or Golden Mean' theory in 1999 which stated that width of maxillary central incisor should be 25%, maxillary lateral incisor 15% and maxillary canine 10% of the total intercanine distance as viewed from front⁸. It is independent of width of lateral incisor for its analysis.

Lombardi in 1973⁶ suggested the Repeated Ratio which states that the existing proportion between widths of central and lateral incisor should be consistently progressing anteriorly to posteriorly in the mouth. Some of these ratios include Plato beauty proportion (57%), Aesthetic norm proportion (71%), Quarter 3:4 proportion (75%) and Human norm 5: 6 proportion (80%)⁹. The Recurring Aesthetic Dental Proportion (RED) states that the proportion of successive widths of maxillary teeth as viewed from front should remain constant. This theory is based on linear coefficient of progression in which width of each successive tooth as viewed from front diminishes by the

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same proportion. The width of lateral incisor is reduced by a selected percentage from the width of central incisor and width of each tooth distally is reduced by this same percentage from its mesial tooth. 70% RED proportion has been recommended for normal length teeth. Rosenstiel and colleagues reported that dentists preferred smile with 80% RED proportion when viewing very short teeth, 70% RED proportion when viewing normal length teeth and 62% RED proportion (golden proportion) when viewing very long teeth⁴. Ward preferred 70% RED proportion and recommended adhering to concept of Repeated Ratio given by Lombardi⁹. Despite these observations, Preston found natural teeth rarely existed in the Golden Proportion¹⁰. Similar findings were reported by Gillien and colleagues in their study on 54 subjects¹¹. Basting *et al* in 2006 conducted a survey and suggested that 70% RED proportion should be used while proportioning the anterior teeth¹².

Conflicting reports indicate that the majority of beautiful smiles did not have proportions coinciding with the golden proportion formula^{13,14,15}. Hulsey and colleagues reported that the most attractive smiles have nearly perfect harmony between the arcs of curvature of the incisal edges of the maxillary incisor and the upper border of the lower lip, and that the upper lip came to the height of the gingival margin of the maxillary central incisor¹⁶. Yoon *et al*¹⁷ found that in an attractive smile, the full shape of the maxillary anterior teeth was displayed between the upper and lower lip, the upper lip curved upward or was straight, the maxillary anterior incisal curve was parallel to the lower lip, and the teeth were displayed to the first molar. The aim of this study was to determine the prevalence of golden proportion and 70% RED proportion in aesthetically pleasing smiles.

MATERIAL AND METHODS

The study recruited 214 students from SDM College of dental sciences and hospitals, Dharwad between the age of 18 – 25yrs with maxillary incisors and canines presenting with anatomic integrity. Individuals who had undergone orthodontic treatment, any kind of prosthetic rehabilitation in the maxillary anterior region, fractured or malformed or congenitally missing teeth were excluded from the study.

Criteria for aesthetically pleasing smile

- displaying at least the second premolar
- revealing no gingival recession in the smile area
- having interdental papilla that filled interdental space that was not hyperplastic
- displaying less than 3mm of maxillary gingiva on smiling
- displaying the line of lower lip parallel to incisal line of maxillary teeth and also to an imaginary line linking the contact points of these teeth
- presenting symmetry upon visual examination

These criteria were considered for a smile to be aesthetically pleasing or agreeable. The rest of the smiles were considered unpleasing or non agreeable¹¹. The obtained data was statistically analyzed using Pearson's chi-square test and Fisher's Exact Test.

DATA COLLECTION

The approval to use human subjects was obtained from the governing body of Rajiv Gandhi University of Health Sciences, Karnataka. Informed consent of individual subject was taken. The subjects were induced to a spontaneous maximum open smile (smile displaying teeth). Frontal photograph of middle and lower third of the face was taken with a Nikon DSLR 200 105mm Macro lens ratio 1:1F/2.8 digital camera. Lighting and staging were kept constant for all the photographs. Digital management of the photographs was undertaken using Adobe photoshop CS (version 8.0, 2003 Adobe) along with visual examination to evaluate for the presence of 6 parameters of aesthetically pleasing smiles. The smiles that fulfilled all the six criteria were then classified as aesthetic smiles and the rest as unpleasing or non agreeable smiles.

In both the groups the apparent mesio-distal measurement of the six anterior teeth was made digitally using Adobe photoshop CS (version 8.0, 2003). The measurements taken were less than the actual ones since the teeth are arranged in a convex arch and the software makes linear measurements. From the obtained measurement ratio of lateral incisor to central incisor and canine to lateral incisor was calculated. Further Recurring Aesthetic Dental proportion was found out by calculating the percentage difference between central incisor, lateral incisor and canine.

RESULTS

All the smile photographs were evaluated for presence of six characters which define an aesthetically pleasing smile. The percentage values of the occurrence of the parameters in 214 subjects is given in figure 1 and table 1.

On evaluation of smiles it was found out that out of 214 smiles analysed, 54 of them satisfied all the six criteria and were classified as aesthetic smiles and the rest as unpleasing smiles as shown in figure 2. All the smiles in both the groups were measured for their apparent mesio-distal width digitally and Golden Proportion and Recurring Aesthetic Dental proportion was calculated. It was seen that Golden Proportion existed in isolation in 3.9% of individuals between central and lateral incisor. Between lateral incisor and canine it was seen in 0.6% of individuals. Whereas Recurring Aesthetic Dental proportion was seen in 6.6% of the individuals.

Pearson's chi-square test was applied to test the association between the golden proportion and aesthetics of smile (table 2 and 3). There was a significant association between the two measures. The prevalence of Golden Proportion was seen to be more in the unaesthetic group than in the aesthetic group.

Fisher's Exact Test was applied to test if there was a significant association between aesthetics of smile and presence of RED (table 4). It was found that there was no significant association between the two ($p=0.34$). However, the aesthetic smiles had slightly higher proportion (9.3% vs 5.5%) of subjects with RED compared to those who did not have aesthetic smile.

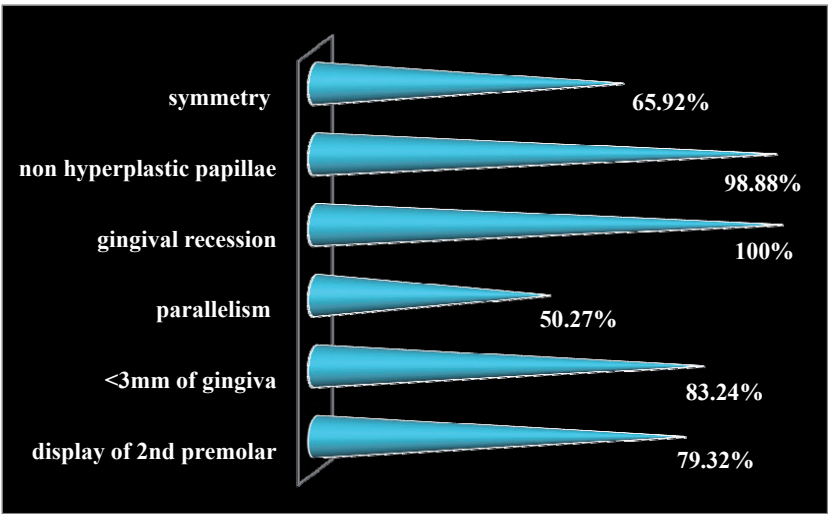


Figure 1. Shows the Percentage values of occurrence of parameters

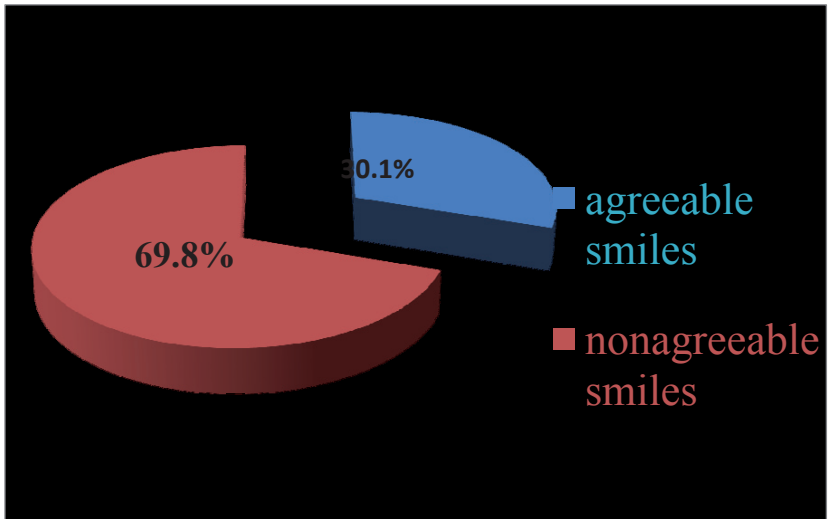


Figure 2. Shows the percentage of agreeable and Non agreeable smiles

Table 1. Percentage values of occurrence of parameters

Absence of gingival recession in smile area	100%
Non hyperplastic papilla filling up all interdental spaces	98.88%
Less than 3mm of gingival displayed on smiling	83.24%
Display of atleast 2 nd premolar	79.32%
Symmetry on visual examination	65.92%
Parallelism of lines	50.27%

DISCUSSION

Many patients come to the dentist seeking an attractive smile. Levin’s idea of Golden Proportion has been advocated by Goldstein to be used as an aesthetic guideline for restoring and replacing maxillary anterior teeth⁵. The golden proportion, when applied to the dentition, indicates that if the perceived width of each anterior tooth is approximately 62% the size of its adjacent anterior tooth, then it is considered aesthetically pleasing¹⁸. Furthermore,

some authors believe that the golden proportion occurs more consistently in aesthetically pleasing smiles as opposed to randomly selected smiles^{5,6}. Recently, the “Recurring aesthetic dental proportion” concept was introduced, stating that clinicians may use a proportion of their own choice, as long as it remains consistent, proceeding distally in the arch^{14,15}. In the current investigation aesthetically pleasing smile was the criterion in selecting the subjects for evaluating golden proportion and RED. Rather than being focused on the 62% proportion, Ward²¹ recommended using other ratios, such as 70%, to provide a more pleasing appearance. In an Internet based study by Rosenstiel⁴ *et al*, it was reported that rather than concentrating on a single ratio such as the golden proportion, other ratios reflecting harmony among the tooth lengths should be considered when striving to produce a satisfactory appearance.

In the study by Castro *et al* it was reported that Golden Proportion was present in only 7.1% of the individuals examined. Mahshid *et al*^{2, 20} concluded that the Golden Proportion was not prevalent and other proportions should be taken into consideration while restoring or replac-

Table 2. Golden proportion percentage values in aesthetically pleasing and unaesthetic smiles

Smile	Golden Proportion - Lateral and Central incisor (within Prestons range of 0.61 – 0.63)			Total
	Golden proportion absent on either side	Golden proportion present on 1 side	Golden proportion present on both side	
Unaesthetic	78.7%	16.5%	4.7%	100%
Aesthetic	94.4%	3.7%	1.9%	100%
Total	83.4%	12.7%	3.9%	100%

(p = 0.033, significant)

Table 3. Golden Proportion - Lateral incisor and Canine (within Prestons range of 0.61 – 0.63)

Smile	Golden Proportion - Lateral incisor and Canine (within Prestons range of 0.61 – 0.63)			Total
	Golden proportion absent on either side	Golden proportion present on 1 side	Golden proportion present on both side	
Unaesthetic	88.2%	11.8%	0 %	100%
Aesthetic	96.3%	1.9%	1.9%	100%
Total	90.6%	8.8%	0.6%	100%

(p = 0.032, significant)

Table 4. RED proportion values in percentage occurring in aesthetic and unaesthetic smiles

Smile	Recurring Esthetic Dental proportion (RED) Within range of 65-75%		Total
	RED present	RED absent	
Unaesthetic	5.5%	94.5%	100%
Aesthetic	9.3%	90.7%	100%
Total	6.6%	93.4%	100%

(p = 0.34, not significant)

ing maxillary anterior teeth. In the present study similar findings were obtained. The Golden Proportion was not prevalent in pleasing or unpleasing smiles. It tended to exist only in isolation between canine and lateral incisor and between lateral and central incisor. This prevalence was more in unaesthetic smiles than in esthetic smiles. On the other hand 70% RED proportion was more prevalent in pleasing than in unpleasing smiles. These findings together with the results of earlier published reports^{4,9,10} on golden proportion suggests that it is not common in esthetically pleasing smile. In the present study it was observed that even though smile was esthetic it did not exhibit golden proportion. This suggests that dentist should not rely on any one proportion such as golden proportion, RED proportion, Golden ratio, Plato beauty proportion (57%), the esthetic norm proportion (71%), the quarter 3:4 proportion (75%)¹⁵. Since many factors contribute to the smile such as tooth shape, lip characteristics, gingival architecture, posterior teeth, mandibular teeth, they should all be taken into consideration while smile designing. Additional research on greater sample size is needed for evaluating variables such as gender, ethnicity.

CONCLUSION

In the 214 smiles examined, 70% RED proportion was more prevalent than the Golden proportion in both pleasing as well as unpleasing smiles. The percentage of smiles showing RED proportion is too small to be advocated as the only proportion to be used while restoring maxillary teeth. Depending upon the size of teeth different tooth proportion options should be explored. Within the limitations of the study it can be concluded that while restoring or replacing maxillary anterior teeth all proportions should be taken into consideration.

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