Comparative photographic evaluation of various geometric and mathematical proportions of maxillary anterior teeth: A clinical study

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ABSTRACT

Aim: This study aimed to investigate the existence of the golden proportion, recurring esthetic dental (RED) proportion and golden percentage between the frontal view widths of the maxillary anterior natural dentition among students of Indian origin by the aid of digital photography.

Materials and Methods: This study was conducted with 80 dental students (41 female and 39 male), with ages ranging from 20 to 23 years. Students whose natural smile did not develop any visual tension with regard to the study’s and their own criteria were selected as having an esthetic smile. Photographs were taken, and the mesiodistal widths of six maxillary anterior teeth were measured digitally using software. Once the measurements were recorded three different theories of proportion were applied and statistical analysis was done.

Results: The golden proportion, i.e., 62% RED proportion and golden percentage were not observed in the subjects. According to the subjects evaluated, the average width of the maxillary lateral incisor was 72% of the frontal view width of the central incisor. The average width of the canine was 84% of the frontal view width of the lateral incisor.

Conclusion: The golden proportion and RED proportion were not observed in the natural smiles of subjects who were deemed to have an esthetic smile. The values proposed for the golden percentage theory were not observed in subjects with an esthetic smile. Average frontal view percentage widths of the maxillary anterior dentition exist and can be useful in predicting naturally occurring widths in smiles deemed to be esthetic in a specific population.

Key words: Golden proportion, golden percentage, recurring esthetic dental proportion

A large number of studies have shown that the esthetics is an important factor in patients treatment decision.1 Ricketts devised a golden proportion caliper to establish and evaluate the ratios between various elements of the attractive face.2 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.”3 Levin pointed out that “the width of the maxillary lateral incisor is in golden proportion to the width of the central incisor and also the width of the maxillary canine to the lateral incisor when viewing from the front.”4 Surprisingly, according to Levin’s idea, the golden proportion has been introduced in most textbooks as an esthetic guideline in maxillary anterior teeth restoration. The concept of the “golden proportion” has often offered as a cornerstone of smile design theory.

Ward recommended the recurring esthetic dental (RED) proportion where the proportion of the successive viewed width of the maxillary anterior teeth remains constant when progressing distally from the midline. He recommended a range of RED proportions from 62% to 80% and that very...
tall teeth looked best with a 62% RED proportion (golden proportion), average length teeth looked best with a 70% RED proportion, and very short teeth looked best with an 80% RED proportion.\textsuperscript{5}

Snow suggests golden percentage where there is fixed proportion of each tooth, canine 10%, lateral 15%, central 25%, central 25%, lateral 15%, and canine 10% of the frontal view intercanine width from distal of the canine to the distal of the canine.\textsuperscript{6}

Preston studied the relationship of the golden proportion to the perspective dimension of the maxillary dentition anteroposteriorly in North American dental students. He reported that the width of the average maxillary lateral incisor was 66% of the frontal view width of the central incisor. The width of the average canine was 84% of the frontal view width of the lateral incisor.\textsuperscript{7}

This study was conducted to compare various proposed mathematical and geometric proportions with the naturally occurring proportions in patients deemed to have an esthetic smile.

**MATERIALS AND METHODS**

**Subject selection**

Eighty dental students, 41 female and 39 male students in 20–23 age group, were selected for the study.

**Inclusion criteria**

Subjects having natural dentition in the maxillary anterior region and belonging to Indian origin were included in the study.

**Exclusion criteria**

Subjects who have undergone surgical or orthodontic treatments, periodontal treatments, and prosthesis in the region of upper teeth, dentoalveolar trauma, dentofacial deformities, or any other asymmetry in upper arch: Spacing, rotation, and tooth inclination were excluded from this study.

**Image capture**

A standardized frontal image of each subject’s face was taken using a digital camera (Canon, PowerShot A2400 IS, Canon Inc., China). The subject’s head was positioned, so the Frankfort horizontal plane was parallel to the floor, and the mid-sagittal plane of the head was aligned with the center of the camera lens. The camera was positioned and adjusted so as to obtain a sharp image of the face from the tip of the nose to the tip of the chin. The distance between the subject and the camera was fixed at a working distance of 60 cm. The camera was stabilized with the help of tripod, at this fixed distance. The image was captured when the subject was asked to smile. The images were downloaded onto a personal computer. All measurements were performed utilizing the Motic Images Plus 2.0 software (Motic Images, China), and all measurements were performed by one investigator [Figure 1].

**Measurements**

The golden proportion was measured as follows: The width of the central incisor was multiplied by 62% and compared with the width of the adjacent lateral incisor. If same values are derived, central incisor is in golden proportion to lateral incisor. Similarly, if same values are obtained when, the width of the lateral incisor multiplied by 62% and compared with the width of the adjacent canine, lateral incisor is in golden proportion to canine.

The RED proportion was calculated by dividing the width of lateral incisor by the width of the adjacent central incisor and multiplying by 100. Similarly, the width of each canine was divided by the width of the adjacent lateral incisor and multiplied by 100. Central incisor, lateral incisor, and canine are in RED proportion, if the resultant values are constant.

The golden percentage was calculated by dividing the width of each central incisor, lateral incisor, and canine by the total width of all six maxillary anterior teeth, multiplied by 100. The six maxillary anterior teeth are in golden percentage, if the values from canine to canine were 10%, 15%, 25%, 25%, 15%, and 10%.

The data were statistically analyzed using the paired Student’s t-test \( P < 0.05 \).

**RESULTS**

Out of total subjects, 3.75% had left central incisor in golden proportion (62% RED Proportion) to left lateral incisor [Graphs 1 and 2], 3.75% subjects had left lateral incisor in golden proportion (62% RED proportion) to left canine [Graphs 3 and 4], and 3.75% subjects had right central incisor in golden proportion (62% RED proportion) to right lateral incisor [Graphs 5 and 6]. 6.25% subjects had right lateral incisor in golden proportion (62% RED proportion) to right canine [Graphs 7 and 8].

The mean values and standard deviation for RED proportions for males and females are listed in Table 1. RED proportion between central and lateral incisor lie in the 74–76% range. RED proportion between canine and lateral incisor lie in the 82–84% range.

The values obtained for golden percentage, beginning with right side canine and moving to left canine, in this study were 13, 15.5, 21.5, 21.5, 15.5, and 13%.

Graph 9 shows the relationship between the golden percentage suggested by Snow and the actual percentage for each anterior tooth in this study.
DISCUSSION

Dental esthetics is a primary consideration for patients. Not only for dental esthetics but also for facial esthetics, the size and form of the maxillary anterior teeth are important. Determination of a mathematical or geometrical relation between anterior teeth is important to achieve an esthetic result. Existence of statistically reliable results will help to support existing theories.

This study was conducted on 80 dental students, 41 female and 39 male students in 20–23 age groups. This study found poor correlation between teeth dimensions and the golden proportion which is similar to the findings of Preston[7] in 1993, Gillen et al.[8] in 1994, Mahshid et al.[9] in 2004, Hasanreisoglu et al.[10] in 2005, Ali Fayyad et al.[11] in 2006,

Figure 1: Measurement by software

Graph 1: Indicates golden proportion relation between left central incisor (blue line) and left lateral incisor (red line) in male subject

Graph 2: Indicates golden proportion relation between left central incisor (blue line) and left lateral incisor (red line) in female subject

Graph 3: Indicates golden proportion relation between left lateral incisor (blue line) and left canine (red line) in male subject

Graph 4: Indicates golden proportion relation between left lateral incisor (blue line) and left canine (red line) in female subject

Graph 5: Indicates golden proportion relation between right central incisor (blue line) and right lateral incisor (red line) in male subject
Murthi and Ramani\textsuperscript{[12]} in 2008, Petricevic \textit{et al.}\textsuperscript{[13]} in 2008, and Al-Marzok \textit{et al.}\textsuperscript{[14]} in 2013. Rosenstiel \textit{et al.}\textsuperscript{[15]} found that golden proportion was preferred only when viewing very tall teeth and less desirable for normal height or shorter teeth. However, the universal use of the golden proportion should no longer be considered since numerous articles have found that the golden proportion was not observed in a majority of observed natural smiles.

With respect to RED proportion, the results of this investigation showed that the ratio of the width of maxillary lateral incisors to the width of central incisors is between 74 and 76\%. The ratio of the width of canine to the width of lateral incisor is between 82 and 84\%. In this study, the ratio between central and lateral incisors and between lateral incisors and canine is not constant. The ratio increases as one move distally. Hence, there is no evidence in this study to support the RED proportion theory as applied to natural dentition. The results of RED proportion obtained were similar to that obtained in the study done by Murthy\textsuperscript{[12]} in 2008 and Shetty\textsuperscript{[16]} in 2011.

For using the golden percentage theory, the result of the present investigation suggests the mean values for a golden percentage for central incisors is 21.11–21.50\%. These figures are lower than those suggested by Snow\textsuperscript{[6]} who estimated a value of 25\% for central incisors. However, the mean values of golden percentage for lateral incisors ranged from 15.44\% to 15.90\%. These figures can be considered to be in agreement with those suggested by
Snow\(^6\) who recommended a value of 15% as the golden percentage for lateral incisors. With respect to the golden percentage of canines, the results of this study showed mean values of 12.91–13.10%. These figures are higher than those suggested by Snow\(^6\) who recommended a golden percentage value of 10% for canines. This values obtained are very comparable to that suggested by Shreenivasan,\(^{12}\) i.e. 22% for centrals, 15.5% for laterals, and 12.5% for canines. Furthermore, a recent study conducted by Markovics\(^{17}\) showed that golden proportion is not applicable. Based on our variable results, golden percentage also does not seem to exist.

**CONCLUSION**

Thanks to the wealth of nature, esthetics cannot be constrained within mathematical limits in dentistry. It is difficult to standardize aesthetics because the perception of beauty varies from person to person.

From this investigation, the following conclusions can be derived:

- The golden proportion was not observed to be present between the successive widths of the maxillary anterior teeth in a significant number of smiles deemed to be esthetic in the natural smiles evaluated.
- The RED proportion was not found to be present between the successive widths of the maxillary anterior teeth in a significant number of smiles deemed to be esthetic in the natural smiles evaluated.
- Golden percentages as defined by Snow were not found to be present in a significant number of smiles deemed to be esthetic in the natural smiles evaluated, however, the concept of different defined percentages between the successive widths of the maxillary anterior teeth was deemed to useful in a given ethnic group.

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**Conflicts of interest**

There are no conflicts of interest.

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