

## Golden proportion: God's signature on his masterpieces

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### ABSTRACT

We can't deny the importance given to beautiful face and smile in the modern society . The golden proportion is based on a very specific mathematical proportion that is acquired from mathematics and nature. Although controversial, the golden proportion has been the gold standard for beauty and fundamental principle in the smile designing to aid in improving dental esthetics in a predictable way. This article discusses the golden proportion and its role in dental aesthetics.

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### Introducion

"The beautiful is a manifestation of the secret law of nature. Nature geometrizes universally in all her manifestations." - H.P. Blavatsky. The Greeks said that all beauty is mathematics and geometry. They were the first to perform facial measurements in the quest to find the mathematical code or formula for facial beauty. The measurements of beautiful and aesthetically pleasing features, animate and inanimate, unveiled this secret. The same proportion or ratio appears so frequently as a measurement of beauty that it has almost become synonymous with beautiful and harmonious forms. This proportion is unique and is called as golden proportion. It appears, as if god has created all his masterpieces with this measure. It's his fingerprints on his creations. The golden proportion is esthetically pleasing for it triggers our senses to a subconscious and innate sense of beauty.[1]

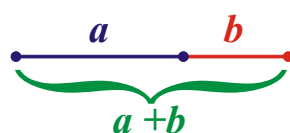


Figure.1  $a+b$  is to  $a$  as  $a$  is to  $b$

In mathematics and the arts, two quantities are in the golden proportion, if the ratio of its parts is in the ratio of 1:1.618. Also, the ratio of the sum of the quantities to the larger quantity is equal to the ratio of the larger quantity to the smaller one (Figure 1).

This mathematical proportion seems to permeate throughout universe; it exists in the smallest to the largest of God's creation, in living and also in nonliving things; from the spirals of

galaxies to the spiral of a Nautilus seashell; from the harmony of music to the beauty in art. A botanist will find it in the growth patterns of flowers and plants, while a zoologist sees it in the breeding of rabbits. This magical number has been called by many names as golden ratio, golden proportion, divine proportion, "Phi".

"There is a proportion that the mind registers at the subconscious level that provides beauty, comfort and pleasures to the senses. This mathematic relation is called golden proportion"-R. E. Goldstein

In a Golden Proportion rectangle however the smaller part is at right angles to the larger part (Figure.1), its sides are in the proportion 1.000:1.618. If a square is removed from this rectangle, the remaining rectangle is also a golden rectangle (Figure.2).

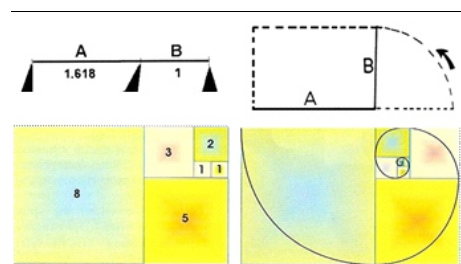


Figure.2 Golden rectangle and golden spiral

Continuing this process produces a series of nested golden rectangles. Connecting the successive points where the 'whirling squares' divide the sides of the rectangles in golden ratios produces a logarithmic spiral, which is found in many natural forms(Figure 3) .



Figure.3 Example of golden proportion in nature

### Historical Background

The ancient Greeks have often been credited with defining the Golden Proportion. Aristotle, pointed out the value of proportion in esthetics as early the fourth century B.C. [2]

Pythagoras and Phidias are believed to have identified it. The Golden Proportion was closely studied by the Greek sculptor Phidias, hence the designated mathematical symbol for the Golden Proportion ratio is  $\phi$ . Badawy claims that the use of proportions was initiated by the ancient Egyptians, based on his study of Egyptian buildings, sculptures, and paintings. The ancient Egyptians used it in the construction of the great pyramids and in the design of hieroglyphs found on tomb walls (Figure 4).

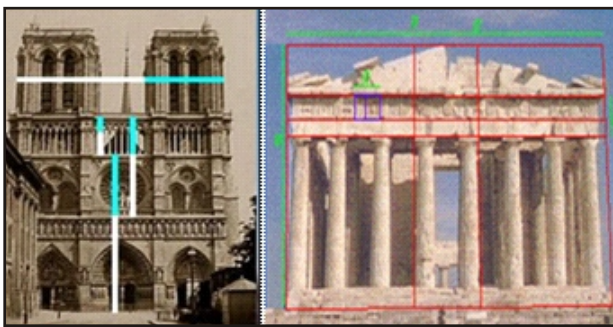


Figure 4. Example of golden proportion in architecture



Figure 5. Example of golden proportion in art

Renowned artists like Michelangelo, Raphael, and Leonardo da Vinci made use of this concept. Leonardo da Vinci drew the "ideal man" using the Golden Proportion, and the head of Mona Lisa was drawn using this relationship (Figure 5). [1,2]

### Golden Proportion in Dentistry

Concept of golden proportion was first mentioned in dentistry by Lombardi and later developed by Levin in 1978. According to Levin (1978) "the perceived width of the maxillary central incisor is in golden proportion to the width of the lateral incisor." Similarly, "the width of the maxillary lateral incisor is in golden proportion to the width of the canine, (Figure 6). These proportions are derived from the apparent size of the teeth as viewed directly from the anterior aspect and not their measured widths. Golden proportion should not be assessed from chairside as there are chances of parallax. Levin also designed the golden mean gauge and diagnostic grid to easily measure and incorporate golden proportion in dentistry. [1]

### Golden Proportion for Restorative /prosthetic Smile Designing

The five main features of the Golden Proportion applicable to dentistry are summarized as follows:

1. The eight teeth of the anterior aesthetic segment are all in the Golden proportion to each other, (Figure 6).
2. The eight teeth of the anterior aesthetic segment from premolar to premolar are all in the Golden Proportion, to the width of the smile, (Figure 6).
3. The width of the two central incisors is in the Golden Proportion to their height as shown in (Figure 7(a))
4. In the relaxed face, the incisal edge of the incisors divides the distance from the bottom of the nose to the bottom of the chin into the Golden Proportion. This way, we can decide the height of the incisors for full dentures and in full mouth- rehabilitation, (Figure 7(b)).
5. Distance between inner canthus of one eye to the outer canthus of other side eye is equal to the width of smile. Also, while smiling anterior esthetic zone is in golden proportion to the width of the smile, (Figure 8 (a& b)).



Figure 6. Golden proportion in natural smile. Note the natural buccal spaces which is in golden proportion to the width of smile

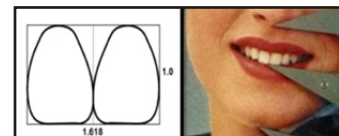


Figure 7a

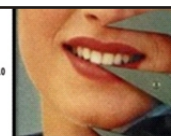


Figure 7b

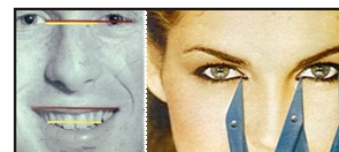


Figure 8a



Figure 8b

## Dental Diagnostic Grids

The most useful tool for the application of the Golden Proportion to dental aesthetics is the set of grids constructed in the Golden Proportion. Grid can be used to assess the aesthetics of the eight front teeth in patient mouth and in dental lab while fabricating the prosthesis.

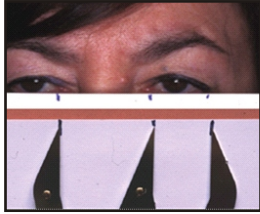


Figure 9(a). Checking that the eye landmarks are in golden proportion



Figure 9(b). Comparing the smile width with eye width

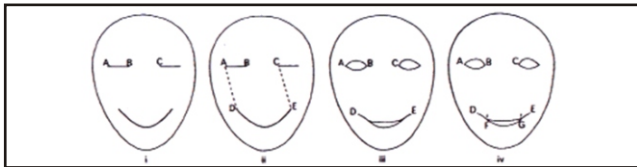


Figure 9(c). Diagrammatic representation of golden proportion relationship between eye and teeth

## Golden Proportion in Full Denture Prosthetics

Arches undergo bone resorption after loss of teeth. Golden proportion helps to find out, how much resorption has taken place and how far the upper incisors should be brought forward. We can build up the smile again close to the esthetic level, compensating for all the shrinkage by bringing the upper incisors forward. Golden proportion will help to determine exactly how wide to make the arch in the canine area or how much to emphasize a dominant feature at the corner of the arch. Following findings can be made use of to re-establish the harmony of the face while fabricating the full dentures.

1. The white of the eyes AB is in the Golden Proportion to the space between the eyes BC i.e.  $AB:BC=1:1.618$ , {Figure 9. a & 9.c (i)}
2. Width of smile DE= AC i.e. distance from the outer canthus of one eye to the inner canthus of the other eye, {Figure 9 c(ii)}
3. By measurement it will be found that the width of the smiling lips from one corner of the mouth to the other is equal to the distance between the bridge of the nose plus the width of the eye,  $AC=DE$ , {Figure 9c (iii)}.
4. Teeth visible in Smile (FG) is equal to the distance between the eyes (BC) and these two values are in golden proportion to the width of the smile (DE) { Figure 9c (iv)}.

We can now adjust the width of the smile by thickening the wax flange of the occlusal rims. The more the thickened flange pushes out the upper lip, the narrower will the width of the smile become. Till this width matches the value obtained by eye width measurements the wax rims should be adjusted.

The permissible width and height of the rehabilitated teeth in full dentures and in fixed prosthesis in view of the space left in maxilla and mandible can be determined by following esthetic principles and golden proportion (Figure 7 a&b). [3,4]

## To Determine the Size of a Replacement for Veneer / Crown on the Lateral Incisors.

Peg shaped lateral incisors are a common anomaly that interferes with the esthetics of anterior teeth. Golden proportion principles can be used to determine the height and width of these teeth for providing best possible esthetic smile. Measure the width of the central and use the appropriate sized grid. Position it in the mouth to see how the grid lines up to the teeth. The central and premolar would be fitting the grid as in natural teeth. We can now assess where and how the lateral should be built up. Cases where there is no space to achieve the correct width of lateral incisor, orthodontic movement of teeth can be done without sacrificing adjacent teeth surfaces by reduction (Figure 10).



Figure 10. Using dental diagnostic grid for determining the correct width of lateral incisor during orthodontic treatment

## Golden Proportion in Tooth Preparation for Veneer/Facing

Facings are used for dramatically improving the smile, with minimal tooth reduction. Usually very successful but occasionally they look peculiar.[3-5] The golden proportion helps us to analyse the error. Teeth should to be reduced in special planes for the thickness of the facing and if this is not followed a much wider looking facings result, which spoils the golden proportion and looks peculiar. It means that we should not reduce the enamel width uniformly all over but more reduction is needed on distobuccal surface of canines. If this is not followed grossly enlarged width of the canines result and things go wrong esthetically. Figure 9 (b) shows the outline of the eight front teeth of the anterior aesthetic segment with super imposed facings drawn in red and no tooth preparation. The red lines represent that the facings have infringed the golden proportion lines especially around the canine and premolar. This diagram shows that to maintain the golden proportions between the teeth, it is necessary to remove tooth substance mesially and distally on the central and lateral and buccally on the canine and premolar.

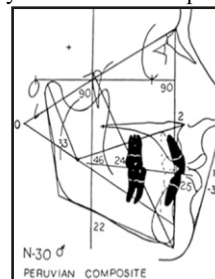


Figure 11. Cephalometric composite showing various golden proportion in the face

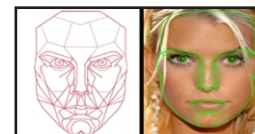


Figure 12. Golden proportion Pentagon Grid for Facial plastic surgery based on the golden proportion

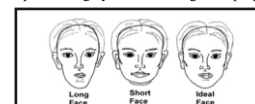


Figure 13. Long face, Short face & Ideal face



## Golden Proportion in Orthodontics & Orthognathic Surgery

It is a common procedure for an orthodontist to reshape incisal edges to obtain esthetic anterior dental contours, so it would not be unreasonable to consider tooth shape and proportionality as part of treatment planning and goal setting.[7]

In orthodontics, Ricketts, an orthodontist was the first to claim that the analysis of a physically beautiful face should be approached mathematically, and he advocated the use of golden proportions in that respect.[8] He performed a small study using beautiful faces of 10 fashion models and the hard tissue ratios were compiled from a composite of 30 Peruvian patients. Ricketts successfully defined several golden proportions in them. Ricketts showed that the proportions in a face generally perceived as being beautiful are intimately related to golden proportions. Ricketts suggested that the divine proportions provided formulas by which orthognathic surgery can be planned, and in 1992, he did indeed describe 2 cases in which orthognathic surgery had been planned using the divine proportions.[9]

Although objections were made against the study design, Ricketts's articles appear to be key publications in orthodontics and oral surgery for facial esthetics.

Marquardt, an oral surgeon developed a golden proportion pentagon grid (Figure 11-13) for facial plastic surgery, based on the golden proportions that exists in naturally beautiful faces.[10] If a face is beautiful, it will fit precisely in the beauty mask. He used it to determine the areas that deviated from beauty proportions. Marquardt claims that whereas nobody fits the mask perfectly, women fit it better than men and the most attractive people fit it the best.

Jefferson states that divinely proportioned face and body are more beautiful and healthy. There is a universal standard for facial beauty regardless of race, age, sex. The further away a person's face is from the ideal proportions and profile, the more likely that person will have certain medical problems. Long faces have nasal obstruction and breathing problems. Short faces tend to have temporomandibular disorders and headaches. Ideally proportioned faces tend to have minimal physiologic problems. This universal standard is based on golden proportion.[11] All living organisms including humans are genetically engineered to develop and conform to the golden proportion. Studies have shown that faces that do not conform to divine proportion have esthetic and physiologic problems.

## Conclusion

Golden Proportion provides a simple guide to achieve optimum esthetics in your restorations, prostheses as well as evaluating and improving facial proportions. Golden proportion can be used to create the illusion of beauty, it can be used as a guide in achieving a harmonious smiles and faces. The principles of golden proportion can be methodically applied to evaluate and improve dental esthetics in predictable ways. According to a popular saying "imitation is the best form of flattery" thus, by imitating the secret law of nature in our work and we can provide the most esthetic, functional and lively creations. It is one of the building blocks of beauty that we can easily apply to our dental work, and be confident of success.

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