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REVIEW ARTICLE

The Golden Proportion

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ABSTRACT

The Golden Proportion has been considered perfect, ideal, and desirable, and it has been used for many years by engineers and architects in studying beauty and in designing patterns and proportions. It has been proposed that the golden proportion is a useful tool for the evaluation of symmetry, dominance, and proportion in the diagnosis of tooth arrangement and in the application of esthetic dental treatment. The golden proportion is an element of design that a dental surgeon should be aware of. An understanding of this enigmatic proportion that has long stood for beauty may provide us with useful guidelines that can be combined with our existing knowledge and applied to our dental work for restoring dental esthetics with reasonable assurance of success.

Keywords: Divine proportion, Extreme mean ratio, Golden proportion, Phi.

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INTRODUCTION

Beauty is the phenomenon of experiencing pleasure through the perception of balance.[1] The Greek philosophers admired beauty and its unique balance in nature and realized that there is divinity in every creation of nature; each natural beauty was in a proportion. They admired this natural proportion and created art in accordance to this proportion. And since they found divinity in this natural proportion, they termed it as Divine Proportion.

The divine proportion was closely studied by the Greek sculptor, Phidias, and as a result, it took on the name of Phi. Phi can be found throughout the universe; from the spirals of galaxies to the spiral of a Nautilus seashell; from the harmony of music to the beauty in art.[2]

Beauty is that which gives the highest degree of pleasure to the mind and suggests that object of delight approximates to one's conception of an ideal. The concept of beauty has most often connected to harmony and harmonic proportions. While beauty cannot be measured, harmony, which is most often associated with beauty, can be expressed in formulas.[3]

The divine proportion also known as the Golden Mean, Golden Ratio, and Golden Section, is based on the Greek letter Phi, which is approximate to 1.618034. Phi is simply an irrational number with very unique properties.

The first clear definition of what has later become known as the Golden Proportion was given around 300 BC by the Euclid of Alexandria. In Euclid's words: "A straight line is said to have been cut in extreme and mean ratio when, as the whole line is to the greater segment, so is the greater to the lesser."

If the ratio of the length AC to that of CB is the same as the ratio of AB to AC, then the line has been cut in extreme and mean ratio, or in a golden ratio. The golden ratio is thus the ratio of the larger sub segment to the smaller (Fig. 1).[4]

This is a geometrical proportion in which a line AB is divided at a point C in such a way that CB/AB = AC/CB. That is, the ratio of the shorter section to the longer section of the line is equal to the ratio of the longer section to the whole line. This gives AC/AB the value 0.618, termed the golden number.[3]

The point at which the line is divided is known as the golden section and is represented by the symbol Φ (Phi), derived from the name of the Greek sculptor Phidias. This proportion has classically been described as pleasing to the eye, the emphasis being upon the proportion of the parts to the whole.[3]

Thus the proportion of the smaller to the greater is the same as the proportion of the greater to the whole. The division of the line by point C thus represents a point of equilibrium between these two proportions. The only time that these two proportions are the same is when they are golden. This point of division is a mathematical confirmation of how the eye senses the balance of this magical proportion that appears so frequently in nature and art.[2]

THE GOLDEN PROPORTIONS OF THE FACE

Golden proportions have also been found in facial and dental elements (Fig. 2).

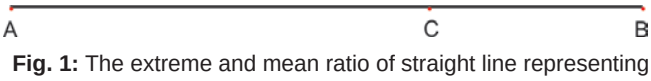

Fig. 1: The extreme and mean ratio of straight line representing divine proportion

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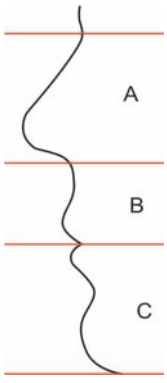

Fig. 2: Golden proportion of the face

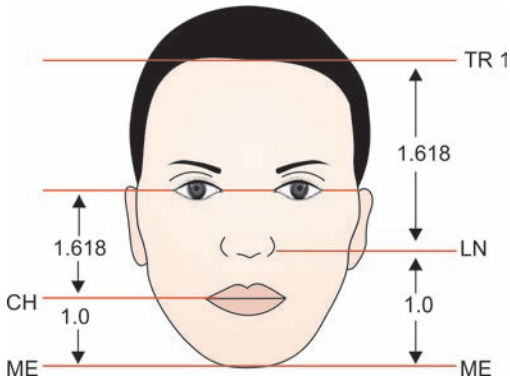

Fig. 3: Ideal vertical position

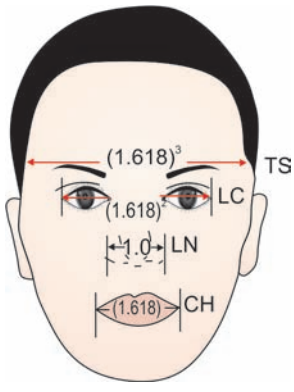

Fig. 4: Ideal transverse position

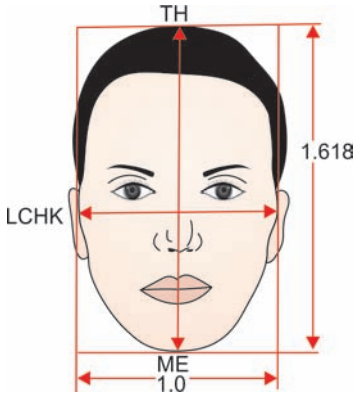

Fig. 5: Ideal height and width of the face

The nasal height (A) is related to the maxillary height (B) as 1.000:0.618. The sum of nasal height and maxillary height (A + B) are related to the mandibular height (C) as 1.618:1.000. The mandibular height (C) is related to the maxillary height (B) as 1.000:0.618. The orofacial height (B + C) is related to the nasal height (A) as 1.618:1.000. Note that each ratio is 1.618.[5]

Ideal Vertical Proportion

If the corner of the mouth (CH) to the bottom of the chin (ME) is one, then corner of the mouth to corner of the eye (LC) is 1. If the corner of the nose (LN) to bottom of the chin is 1, then the corner of the nose to hairline is 1 (Fig. 3).[6]

Ideal Transverse Proportion

If the width of the nose (LN) is 1, then the width of the mouth (CH) is 1.618; the width between two corners of the eyes (LC) is 1.6182, and the width between two temples (TS) is 1.6183 (Fig. 4).[6]

Ideal Height and Width of a Face

If the distance between the two cheeks is 1, then the ideal height is 1.618 (Fig. 5).[6]

THE GOLDEN RECTANGLE

A golden rectangle is formed from facial height and from the end of the nose; bisection is noted at the lateral canthus of the eye. The divine proportion can be seen on the lip portion relative to the nose tip and lateral canthus of the eye. The middle facial rectangle, the upper facial rectangle and the lower facial rectangle are all equal in height.[7]

The teeth, as with the other perspectives of dental esthetics, display variance and nuances, showing individuality in a given dentition. The divine proportion in esthetic dentistry concerns the teeth, their shape, size, intra- and inter-arch relationships. No single aspect can be accredited with successfully arriving at the final shape and dimensions of the maxillary anterior teeth.

The width/length ratio of the central incisor should range from 0.65 to 0.75, a value less than 0.6 creates a long narrow tooth, beyond this number result in a short wide tooth. Secondly, the central incisor should be the dominant element in the anterior dental composition (Fig. 6).

INTRA-ARCH RELATIONSHIP

Having established guidelines for shape and dimensions of the maxillary anterior segment, in particular that of the central incisor, the next point to consider is the relationship between incisors and canines. The tooth-to-tooth

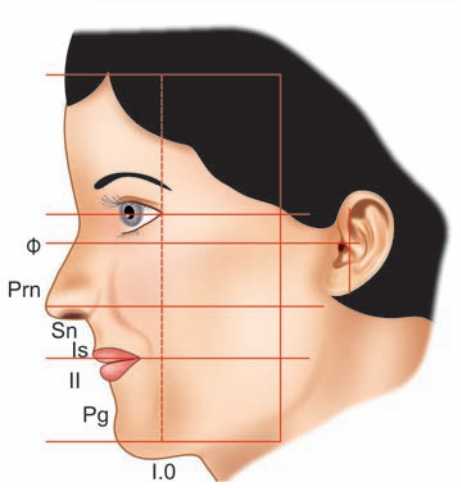

Fig. 6: Golden rectangle of the face

relationship frequently relies on the divine (or golden) proportion and dynamic symmetry.[8]

Another esthetic marker is the axial inclination of the upper anterior teeth. Ideally, a mesial axial inclination seems to attract esthetic approval, while a distal one conveys visual tension. One explanation why a mesial inclination, as opposed to distal one, invokes a sense of esthetic approval is that the curvature of an object (convex or concave) is important to the way it is perceived. Concavity conveys receptiveness and belonging, while convexity the opposite, e.g., pushiness and aggression. In a similar manner, mesial axial inclination forms a concave curvature, also conveying receptiveness and belonging.

Further enrichment of the anterior dental segment is created by ensuring that the interproximal contact points coincide with the incisal edges, and the curvature of the mandibular lip, enhancing the cohesiveness of the dentofacial composition.

Incisal embrasures have a distinct appearance depending on age and sex. As a generality, pronounced embrasures convey youthfulness and femininity, while shortened, worn edges convey ageing and masculinity. The clinician should be guided by patient preferences, age and gender before prescribing precise incisal embrasure angles for artificial restorations.

INTER-ARCH RELATIONSHIP

Horizontal and vertical overbite depends on the incisogingival length of the anterior teeth, the shape of the arches, and angulations of the teeth. In ideal circumstances, the maxillary central incisors are 12 mm long, perfectly aligned and the arch form is within the norm, with the mandibular central incisor 10 mm long. In this case, the vertical overlap and horizontal overlap are 4 and 2 mm respectively.[8]

To establish a correct inter-arch relationship, the starting point is the location of the maxillary central incisor edge position with the lips at rest, and during a relaxed smile.

During these two soft tissue positions, the incisal edges are assessed, and influenced by three variables. The first is esthetics. Ideally, the maxillary incisal edges should be parallel to the curvature of the mandibular lip. The second issue is to ensure that phonetics is not compromised. In the sagittal plane, when the "f" and "v" sounds are spoken, the buccal surfaces of the maxillary incisors should contact the inner or mucosal surface of the mandibular lip. If these teeth encroach on the cutaneous part of the mandibular lip, this indicates either an overcontoured or bulbous restoration or incorrect tooth angulations. Lack of contact with the lower lip indicates shortened or incorrectly aligned maxillary incisors. The "s" sound determines the vertical dimension of speech, characterized by an unimpeded edge-to-edge position of the maxillary and mandibular incisors. The third determinant of the incisal edge position is the anterior guidance, often ignored at the expense of esthetics, resulting in ultimate failure of restorations due to unwanted protrusive interferences.

TOOTH TO TOOTH RELATIONSHIPS

The first golden proportion relationship, and the most important to be discovered, is a simple tooth to tooth golden proportion as shown above. This shows the golden mean gauge superimposed on a photograph of teeth showing that the width of the central incisor is in the golden proportion to the width of the lateral incisor. Similarly, the gauge shows the lateral incisor is in the same golden proportion to the canine in the adjacent photo and the canine is in the golden proportion to the first premolar (Fig. 7).[9]

THE PROPORTIONS OF THE FRONT TEETH

Ricketts calls the teeth proportion "The Divine Progression."[9] The front teeth should have the following width proportions (Fig. 8).

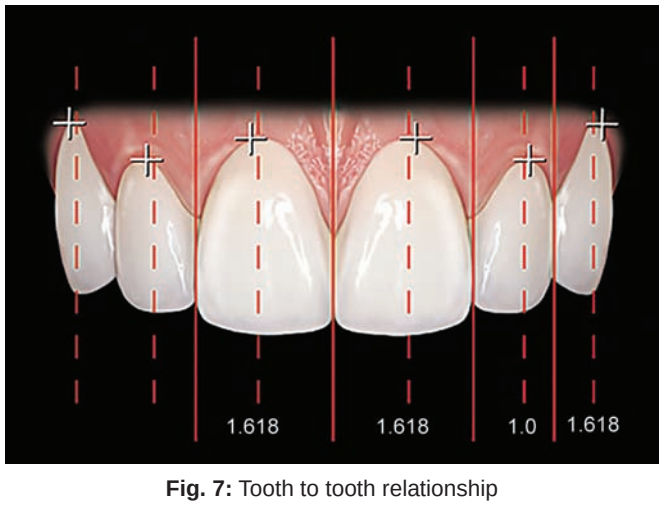

Fig. 7: Tooth to tooth relationship

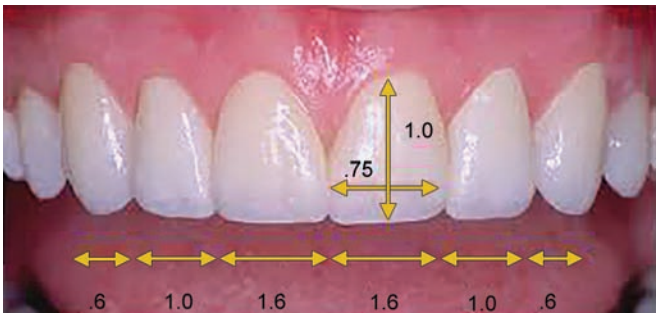

Fig. 8: Golden proportion of the upper incisors

The central incisor is 1.618 times larger than the lateral. The lateral incisor is 1.618 times larger than the visible part of the canine seen from the vertical axis. From the same perspective the visible part of the canine is 1.618 times larger than the visible part of the first bicuspid. The full visible part of the anterior teeth between the incisal points of the canines is 1.618 times larger than the lower four incisors Also the labial and the palatal sides of the front teeth crown parts have golden proportion relations: The labial surface of the central incisor is cut in two with a line in the region 1 to 1.618. The 1.618 part is flat; the 1 part toward the gingiva is rounded (Figs 9 and 10).

POSTERIOR AND GOLDEN PROPORTIONS

The total width of a molar or premolar is 1.618 times larger than the cross distance of their cuspids. The distance between the buccal wall of the first two lower molars is 1.618 times the width of the lower front teeth (teeth 43–33).[10]

THE LIP LINE

In the relaxed face, where the teeth are not touching together (when the lower jaw is in the rest position with free way space present) the lip line divides the lower third of the face into the golden proportion. The space between the bottom of the nose and the bottom of the chin is divided by the lip line into a "chin to lip line" (the larger part) and a smaller part the "lip line to under the nose" The smaller to the larger is in the golden proportion as illustrated earlier. These photographs show how the golden mean gauge could be used in prosthetics to assist in determining the height of the incisors (Fig. 11).[11,12]

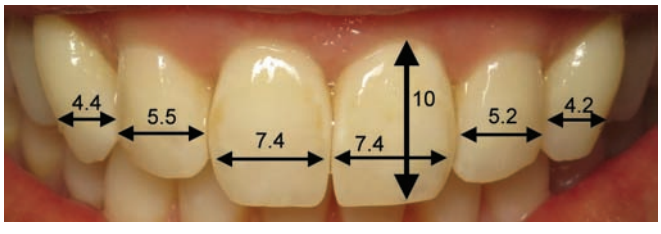

Fig. 10: Golden proportion of the labial surface of the front teeth

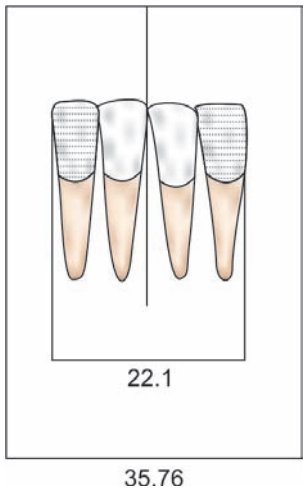

Fig. 9: Golden proportion of the lower incisors

THE GOLDEN RECTANGLE AND DENTAL ESTHETICS

Dentists find the proportions of the central incisor very beautiful, but they were not been able to find a golden proportion relationship between the obvious width and height.[5] The problem was recently solved when Dr Stephen Marquardt, an eminent oral surgeon in California, discovered that, "The HEIGHT of the central incisor is in the Golden Proportion to the WIDTH of the TWO central incisors" (Fig. 12).

The rectangle is determined by using the golden proportion gauge to measure the width of the two incisors and then to use the gauge to check the height. This revelation has offered solutions to a host of dental esthetic problems.

The golden proportion shows us a way of confirming the widths of the incisors by measuring their heights. It is a formula for evaluating the horizontal against the vertical. Testing the phenomenon on photographs of

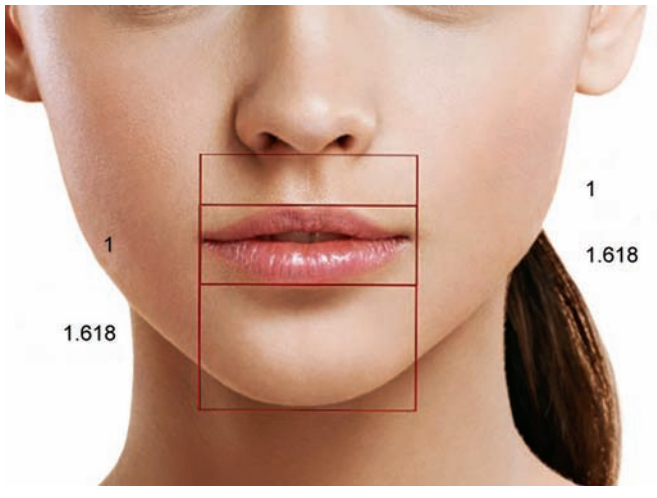

Fig. 11: Lip line

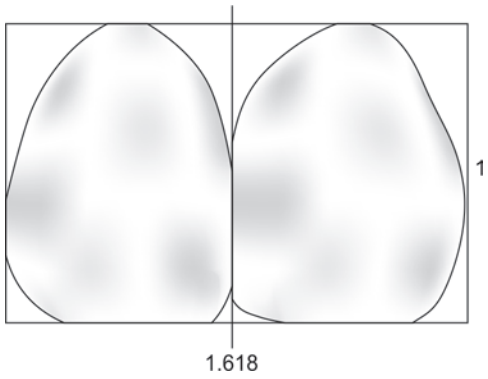

Fig. 12: Golden rectangle of the tooth

attractive teeth shows a very close compliance between the theoretical and the practical.

CONCLUSION

The golden proportion is a constant that mathematically defines the ratio between the dimensions of a larger and a smaller length. The specific relation is unique in that the ratio of the larger length relative to the smaller length is identical to the ratio of the total length to the larger. As a result, the golden proportion has been considered perfect, ideal, and desirable, and it has been used for many years by engineers and architects in studying beauty and in designing patterns and proportions.[4]

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