REVIEW

GOLDEN PROPORTION IN DENTURE ESTHETICS

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Abstract

Esthetic dental treatment involves artistic and subjective components designed to create the illusion of beauty. Scientific analysis of beautiful smiles has shown that the principle of golden proportion can be systematically applied to evaluate and improve dental esthetics in predictable ways. The golden proportion mathematically denotes that the ratio of a smaller to a larger length is equal to the ratio of the larger length to the total length. This ratio has been used for centuries by artists, mathematicians, architects and engineers to study and design proportion in art and nature. This review article describes the application of the Golden Proportion in dentistry, as a tool for the initial evaluation of symmetry, dominance and proportion for esthetic treatment planning.
Introduction

One of the important features, predicting the attractiveness of the face is the ‘smile’ and most often the need for ‘esthetics’ motivates the patient to seek dental treatment. \(^1,2,3\)

“Beauty is power, a smile is its sword” - Charles Reade. \(^4\) But, what is beauty? Is it something that can be produced by taking some measurements, or is it based purely upon the perception and realization of the beholder?

In the study of nature, art and life itself, we discover the existence of a common principle running throughout with a pleasant, magical proportion - The Golden Proportion. Why ‘Golden’? because it seems to be so noble and perfect with many amazing properties. The first feature to understand is that the beauty of nature shows not just one simple Golden proportion, but a multiple of relationships in the Golden Proportion. Can we do exactly the same when making our dentures?

History of golden proportion

The term golden proportion (GP) has been used for centuries by artists (Leonardo Da Vinci, “Sectio Aurea” The Golden section), mathematicians (Pythagorus, Luca Paccioli-“Da Divine Propportine” -The Divine Proportion, Fibonacci -Fibonacci numbers), architects and engineers to study and design proportion in art and nature. Golden Proportion was used in the ancient Greek architecture, Parthenon, considered the most beautiful architectural creation in history, has all its parts laid out in GP. One cannot talk about Golden Proportion without referring to its counterpoint, which is the Fibonacci Series.

The concept of golden proportion

The ancient Greeks believed that there was a constant proportion between a large and a small in the beauty of nature. Whilst the concept of golden proportion is easy to understand, attempts at its application have proved to be complex and difficult to explain. \(^5\) The golden ratio is the number you get when you compare the lengths of certain parts of perfectly beautiful things. The peacock feather has 12 discreet Golden proportions, which are all interrelated (Figure 1). Nature is abundant with examples of golden proportion. From the double helical form of our DNA to flowers and insects; the golden proportion is evident all around us.
Golden proportion in denture esthetics

The Golden Proportion mathematically denotes the ratio of a smaller to a larger. Length is equal to the ratio of the larger length to the total length. The ratio is equal to 0.618 or 1.618.\(^6\) It is mathematically depicted as Greek letter ‘\(\phi\)’ (studied by Greek sculptor, Phidias)\(^7\) This ratio is also referred to as the Fibonacci Ratio or Divine Ratio. The symbol of golden proportion is the pentagon, which was the symbol of the Pythagorean School, which was deeply involved in the study of golden proportion.

Golden Proportion occurs in triangles, circles and spirals…but notably in the Golden Rectangle, whose sides are having a golden relationship to each other. The Golden Rectangle is said to be one of the most visually appealing of all geometric forms.\(^8\)

*The Golden Proportion Caliper (The Golden Mean Gauge)-*The GP Calipers were developed by Ricketts. \(^9\) These Calipers always open to a constant Golden Proportion between the larger and smaller portions (Figure 2). The use of the gauge makes it easy to assess the golden proportion.

**Figure 1.** Peacock feather having 12 discreet golden proportions

Application of GP to dental esthetics was first documented by Levin in 1978.\(^\text{10}\) He explained the association of proportion with an esthetically pleasing dentition and smile. A proportion between 2 adjacent parts which is repeated across enhances the unity

**Figure 2.** Golden Proportion Calipers always opens in GP

**GP in dental esthetics**

Application of GP to dental esthetics was first documented by Levin in 1978.\(^\text{10}\) He explained the association of proportion with an esthetically pleasing dentition and smile. A proportion between 2 adjacent parts which is repeated across enhances the unity
within the diverse parts of a composition. Lombardi stated that when this repeated ratio is equal to the Golden Mean, the composition is said to be esthetic. Chiche published a prosthodontic book with references to Golden proportion. Shoemaker wrote a series of articles relating to GP and aesthetics.

Tooth to tooth proportion

Levin advocated the use of the golden proportion for establishing tooth size and stated that the width of the central incisor is in golden proportion to the lateral incisor, as is the lateral to canine and the canine to first premolar, when viewed from the front (Figure 3 and 4).

This phenomenon has been combined in a grid (developed by Lewin) called the diagnostic grid or golden proportion grids which can be used to assist in perfecting the
esthetics of anterior teeth (Figure 5). These grids are templates for spaces in the GP, between the teeth, from central incisor, to first bicuspid, based on the widths of the central incisor, with 4 grids varying from 7.5 to 9.0mm. It also shows that the width of teeth is in Golden Proportion to the width of smile (from lips at one corner of the mouth, to the other corner) as seen in Figure 5. But the common errors due to parallax should be avoided while using the gauge at chairside. These errors can be avoided by using the accurate paper grids in the mouth. Levin also states that when doing facings for teeth, it is necessary to remove tooth substance mesially and distally on central and lateral and buccally on the canine and premolar.

Figure 5. Golden Proportion Grid illustrating how well the teeth fit into the golden proportion spaces. Note that the neutral buccal space is in golden proportion to the teeth showing in the smile

Bukhary et al conducted an interesting study in which six photographs with different widths of lateral incisor were used. When people were asked to choose the best; not surprisingly, the lateral incisor closest to the golden proportion was selected. However, in a recent study, golden proportion was not found between the width of the right central and lateral incisors in 53% of women and 47% of men (in Indian population). The results of the study revealed that the golden percentage was rather inconstant in terms of relative tooth width.

Anterior teeth and width of smile

The anterior aesthetic segment (8 teeth-central incisor, lateral incisor, canine and 1st premolar is in Golden Proportion to the
width of smile) is in golden proportion to the width of the smile.\textsuperscript{19}

The golden rectangle of the central incisors: Stephen Marquardt found that the height of the central incisors is in the Golden Proportion to the width of the two centrals (Figure 6).

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Figure 6. The width of both central incisors is in golden proportion to their height (The Golden Rectangle)

The golden rectangle defined by the incisal edge of the maxillary central incisors, if they are of normal length, to the superior tip of the eyebrow and the pupillary width can be used as a guide in determining incisal edge position.\textsuperscript{20,21,22} Another guide to assess the incisal edge of the maxillary central incisors is the golden proportion between subnasale to the incisal edge and that to the menton. The incisal edge of the incisors divides the distance from the bottom of the nose to the bottom of chin into golden proportion. Still, one can also assess incisal edge position with the golden proportion that exists between the eyes, the incisal edge of the maxillary incisors (if ideal in length), and the chin.\textsuperscript{22}

The Golden Proportion gives good guidance for the position of the height of the incisors but this only applies in about 75% of the population.\textsuperscript{23} The maxillary central incisors, because of their position in the front of the arch, should appear to be the widest, whitest, and therefore, the most predominant teeth when viewed from front.
Height of 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 GP.

Golden proportion exists between (Figure 7)

1. The central incisor and lateral incisor, lateral incisor and canine, canine and 1st premolar (8 teeth of the anterior aesthetic segment are in GP to each other)

2. The 2 central incisors (width of centrals is in GP to their height)

3. The anterior teeth and width of smile (8 teeth of the anterior aesthetic segment is in GP to the width of smile)

4. The lower edge of the nose to the incisal edge of the maxillary incisors

5. The incisal edge of the maxillary incisors to the bottom of the chin

6. The inner canthus to the outer canthus of each eye

7. The inner canthus of the right eye to the inner canthus of the left eye.

8. The pupil of the eye to the inner canthus of the eye

9. The midline between the eyes to the inner canthus of the eye

10. The cervical apex of a tooth to the height of the gingival papillae

11. The height of the gingival papillae to the incisal edge of a tooth.

Figure 7. Various golden proportions seen in the face (explained in detail in the text)

At times, the GP of maxillary anterior teeth may have a larger ratio on one side of the arch relative to the other side (eg., when a peg lateral is present unilaterally). Therefore
it is clear that for golden proportion to be useful in esthetic dentistry, it must be adapted for easy bilateral analysis of the teeth. Snow advocates the use of the ‘Golden Percentage’ as a means of applying the golden proportion across the midline to encompass the total canine-to-canine width (six anterior teeth). According to him, the proportional width of each tooth should be: canine 10%, lateral 15%, central 25%, central 25%, lateral 15% and canine 10% of the total distance across the anterior segment. The principle of the golden percentage in evaluation and treatment planning appears to be of significant benefit in esthetic smile design.

What’s the latest? A new dental software has been developed to determine the dental golden proportions digitally (PhiDental). In addition to the clinical grids used in mouth and the golden gauge we can do a GP analyses and manipulation with a digital camera.

Conclusion

In today’s health and esthetic conscious world, the smile is considered an important component of an individual’s overall appearance and well being. Golden Proportion is considered as the “Starting Point” in designing the relative width of teeth in a beautiful smile. Esthetic dental treatment involves artistic and subjective components designed to create the illusion of beauty. Scientific analysis of beautiful smiles has shown that the principle of golden proportion can be systematically applied to evaluate and improve denture esthetics in predictable ways. Golden Proportion is undoubtedly a useful tool in the initial evaluation of proportion in tooth arrangement and cosmetic dental treatment planning.

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References


