REVIEW ARTICLE

Golden proportion: A review

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Abstract

Golden proportion is a geometric proportion which is theorized to be the most esthetically pleasing to the eye. For appreciation of beauty, it has been suggested that the human mind functions at the limbic level in attraction to proportions which is in harmony with the golden section. This divine proportion is the ratio of 1:1.618. It aids the clinician in determining the area most out of harmony and balance and hence determines the best approach to achieve "harmonic unity" in aesthetics, which in most instances leads to functional unity and efficiency.

Introduction

The study of the face and the ability to alter its form has fascinated mankind for thousands of years. The clinical ability to alter dentofacial form, whether through facial growth modification, orthodontics or surgery, requires an understanding of facial beauty, including the evaluation of facial esthetics, proportions and symmetry.

Many guidelines, norms, and standards have been proposed to describe ideal proportions in the human face, and for a long time, golden proportions have supposedly been apparent in the ideal human face.[1] The golden proportion was described geometrically in the 4th century BC by Euclid as the unique division of a line (AB) into 2 parts (AC and CB) in such a way that AB:AC=AC:CB.

Although Euclid is the oldest known writer to describe the construction of this golden proportion, the proportion was probably already known by the ancient Egyptians, since this ratio can be recognized in the large Egyptian pyramids from the 3rd millennium BC. A more accurate mathematical approach came from Fibonacci in the 12th century, in which the golden proportion was defined as phi, and was found to be equal to 1.618. The golden proportion is often associated with esthetics and harmony in many fields such as architecture, sculpture, music, poetry, the morphology of flowers, sea shells, mammals, and the human face.[2]

In orthodontics, Ricketts[3,4] 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.

The apparent widths of the maxillary anterior teeth on smile, and their actual mesio-distal width, differ because of the curvature of the dental arch. Particularly, only a portion of the canine crown can be seen in a frontal view. For best appearance, the apparent width of the lateral incisor should be 62% of the width of the central incisor, the apparent width of the canine should be 62% of that of the lateral incisor, and the apparent width of the first premolar should be 62% of that of the canine. This ratio of recurring 62% proportions appears in a number of other relationships in human anatomy, and is referred to as the "golden proportion."[5]

Huntley rightly considers that the divine proportion-the golden rectangle, triangle, cuboid, and ellipse represents mathematical beauty and harmony.[6]

The Golden Section

The geometric method of arriving the golden section

The line AB is bisected [Figure 1] and that distance is erected perpendicular for B as a new line AD is formed. The bisection

of AD, in turn dropped down to the beginning line, produces a golden section which is 0.618 the total length of the line AB. AC, in turn, is 1.618 times the length of CB.[4]

Golden Rectangle

The golden rectangle and its method of construction

By bisecting the line AB [Figure 2] of a square and swinging an arc from that line to the parallel of AB at F, the golden rectangle can be constructed. The altitude of this rectangle being taken as 1, the base is 1.618. This particular rectangle is pleasing to the eye and to the senses.[4]

Pentagon analysis

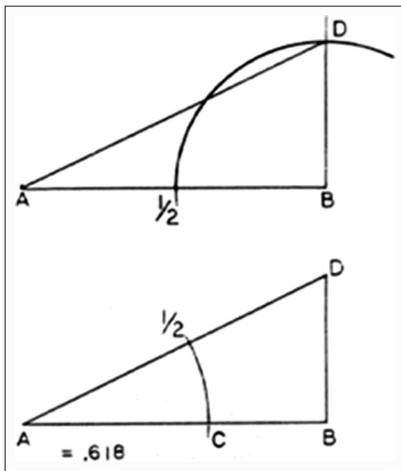When two corners of the pentagon [Figure 3] are connected and crossed with two other corners, the lines are sectioned in the golden section. It will further be noted that the repeated procedure will cut the original AB line again into a golden section on the opposite side; this leaves the area PQ being the congruent area and can serve reciprocally for the golden section to both ends. These two connections will also form a 36°, 72°, 72° triangle which is called the golden triangle.[4]

Golden Triangle

With a series of bisections of the 72° angle, a series of identical triangles can be formed [Figure 4].

Facial analysis with the golden proportion

In the width relations[4]

Progressive phi relationship was found with golden proportion having the four parts in series and in dynamic relationship [Figure 5]. Starting with the nose the mouth is golden and, in
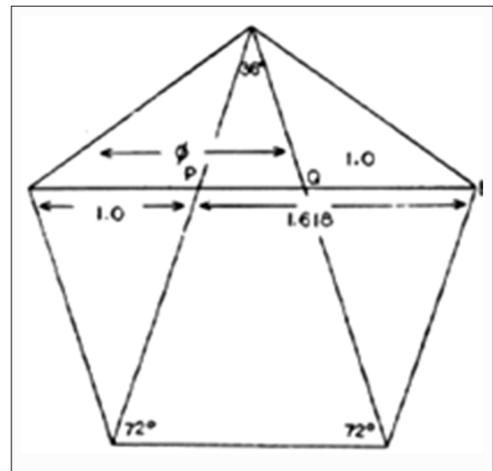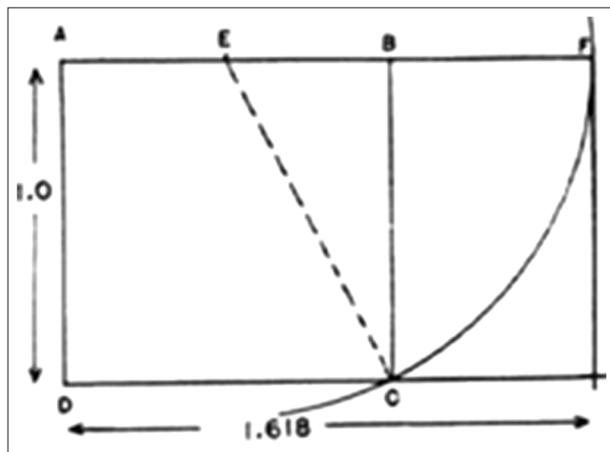

Figure 1: The golden section

Figure 3: Pentagon analysis
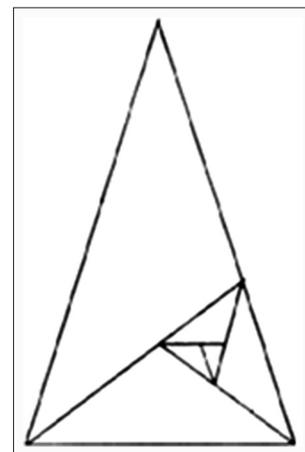

Figure 2: Golden rectangle

Figure 4: Golden triangle

turn the eyes-golden to mouth, making the eyes φ^2 to the nose. Head width at temple golden to eyes width which made the head φ^3 to the nose.[4]

In the height relations[4]

- The first golden proportion observation concluded that nose length (from the eye to the ala) the area of balance or congruence. It could give the orthodontist and the orthognathic or plastic surgeon a starting reference
- A second set of divine proportion was represented the upper lip length as the area of congruence. Orthodontist may use this for planning treatment orthopedically
- A third set of divine proportion concluded three values in the face were approximately even, 4=5=6.

The human face has rhythm both transversely and vertically in width and height. The basic phi unit is nose at the ala as it flows rhythmically and gracefully to the mouth, eyes and to total facial width. Vertically rhythm starts with upper lip length
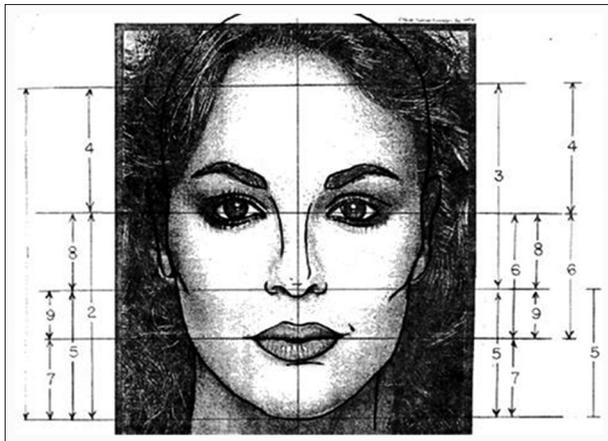

Figure 5: Facial analysis with the golden proportion

Figure 6: Divine proportions in human dentition - lower incisor – a basic unit

from ala of nose and flows downward to chin and upward to eye.

Divine Proportions in Human Dentition

With the foregoing findings, it was natural to seek divine proportions in the dentition. The Lower incisor became a basic unit [Figure 6]. Upper incisor was golden to the width of lower incisor. A rhythm is seen in the natural normal ideal occlusion with the lower incisor phi for the upper central incisors, φ^2 for lateral incisor width and φ^3 for premolars. Significant in cases related to Missing teeth and collapsed arches in the 1st premolar area.

A second series of divine proportions[4] was discovered in the teeth. Starting with the widths of all four lower incisors [Figure 7] as 1.0 value, a phi relation to the tips of the upper canine widths was found. A φ^2 relationship to the four lower incisors was found at the widths of the upper second molars. Thus, in the broad smile, there is harmony from the lower to the upper arch and harmony within the upper arch itself.

A third golden proportion[4] was seen from the distal aspect of the lower canines. This measurement as a base revealed the lower first molars at the mesial cusps to be in the phi relationship. Thus, the normal human dentition represents a concert of harmony – undoubtedly a factor in natural selection at the subliminal level.

Golden Proportion and Smile

It has been noticed that there exists another compound golden proportion in which the width of all the 8 anterior teeth together are in the golden proportion to the width of the smiling lips [Figure 8].

The anterior dental segment when viewed from maxillary right 1st premolar to maxillary left 1st premolar, it is highlighted
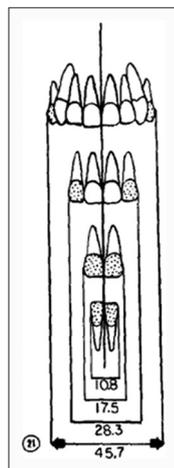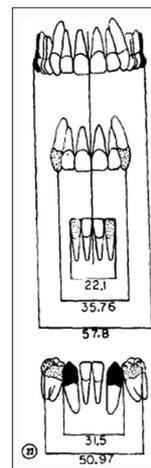

Figure 7: Divine proportions in human dentition - width of all four lower incisors to upper canine and upper second molars

against the backdrop of the smiling lips, with two neutral parts laterally between lips and teeth. The width of the eight anterior teeth is in the golden proportion to the width of the smile.

Analysis of cephalometric matrix

- Eight divine proportions have been established[4]
  1. Corpus axis length phi to condyle axis length (to condyle tip) [Figure 9]
  2. Anterior cranial fossa length SN to posterior cranial fossa length S Ba [Figure 10]
  3. Basal or cranial anterior base length (cc to N) phi to cranial centre to articulare (ar) [Figure 10]
  4. Length of the hard palate ANS-PNS phi to depth of nasopharynx and point A to PNS to posterior margin of the condyle neck [Figure 11]
  5. Anterior length of Frankfort plane (Pt V to orbitale) phi to Pt V to glenoid fossa (GL) [Figure 11]
  6. Vertical height of point A to Pm phi to A to the Frankfort plane [Figure 12]
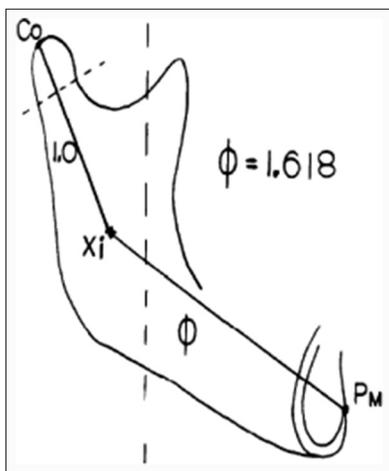 7. Palate at incisive canal to menton phi to canthus of eye [Figure 12]

8. Height of the lower incisor tip from Pm phi to distance of incisor tip to point A [Figure 12].

Clinical applications

Golden proportions have a significant relationship with facial esthetics in adolescents.[7]

Various angles and linear measurements in cephalometrics have served as excellent guides for the understanding of planning for both orthodontic treatment and surgical correction. The findings of the golden relationship can aid the clinician in determining the area most out of harmony and balance and hence determine the best approach to achieve "harmonic unity" in aesthetics, which in most instances leads to functional unity and efficiency. The biologic verification of Xi in every normal

Figure 8: Golden proportion and smile

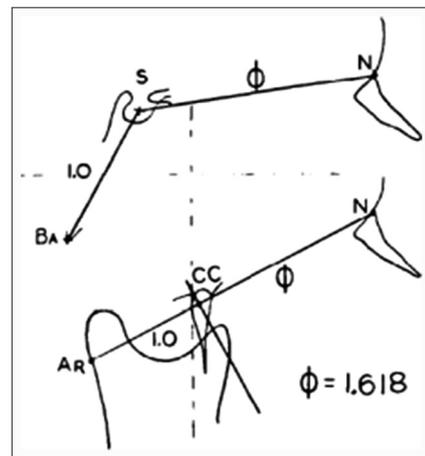**Figure 9:** Corpus axis length phi to condyle axis length

Figure 10: Anterior cranial fossa length SN to posterior cranial fossa length S Ba and cranial anterior base length (cc to N) phi to cranial centre to articulare
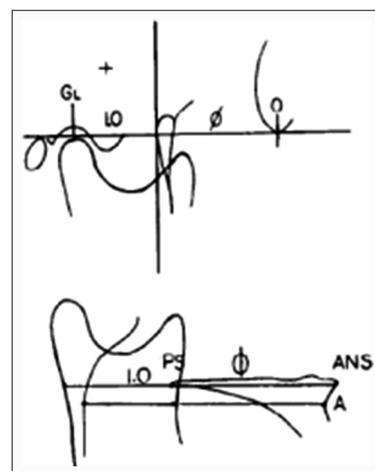

Figure 11: Length of the hard palate ANS-PNS phi to depth of nasopharynx and point A to PNS to posterior margin of the condyle neck and anterior length of Frankfort plane (patient V to orbitale) phi to patient V to glenoid fossa (GL)
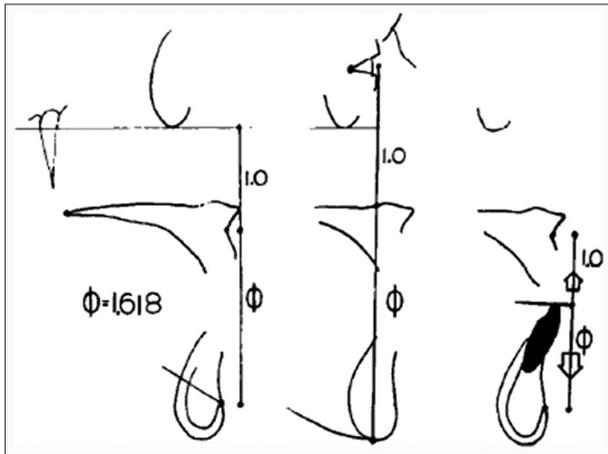
Figure 12: Vertical height of point A to Pm phi to A to the Frankfort plane, palate at incisive canal to Menton phi to canthus of eye and height of the lower incisor tip from Pm phi to distance of incisor tip to point A

composite of mandibles studied, the corpus axis was in the divine proportion to the condyle axis when measured to the top of the condyle. This approach makes an excellent tool to determine mandibular dysplasia because the relationship is irrespective of age; hence, a predictor!

The divine proportions, found in normal composites, point to the "dynamic symmetry" method as being a convenient guide for the diagnosis of structural craniofacial dysplasia.

The golden relation of SN and S Ba may serve as a guide for analysis of the nasopharynx and naso-oro airway and the proportionality of the anterior and posterior cranial base and protrusion of the maxilla. This, together with palatal length and nasopharyngeal depth golden proportions, adds to estimates of functional desirability.

The findings of the association of canine width with soft-tissue nasal width in the smile, and the geometric progression of the nose to the mouth to the eyes to the head in the soft tissues were fascinating.

The bony nasal width was also found in a progression through the midface with the lateral dimensions to the lateral articulare and to the maxilla width. In addition, the dental arch width (in the adult) at the first molar was golden to the base of the trihedral eminences, which would be an important determinant for adult treatment planning.

Conclusion

Beauty is not in the eye but the phi of the beholder. With recognition of this golden proportion principle, these relationships can be employed by the clinician on the practical basis and objective relationships can be assessed and planned.

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