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Research Article

GOLDEN RATIO AND LENGTH OF THE TEETH: ESTABLISHING THE SHAKIL'S CONSTANT

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ABSTRACT

The Golden Ratio is a ratio intimately related to the Fibonacci sequence and defined by the irrational number Phi. In mathematics, two quantities are in the golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities. The golden ratio appears in all forms of nature and science, indicating a natural balance between symmetry and asymmetry. In the effort to substantiate the divine proportion with reference to the length of the crown and root of teeth, we made an interesting discovery that the total root length of the maxillary and mandibular teeth is in golden proportion ratio to the total crown length of the maxillary and mandibular teeth; suggesting that the golden ratio can be used as a guideline to maintain the stomatognathic system in harmony.

Keywords: Golden Ratio, Crown Length, Root Length, Stomatognathic System

INTRODUCTION

The Golden Ratio, also called the golden proportion, golden section, golden number, golden mean, divine proportion or divine section, is a ratio or proportion defined by the irrational number *Phi*. The golden ratio is intimately related to the Fibonacci sequence, which are numbers in the following integer sequence: 1,1,2,3,5,8,13,21,34,55,89,144…, where each number is the sum of the previous two numbers. As we continue down the sequence, the ratio of the larger number to the smaller number converges on the golden ratio[1].

In mathematics, two quantities are in the golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities. Expressed algebraically, for quantities a and b with $a > b$,

$$\frac{a+b}{a} = \frac{a}{b} \stackrel{\text{def}}{=} \varphi,$$

Where, the Greek letter phi (φ) represents the golden ratio. Its value is

$$\varphi = (1 + \sqrt{5})/2 = 1.6$$

This divine proportion of 1.6 has fascinated intellectuals of diverse interests since time immemorial. From Pythagoras and Euclid in ancient Greece, through the medieval Italian mathematician Leornado of Pisa and the Renaissance astronomer Johannes Kepler, to present day scientific figures such as Oxford physicist Roger Penrose, have spent endless hours over this simple ratio and its properties. In fact, such was the intrigue it generated that it is probably fair to state that the golden proportion has inspired thinkers of all disciplines like no other[2].

So what makes the golden proportion so special, that biologists, artists, musicians, historians, architects, psychologists, and even mystics have pondered and debated over its appeal and ubiquity? Phi is more than an obscure term found in mathematics and physics. It appears around us in our daily lives, even in our aesthetic views.

Studies have shown that when test subjects viewed random faces, the ones they deemed most attractive are those with solid parallels to the golden ratio. Faces judged as the most attractive exhibited golden ratio proportions between the width of the face and the width of the eyes, nose, and eyebrows. The test subjects weren't mathematicians or physicists familiar with phi — they were just average people, and the golden ratio elicited an instinctual reaction.

The golden ratio also appears in all forms of nature and science. Some unexpected places include flower petals, seed heads, pinecones, tree branches, shells, fingers, animal bodies etc[3].Research has also shown that this Ratio of 1.6180 probably forms the basis in the building of the Pyramids in Egypt, the Parthenon in Athens, The Stuppa of Borobudur in Indonesia, which is the largest known Buddist stupa, the Palacio Barolo in Argentina and in paintings such as the Mona

Lisa and the Last Supper by Leonardo Da Vinci[3,4]. It is also believed that the Golden Ration point of the world lies on the city of Mecca, according to the longitude and latitude map which is a common determinant of location[4].

Eddy Levin, a practicing dentist from London made an overwhelming discovery by applying golden ratio into his practice; he found that the golden proportion and the beauty of teeth are interconnected. Levin put this into practice and tested his ideas on his patients. His studies led him to the conclusion that the four front teeth, from central incisor to premolar, which are the most significant part of the smile, are in golden proportion to each other. This idea was incorporated into developing a grid which can be used to assist in perfecting the aesthetics of the eight front teeth. Dr. Stephen Marquardt, an eminent oral surgeon in California, discovered that "the height of the central incisor is in golden proportion to the width of the two central incisors". This revelation has offered solutions to myriad dental aesthetic problems[5].

GOLDEN RATIO AND THE LENGTH OF TEETH

We have made an effort to substantiate the divine proportion with reference to the length of the crown and root of teeth. It's a known fact that a definite average length of crown and root of teeth is accepted as a standard worldwide. We calculated the total crown length of maxillary teeth and the total crown length of mandibular teeth according to the values of each given in Ash Nelson- Wheeler's Dental Anatomy, Physiology and Occlusion[6], which are accepted worldwide. The values were tabulated as given in Table 1 and Table 2

Table 1: Total Crown Length of Maxillary Teeth in mm

Central incisor	Lateral incisor	Canine	First premolar	Second premolar	First molar	Second molar	Third molar	Total crown length
10.5	9.0	10	8.5	8.5	7.5	7	6.5	67.5

Table 2: Total Crown Length of Mandibular Teeth in mm

Central incisor	Lateral incisor	Canine	First premolar	Second premolar	First molar	Second molar	Third molar	Total crown length
9.0	9.5	11.0	8.5	8.0	7.5	7.0	7.0	67.5

It is noted that the total crown length of maxillary teeth in mm is equal to the total crown length of mandibular teeth in mm. So the ratio of the total crown length of maxillary teeth to the total crown length of mandibular teeth = 67.5/67.5 =1

The ratio is called as **Shakil's Ratio** and the constant 1, is called as **Shakil's Constant**.

The above value contributes to an ideal occlusion and maintains the stomatognathic system in harmony.

Similarly, the total root length of maxillary teeth and the total root length of mandibular teeth were calculated separately and tabulated as given in Table 3 and Table 4.

Table 3: Total Root Length of Maxillary Teeth in mm

Central incisor	Lateral incisor	Canine	First premolar	Second premolar	First molar	Second molar	Third molar	Total root length
13	13	17	14	14	13	12	11	107

Table 4: Total Root Length of Mandibular Teeth in mm

Central incisor	Lateral incisor	Canine	First premolar	Second premolar	First molar	Second molar	Third molar	Total root length
11	13	14	14.5	14	16	14	12.5	109

Applying the Golden Proportion formula and substituting for a and b:

Total root length of maxillary teeth + total root length of mandibular teeth =

$$107 + 109 = 216 = a$$

Total crown length of maxillary teeth + total crown length of mandibular teeth =

$$67.5 + 67.5 = 135 = b$$

$$\frac{a+b}{a} = \frac{a}{b} \stackrel{\text{def}}{=} \varphi,$$

$$\frac{216+135}{216} = \frac{216}{135} = 1.6 = \textbf{Golden Proportion Ratio}$$

THE APPLICATIONS OF SHAKIL'S CONSTANT:

- Can be used in Orthodontics and Dentofacial Orthopedics
- Can be applied in Implantology
- Can be applied for better esthetics in Prosthodontics and CAD-CAM derived crowns and bridges etc

CONCLUSION

While the golden ratio doesn't account for *every* structure or pattern in the universe, it certainly does play a major role. It wouldn't be wrong to state that there may be a plethora of evidences that are still untouched or that we are not yet aware of. The above corroboration indicates that the values used in calculating the golden ratio give an insight into the hidden portion of the tooth within the jaws. The golden proportion, thereby, enables the dentist to visualize the unseen.

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