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Research Paper

A New Mathematical Approach to Esthetic Proportion

Medical Science

KEYWORDS : Golden proportion, Central incisor, Inner canthal distance

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ABSTRACT

Golden proportion has been a word of curiosity from a long-long time in dentistry and particularly in the selection of anterior teeth. Lombardi and there after Levin proposed the concept of golden proportion for selection of anterior teeth. A series of studies have been done to verify this proportion, many studies were in favor of but others were against it. In the present study, we have tried to deduce a mathematical relationship between inner canthal distance (ICD) and central incisor width (CIW) and tried to establish a relationship in terms of golden proportion. The relationship in males was found to be 10 times golden proportion + ICD and age correction factors whereas among females this was 11 times golden proportion + ICD correction factor.

Introduction

Dentists find the proportions of the central incisor very beautiful, but they were not been able to find a Golden Proportion between the obvious width and height. 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. He began to put this into practice and started testing his ideas on his patients[1]. Many factors influence the perception of beauty, including makeup, clothing, jewelry and facial expressions. However, it is the relational proportion of our physical features that is the primary factor in determining the perception, conscious or subconscious, of beauty. According to Golden proportion the ideal ratio of central incisor: lateral incisor: canine should be 1.6:1:0.6[2]. Maxillary central incisor has a strategic location that affects the entire personality of a person. Hence, it's essential to have a proportionate central incisor size which may enhance the personality of the individual wearing that prosthesis. In the edentulous patients, the golden proportion rule can be applied well if we are able to detect either of the two dimensions in the golden proportion. Selection of an arbitrary measurement for width can result in a facial disproportion rather than adding to the facial esthetics. It is hence essential that the prediction of the central incisor width must be in proportion with the facial structure and other bodily proportions. There have been a lot of studies done on the prediction of correct maxillary central incisor size using various techniques. Some earlier attempts were based around finding the mean central incisor width[3,4]. However, finding out a universally fit width was as impractical as preparing a prosthesis with a universal size. Soon it was realized that the facial proportions, individual's personality and other physical traits have a detrimental role to play while predicting the size of maxillary central incisor. Based on this hypothesis several workers started to find out correlation between various facial proportions and central incisor dimensions. It was Sears (1938)[5] who measured the mesiodistal widths of the six anterior teeth, the cranial circumference and the bizygomatic width on live subjects as well as on human skulls and observed that a certain amounts of correlation existed between the combined width of the six anterior teeth with the cranial circumference, as well as with the bizygomatic width. He put forward a mathematical relationship between maxillary central incisor and bizygomatic width. According to his observations, maxillary central incisor was 1/18 of the bizygomatic width. Maxillary lateral incisor was 1/22 of the bizygomatic width. Maxillary canine was 1/19 of the bizygomatic width. In the more recent studies association between various facial measurements such as width of the mouth, interalar width, bizygomatic width, and interpupillary distance has been explored but resulted in no correlation[6,7] while in some though some correlations were found but they did not explore it further for clinical application[8]. Despite such mathematical and scientific correlations, dental esthetics has been considered more of an art than a science result of which are considered to be dependent more on the dentist's skills than his knowledge and canonical use of a law[9]. The perceptions take over the scientific methodology which limits and restricts the dispersion of benefit of a technique or skill among the masses. Relationship between bizygomatic width and central incisor width seems to have attracted the attention of many workers at different times. In a study by El-Sheikh[10]a significant association between bizygomatic width and the width of maxillary anterior teeth was found amongst females while a significant association between bizygomatic width and the width of the central incisors was found among males. In another study[11] the utility of bizygomatic width and interalar width as references for establishing the ideal width of the maxillary anterior teeth particularly in women was established. Abdullah[12] reported inner canthal distance and geometric progression as a predictor of maxillary central incisor width. In another study Abdullah et al.[13] reported that inner canthal distance can successfully be used for prediction of combined width of maxillary six anterior teeth.

In the present study, we have tried to deduce a mathematical relationship between inner canthal distance (ICD) and central incisor width (CIW) and tried to establish a relationship in terms of golden proportion, which is in different line from the earlier studies done to establish this relation.

Methodology

A total of 305 subjects of district Ghaziabad served as the study subjects for the present study. There were 171 males and 134 females. The age of the subjects varied from 20 to 30 years with a mean age of 23.82±3.1 years. Inner canthal distance was selected as landmark because it is established by 1 year of age, after which the rate of growth in the area is slow in contrast to the outer orbital dimensions[14]. It has been suggested that after 16 years, no great increase is found in head and face measurements[15]. To be included in the study, subjects had to be free from congenital or acquired facial defects including diastema and have had no orthodontic and/or crown restorations of the maxillary anterior teeth. To record inner canthal distance (ICD) subjects were seated with their heads in an upright position looking forward at the horizon. The Digital caliper (Yamayo Classic, Japan, measuring capacity as minimum as 0.01mm) was placed against the forehead and lowered towards the eyes. The arms of the caliper were adjusted so that they were in gentle contact with the medial angles of the palpebral fissures of the eyes . The distance between these two anatomical landmarks was record-

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ed as the inner canthal distance (ICD). The two central incisors were treated individually as separate entity. The mesiodistal width of each maxillary central incisor was recorded intraorally with the help of spring loaded divider. The pointed members of the divider were then placed on a white paper. The perforations thus produced were joined by a straight line thereafter the length of the line was measured by the same digital caliper. These two measurements of the length were summed and divided by two to get the mean width of a single central incisor. This procedure was similar to that reported by Garn et al.[16], who found no significant difference in the mesiodistal diameters of left and right maxillary central incisors and thus justified the common practice of combining these tooth measurements. All measurements were recorded by the same operator. For the analytical part of the study, gender wise segregation of data was done as in several previous studies gender wise differences in correlations were observed[10,11]. Now the inner canthal distance values were regressed against the CIW values measured by linear regression method. In order to assess whether the age also has some role to play in this relationship, age was also regressed. On the basis of linear regression a constant value and a coefficient for CIW was obtained in the following form

$$y = a + b_1x_1 + b_2x_2$$

where y is the dependent variable (CCIW – Calculated central incisor width), a is the constant for linear regression, b_1 is the coefficient for ICD (Inner Canthal distance), x_1 is the ICD value, b_2 is the coefficient for age and x_2 is the age of the subject.

For males the equation obtained was
CCIW = 6.188 + 0.053*ICD + 0.048 * Age

However, among females age did not show a significant as

sociation and hence the equation obtained for females was :
CCIW = 6.972 + 0.057*ICD

After obtaining this relationship separately for both the genders the CCIW values were compared with the observed CIW. On dividing the value of a with 0.618 (Golden proportion), we found that for males this relationship becomes:

CCIW = 10*Golden Proportion + 0.053*ICD + 0.048*Age

Whereas amongst females this relationship stands as:
CCIW = 11*Golden Proportion + 0.057*ICD

Statistical Analysis
The data was analyzed using Paired "t" test to assess the difference between observed CIW and CCIW values. Gender wise differences in ICD, CIW and CCIW values were compared using Independent samples "t" test. The data was analyzed using Statistical Package for Social Sciences Version 15.0. The confidence level of the study was kept at 95%, hence a "p" value less than 0.05 indicated a statistically significant difference.

Results
Mean values of ICD, CIW and CCIW have been shown in Table I. Table II shows correlation between ICD, CIW and CCIW. It is seen that there is a weak correlation between CIW and ICD (r=0.341) and a strong correlation was observed between CCIW and ICD (r=0.788) where as a weak to moderate correlation (r=0.444) was observed between CIW and CCIW. In Table III the comparison between mean CIW and CCIW showing no statistically significant difference between the two (p=0.984). Table IV shows the range of differences between CCIW and CIW. It was seen that in majority (56.7%) the calculated central incisor width was within 5% deviation from the observed central incisor width while in more than one third (36.1%) this difference was within 5-10% and in only 8.2% cases the difference was above 10%.

Discussion
In the present study, the relationship of CIW with ICD and age was found to be different for both the genders. In males the relationship was found to be 10 times golden proportion + ICD and age correction factors whereas among females this was 11 times golden proportion + ICD correction factor. This difference amongst genders may be attributed to the difference in morphometry of two genders as observed in North Indian population[17]. However, the role of age which was found to have a significant association with outcome variable (i.e. CIW) among males but not among females needs further exploration and logical explanation. In a previous study Abdullah[12] had shown a significantly higher mean inner canthal distance and maxillary central incisor width were recorded for male subjects. The lower value for constant (in terms of golden proportion) for males could be attributed to the higher inner canthal distance amongst males as compared to females. Abdullah[13] in a different study also showed an association between maxillary central incisor width and facial parameters including inner canthal distance. In the present study too we found an association between inner canthal distance and maxillary central incisor width. Though in present study, the emphasis was on golden proportion and ICD and age have been used as the correction factors to provide more accurate results. The extent of association in two genders was different as elucidated by the linear regression equation obtained in the present study. Abdullah[12] derived two different functions for prediction of maxillary central incisor. However, in case of Abdullah the selection of the function was random while in present study we have tried to solve the problem in a more scientific and methodological method. In the quoted study[12] golden proportion has been taken as a function of maxillary central incisor width and ICD using Fibonnacci series. In present study, after performing linear regression, the constant obtained had been rounded off to the nearest golden proportion multiple. This is because we have assumed that there is variation in the facial profile of different races and populations hence a universally acceptable relationship is not in finding a same constant rather it must depend upon the population characteristics themselves. However, we also assume that golden proportion has a role to play while determining an esthetically pleasing tooth, but we also take into view that it is not the golden proportion alone that determines the selection of maxillary central incisor for an individual. We believe as not all individuals can have facial structure in golden proportion, but the earnest urge to rely on the golden proportion alone while selection the teeth is not the right choice, though it can be taken as a reference, yet other facial parameters do play a role. There is always a difference in the best and the most suitable. Instead of adopting the myopic approach that whatever we are providing is the best, it is the patient's right to get what is most suitable to him. The present study takes into account the facial proportion in terms of ICD and age as two determinants that act as correcting factors in determination of maxillary central incisor width by performing linear regression through which a relationship between different factors in a homogeneous population has been standardized. The hypothesis behind this is that each population had different facial characteristics and this relationship between factors is ever changing. The universal applicability of the technique lies in standardization of this relationship in different population groups. Our assumption gains momentum as the universal application of relationships on a single constant has often been rejected while being tested in different population[7]. The present study thus offers a new method to address the problem of determination of maxillary incisor width taking facial morphometric parameters while keeping in mind that golden proportion has an important role in this exercise.

Table I: Comparison of ICD, CIW and CCIW amongst study subjects

	Mean	SD
ICD	31.63	2.41
CIW	8.82	0.61
CCIW	8.82	0.26

Table II: Correlation Between ICD, CIW and CCIW

	ICD	CIW	CCIW
ICD	1		
CIW	0.341	1	
CCIW	0.780	0.444	1

Table III: Comparison between CIW and CCIW

Mean Difference	"t"	"p"
0.00062	0.020	0.984

Table IV: Range of Differences between CCIW and CIW

Range	No. of subjects	Percentage
<5%	170	56.7
5-10%	110	36.1
>10%	25	8.2

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