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ORIGINAL: Evaluation of Golden Proportion in Maxillary Anterior Teeth in Students of Mazandaran University of Medical Sciences in 2020-2021

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ABSTRACT

Introduction: Some dentists use the golden ratio to balance the dimensions of the teeth and create a harmonious transverse ratio when reconstructing the maxillary anterior teeth. The aim of this study was to evaluate the presence of golden ratio in the visible width of maxillary anterior teeth in students of Mazandaran University of Medical Sciences.

Material and Methods: In this cross-sectional descriptive-analytical study, 100 students (average age of 22 years) were selected from Mazandaran University of Medical Sciences whose anterior maxillary teeth met the inclusion criteria. Photographs of the teeth in normal position of head and social smile were taken from a distance of 30 cm. The apparent width of teeth was measured with a digital ruler. Kolmogorov-Smirnov test was used to evaluate the normal distribution of data, independent t-test was used to compare the width of anterior teeth and t-1 test was used to evaluate the golden ratio in transverse ratio of teeth. Data were analyzed using SPSS 24 software.

Results: Measurements showed that the visible width of maxillary anterior teeth on the right and left as well as between men and women was not significantly different. Golden ratio was only established between the visible width of the right lateral to the right central teeth ($P<0.05$).

Conclusion: The golden ratio was not established between any of the teeth, except for the right central to the right lateral. Therefore, the golden ratio cannot be a permanent criterion for the reconstruction of maxillary anterior teeth.

Introduction

When examining the face, smile is the second indicator that experts want to evaluate after the eyes (1). One of the issues that is always raised in dentistry when considering the principles of beauty, is how to create a pleasant fit between the width of the upper anterior teeth during their restoration and replacement (2).

In 1973, Lombardi was the first to introduce the use of proportions in dentistry (3). Also, he explained the concept of repetitive ratios in a beautiful dental set and equality of the ratios between the visible width of central to lateral, lateral to canine, and canine to first

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premolar teeth (4). In 1978, Levin proposed the theory of the golden ratio between the central and lateral teeth, as well as the lateral and visible part of the canine, using a grid (5). This ratio is still used todays in many reference books, including Rufenacht, Shillingburg, Goldstein, and Rosensteil, and according to Levin's theory, the golden ratio has been introduced as an aesthetic criterion in the reconstruction of upper anterior teeth (6).

The golden ratio was described by Fibonacci in the 13th century. This ratio actually represents a mathematical pattern that is repeated in nature. Fibonacci expressed this pattern of nature in the form of a series of numbers called the Fibonacci series. This ratio is equal to 1.61803398875, and is called the Fibonacci number. The application of this number is considered as the number f and equivalent to 1.62 (7).

As an aesthetic criterion in the reconstruction of maxillary anterior teeth, witnessing different and sometimes contradictory theories of dental aesthetic factors such as crown ratio or midline width symmetry can be calculated with this golden ratio. In a beautiful smile, the ratio of the visible width of the central tooth to the lateral tooth in maxilla is 1:1.62 and the visible ratio of the lateral tooth to the canine is 1:1.62 and also the ratio of width to height in the teeth is 0.62 (8). In the beauty of the anterior teeth of the maxilla, the transverse ratio of the teeth is very important and some dentists use the golden ratio (1.618) as a main guide to establish a harmonious ratio (9).

By reviewing various articles and reference books regarding the golden ratio, we have found confusion among dentists and technicians in this field (10). Therefore, we decided to conduct a study to investigate the golden ratio in the upper anterior teeth in a group of students of Mazandaran University of Medical Sciences so that the results can provide practical information in the field of beauty and design of ideal dental ratios.

Methods

This cross-sectional descriptive-analytical study was performed among students of Mazandaran University of Medical Sciences in 2020-21. This study was carried out after approval by the Vice Chancellor for Research and Technology of Mazandaran University of Medical Sciences and approval of the Ethics Committee in Biomedical Research (code number: IR.MAZUMS.REC.1399.686) and obtaining written informed consent from the participants. One hundred students (50 women and 50 men) in the age of 18 to 25 years were randomly selected. The sample size was calculated based on the results of the study of Tabatabai et al. (11) as follows:

$$n = \frac{(z_{\frac{\alpha}{2}} + z_{\beta})^2 \sigma^2}{(\mu - \mu_0)^2} = 117, \sigma = 0.3, \mu = 1.53, \mu_0 = 1.62, \alpha = 0.05, \beta = 0.1$$

Inclusion criteria included normal overjet and overbite and the alignment of the dental and facial midlines with each other. Students who had a history of orthodontic treatment, caries and restoration of upper anterior teeth, trauma or maxillofacial surgery, crowding or spacing, periodontal surgery, tooth loss (except for wisdom teeth), gingival recession or hypertrophy, and gum show of more than 3 mm when smiling were excluded from the study (11).

Images were taken using a digital camera (canon Eos 5D Tokyo, Japan) with a resolution of 17.9 megapixels and a screen size of 7.6 cm and a flash from the frontal view. The camera was fixed at a distance of 30 cm from the frontal view of the anterior teeth and a tripod was used to hold the camera fixed. To ensure parallelism of the camera, the center line of the camera lens was adjusted on the incisal edge of the central tooth. In order to that, participants were asked to take one step forward to reach the natural head position (NHP) and then stare at a distant point. They were also asked to smile when taking a photo to create a social smile, and to say the word cheese to place the teeth in the central occlusion. This operation was repeated several times and after ensuring its repeatability, a photograph was taken. All photographs were taken by one person (11).

After transferring the images to the computer,

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the visible width of the central, lateral, canine and the first premolars of the maxilla in both sides were digitally measured by the 2.1 Gimp ruler with an accuracy of 0.1 mm. The widest mesiodistal part was measured in the central tooth and the visible width of the tooth was measured in the lateral, canine and first premolars. After measuring each tooth 3 times, if there was a difference between the sizes, the average was taken.

Statistical data analysis was performed in SPSS software version 24. Kolmogorov-Smirnov test was used to examine the normal distribution of observations of variables. T-test was used to compare the width of anterior teeth, and t-one test was used to establish the golden ratio of tooth size. The significance level of the relationship between the two variables was considered 0.05.

Results

The central indicators for the quantitative variables of the study, including the measured width of the right and left anterior teeth, as well as the ratio of these widths to each other are shown in ***Table 1***. The normal distribution of observations of these variables was investigated by Kolmogorov-Smirnov test.

Table 1. Descriptive indicators measured for the visible width of the teeth

Tooth (n=100)	Side	Mean	Median	SD	Minimum	Maximum	Normality test	P-value
Premolar	R	0.23	0.20	0.10	0.00	0.50	2.36	0.000
	L	0.37	0.35	0.12	0.10	0.70	2.21	0.000
Canine	R	0.52	0.50	0.13	0.00	0.90	1.75	0.004
	L	0.85	0.80	0.14	0.60	1.30	2.01	0.001
Lateral	R	0.86	0.80	0.14	0.50	1.20	1.89	0.002
	L	0.54	0.55	0.14	0.30	1.00	1.62	0.011
Central	R	0.36	0.30	0.11	0.00	0.60	2.52	0.000
	L	0.20	0.20	0.13	0.00	1.00	2.43	0.000
Central/lateral	R	1.70	1.60	0.43	1.11	4.00	1.67	0.008
	L	1.67	1.60	0.45	0.86	3.33	1.27	0.081
Lateral/canine	R	1.58	1.50	0.60	0.80	4.00	1.93	0.001
	L	1.56	1.50	0.43	0.75	3.00	1.01	0.258
Canine/premolar	R	1.81	1.50	0.87	0.67	6.00	2.14	0.000
	L	2.01	1.67	1.53	0.30	15.00	2.63	0.000

According to ***Table 2***, no significant difference was observed between the visible width of each of the right anterior teeth compared to the left (P>0.05). Therefore, the visible width of each maxillary anterior tooth appears to be similar on the right and left sides.

Table 2. Results of independent t-test in examining the visible width of the maxillary anterior teeth on the right and left sides

Tooth (n=100)	Side	Mean	SD	Levene's test		Independent t-test	
				F test	P-value	T-test	P-value
Premolar	R	0.228	0.105	0.215	0.643	1.454	0.148
	L	0.204	0.126				
Canine	R	0.370	0.119	1.500	0.222	0.809	0.419
	L	0.357	0.108				
Lateral	R	0.515	0.134	1.317	0.253	-1.336	0.183
	L	0.541	0.141				
Central	R	0.848	0.144	0.005	0.945	-0.495	0.621
	L	0.858	0.142				

To evaluate the ratio of visible width of anterior maxillary teeth on the right and left sides, the results of t-one test showed that the average ratio of visible width only in right central to right lateral teeth follows the golden ratio (P<0.05) (***Table 3***).

According to the results of independent t-test to compare the visible width of anterior maxillary teeth between men and women, no significant difference was observed for any tooth (***Table 4***).

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Table 3. Results of t-one test in examining the ratio of the visible width of the maxillary anterior teeth on the right and left sides

Tooth	Side	N	Mean	SD	T-test	P-value	CI 95%
Central/lateral	R	99	1.701	0.430	1.867	0.032*	±1.629
	L	99	1.674	0.452	1.194	0.118	±1.599
Lateral/canine	R	100	1.580	0.601	-0.659	0.744	±1.481
	L	98	1.564	0.425	-1.303	0.902*	±1.493
Canine/premolar	R	92	2.009	1.529	2.437	0.008**	±1.744
	L	97	1.807	0.874	2.112	0.019*	±1.660

*P<0.05
**P<0.01

Table 4. Results of independent t-test in comparison of visible width of anterior maxillary teeth between men and women

Tooth	Side	Sex	N	Mean	SD	T-test	P-value
Premolar	R	Male	50	0.23	0.13	0.190	0.849
		Female	50	0.23	0.08		
	L	Male	50	0.19	0.11	-1.129	0.262
		Female	50	0.22	0.14		
Canine	R	Male	50	0.23	0.13	0.501	0.618
		Female	50	0.36	0.10		
	L	Male	50	0.35	0.12	-0.649	0.518
		Female	50	0.36	0.09		
Lateral	R	Male	50	0.50	0.15	-1.124	0.264
		Female	50	0.53	0.12		
	L	Male	50	0.52	0.16	-1.493	0.139
		Female	50	0.56	0.12		
Central	R	Male	50	0.84	0.15	-0.693	0.490
		Female	50	0.86	0.14		
	L	Male	50	0.84	0.15	-1.276	0.205
		Female	50	0.88	0.13		
Central/lateral	R	Male	49	1.74	0.52	0.885	0.378
		Female	50	1.66	0.31		
	L	Male	50	1.72	0.49	1.089	0.279l
		Female	50	1.62	0.41		
Lateral/canine	R	Male	50	1.52	0.63	-1.023	0.309
		Female	50	1.64	0.57		
	L	Male	49	1.52	0.42	-1.053	0.295
		Female	50	1.61	0.43		
Canine/premolar	R	Male	42	1.76	0.57	-1.427	0.157
		Female	50	2.22	1.99		
	L	Male	47	1.86	1.06	0.625	0.534
		Female	50	1.75	0.66		

Discussion

As mentioned before, one of the main reasons for patients to go to dental offices and orthodontic treatments is to improve the appearance of the face and increase beauty, and smile is the most important component in maintaining facial beauty and social life. So far, limited criteria have been developed to assess the fit of a smile, and most methods of evaluating it are qualitative. One of the few criteria used to assess the proportion of a smile is the golden ratio discussed earlier.

The results of this study showed that only the ratio of the visible width of the right lateral tooth to the right central tooth is golden and in other cases no golden ratio was observed between the visible width ratio of the maxillary anterior teeth on the right and left. Also, the visible width of the maxillary anterior teeth on the right and left and between men and women is not significantly different. In women, small lateral teeth may cause no golden ratio between central and lateral and between lateral and canine, and large canine teeth in men may distort the presence of golden ratio between lateral and canine in men (12).

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In 2006, Fayyad et al. Evaluated the geometric and mathematical ratios of maxillary anterior teeth and found that there was a golden ratio between the width of the central and lateral teeth in 31.3% of men and 27.27% of women, but in the present study the golden ratio in women It was not present and was not seen in men between canine and lateral teeth (13).

Preston also showed a golden ratio between the width of the central and lateral maxillary teeth in 17% of cases and this ratio was not between the width of the lateral and canine teeth. In the present study, there was no golden ratio between the lateral and canine teeth and a smaller percentage of the population. Men showed a golden ratio (4).

Murthy and Ramani also found a golden ratio in 25-25% of the samples in India and stated that the golden ratio is not suitable for a successful examination of the width of the anterior teeth unless the patient's race is considered (14). de Castro and colleagues in Brazil also observed this ratio in 71% of people (15).

Tabatabai and his colleagues in 2011 conducted a study to examine the golden ratio in social smile from the orthodontic point of view. They acknowledged that the golden ratio between left and right is seen in men, but the golden ratio between lateral and male canine is not found due to large canine and in female anterior teeth due to small lateral (11). Therefore, this level of similarity and in comparison with other studies cannot prove that the golden ratio is a reliable ratio for the reconstruction of maxillary anterior teeth. And in most studies between right and left women and men and separately There is no significant difference between men and women in terms of gender, and what Levin and his colleagues achieved years ago was simply to attribute a mathematical ratio to dentistry. While the beauty and proper proportions of the teeth are to some extent related to each person's criteria.

Conclusion

Considering the limitations of this study, it was found that the visible width of the maxillary anterior teeth on the right and left, as well as between men and women, was not significantly different. This ratio was not maintained in other teeth. Therefore, the golden ratio cannot be a permanent criterion for the reconstruction of the maxillary anterior teeth.

Ethical standards statement

This study was carried out after approval by the Vice Chancellor for Research and Technology of Mazandaran University of Medical Sciences and approval of the Ethics Committee in Biomedical Research (code number: IR.MAZUMS.REC.1399.686).

Conflicts of interest

The authors consider it necessary to thank the Vice Chancellor for Research and Technology and the Student Research Committee of Mazandaran University of Medical Sciences for financial support.

Authors' contributions

All authors have intellectually committed to the study design and process. The final manuscript was revised and accepted by all authors.

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