Proportion of Maxillary Anterior Tooth Width to the Concept ofGolden Proportion, RED Proportion and Preston Proportion Based on Facial Type Among Students of Faculty of Dentistry inUniversity of Sumatera Utara

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Background

Objective :Theaimof thestudyisto determine difference in proportion of maxillaryanterior toothwidthtothe concept of goldenproportion, recurringesthetic dental (RED)proportion and Preston'sproportionbasedon facial typeamongstudents of Faculty of Dentistryin University of SumateraUtara (FKG USU).

Materials and methods :The study was conducted on 102 students of FKG USU meeting the criteria of inclusion, i.e. 34 students with euryprosopic facial type, 34 students with mesoprosopic facial type and 34 students with leptoprosopic facial type. It is an analytic observational study by measuring maxillary anterior tooth width with cross sectional approach using front-facing pictures. These pictures were taken with Canon 60D camera in 45 cm distance, measurements of pictures were performed by using Corel Draw Graphics Suite 12 software and data was statistically analyzed by using one-sample t-test.

Results :The study showed significant difference (p < 0.05) between proportion of maxillary anterior tooth width with the concept of golden proportion in three facial types in both male and female participants, significant difference (p < 0.05) between proportion of canine to lateral incisor width with the RED proportion and no difference (p > 0.05)between proportion of lateral to central incisor width with the RED proportion in three facial types in both male and female participants. There was no difference (p> 0.05) between proportion of maxillary anterior tooth width with the concept of Preston's proportion in three facial types in both male and female participants.

Conclusion:The concept of Preston's proportion is a more appropriate esthethic concept for samples of the study with euryprosopic, mesoprosopicand leptoprosopic facial types.

Keywords: Golden proportion, RED proportion, Preston's proportion, Euryprosopic,mesoprosopic, Leptoprosopic

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I.   Introduction

Fabrication of full denture for edentulous patient is expected to provide satisfaction functionally and esthetically to increase patient's psychology. Esthetic is the main consideration for patients undergoing prosthodontictreatments.The simple techniqueto determine the ideal width of maxillary anterior toothcomplyingwithesthetic factor isbymeasuring facial appearance, intercaninewidth of sixmaxillary anterior teeth as guidance inselection and harmonicarrangement of maxillary anterior teeth. Thetechniqueincludes concept of goldenproportion, recurringesthetic dental (RED) proportion and Preston's proportion.[3-7]

The concept of golden proportion is based on the theory stating that natural and mathematic esthetics are related. This concept shows a constant proportion between the larger and smaller length in every beauty. This concept could be found not only in geometric elements, but also in living subjects such as human body.Levin (1978) stated that in front view, the surface of maxillary anterior teeth should be in golden proportion, with width of lateral incisor in golden proportion to that of central insisor, and width of canine in golden proportion to that of lateral incisor.The golden proportion for each subject determined by measuring width of the central incisor was multiplied by 62% and compared with the width of the adjacent lateral incisor. Similar values mean the width of the central incisor is in golden proportion to the width of the lateral incisor. In comparing the width of the lateral incisor multiplied by 62% with the width of the adjacent canine it can be determined if the width of the lateral incisor is in golden proportion to the width of canine (Figure 1).[3,12-14]
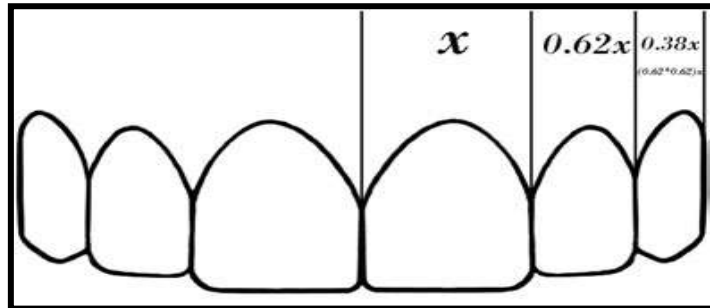

Figure 1. Concept of golden proportion[4]

In 2001, Ward introduced recurring esthetic dental (RED) proportion. Ward recommended the use ofrepeated ratioconcept and declared RED proportion more consistent and constant than golden proportion. Recurring esthetic dental (RED) proportion is a constant width proportion of two adjacent teeth that is front viewed from midline progressing to the posterior of the jaw arch (Figure 2).[3,4,12,14]
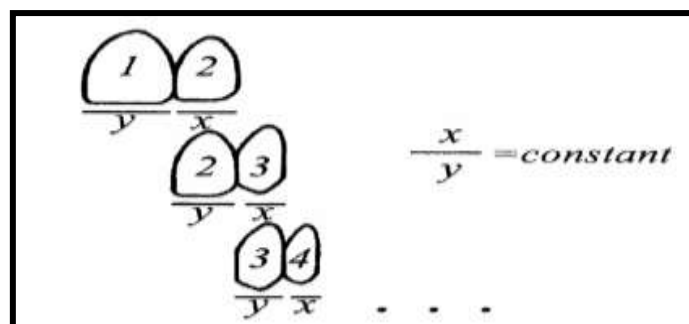

Figure2. Principle ofRED proportion[14]

Preston (in 1993) studied the existence of golden proportion in natural dentition and found that only 17% of the maxillary lateral incisor width was in golden proportion with the width of maxillary central incisor and none of the canines width were in golden proportion to the width of maxillary lateral incisor. He proposed Preston's proportion, that is, the width of maxillary lateral incisor should be 66% the width of central incisor and the width of maxillary canines should be 55% the width of maxillary central incisor or should be 84% the width of lateral incisor in the front view (Figure 3).[4,7]
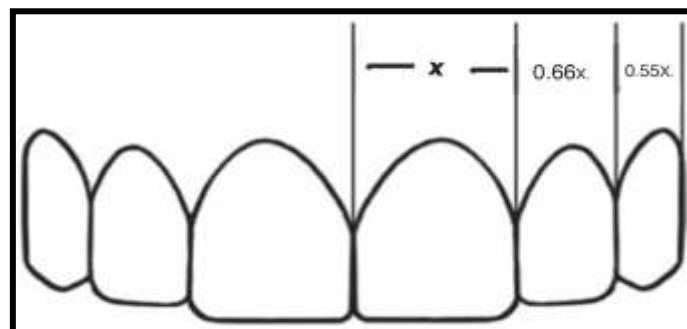

Figure 3. Concept ofPreston's proportion[7]

One of the factors relating to the width of the teeth is the facial type. Facial type examination is performed by using extra oral photography. Herzberg (1952) stated that standardized photography is the best method in facial evalution of individuals, as photography of a practician could detaillyaffect facial proportion and result of measurement. Martin classified facial types to hypereuryprosopic, euryprosopic, mesoprosopic, leptoprosopic, and hyperleptoprosopic.[15,16]Measurement with front pictures could be performed by facial index formula measuring facial length and width.Facial type is related to the shape of head and tooth arch. Narrow arch is found on leptoprosopicfacial type individuals, wide arch is found on euryprosopic facial type individuals, and wider arch is found on mesoprosopic facial type individuals.[17-19]

Based on the introduction, author was motivated to conduct the study on proportion of maxillary anterior tooth using concept of golden proportion, RED proportion and Preston's proportion in students of FKG USU based on facial type.

II. Materials And Methods

The study is an analytic observational study by measuring width of maxillary anterior teeth with cross sectional approach using front view pictures in Faculty of Dentistry, University of Sumatera Utara (FKG USU). The samples of the study include 102 students of FKG USU, which were divided to 34 euryprosopic facial type, 34 mesoprosopic facial type, and 34 leptoprosopic facial type male and female students who meet the criteria of inclusion.Criteria of inclusion includes Indonesian students of FKG USU aged 18-25 years old, written consent, complete 6 maxillary anterior teeth with no caries and restoration, normal tooth morphology, fine arrangement of tooth, healthy periodontal tissue, no history of orthodontic treatment, no history prosthetic treatment of anterior teeth, no history of facial reconstruction, normal overjet and overbite.

Tools and materials of the study include questionnaire, informed consent form, subject's data, Canon EOS 60D 18MP Digital Single Lens Relflex camera, tripod, measuring tape 3M/16FT, head fixator, face marker, cheek retractor, Acer laptop, Corel Draw Graphics Suite 12 and SPSS 18.0.

Subject was selected by questionnaire, given oral and written explanation. Consent was acquired by signing informed consent form. To obtain picture of maxillary anterior teeth, subject was seated and camera adjustment was made, with subject seated 120 cm away from background and 45 cm away from the outer surface of the camera. Subject was positioned in natural head position, frankfurt plane perpendicular to the ground, facial midline adjusted to focus of camera lense, and subject's head fixated. Cheek retractor was placed on mouth of subject to show servical part of maxillary anterior teeth. Pictures of subject were then taken (Figure 4).
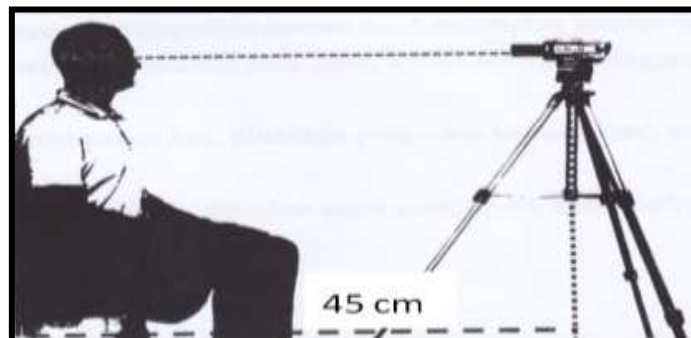
Figure 4. Position of subject during picture taking process

Measurements of maxillary anterior tooth width were performed by using Corel Draw Graphics Suite 12 software, by determining and marking mesial and distal points of maxillary central incisor, lateral incisor, and canine,and made the vertical line on these points, then measuring the width of the vertical lines to obtain width of maxillary central incisor, lateral incisor and canine (Figure 5). The proportion of maxillary lateral to central incisor width and canine to lateral incisor width were determined. The results were processed by computerization system and analyzed by SPSS 18.0.
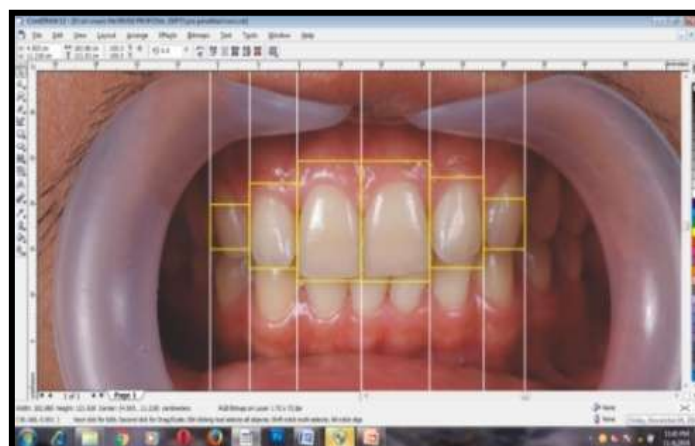
Figure 5. Anterior tooth width measurement technique with Corel Draw 12

III. Results

Results show mean value of maxillary anterior tooth width among 102 students of FKG USU based on facial types (front view). Mean value of central incisor width, lateral incisor width and canine width of male participants with euryprosopic facial type are8.93±0.47; 6.25±0.81; 5.12±0.65sequentially, mesoprosopic facial type are 8.82±0.66; 6.07±0.58; 5.18±0.67sequentially, and leptoprosopic facial type are 8.91±0.68; 6.13±0.53; 5.03±0.74sequentially.Mean value of central incisor width, lateral incisor width and canine width of female participants with euryprosopic facial type are 8.70±0.48; 6.04±0.52; 4.86±0.51sequentially, mesoprosopic facial type are 8.57±0.56; 5.92±0.52; 5.02±0.50 sequentially and leptoprosopic facial type are 8.66±0.54; 5.87±0.56; 4.95±0.63sequentially.

One sample t-test analysis showed proportion of maxillary lateral to central incisor width and proportion of canine to lateral incisor width in male participants with euryprosopic facial type are 0.70±0.09; 0.83±0.15sequentially, mesoprosopic facial type are 0.69±0.07; 0.86±0.18sequentially, and leptoprosopic facial type are 0.69±0.07; 0.82±0.17sequentially (Table 1).The proportion of maxillary lateral to central incisor width and proportion of canine to lateral incisor width in female participants with euryprosopic facial type are 0.69±0.06; 0.80±0.09sequentially, mesoprosopicfacial type are 0.69±0.06; 0.85±0.09sequentially, andleptoprosopicfacial type are 0.64±0.15; 0.85±0.16 sequentially(Table 1).

Table1. Mean value of maxillary anterior tooth width of FKG USU students based on facial types

Facial types	Anterior tooth proportion	Gender	
		Male ($\bar{X} \pm$ SD)	Female ($\bar{X} \pm$ SD)
Eurypro sopic	I2 : I1	0.70±0.09	0.69±0.06
	C : I2	0.83±0.15	0.80±0.09
Mesopro sopic	I2 : I1	0.69±0.07	0.69±0.06
	C : I2	0.86±0.18	0.85±0.09
Leptopro sopic	I2 : I1	0.69±0.07	0.64±0.15
	C : I2	0.82±0.17	0.85±0.16

One sample t-test analysis shows significant difference p= 0.002 andp= 0.000 (p < 0.05) between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of golden proportion based on euryprosopic facial types of male participants. There was significant difference p= 0.001 andp= 0.000 (p < 0.05)between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of golden proportion based mesoprosopic facial types of male participants.There was significant difference p= 0.001 andp= 0.000 (p < 0.05)between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of golden proportion based on leptoprosopic facial types of male participants(Table 2).

One sample t-test analysis shows significant difference p= 0.000andp= 0.000 (p < 0.05) between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of golden proportion based on euryprosopic facial types of female participants. There was significant difference p= 0.000andp= 0.000 (p < 0.05)between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of golden proportion based onmesoprosopic facial types of female participants.There was significant difference p= 0.017 andp= 0.000 (p < 0.05)between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of golden proportion based onleptoprosopic facial types of female participants (Table 2).

Table2. Difference between proportion of maxillary anterior tooth width with the concept of golden proportion in students of FKG USU based on facial types

Gender	Facial Types	Anterior Tooth Proportion	($\bar{X} \pm$ SD)	GP	p
Male	Eurypro sopic	I2:I1	0.70±0.09	0.62	0.002*
		C:I2	0.83±0.15	0.62	0.000*
	Mesopro sopic	I2:I1	0.69±0.07	0.62	0.001*
		C:I2	0.86±0.18	0.62	0.000*
	Leptoprosopic	I2:I1	0.69±0.07	0.62	0.001*
		C:I2	0.82±0.17	0.62	0.000*
Female	Eurypro sopic	I2:I1	0.69±0.06	0.62	0.000*
		C:I2	0.80±0.09	0.62	0.000*
	Mesopro sopic	I2:I1	0.69±0.06	0.62	0.000*
		C:I2	0.85±0.09	0.62	0.000*
	Leptopro sopic	I2:I1	0.64±0.15	0.62	0.017*
		C:I2	0.85±0.16	0.62	0.000*

*Significant difference (p< 0.05)

One sample t-test analysis shows no significant difference p= 0.955 (p>0.05) between proportion of maxillary lateral to central incisor width and a significant differencep= 0.003 (p<0.05)between proportion of canine to lateral incisor width with the concept of RED proportion based on euryprosopic facial types of male participants. There was no significant difference p= 0.638 (p>0.05)between proportion of maxillary lateral to central incisor width and a significant difference p= 0.002 (p < 0.05)between proportion ofcanine to lateral incisor width with the concept of RED proportion based on mesoprosopic facial types of male participants.There was no significant difference p= 0.633(p>0.05)between proportion of maxillary lateral to central incisor width and a significant difference dan p= 0.006 (p < 0.05)between proportion ofcanine to lateral incisor width with the concept of RED proportion based on leptoprosopic facial types of male participants(Table 3).

One sample t-test analysis shows no significant difference p= 0.763(p>0.05)betweenproportion of maxillary lateral to central incisor width and a significant differencep= 0.000(p<0.05)between proportion of canine to lateral incisor width with the concept of RED proportion based on euryprosopic facial types of female participants. There was no significant difference p= 0.655(p>0.05)between proportion of maxillary lateral to central incisor width and a significant difference p= 0.000 (p < 0.05)between proportion of canine to lateral incisor width with the concept of RED proportion based on mesoprosopic facial types of female participants. There was no significant difference p= 0.173 (p>0.05)between proportion of maxillary lateral to central incisor width and a significant difference dan p= 0.001 (p < 0.05)between proportion of canine to lateral incisor width with the concept of RED proportion based on leptoprosopic facial types of female participants (Table 3).

Table3.Differencebetween proportion of maxillary anterior tooth width with the concept of RED proportion in students of FKG USU based on facial types

Gender	Facial Types	Anterior Tooth Proportion	($\bar{X} \pm SD$)	RED	p
Male	Euryprosopic	I2:I1	0.70±0.09	0.70	0.955
		C:I2	0.83±0.15	0.70	0.003*
	Mesoprosopic	I2:I1	0.69±0.07	0.70	0.638
		C:I2	0.86±0.18	0.70	0.002*
	Leptoprossopic	I2:I1	0.69±0.07	0.70	0.633
		C:I2	0.82±0.17	0.70	0.006*
Female	Euryprosopic	I2:I1	0.69±0.06	0.70	0.763
		C:I2	0.80±0.09	0.70	0.000*
	Mesoprosopic	I2:I1	0.69±0.06	0.70	0.655
		C:I2	0.85±0.09	0.70	0.000*
	Leptoprosopic	I2:I1	0.64±0.15	0.70	0.173
		C:I2	0.85±0.16	0.70	0.001*

*Significant difference (p < 0.05)

One sample t-test analysis shows no significant difference p= 0.083andp= 0.893 (p> 0.05) between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of Preston's proportion based on euryprosopic facial types of male participants.There was no significant difference p= 0.100andp= 0.581 (p> 0.05)between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of Preston's proportion based on mesoprosopic facial types of male participants.There was no significant difference p= 0.105andp= 0.801 (p> 0.05)between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of Preston's proportion based on leptoprosopic facial types of male participants (Table 4).

One sample t-test analysis shows no significant difference p= 0.280andp= 0.225 (p> 0.05) between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of Preston's proportion based on euryprosopic facial types of female participants. There was no significant difference p= 0.050andp= 0.594 (p> 0.05)between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of Preston's proportion based on mesoprosopic facial types of female participants.There was no significant difference p= 0.708andp= 0.715 (p> 0.05)between proportion of maxillary lateral to central incisor width and canine to lateral incisor width with the concept of Preston's proportion based on leptoprosopic facial types of female participants (Table 4).

Tabel 4.Difference between proportion of maxillary anterior tooth width with the concept of Preston's proportion in students of FKG USU based on facial types

Gender	Facial Types	Anterior Tooth Proportion	($\bar{X} \pm SD$)	Preston	p
Male	Euryprosopic	I2:I1	0.70±0.09	0.66	0.083
		C:I2	0.83±0.15	0.84	0.839
	Mesoprosopic	I2:I1	0.69±0.07	0.66	0.100
		C:I2	0.86±0.18	0.84	0.581
	Leptoprossopic	I2:I1	0.69±0.07	0.66	0.105
		C:I2	0.82±0.17	0.84	0.801
Female	Euryprosopic	I2:I1	0.69±0.06	0.66	0.280
		C:I2	0.80±0.09	0.84	0.225
	Mesoprosopic	I2:I1	0.69±0.06	0.66	0.050
		C:I2	0.85±0.09	0.84	0.594
	Leptoprosopic	I2:I1	0.64±0.15	0.66	0.708
		C:I2	0.85±0.16	0.84	0.715

*Significant difference ($p < 0.05$)

IV.   Discussion

The study used a cross-sectional approach by using questionnaire and digital pictures measured with Corel Draw Graphics Suite 12. Selected samples were evaluated with facial index to determine facial type. Enlow and Hans classified facial types to three categories, i.e. euryprosopic, mesoprosopic, and leptoprosopic.

Proportion of lateral to central incisor width is commonly smaller than proportion of canine to lateral incisor width, where it is similar sequentially, in euryprosopic, mesoprosopic and leptoprosopicfacial types.

Mahshid et al(2004) declared that maxillary anterior tooth arrangement based on gender does not affect golden proportion, where proportion of lateral to central incisor width is 0.67 and proportion of canine to lateral incisor is 0.84. The statement is supported by Forster et al (2013) who stated that width of central incisor, lateral incisor and canine are 1.6: 1: 0.85 sequentially on both sides (proportion of lateral to central incisor width is 0.62 and proportion of canine to lateral incisor width is 0.85).This study showed that proportion of lateral to central incisors and proportion of canine to lateral incisor width with the concept of golden proportion based on facial types is not appropriate to obtain esthetic smile in both male and female. This finding is consistent to study of Al-Marzok et al (2013) who stated that in population of Malaysia, there is a significant difference between proportions of maxillary lateral to central incisor and proportion of canine to lateral incisor width with the concept of golden proportion p=0.026 and p=0.017 (p<0.05) sequentially. The study stated that golden proportion is not found in proportion of maxillary anterior tooth width.Gillen (1994), Hasanreisoglu (2005), Fayyad (2006), Murthy (2008), Rita (2013) stated that golden proportion is not found in proportion of maxillary anterior tooth width and that concept of golden proportion is not a suitable method to be used as guidance in determining proportion of maxillary anterior tooth width.[3,5,10]

The different result in concept of golden proportion might be due to racial difference in samples. Concept of golden proportion was developed in Europe using characteristics of Caucasoid race, while this study involved samples of Mongoloid race.This study shows no significant difference in proportion of lateral to central incisor width and a significant difference between proportion of canine to lateral incisor width with the concept of RED proportion, based on facial types in male and female participants. Generally, the study is not consistent with the concept of RED proportion which is a repeated ratio concept developed by Ward with 0.70 beween in proportion of lateral to central incisor width and between proportion of canine to lateral incisor width. The result is consistent to the study of Gillen (1994), Fayyad et al (2006), Murthy (2008), Shetty (2011) and Rita (2013) which state that RED proportion is not found in the six maxillary anterior teeth of their subjects and is not recommended to be used as a method to determine maxillary anterior tooth width.[3,5,7,10]

The result of this study differs from concept of RED proportion. This concept is proposed by Ward based on his survey on North America's dentist population. The different result might be contributed to racial variation of subjects.This study shows no significant difference betweenproportion of maxillary lateral to central incisor width and proportion of canine to lateral incisor width with the concept of Preston's proportion based on facial types in male and female. Preston's study result (1993) showed that proportion of lateral to central incisor width is 0.66 and proportion of canine to lateral incisor 0.84.[7] The difference of proportion is due to variation of maxillary anterior tooth width that is related to race of study population, and shape of individual jaw arch.

V.   Conclusion

Based on the result, it is concluded that: there is a significant difference (p< 0.05) between proportion of lateral to central incisor width and proportion of canine to lateral incisor width with the concept of golden proportion in male and female with euryprosopic, mesoprosopic and leptoprosopic facial types. There is a significant difference (p< 0.05) between propotion of canine to lateral incisor with the concept of RED proportion in male and female with euryprosopic, mesoprosopic, and leptoprosopic facial types. There is no significant difference (p > 0.05) betweenpropotion of lateral to central incisor width with the concept of RED proportion in male and female with euryprosopic, mesoprosopic, and leptoprosopic facial types. There is no significant difference (p > 0.05)betweenproportion of lateral to central incisor width and proportion of canine to lateral incisor width with the concept of Preston's proportion in male and female with euryprosopic, mesoprosopic, and leptoprosopic facial types.

Proportion of lateral to central incisor width and proportion of canine to lateral incisor width in the study showed that concept of Preston's proportion is more suitable to be used as esthetic concept among students of FKG USU compared to concept of golden proportion and RED proportion of three facial types.

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