

Divine Proportions as Predictors of Facial Esthetics : A Photometric Study Using AutoCAD Software

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ABSTRACT

Objective: The aim of the study is to analyze the relationship between Divine proportions and facial esthetics in horizontal and vertical proportions. **Materials and methods:** Two hundred facial photographs of subjects were analysed into attractive and unattractive group using visual analog scale numbered from 0 to 100, by a panel of thirty members with attractive group consisting of 36 male and 28 female and unattractive group consisting of 30 male and 34 female subjects. Later these photographs were digitized in Adobe Photoshop software and analysed for divine proportion utilizing AutoCAD 2019 software, after calculating divine proportion for each subject comparison of mean values for each parameter between attractive and unattractive groups was done by unpaired 't' test for significance. **Results:** Comparing attractive and unattractive group attractive group showed values closer to divine proportion than unattractive group, however few parameters Eye width in horizontal parameters, Upper facial height and Lower facial height in vertical parameters were closer to divine proportion value and statistically significant ($P < 0.05$) indicating that only these three parameters are reliable in predicting facial esthetics. **Conclusion:** Attractive individual parameters shown values closer to divine proportions than unattractive individual in general, but only few parameters are of statistical significance. Hence, facial beauty is only measurable to some extent with divine proportions.

Keywords: Divine proportions, Golden proportions, Facial esthetics, Esthetics, Attractiveness.

INTRODUCTION

Facial beauty is defined as a combination of qualities such as shape, color and form which pleases the aesthetic senses especially the sight.¹ Facial proportions are of interest in orthodontics as the clinical ability to alter dentofacial form requires an understanding of facial aesthetics and this understanding of facial proportions is vital for any clinician involved in treatment that will alter patient's dentofacial appearance whether through orthodontics, facial growth modification, and corrective jaw surgery.²

Throughout the ages, painters and sculptors have attempted to establish ideal proportions for the human facial form. However, possibly the most famous of all axioms about ideal proportions is best described with golden proportions. Scientists began to discover the examples of golden proportion number in nature, hence also called as divine proportion.³ Attempts have made to correlate ideal facial proportions with the golden proportion, such that esthetics can indeed be analysed scientifically. Rickett's⁴ introduced golden divider in which the divine proportion (1.618) is the length of the longer side and the short side is 1 used for

morphologic analysis of the teeth, the skeleton and the soft tissues of the face. Rickett's mathematically analysed divine proportions in human face using 12 reference distance (5 transverse and 7 vertical). According to him progressive phi relationship was found with the golden proportion having the four parts (0.618, 1.618, 2.618, and 4.236) in series and in dynamic relationship.⁶

However there had been many attempts to correlate ideal facial proportions with the golden proportion and found that most attractive faces including professional models, beauty pageants has not been found to always fit the golden proportion, Therefore, more evidence is required to substantiate the true significance of this concept in the clinical assessment of facial aesthetics.^{7, 8} The purpose of this study is to measure the facial proportions in attractive and unattractive groups and compare these values in relation to divine proportion.

Subjects and Methods:

Sample

The sample size consists of 200 subjects with 100 males and

100 females, age ranged from 18 to 25 years. Inclusion criteria consist of subjects with

1. No dental or facial trauma,
2. No known congenital facial defects,
3. No dentofacial deformity
4. No previous orthodontic treatment.

Study methodology:

Frontal view photographs of subjects were taken in Natural head position (NHP) with lips in a relaxed position and the photographic frame should encompass the crown of the head and the clavicle of the subject.⁹ Photographs were taken with Nikon D3100 single lens reflex digital camera attached with a lens of 105mm focal length in portrait mode, the simplest method of standardization for taking photographs achieved by maintaining a fixed distance of the tripod from the subject.¹⁰

The facial photographs of these 200 subjects were examined as a slideshow by a panel of 30 appreciation members consisting of 10 dentists, 8 lay men, 5 orthodontists, 4 artists, and 3 beauticians. All the photographs were scored by each panel member using a visual analog scale numbered from 0 to 100¹¹, with 100 as most attractive and 0 as least attractive face, later the mean score for each photograph is calculated so that each subject received a total score of attractiveness ranging from 0 to 100. Individuals with total score 70 or more were considered as attractive faces and individuals with total score less than 30 were considered as unattractive faces and considered for further analysis in the study and rest of were excluded from the study. Based on mean score value 200 subjects were divided into two groups. Attractive group consisting of 36 male and 28 female subjects and Non attractive consisting of 30 male and 34 females subjects. The photographs were analysed at 500 x 751 pixels in Adobe Photoshop software and measurements for facial proportions were made utilizing AutoCAD 2019 software in the transverse and vertical facial planes (Figure 1).

In this study eight landmarks were used on facial photographs (Figure 2 and Table 1) from which five reference distance in transverse plane (Figure 3) and seven reference distance in vertical plane (Figure 4) were used to calculate divine proportion. For calculation of divine proportion in the transverse plane, NW-NW (nose width) is used as base value (1.0) and in the vertical plane, AL-MW (nose-lip distance) is used as base value (1.0), these two base values were used to calculate the phi relationship of all the reference distances used in this study. (Table 2 and Table 3).

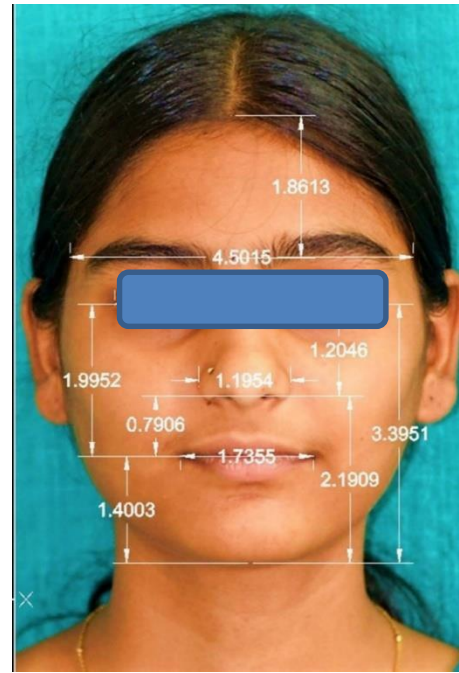


Figure 1: Facial proportions done using AutoCAD 2019 software.



Figure 2: Landmarks used in this study.

RESULTS

All the analysis was done using SPSS (Statistical Package for the Social Sciences) version 25. For each variable, the arithmetic mean and standard deviation (SD) were calculated. Later an independent student t test is done to compare variables between attractive and unattractive groups with respect to horizontal (Table 4, Graph 1) and vertical proportions (Table 5, Graph 2). Comparing attractive and unattractive faces by Independent sample t test in general showed attractive individual parameters shown values closer to divine proportions than unattractive

individual. Comparison of horizontal proportions in attractive and unattractive faces showed one parameter Eye width which is statistically significant ($p=0.027$) and in vertical proportions showed two Upper facial height ($p=0.026$) and Lower facial height ($p=0.022$) which were statistically significant indicating that Eye width, Upper facial height, Lower facial height reliable in predicting the facial esthetics.

importance of role esthetics before and after Orthodontic treatment. Beauty lies in the eye of the beholder face, which one person finds beautiful may not be same to another person due to some objective quality inherent in the face or was it subjectively determined by each individual with their sensory enjoyment depending on their own ideas, feelings and judgments, which themselves have a direct relation to sensory enjoyment.¹²

Table 1: Landmarks used in the study

Landmark	Description of the land mark
TR	Trichion is top of the wrinkled forehead or near the hair line
TS	Temporal surface is the width of head at the temporal soft tissue above the ears at the level of the eyebrow where skull and facial fascia meet.
LC	Lateral canthus of the eye.
AL	Alar rim.
LN	Lateral side of the nose.
CH	Cheilion is at the corner of the mouth.
ME	Soft-tissue menton.
DA	Dacryon is noted at the inner border of the orbit.



Figure 3: Reference distances in transverse plane

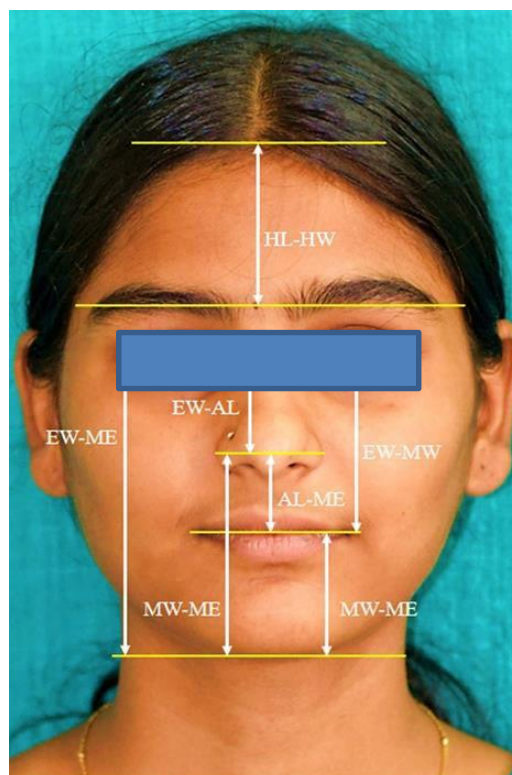


Figure 4: Reference distances in the vertical plane

DISCUSSION

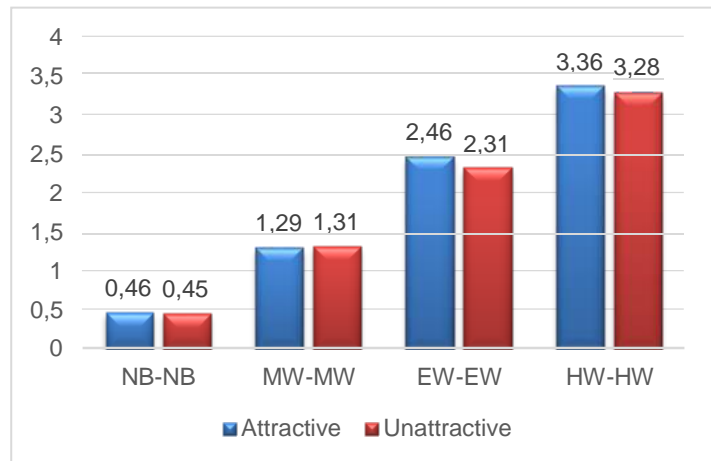
The aims of orthodontic treatment according to Jackson famously known as Jackson triad are Functional efficiency, Structural balance and Esthetic harmony indicating the

Table 2:Reference distances and Phi relationship in transverse plane

Reference distance	Phi relationship	Description of reference distance
NW-NW	Base value (1)	Nose bridge width, is the distance between Draycon on right and left side.
NB-NB	1:φ (0.618)	Nose width, is the distance between the Lateral side of the nose on right and left side.
MW-MW	φ (1.618)	Mouth width, is the distance between the Cheilion at the corner of the mouth on right and left side.
EW-EW	φ ² (2.618)	Eye width, is the distance between the Lateral canthus on right and left side.
HW-HW	φ ³ (4.236)	Head width, is the distance between the temporal surface on right and left side.

Ricketts^{4, 5, 6} was the first to stipulate that instead of resorting to a subjective perception, a face’s beauty should be mathematically analysed on the basis of the divine proportions (1.618) and calculated divine proportions and their progressions human face using 12 references values and gave their respective golden proportion. According to him progressive phi relationship was found within the parameters in both horizontal and vertical parameters and concluded that esthetics can indeed made scientific rather than the need to resort to subjective perceptions. The results obtained in this study were different from the Ricketts study, an important factor to be emphasized was that when Ricketts performed his studies he employed the golden compass directly over the facial photographs of beautiful faces, which probably, allows obtaining approximate divine proportion values. In this study, sample selection of subjects was done by a panel of members

present study revealed that three out of twelve parameters EW – EW (Eye width) in horizontal proportion, EW - MW (Upper facial height) and AL- ME (Lower facial height) showing statistical significance and can be used for predicting facial esthetics.



Graph 1: Bar diagram representing horizontal proportions in attractive and unattractive group

TABLE 3:REFERENCE DISTANCES AND PHI RELATIONSHIP IN THE VERTICAL PLANE		
Reference distance	Phi relationship	Description of reference distance
AL-MW	Base value (1)	Nose-Lip distance
EW-AL	φ (1.618)	Nose height
MW-ME	φ (1.618)	Chin height,
HL-HW	φ ² (2.618)	Forehead height
AL-ME	φ ² (2.618)	Lower face height
EW-MW	φ ² (2.618)	Upper face height
EW-ME	φ ³ (4.236)	Total face height

into attractive and unattractive groups, analysis of divine proportion was done through a computer program AutoCAD 2019, establishing and marking each photometric points of reference in this way we obtained exact measurements. The

Moss et al ¹³analyzed three-dimensional nature of beautiful faces by means of optical-surface scanning performed on 9 men and 15 women employed as professional models and concluded that proportional measurements of professional models did not fit to divine proportions. Baker et al ¹⁴investigated role of the divine proportion in the esthetic improvement of patients undergoing combined orthodontic and orthognathic-surgical treatment. Pre and post treatment photographs of most subjects were considered esthetic after treatment, no correlation was evident between the change in facial esthetic rating and the movement of each of the facial proportion ratios towards divine proportion.

Shell et al ¹⁵compared selected divine or golden proportions in Class II division 1 patients treated either during the growth phase with an activator and fixed appliances or after the completion of growth with fixed appliances and orthognathic surgery to determine the associations between divine facial proportions and

perceived facial attractiveness. Divine relationships of the

esthetics in adolescents. Mizumoto et al¹⁸ assessed facial golden

Table 4: Comparison of horizontal proportions in attractive and unattractive faces

Variables	Normal value	Attractive			Unattractive			p-value
		Mean	S.D	P.D	Mean	S.D	P.D	
NW-NW	1	1.00	-		1.00	-		
NB-NB	0.618	0.46	.09	25.5%	0.45	.09	27.1%	0.841
MW-MW	1.618	1.29	.09	19.6%	1.31	.15	19.0%	0.911
EW-EW	2.618	2.46	.21	5.9%	2.31	.19	12.1%	0.02*
HW-HW	4.236	3.36	.32	9.1%	3.28	.24	23.0%	0.484

subjects were assessed on pre- and post-treatment facial photographs by a panel of judges using a visual analogue scale. Facial aesthetic scores were then correlated with the presence of particular divine facial proportions and the achievement of divine proportions seemed to have little influence on overall aesthetic outcomes. Filho et al¹⁶ investigated the relationship between divine proportion and facial esthetics in frontal photographs before and after manipulation of facial proportions towards divine ratio. It was observed that manipulated photographs showed better esthetic rating than original photographs and concluded there exists a relationship between divine proportion and facial aesthetics.

proportions among three groups of young Japanese women with group 1 consisting of 30 young adult patients with a skeletal Class 1 occlusion, group 2 consisting of 30 models and group 3 consisting of 14 popular actresses. Facial proportions of 3 groups were calculated and compared, proportions of group 1 and 2 differed from the golden proportion whereas group 3 had golden proportions in all measurements suggesting that divine proportion might be useful application in determining facial esthetics.

Pancherz et al¹⁹ compared attractive and non-attractive faces of females and males with respect to the presence of the divine proportions and concluded that attractive individuals have facial

Table 5: Comparison of vertical proportions in attractive and unattractive face

Variables	Normal value	Attractive			Unattractive			p-value
		Mean	S.D	P.D	Mean	S.D	P.D	
AL-MW	1	1.00	-		1.00	-		
EW-AL	1.618	1.46	.23	9.7%	1.38	.27	14.7%	0.181
MW-ME	1.618	1.72	.27	6.3%	1.59	.25	1.73%	0.066
HL-HW	2.618	2.32	.29	11.3%	2.18	.39	16.7%	0.106
AL-ME	2.618	2.69	.21	2.7%	2.55	.26	2.5%	0.022*
EW-MW	2.618	2.49	.31	4.8%	2.32	.27	11.3%	0.026*
EW-ME	4.236	4.18	.47	1.3%	3.94	.54	6.98%	0.059

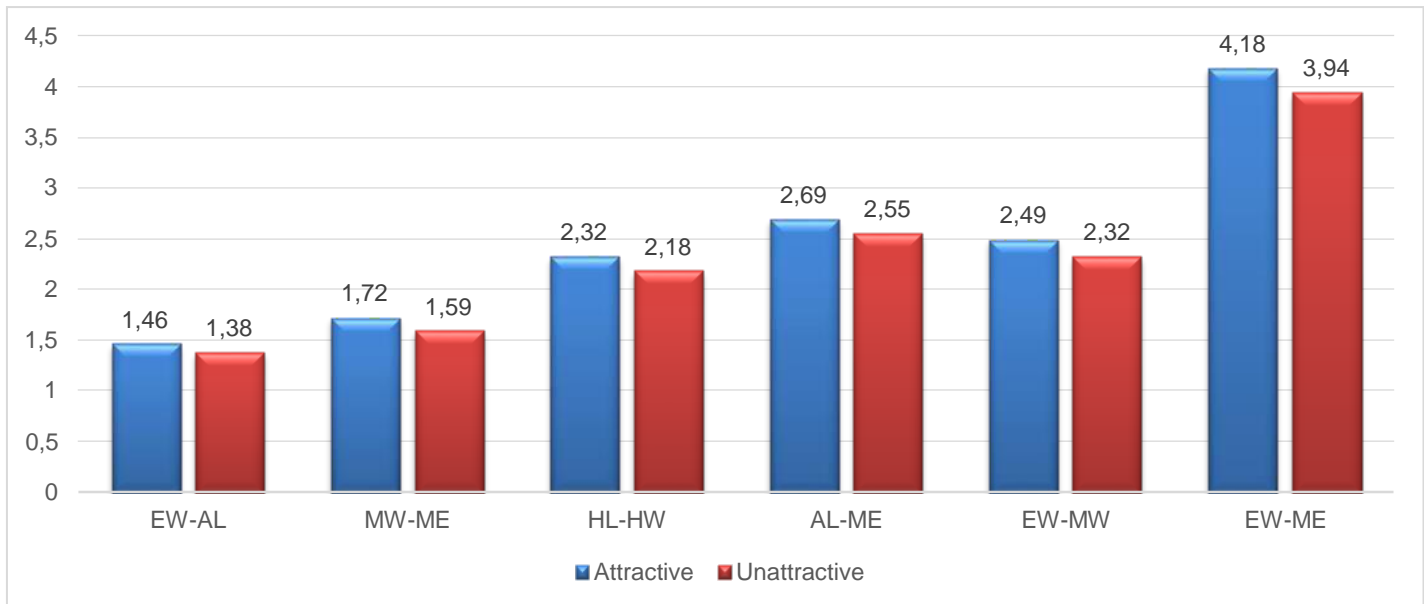
Kiekens et al¹⁷ analyzed the relationship between facial esthetics and golden proportions in white adolescents, Seventy-six adult laypeople evaluated sets of photographs of 64 adolescents on a visual analog scale (VAS) from 0 to 100. The facial esthetic value of each subject was calculated as a mean VAS score and the between golden proportions and facial esthetics was determined and concluded that only few proportions have a significant relationship with facial

proportions closer to the divine values than non-attractive subjects but no statistical difference is found between the two groups in both males and females and concluded that divine proportions are not absolute determinants and partially related of facial attractiveness. Rossetti et al²⁰ investigated role of the golden proportion in the evaluation of facial esthetics using 3D stereophotogrammetric facial acquisitions of 60 attractive young adult subjects, for each subject a set of facial distances was

obtained from the stereophotogrammetric facial reconstruction, and 10 ratios were computed. Ratios between 3D facial distances were not related to attractiveness as most of the facial ratios were different from the golden ratio.

and compared with the golden proportion and no correlation was found between facial ratios in professional black models with the golden proportion.

This result of this study was correlated with the studies done by



Graph 2: Bar diagram representing vertical proportions in attractive and unattractive group

Carrera Garrido et al²¹ esthetically assessed class III patients requiring orthodontic - orthognathic surgical treatment according to the divine proportion. Pre and post treatment photographs of 28 subjects were obtained and linear measurements for different facial ratios were calculated in both groups and compared, subjects appeared esthetic after treatment and most facial ratios presented a statistically significant difference approximating to the golden number after surgical treatment in class III patients. SiddikMalkoc et al²² investigated divine proportions and their influence on facial esthetics. Sixty subjects with good facial esthetics were selected and facial proportions of subjects were evaluated for divine proportions and concluded that none of the divine proportions was associated with facial aesthetics.

Jang et al²³ measured and compared the facial dimensions and facial ratios of Miss Korea pageant contestants and a selected group of women having straight profile, mesocephalic face type and balanced facial appearance by using three-dimensional (3D) image analysis, the facial ratios obtained in each group were compared to golden ratio. The ratios between the facial dimensions in both groups were not matching the golden ratio and conclude that the golden ratio used was not matching the current facial esthetic standards. Mantelakis et al²⁴ assessed facial ratios of professional black models and correlated these ratios with the golden proportion. Forty photographs of male and female professional black models were collected and categorised into best graded models and not well-graded models, facial ratios of both were calculated

Moss et al¹³, Baker et al¹⁴, Shell et al¹⁵, Kiekens et al¹⁷, Pancherz et al¹⁹, Rossetti et al²⁰, SiddikMalkoc et al²², Jang et al²³, Mantelakis et al²⁴ suggesting that only few golden proportion can be used in assessing facial esthetics. However few studies done Filho et al¹⁶, Mizumoto et al¹⁸, Carrera Garrido et al²¹ shown that there exists a relationship between divine proportion and facial esthetics.

CONCLUSION

1. Attractive subjects have parameters closer to divine proportion than in unattractive subjects with, few proportions (three out of twelve parameters) have a significant relationship with facial esthetics
2. Eye width in horizontal parameters, upper facial height and lower facial height in vertical parameters is reliable in predicting facial esthetics.
3. On the contrary to hypothesis of Ricketts, facial beauty can be analyzed quantitatively to some extent with divine proportions.
4. Therefore, if divine proportions need to be employed in orthodontic or orthognathic surgical planning, should be used only as a guideline working together with other already established methods like facial assessment, facial symmetry, averageness, sexual dimorphism and cephalometrics.

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