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Comparation between golden rectangle and ideal facial height proposed by the Silva Cephalometric Method (MCS) through digital analysis (NemoStudio 2022) in a university population

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Abstract

Objective: The purpose of this work was to establish a statistical relationship of the results obtained with two different techniques. The comparison was made between the ideal facial height proposed in the Silva cephalometric method (SCM) and the facial height obtained using Euclid's rectangle or golden rectangle.

Materials and Methods: 38 cephalometric radiographs of dentistry students of Universidad de Cuenca, of both sexes, were used. All of these radiographs had suitable characteristics for cephalometric tracing in the NemoStudio 2022 software. Once the cephalometric tracing was made using these software tools, SCM was performed on each one of them to collect the data, and then we proceeded to overlap Euclid's rectangle on all the images. The correlation of these two methods was established with Pearson's correlation coefficient.

Results: It was concluded that the Pearson correlation coefficient was [r]: 0.9271

Conclusions: 5% of the patients presented compatibility with the logarithmic spiral of the golden ratio.

Keywords: Golden rectangle; Facial height; Golden proportions; Lateral cephalic x-ray

1. Introduction

It is necessary that there is a correct harmony in the aesthetic field to be able to understand various artistic factors. One of these, are the mathematical agents of the Golden ratio and beautiness.

Currently, aesthetics is a phenomenon that increasingly influences society, it is encouraged from an early age to adulthood. A lot of benefits come with good aesthetics, such as improved self-esteem and greater confidence. All of these boost interpersonal relationships and social connections [1].

In ancient Greece, it was believed that beauty existed due to a correct harmony of the proportion of ordered elements of a certain object, and it was concluded that this element that lies between harmony and proportion was defined by a rule of mathematical nature, which they called the Golden Ratio. It is thought that the distribution of numbers that make up an object is random, but for mathematics everything has a specific pattern, nothing is random. For that reason, Euclid, one of the great Greek mathematicians, first determined the Golden Ratio to, through mathematics, explain the proportions the human eye innately consider beautiful [2].

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Regarding the advantages in oclussion related to the Golden Ratio, Ricketts proved that in some cases, the mandibular growth pattern reaches a logaritmic spiral of the Golden Ratio. This may have a very close relationship with cephalometric tracing points. In turn, Johnston was able to verify that people who present Angle Class I are considered much more attractive, since they do not present dissimilarities like Angle Class II and III do [3].

The Golden Ratio is the most renowned aesthetic balance ratio, its numerical value is expressed as 1.618. This is of great help in Orthodontics, especially in the field of diagnosis of malocclusions and to consider aesthetic parameters. According to Ricketts, the lower incisor is the basic unit, while the upper incisor is gil to the width of the lower. The relationship as a unit between the upper and lower incisors is gilt; when comparing the four lower central incisors and the two upper central incisors, a progression is observed. Also, the width of the upper first premolars is a progression.

Ricketts further mentions a second set of dental divine proportions, in which the four lower incisors have a width of 1.0, and notes that the upper canines have a ratio of 1.618 to the tip. Also, note the ratio of the four lower incisors to the width of the upper second molars, which is 2 phi (2x1.618). Marcuschamer points out that for anterior teeth, a sum of the total mesiodistal width from maxillary right first premolar to maxillary left first premolar is 1.618 the sum of the six mandibular anterior teeth. It is recommended that for the posterior zone, the sum of the mesiodistal widths of the first permanent molars and also the premolars must be taken, and these will have a Golden Ratio to the sum of the mesiodistal widths from the canine to the second upper permanent molar.

On the other hand, the application of cone beam computed tomography (CBCT) for orthodontics has helped to have a better understanding of craniofacial skeletal anatomy. However, conventional cephalometric analysis is still not being replaced in the diagnosis of malocclusions, let alone discarded. Measuring and understanding facial height and divergence are considered essential information for a good diagnosis of malocclusion. Sassouni, in his analysis, proposed that the SN, Frankfort, palatal, occlusal and mandibular planes converge at a single point, and classified facial divergence as neutral, hyperdivergent and hypodivergent. [4].

Hyperdivergent people have weaker bites and small muscles. It is important to know the difference between facial height and head height, the latter presents thirds while facial height does not.

Some measures are used to establish facial height: angular, linear and even proportional. Silva's cephalometric method first performs the ideal proportional facial height and then compares it with the patient's real height in order to finally observe the condition of the facial height: neutral, long or short face.

The Euclidean rectangle has the same proportionality between its sides, there is a golden ratio. For example, a rectangle that when subtracting the image of the square equal to that of the smaller side, the resulting rectangle is also a golden rectangle.

The ideal facial height projected in Silva's cephalometric method has an upper segment (N-ENA), equivalent to 50% and is located between the horizontal line of Nasion and the middle between the horizontal lines of the nasal spines (anterior and posterior), and a lower segment (ENA- Me), equivalent to 66.6% approximately, this goes from this horizontal line between the nasal spines to the horizontal line of Menton, this of course vertically [5].

2. Material and methods

Thirty-eight images were used for lateral cephalometric tracing in the multidisciplinary dental software NemoStudio 2022 (Figure 1) of male and female students aged 21-25 years from the Faculty of Dentistry of the University of Cuenca in Cuenca, Ecuador.

The first line was drawn following the indications of Silva's cephalometric method (Fig 2), in order to interpret the facial height and thus determine if the patient has a neutral face, long face or short face. At the same time the same cephalometry was used to draw the Euclid rectangle having two standardized parameters, the horizontal line of Nasion and another parallel line that was found located at the height of the most prominent part of the pterygomaxillary fossa (fig 3 and 4).

Using the NemoStudio 2022 functions, facial height is interpreted as follows: 4 horizontal lines are drawn parallel and perpendicular to the true vertical, the first is located at the Nasion point, the second at the anterior nasal spine, the third at the posterior nasal spine and the fourth at the chin.

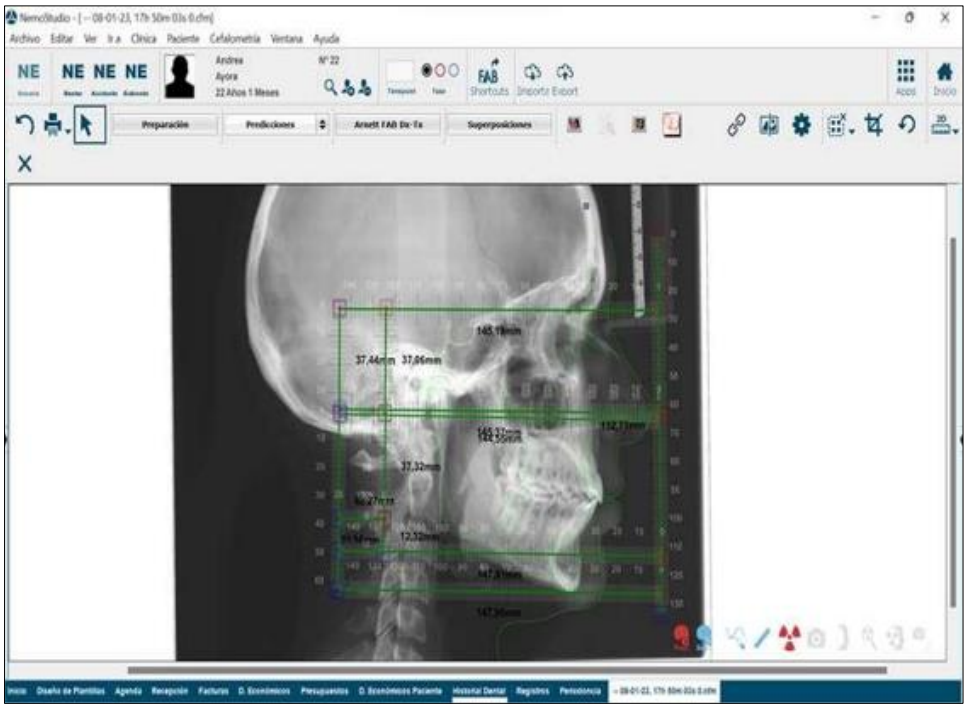


Figure 1 NemoStudio 2022

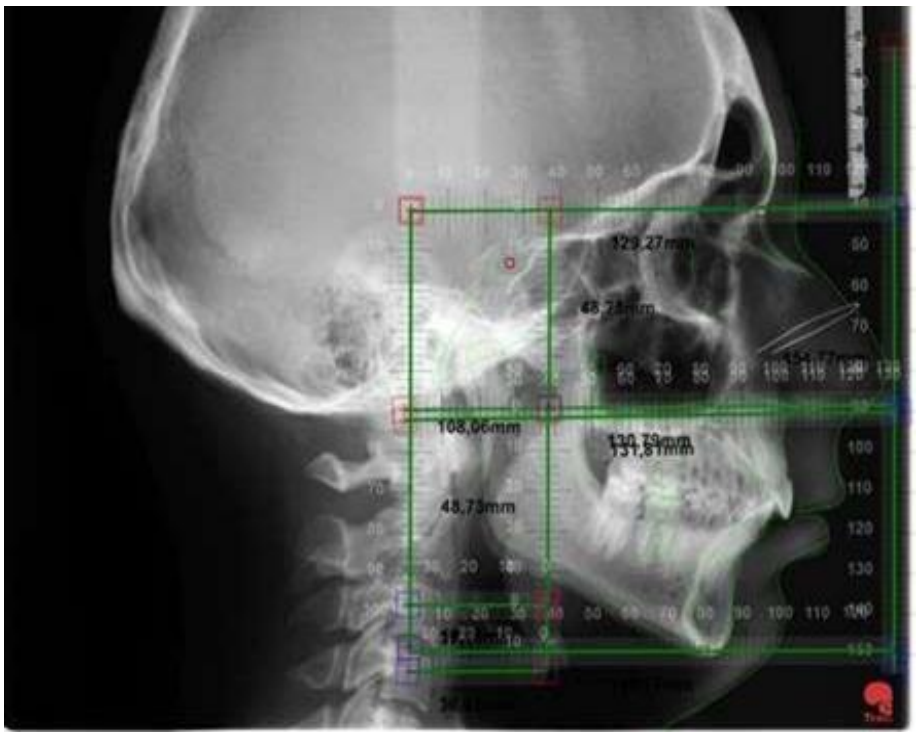


Figure 2 Silva cephalometric method (CSM)

After that, a rectangle is drawn with the functions of the program located between the horizontal line of Nasion and the middle point between the two horizontal lines of the nasal spines both anterior and posterior. To identify the lower facial area, the upper rectangle is duplicated and placed under the upper rectangle, then the height is divided in three and with this result the height of the rectangle that will complement the lower segment is created.

Once the rectangles of both the upper and lower segments have been constructed, we obtain the ideal facial proportion (50%- 66.6%). The height of the three rectangles represents the ideal facial height and by projecting the base of the last

lower rectangle with a broken line, we can observe the relationship it has with the horizontal line that is located at the chin point of the patient. When these two horizontal lines coincide, it is interpreted as a neutral face. If the horizontal chin line is below the broken line projected by the lower rectangle, it is known as a long face, and if the horizontal chin line is above the projection of the ideal height, it is known as a short face.

As for the golden rectangle, it coincides with the ideal total facial height when placed vertically with the horizontal line of Nasion and a horizontal line perpendicular to the true vertical located at the tip of the pterygoid fossa.

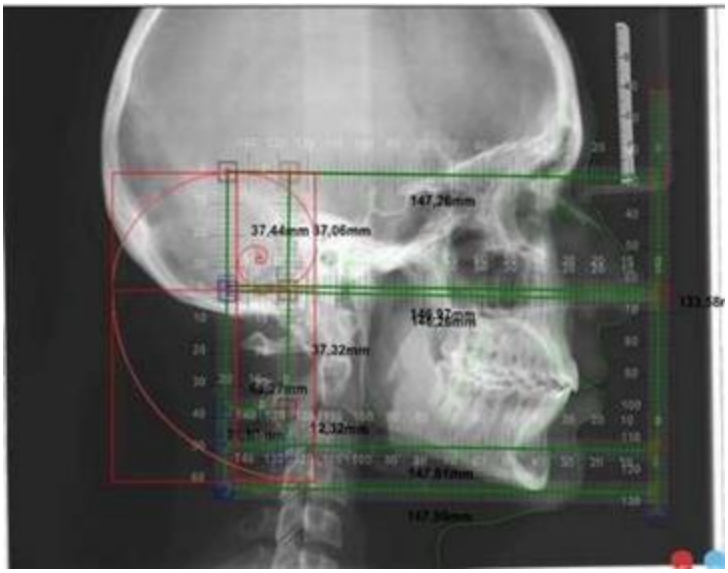


Figure 3 Euclidean rectangle in lateral cephalic of female student

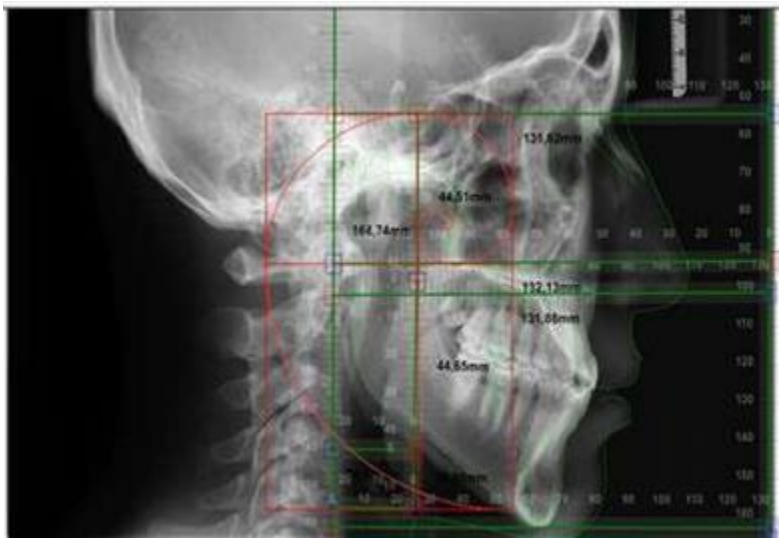


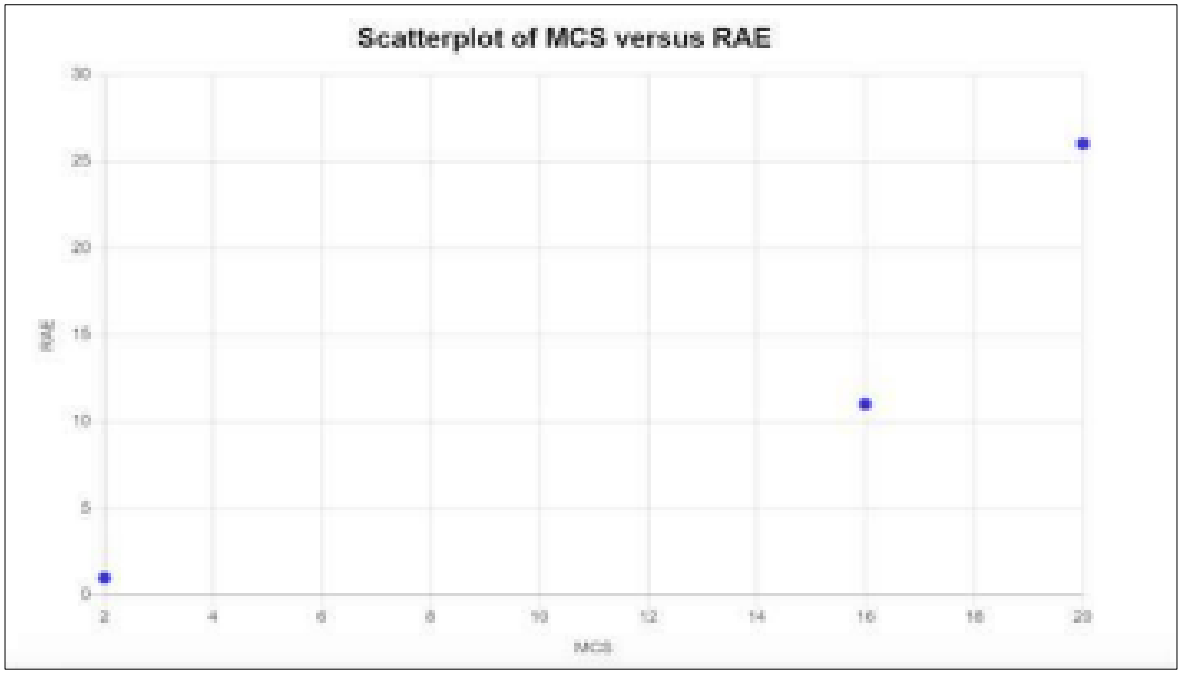
Figure 4 Euclidean rectangle in lateral cephalic of male student

Using the software functions, a calibrated millimeter ruler was placed to make the measurements between the two horizontal lines in each student, noting the sex and age of each one to observe the different varieties, and the tabulation of data was done by Pearson's dispersion coefficient, which indicates the relationship between the standard deviation of a sample and its mean; it takes values between 0 and 1, if it is close to 0, it means that the data are compact and have little variability, while if it tends to 1 it means that it loses reliability and it is a very large and dispersed data sample, even if the coefficient exceeds 0.3% indicates that the mean is not very representative.

3. Results

In the present study 38 lateral cephalic radiographs were examined, in which 14 males and 24 females were analyzed, with a maximum age of 25 years and a minimum of 21 years, with a mean age of 22 years and 5 months.

The Silva cephalometric method was used to determine the facial height of each patient to determine whether they had a short, long or normal face, and later a comparison was made with the facial height result of Euclid's golden rectangle. Of the 38 images observed, 52.63% (20 images) were classified as short face according to Silva's cephalometric method (15 females, 5 males), while 42.10% (16 images) were classified as long face (8 females, 8 males), only 5.26% were classified as neutral face (1 female, 1 male).



	MCS	FEM	MASC	TOT	RAE	FEM	MASC	TOT
Short Face		15	5	20		18	8	26
Normal Face		1	1	2		1	0	1
Long Face		8	8	16		5	6	11
	TOT	24	14		TOT	24	14	
EDAD	MAX	25						
	MIN	21						

Table 1 Correlation between both methods according to facial height and gender

As for the Euclid's golden rectangle method, a percentage of 68.42% (26 images) were classified as short face (18 women, 8 men), 28.94% (11 images) were classified as long face (5 women, 6 men) and finally 2.64% (1 image) were classified as neutral face (1 woman) (Table 1).

Once the statistical data were obtained, the Pearson dispersion coefficient was performed in order to establish if there was indeed a correlation between the two methods to determine the facial height of the entire study. A result of the correlation coefficient of ®= 0.9271 and the value of R^2, which is the coefficient of determination, was achieved: 0.8595, which tells us that it is a strong positive correlation, which means that high scores of variable X, go with high scores of

variable Y (and vice versa), with this we can conclude that in the analysis there is an important correlation, but it does not reach perfection.

4. Discussion

Lombardi [6] mentions that the use of the golden ratio was a reliable method to determine the dimensions of the tooth surfaces. Five years later, Levin [7] and other authors [8],[9] explain how these proportions are related to a pleasant esthetics of the dentition and smile, and also there is a phi relationship in the central and lateral incisors both right and left in a labial type aspect, therefore the previously mentioned are in golden ratio and these in turn with the canine; this is the most evaluated dental relationship in relation to the divine proportion. In contrast, some studies [10,11,12,13] report that this relationship is not connected to the golden ratio. In the present work, it is considered that in some cases, this is due to the extreme way of assessing the presence of the proportion expecting it to give exactly the value of the same, without considering a minimum range of discrepancy.

Vadachkoriia [14] et al further noted that the height of the lateral incisor corresponds to its width by 1.618. Levin mentions that a reconstruction of the anterior sector could be performed only by knowing the width of one of its teeth, using the golden ratio as a criterion.

There are several studies that have validated a relationship between Phi and the width and height of the anterior teeth as a reference of an aesthetic pattern, without finding any disparity according to gender.[15] In addition, there are several studies that have validated the relationship between Phi and the width and height of the anterior teeth as a reference of an aesthetic pattern.

Marcuschamer [16] suggests it is useful to establish from the beginning of the treatment the disproportion presented between the amount of dental tissue in both arches as an individualized method, similar to the analysis offered by Bolton's index. In the anterior region, he mentions that the mesio-distal width from the first right upper bicuspid to the left is the golden ratio (1.618) times the sum of all the anteroinferior teeth, while in the posterior region the mesio-distal widths from the premolars to the first molar should have a golden ratio with the total of the sum of the mesio-distal widths from the canine to the second upper molar.

5. Conclusion

It can be said that the vertical diagnosis of facial height obtained by the Silva Cephalometric Method is equivalent to the ratio of Euclid's Golden Rectangle in patients with palatal plane in norm and at the level of the tip of the pterygomaxillary fossa.

In addition, within the university population, only 5% (two students) presented a compatibility with the logarithmic spiral of the golden ratio.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The conflict of interest in this manuscript is that the information used randomly from the database of the University of Cuenca consists of the data of the authors of the following article.

Statement of ethical approval

The present research work does not contain any studies performed on animals/humans subjects by any of the authors.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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