(RESEARCH ARTICLE)

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Correlation of the golden proportion between the intercanine distance and the vertical measurement of the middle third of the face in fourth year students of the faculty of dentistry of the University of Cuenca, 2023

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Abstract

Introduction: The human face is a disconcerting source of information, since cultural influences, masculine-feminine characteristics, the aging process, the subtleties of light that change with the orientation of the face, rest, smiling and others configurations endow each particular face with a uniqueness that is difficult to quantify. The objective of this study was to determine whether or not there is a golden ratio between the intercanine distance and the vertical measurement of the midface of fourth-year students of the Faculty of Dentistry of the University of Cuenca.

Methods: Descriptive, cross-sectional and randomized study. The sample consisted of 40 fourth-year students from the Faculty of Dentistry of the University of Cuenca, Ecuador. The observation technique was used. The following were observed and analyzed: 1) the intercanine distance and 2) the vertical measurement of the middle third of the face, to determine if there is a presence or absence of the golden ratio.

Results: For the frequency of values about whether there is a Golden Ratio or not, it is shown that: in the intervals 2.65 - 12.90 mm (very close) there are 4 men with 13.33 % and 3 women with 6 00 %, in the interval 12.91 - 23.16 mm (close) there are 8 men with 26.66 % and 15 women with 30.00 %, and in the interval 23.27 - 33.52 mm (distant) there are 3 men with 10.00 % and 7 women with 14.00 %.

Conclusion: It is observed that in 56.66 % of the fourth-year students of the Faculty of Dentistry of the University of Cuenca there is a close correlation to the golden ratio between the intercanine distance and the middle third of the face, this being the most representative of the three intervals analyzed (very close, close and distant).

Keywords: Intercanine Distance; Middle Third Facial; Golden Ratio; Tomography; Intraoral Photography; CBCT

1. Introduction

The human face is a bewildering source of information, as cultural influences, male-female characteristics, the aging process, subtleties of light that change with facial orientation, rest, smile and other configurations endow each particular face with a uniqueness that is difficult to quantify. Facial analysis has moved into sophisticated terrain and it seems that the Phi ratio helps to overcome some difficulties in explaining complex issues such as facial harmony in the moving face, interracial mixtures and their effect on the concept of beauty. (1)

According to some authors, attractive faces have ideal proportions that are related to the golden ratio. For this reason, esthetic assessment is an important part of the clinical examination in dentistry, and this depends very much on the

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point of view of the clinician who performs them, so it is more convenient to perform the assessment of facial proportions rather than just reviewing the esthetic qualities. (2)

In general, aesthetic criteria have been defined in almost all cultures, but the actual existence of coded facial proportions in attractive subjects remains a matter of debate. Therefore, it is emphasized that scientific studies on the quantitative basis of human facial attractiveness are still in progress. (1)

It is hoped that with the establishment of a universal standard for facial beauty, the diagnosis and treatment of facial disharmonies and anomalies will be significantly simplified. (3)

1.1. Intercanine distance

It is the transverse distance in millimeters obtained from the cusp of the right canine to the cusp of the left canine (4).

Andrade et al. refer that Bishara mentioned that the intercanine distance at the age of 2 years increases by 0.5 mm in the maxillary arch and 3.5 mm in the mandibular arch, and also noted in his study that this distance was greater in males than in females in both arches. The intercanine distance and intermolar distance increase significantly between 3 and 13 years of age. After the completion of the eruption of the canines and molars of the second dentition, these dimensional changes remain unchanged. (5)

1.2. Vertical measurement of the mid-facial third

Also known as upper midface, to obtain this dimension an imaginary line drawn from the glabella to the subnasal point is used as a reference guide in soft tissues, while in skeletal references the guide will be at the level of the frontonasal, frontomaxillary and frontomalar sutures as the upper limit and at the level of the anterior nasal spine as the lower limit. (6)

The ideal facial height projected in the Cephalometric Method proposed by Silva (MCS) originates from the parameters obtained in the cephalometric analysis of Legan and Burstone, where it follows that the facial proportion can be divided in general into an upper segment (N-ENA), equivalent to 50 %, and a lower segment (ENA-Me), equivalent to approximately 66.6 %. In the MCS the upper facial segment is located with the horizontal line of Nasion (perpendicular to the true vertical) up to the median between the horizontals of the anterior and posterior nasal spines, while the lower facial segment goes from this horizontal line between the nasal spines towards the horizontal line of Chin. (7)

1.3. Golden ratio

The golden ratio is one of the most essential and valuable aesthetic guidelines, this is a constant ratio of 1.618:1. It is widely observed in nature and is pleasing to the human eye. (14) It is also known as the divine proportion according to Luca Pacioli or as the golden or golden section according to Leonardo Da Vinci. It is based on the golden or golden number 1.618, an irregular number identified with the Greek letter Phi according to the term given by Mark Barr and Schooling in honor of Phidias, a sculptor of classical Greece. (6)

1.3.1. Golden ratio on the face

In facial aesthetics there is a specific mathematical proportion that is called the golden ratio (GP), divine or Phi (Ø) after the Greek sculptor Phidias. The GP is an identity commonly observed in nature. In the 4th century BC. Euclid geometrically described the GP, which divides a line into two parts (a, b), and the ratio of the two parts (a/b) is equal to the ratio of the total length of the longer. part (a + b/a) (Fig 1). Clinical applications of GP are mainly used in the fields of dental prosthetics, cosmetic surgery, orthodontics and face mask. (8)

Ricketts was the first orthodontist to publish a study of facial dimensions and their relationship to the golden ratio and facial aesthetics (Divine proportion and the Fibonacci Series, 1981). According to Ricketts, at the level of the limbic system, facial proportions in harmony with the golden ratio produce pleasure and attraction in the mind. For the anthropometric measurement of these, he created a special instrument, the "Golden divider" or golden compass, which accurately maintains the golden ratio when expanding or contracting. (9)
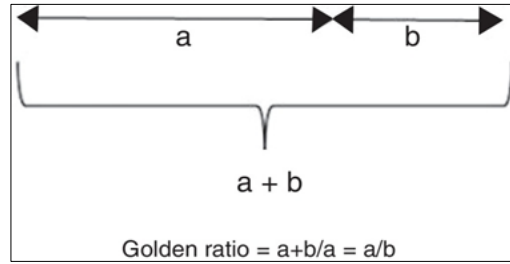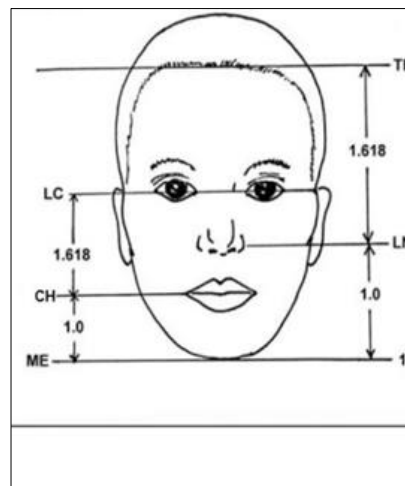
Figure 1 Golden ratio calculation

In this way, the following parameters are considered in the face to relate it to the golden ratio:

Vertical ratios (Fig 2) (9)

- If the distance from LN to ME is 1, the distance from LN to TR is 1.618.
- If the distance from CH to ME is 1, the distance from CH to LC is 1.618.

LN (Lateral nose): Lateral edge of the wing of the nose; TR (Trichion): Hairline; CH (Cheilion): Corner of the mouth; LC (Lateral cantus): Lateral or external edge of the eye; ME (Chin): Lower edge of the chin.

Figure 2 Vertical ratios

Horizontal ratios (Fig 3) (9)

- If the distance from LN to LN is 1, the distance from CH to CH is 1.618.
- The distance from LC to LC is 1.618.
- The distance from LT to LT is in turn 1.618.
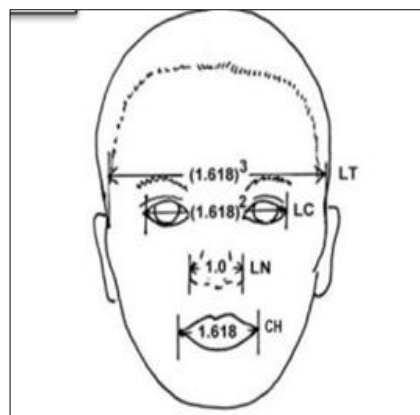
LT (Lateral border of the temple): Lateral border of the temporal bone in soft tissue, at the level of the superciliary arches.

Figure 3 Horizontal ratios

Lateral auric ratios (Fig 4) (9)
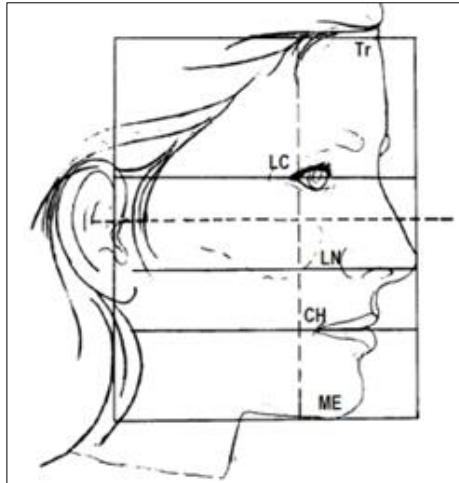
- Vertical ratios

Figure 4 Lateral auric ratios

- If the distance from LC to LN is 1, the distance from LN to ME is 1.618.
- If the distance from LN to CH is 1, the distance from CH to ME is 1.618.

Horizontal proportions

- If the distance from LC to the tip of the nose is 1, the distance from the base of tragus to LC is 1.618.

1.4. Accuitomo 170 Morita 3D Tomographer

The Accuitomo 170 3D tomograph is Morita's most advanced unit. Highly refined, it is the fourth generation of the Accuitomo product line. It offers a voxel size of only 80 μm and shows subtle details of bone structure. This super-fine voxel combined with the unit's 14-bit grayscale capability creates a wide dynamic range that produces many grayscale values to visualize hard and soft tissue areas with subtle contrast dispersion. It has a 40 mm diameter, 30 mm high cylinder that provides a 3D volumetric image with axial, coronal, sagittal view. It allows obtaining slices from 0.125 to 2 mm. Scanning time is 17 seconds or less. It has different fields of view (FOV) being the smallest 40x40 mm and the largest 170x120 mm. (10)

1.5. Principles of intraoral photography

Digital photography has now penetrated all segments of science, medicine, industry, fashion design, communication and the arts. It has a multilevel significance and represents the synonym of contemporary dentistry. (11)

The use of photographs in dentistry has offered an up-to-date perception of daily clinical practice. Apart from educational purposes, photography can be used for treatment planning, monitoring of treatment progress, documentation, evaluation, communication, publication, lectures and marketing, artistic images, insurance or legal purposes. (12)

1.5.1. Standards for intraoral photography

General (13)

- The camera and flash should be held with two hands to provide stability for good alignment for photography. One hand should grip the camera body and the other should hold the lens, supporting the ring flash.
- Determine whether removable appliances should be removed or remain in place.
- Make sure there is no impression material or food adhering to the teeth.

Alignment (13)

- When photographing the patient while in the dental chair, the chair should be elevated so that the photographer can move easily, without having to bend over or be in an awkward position, to obtain the correct viewpoint.
- For frontal, left and right lateral and overbite images, it is easier to obtain consistent views if the patient's head is kept level with the Frankfort plane.

Use of mirrors (13)

- Warn the patient that the mirror is made of glass and that he/she should not bite it, it is necessary to keep the mouth open.
- The largest mirror that the patient can comfortably hold should be used. This will help to press the buccal mucosa away from the teeth.
- Warm the mirror slightly by immersing it in warm water and then dry it carefully with a microfiber. This will prevent fogging when placed in the patient's mouth.
- If you do not have an assistant, the patient will be able to hold the mirror by himself/herself. The mirror should be held by the edges or the handle, with the fingers and thumb as far away from the mouth as possible.
- It is important to be especially careful if the patient has a gag reflex, it may be helpful to ask the patient to breathe slowly through the nose

2. Material and methods

Descriptive, cross-sectional and randomized study. The sample consisted of 40 fourth-year students from the Faculty of Dentistry of the University of Cuenca, Ecuador.

The observation technique was used. It was observed and analyzed by means of the Digital Software "Nemocast": 1) Intraoral photographs to obtain the intercanine distance and 2) Tomography to obtain the vertical measurement of the middle third of the face. Subsequently, to record the data, a registration card was prepared where the number of the card, gender, intercanine distance and the vertical measurement of the middle third of the face were specified. To synthesize the results, double entry tables were used to reflect the measurements of the intercanine distances and the vertical measurement of the middle third of the face, then the intercanine distance was multiplied by 1.618 (golden ratio) and see if there is a direct correlation with the measurement. Vertical of the middle third of the face. In this way it was determined if there is presence or absence of golden ratio. Finally, graphs were made for each table made.

Table 1 Measurement variables

| Variables	Indicator	Sub indicators
Intercanine distance.	Half of the canine in its mesio-distal proportion	Measured in mm.
Vertical measurement of the middle third of the face.	Measurement of the distance from the glabella to the anterior nasal spine.	Measured in mm.
Golden ratio	Number phi (1.618...)	Yes / no ratio.

Objectives of the study

- Analyze and determine the average intercanine distance intraoral photographs of fourth-year students of the Faculty of Dentistry of the University of Cuenca.
- Analyze and determine the average of the vertical measurement of the facial middle third of the fourth year students of the Faculty of Dentistry of the University of Cuenca.
- To determine whether or not there is a golden ratio between the intercanine distance and the vertical measurement of the middle third of the face of fourth-year students of the Faculty of Dentistry of the University of Cuenca.

3. Results

Table 1 Distribution according to gender

| Genre	Number of individuals	Percentage
Male	15	37.50 %
Female	25	62.50 %
Total	40	100 %
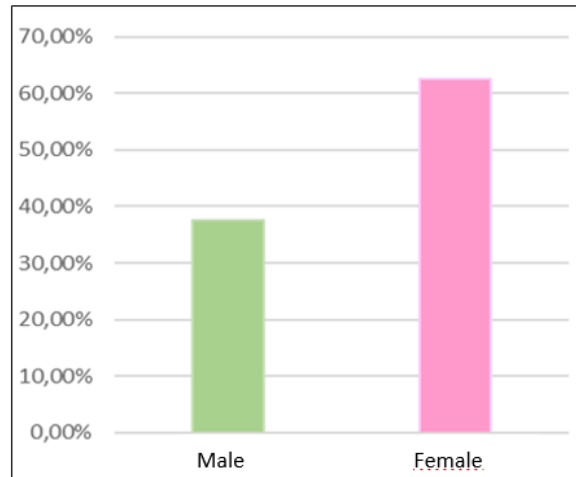
Source: Own elaboration, Data Matrix 2023

Graph 1 Distribution according to gender

3.1. Interpretation

We found in table #1 that, for the distribution according to gender there are: 15 males with 37.50 %, and 25 females with 62.50 %, for a total of 40 individuals at 100 %.

Table 2 Average Intercanine Distance and Vertical Measurement of the Facial Mid-Third

| GENRE	MALE	FEMALE
Number of Individuals	15	25
Average intercanine distance	37.42 mm	36.94 mm
Average vertical measurement of the ⅓ midface	42.6 mm	39.92 mm
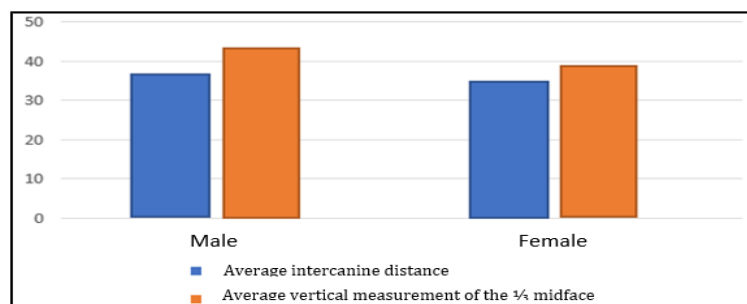
Source: Own elaboration, Data Matrix 2023

Graph 2 Average intercanine distance and vertical measurement of the mid-facial third

3.2.   Interpretation

We found in table #2 that the average intercanine distance for 15 males is 37.42 mm and for 25 females is 36.94 mm. While, the average vertical measurement of the midface for 15 males is 42.6 mm and for 25 females is 39.92 mm.

Table 3 Intercanine Distance Range of Values

| INTERVALS	MALE		FEMALE		TOTAL	
mm	N	%	N	%	N	%
32.40 - 35.18	4	13.33	6	12.00	10	25.33
35.19 - 37.97	4	13.33	12	24.00	16	37.33
37.98 - 40.76	4	13.33	5	10.00	9	23.33
40.77 - 43.55	3	10.00	2	4.00	5	15.00
TOTAL	15	50.00	25	50.00	40	100.00
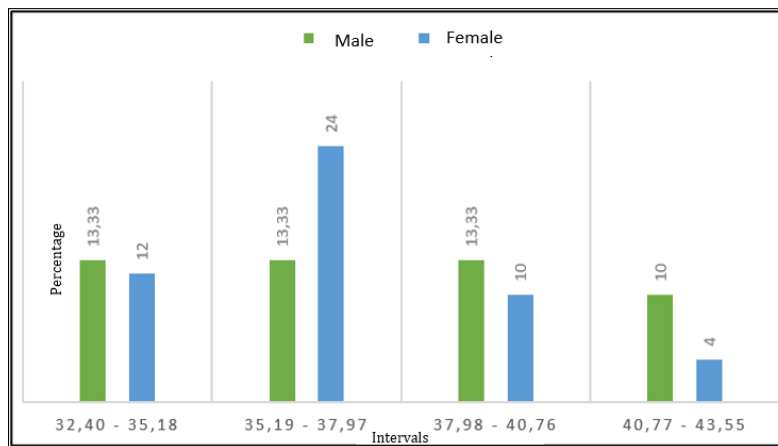
Source: Own elaboration, Data Matrix 2023

Graph 3 Intercanine Distance Range of Values

3.3.   Interpretation

We find in table #3 for the frequency of intercanine distance values that there are: in the intervals 32.40 - 35.18 mm there are 4 males with 13.33 % and 6 females with 12 %, being in total 10 individuals with 25. 33 %; in the interval 35.29 - 37.97 mm there are 4 males with 13.33 % and 12 females with 24.00 % , being a total of 16 individuals with 37.33 %; in the interval 37.98 - 40.76 mm there are 4 males with 13.33 % and 5 females with 10.00 % being a total of 9 individuals with 23.33 %; in the interval 40.77 - 43.55 mm there are 3 males with 10.00 % and 2 females with 4.00 % being a total of 5 individuals with 15.00 %. For a total of 40 individuals at 100.00 %.

Table 4 Range of Values of the Vertical Measurement of the Facial Midface Middle Third

| INTERVALS	MALE		FEMALE		TOTAL	
mm	N	%	N	%	N	%
34 - 38.75	3	10.00	11	22.00	14	32.00
38.76 - 43.51	6	20.00	7	14.00	13	34.00
43.52 - 48.27	5	16.66	7	14.00	12	30.66
48.28 - 53.00	1	3.33	0	0.00	1	3.33
TOTAL	15	50.00	25	50.00	40	100.00
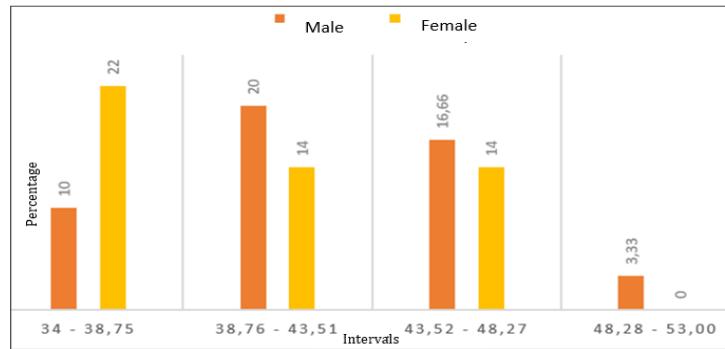
Source: Own elaboration, Data Matrix 2023

Graph 4 Interval of Vertical Mean Midface Vertical Mean Values

3.4.   Interpretation

We find in table #4 for the frequency of values of the vertical measurement of the facial middle third that there are: in the intervals 34 - 38.75 mm there are 3 males with 10.00 % and 11 females with 22.00 %, being in total 14 individuals with 32.00 %; in the interval 38.76 - 42.51 mm there are 6 males with 20.00 % and 7 females with 14.00 % , being a total of 13 individuals with 34.00 % , and in the interval 43.52 - 48.27 mm there are 5 males with 16.66 % and 7 females with 14.00 % being a total of 12 individuals with 30.66 %; in the interval 48.28 - 53.00 mm there is 1 male with 3.33 % and 0 females. For a total of 40 individuals at 100.00 %.

Table 5 Range of Values Nearest to the Golden Ratio

INTERVALS	MALE		FEMALE		TOTAL	
mm	N	%	N	%	N	%
2.65 - 12.90 (Very close)	4	13.33	3	6.00	7	19.33
12.91 - 23.16 (Close)	8	26.66	15	30.00	23	56.66
23.27 - 33.52 (Distant)	3	10.00	7	14.00	10	24.00
TOTAL	15	50.00	25	50.00	40	100.00
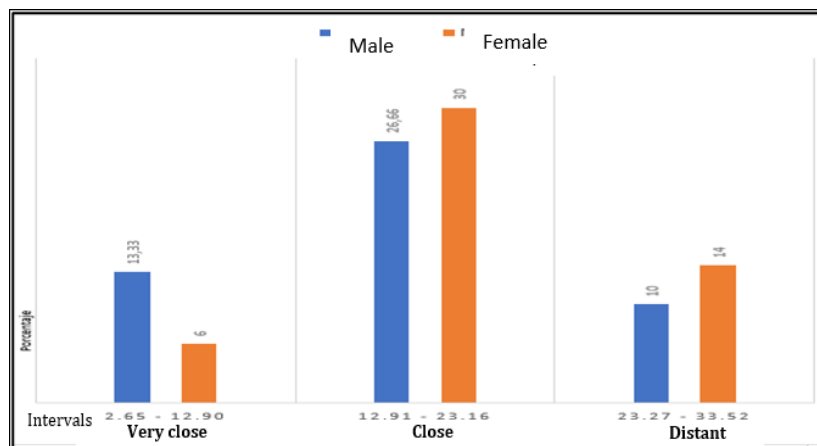
Source: Own elaboration, Data Matrix 2023

Graph 5 Range of Values Closest to the Golden Ratio

3.5.   Interpretation

We found in table #5 for the frequency of values about whether there is Golden Ratio or not: That in the intervals 2.65 - 12.90 mm (very close) there are 4 males with 13.33 % and 3 females with 6.00 %, being in total 7 individuals with 19.33 %, and in the interval 12.91 - 23.16 mm (close) there are 8 males with 26, 66 % and 15 females with 30.00 % , being a total of 23 individuals with 56.66 %, and in the interval 23.27 - 33.52 mm (distant) there are 3 males with 10.00 % and 7 females with 14.00 % being a total of 10 individuals with 24.00 %. A total of 40 individuals at 100.00 %.

4.   Discussion

The aim of the present investigation was to determine the presence of the golden ratio in the intercanine distance and the vertical measurement of the midfacial third analyzed in CT scans and intraoral photographs of fourth year students of the Faculty of Dentistry of the University of Cuenca.

Londono et al. (2021) in their meta-analysis "Evaluation of the golden ratio in the natural dentition" in which they evaluated the presence of the golden ratio in individuals of the target population who were evaluated from the frontal view, evaluated the presence of the golden ratio in individuals considered to have an esthetically pleasing smile, It also concluded that the presence of different proportions may be directly related to ethnicity and sex, and that the average dimensions of the upper anterior teeth vary, making it necessary to evaluate the anterior dentition among various populations or ethnic groups. The analyses in this study demonstrated that intercanine width can be used as a guide for different facial proportions, but not for all ethnic groups. (14) Whereas, Swileh et al. state that there are findings that support the current debate on the validity of the golden ratio as a guiding factor for a pleasing smile when it comes to the esthetic zone. Furthermore, some variations may also be related to numerous factors that influence the similar beautiful smile, such as dentofacial specificities, cultural considerations, racial background, perception of the individual, and different characteristics of the study sample in each country. (15) In the present study, the relationship between the dimensions of intercanine distance and the dimensions of the middle third of the face according to the golden ratio of 1.618 was recorded and no significant relationship was found. Then, the results of the current study coincided with previous studies, that golden ratio does not exist in the study sample of fourth year students of the Faculty of Dentistry of the University of Cuenca, similar to the results of a study conducted by Wadud A. et al (2021) who concluded that no GP or GS was found in the comparison of the facial types with the 6 maxillary anterior teeth in their studied population. (16)

Amal Ali Swelem in their research found that the mean perceived width was always greater in males than in females for all tooth groups. However, statistical analysis revealed significant differences between the sexes only for the central incisors. (17) In this study according to photographs of the patients analyzed, the average intercanine distance in 15 males was found to be 37.42 mm and in 25 females it was 36.94 mm, this value being higher in males coinciding with previous research.

Kawakami et al., Filho et al., Mizumoto et al. and Sunilkumar et al. reported that there is a relationship between divine proportion and facial aesthetics. Kiekens et al. reported that attractive face proportions are closer to GP. However, Rossetti et al. showed that there was no correlation between the perception of facial beauty and the divine proportion. (7) In this research the results showed that in more than half of the individuals studied (56.66 %) there is a golden ratio between the intercanine distance and the midface demonstrating that different proportions can be directly related to ethnicity and sex.

Dental esthetics depend on numerous factors and their interrelationships. Although information regarding general practitioners is important for clinicians when working within the esthetic zone, racial differences must be taken into account. Esthetic proportions should be adapted according to these differences. Alhabahbah et al. found that the average perceived widths of the anterior teeth were significantly greater for males compared to females. (18) In this study they concluded that in fourth year students of the Faculty of Dentistry of the University of Cuenca, the male sex has a very close correlation with the golden ratio between the intercanine distance and the midfacial third.

5.   Conclusion

- **First;** the average intercanine distance in 15 men is 37.42 mm and in 25 women it is 36.94 mm in photographs of the patients analyzed.
- **Second;** it is considered that the average intercanine distance in 15 men is 42.60 mm and in 25 women it is 39.92 mm in tomographies of the patients analyzed.

- **Third;** it is observed that in 56.66 % of the fourth year students of the Faculty of Dentistry of the University of Cuenca there is a correlation close to the golden ratio between the intercanine distance and the middle third of the face, being this data the most representative of the three intervals analyzed (very close, close and distant).
- **Fourth;** there is a predominance in the male sex of a correlation very close to the golden ratio between the intercanine distance and the mid-facial third in the fourth year students of the Faculty of Dentistry of the University of Cuenca.

Compliance with ethical standards

Acknowledgments

We thank all the participants included in the study who gave us their consent to carry out the research.

Disclosure of conflict of interest

The authors agree no conflict of interest

Statement of informed consent

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

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