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Photographic analysis of symmetry and aesthetic proportion of the anterior teeth*

Análise fotográfica da simetria e da proporção estética dos dentes anteriores

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Abstract

Introduction *– This research's objectives are to assess the symmetry of anterior teeth and the relation between intra-arches and inter-arches proportion.* ***Material and Methods*** *– Thirty pictures of dental models of young Caucasian Brazilians, between 12 and 17 years old, with permanent dentition and normal occlusion were selected; measurements were done with digital calipers. The method error was assessed by simple linear regression, regression variance analysis, determination coefficient and residue analysis. Descriptive statistics were carried out and the confidence intervals were built at 95%. To study the divine relation, a hypothesis test with a significance level of 0.05 was used.* ***Results*** *– Symmetry was perfect in the superior arch in 63% of the cases between the central incisors, in 30% between the lateral incisors and in 63% between the canines. Symmetry was perfect in the inferior arch in 63% of the cases in central incisors, in 47% between the lateral incisors and in 43% between the canines. Relations between the averages of the intra- and inter-arch measures were calculated and, in several relations, the divine proportion was found.* ***Conclusion*** *– This article considers the dental analysis with photography a practical and efficient method to check or restore symmetry and proportion of the anterior teeth.*

Key words: Esthetics, dental; Photography, dental; Dental models

Resumo

Introdução – Os objetivos desta pesquisa foram avaliar a simetria dos dentes anteriores e as relações entre as proporções intra e interarcos. Material e Métodos – Foram selecionadas trinta fotografias de modelos ortodônticos de jovens brasileiros, leucodermas, na faixa etária de 12 a 17 anos, com dentição permanente e oclusão normal; as medidas foram realizadas com paquímetro digital. Foi avaliado o erro do método a partir de regressão linear simples, análise de variância da regressão, coeficiente de determinação e análise de resíduos. Foi realizada estatística descritiva e os intervalos de confiança foram construídos a 95%. Para estudar a relação divina, utilizou-se um teste de hipótese com nível de significância de 0,05. Resultados – A simetria das medidas dentárias foi perfeita na arcada superior, entre incisivos centrais em 63% dos casos estudados, entre os incisivos laterais, em 30% e entre caninos em 63%. A simetria na arcada inferior foi perfeita entre incisivos centrais, em 63% dos casos estudados, entre incisivos laterais, em 47% e entre caninos, em 43%. Foram encontradas proporções entre as médias das medidas intra e interarcos, e, em diversos relacionamentos, foi encontrada a proporção divina. Conclusão – Este artigo considera a análise fotográfica dos dentes um método prático e eficiente para checar ou restabelecer a simetria e a proporção dos dentes anteriores

Palavras-chave: Estética dentária; Fotografia dentária; Modelos dentários

Introduction

The search for a method that could offer scientific parameters for beauty has been an object of research because patients who want to improve their aesthetics and quality of life often seek out advice from health professionals[16].

Dentistry, more than any other health area, has worked to offer a pleasant smile, to enhance and improve each human face´s beauty. In order to improve the patient's appearance a complete treatment plan cannot depend on only one aspect, such as the Class I occlusion. It should include facial equilibrium and smile aesthetics, integrating them with respect to function[18].

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It is very important to evaluate the individual characteristics of the patient and to classify them into normal or pathological for the biology of that individual. For this reason, planning should be based on the analysis of the clinical characteristics of the patient to determine if there is maxillomandibular balance as well as balance in relation to the face and whether there is discrepancy between teeth sizes and maxillomandibular structure. Furthermore, if there is no dental proportion and symmetry for the necessary interventions, the medical professional has the responsibility to inform the patient about his/her anatomic and aesthetics characteristics, and the implications for treatment.

When evaluating the natural beauty of normal arches, we observe the presence of a mathematical relation: 1:1.618. This ratio is termed the divine or golden proportion; it is believed that this harmonic composition generates beauty and well-being to the human perception, providing equilibrium and symmetry[16].

The golden number is represented by the Greek letter φ (*phi*). Many artists have used the golden proportion in their work, including Da Vinci who, in his painting the Mona Lisa, portrays the divine proportion in several situations. This proportion is also present in nature, in the anatomy of the human body, in architecture, in industry, in commerce and in several situations where we have the feeling of harmony and beauty. Plants and animals, including humans, despite enormous differences, all show a relationship in terms of this proportion.

Symmetry is one of the esthetic characteristics. The static symmetry is based in an absolute equilibrium, of both sides, but this is a tiring symmetry. When the divine proportion is present, there is a dynamic symmetry which has a quality to stimulate the observer, retracting action and continuity[16].

In esthetic dentistry one of the most important tasks is creating harmonious proportions between the widths of maxillary anterior teeth when restoring them. But to reach this point, the importance of the symmetry needs to be evaluated first in order to suggest a guideline in this field.

The objective of this study was to analyze the anterior teeth area, of the upper and lower arches, assessing the symmetry between right and left sides and the existence of intra- and inter -arch divine proportions.

Material and Methods

Thirty study plaster casts of young Caucasian Brazilians were selected from Professors Kurt Faltin Junior and Cesário Ramos Machado's sample. Nineteen of them were men and 11 women. They were between 12 and 17 years old, with permanent dentition and normal occlusion, according to Angle[3]. The study models base were cut parallel to Camper´s plan orientation[6].

The anterior regions of the upper and lower models were photographed. For standardization, the camera was placed on a reproduction table in order to allow the positioning of the Camper plan perpendicular to the ground. The photographs were taken with Kodak 35 mm Tri-X film and developed with D-76 developer of the same brand. The proportion used was of 1:1 and the photograph paper was Kodak´s Kodachrome F3, size 4x4 cm, to allow amplification of the image in real size. To check this proportion, a Trident® transparent millimeter ruler was photographed along with the models touching the cast base. For correct identification, the number of each model was photographed on the right lower corner of the image. The photography method was chosen because it directly conveys the aesthetic impression of teeth in the harmony of the arch shape, as determined by Ricketts[16].

The measurements on the photograph were made by the same examiner, previously calibrated, twice, on alternate days, using a digital caliper (Digimess™).

The dental measures were taken at the largest width of the mesiodistal axis of the right central incisor (RCI), left central incisor (LCI), right lateral incisor (RLI), left lateral incisor (LLI), right canine (RC) and left canine (LC). Measurements were also obtained for the largest visible space, between the central incisors (CI), the lateral incisors (LI), the distal faces of the canines (DC) and between the canines' cusps (CC).

For analysis of the data, evaluating the method error was carried out through the establishment of simple linear regression. The evaluation of the symmetry of the individual dental measures of the same arch, between the right and the left sides was assessed according to descriptive statistics such as: average, standard deviation, minimum, maximum and statistical interference values, with the average estimation and the construction of trust intervals at 95%. The verification of the hypothesis that there is a divine proportion between the measures of the same arch and the inter-arch measures was translated as a values average of the relation between both measures as equal to 0.618, 1.618 or their exponentials (reference values), from the trust interval at 95%. The verification of the gender influence over the measures and their relations was carried out using the Student's t-test. The statistical tests were carried out to the significance level of 0.05%.

Results

Analysis of the method error revealed that the values obtained in the first and the second measures were statistically similar, demonstrating that the researcher was calibrated in relation to the measures taken in this research ($R^2 = 0.99$). The evaluation of the precision of the casual error in each measure taken by Bartlett's test was not substantial ($p < 0.859$).

The symmetry comparison through difference analysis, in absolute values, between the measure observed in a tooth of the right side and its correspondent of the left side evidenced perfect symmetry in the upper arch between the central incisors and between the canines in 63% of the cases studied and between the lateral incisors in 30% (Table 1). The greatest difference observed in the measure of the central incisors was 0.89 mm. For the lateral incisors a difference of 1.62 mm was observed between the right and the left sides.

In the lower arch the symmetry found between the central incisors was present in 63% of cases; between the lateral incisors, 47%, and between the canines, 43% (Table 2). The greatest difference between the central incisors

was 1.09 mm; between canines a difference of 1.67 mm was observed between the left and right sides.

Table 1. Classification of the models according to the difference between the right and the left sides of central incisors, lateral incisors and canines of the upper arch

Difference (mm)	Compared measures*					
	RCI-LCI		RLI–LLI		RC–LC	
	Nr.	%	Nr.	%	Nr.	%
0	19	63.3	9	30.0	19	63.2
From 0.01 to 0.20	3	10.0	2	6.7	1	3.3
From 0.21 to 0.40	2	6.7	5	16.7	2	6.7
From 0.41 to 0.60	2	6.7	9	30.0	4	13.3
From 0.61 to 0.80	2	6.7	3	10.0	3	10.0
From 0.81 to 1.00	2	6.7	1	3.3	–	–
From 1.01 to 1.20	–	–	–	–	1	3.3
From 1.21 to 1.40	–	–	–	–	–	–
From 1.41 to 1.60	–	–	–	–	–	–
From 1.61 to 1.80	–	–	1	3.3	–	–
Total	30	100.0	30	100.0	30	100.0

* RCI = mesiodistal width of the right central incisor; LCI = mesiodistal width of the left central incisor; RLI = mesiodistal width of the right lateral incisor; LLI = width of the left lateral incisor; RC = mesiodistal width of the right canine; LC = mesiodistal width of the left canine.

For the intra-arches proportion evaluation, in the upper arch the real average of the proportion between the RCI and RLI was between 1.54 and 1.72, with no errors for more than 0.09 over or above this estimate. With this interpretation for the measures from the trust interval it was

Table 2. Classification of the models according to the difference between the right and the left sides of central incisors, lateral incisors and canines of the lower arch

Difference (mm)	Compared measures					
	RCI-LCI		RLI–LLI		RC–LC	
	Nr.	%	Nr.	%	Nr.	%
0	19	63.3	14	46.7	13	43.3
From 0.01 to 0.20	4	13.3	3	10.0	2	6.7
From 0.21 to 0.40	4	13.3	6	20.0	6	20.0
From 0.41 to 0.60	–	–	3	10.0	1	3.3
From 0.61 to 0.80	1	3.3	2	6.7	4	13.3
From 0.81 to 1.00	1	3.3	2	6.7	–	–
From 1.01 to 1.20	1	3.3	–	–	2	6.7
From 1.21 to 1.40	–	–	–	–	–	–
From 1.41 to 1.60	–	–	–	–	1	3.3
From 1.61 to 1.80	–	–	–	–	1	3.3
Total	30	100.0	30	100.0	30	100.0

Table 3. Average, standard deviation, minimum and maximum values, estimate by interval and error of estimative according to proportions between the measures of the upper arch

Proportions of measures*	Average	S.D.	Min. V.	Max. V.	Inferior Limit	Superior Limit	Error
RCI/RLI	1.63	0.24	1.13	2.29	1.54	1.72	± 0.09
RCI/RC	2.16	0.31	1.68	3.01	2.05	2.28	± 0.11
LCI/LLI	1.65	0.17	1.36	2.05	1.59	1.72	± 0.06
LCI/LC	2.16	0.33	1.68	3.03	2.04	2.29	± 0.12
RLI/RC	1.35	0.24	0.88	2.07	1.26	1.44	± 0.09
LLI/LC	1.32	0.23	0.90	2.07	1.23	1.40	± 0.09
LI/CI	1.62	0.07	1.48	1.74	1.59	1.64	± 0.02
DC/LI	1.29	0.04	1.20	1.37	1.27	1.30	± 0.01
DC/CI	2.09	0.10	1.89	2.29	2.05	2.12	± 0.04
CC/CI	1.89	0.09	1.73	2.12	1.85	1.92	± 0.03
CC/LI	1.17	0.03	1.09	1.25	1.15	1.18	± 0.01
CC/DC	0.90	0.02	0.87	0.94	0.90	0.91	± 0.01

* RCI = mesiodistal width of the right central incisor; LCI = mesiodistal width of the left central incisor; RLI = mesiodistal width of the right lateral incisor; LLI = width of the left lateral incisor; RC = mesiodistal width of the right canine; LC = mesiodistal width of the left canine; CI = largest visible space between the central incisors; LI = largest visible space between the lateral incisors; DC = largest visible space between the distal faces of the canines; CC = largest visible space between the canines' cusps.

Table 4. Average, standard deviation, maximum and minimum values, estimate by interval and error of estimative according to proportions between the measures of the lower arch

Proportions of measures	Average	S.D.	Min. V.	Max. V.	Inferior Limit	Superior Limit	Error
RCI/RLI	0.95	0.11	0.76	1.31	0.91	0.99	± 0.04
RCI/RC	1.29	0.17	0.95	1.66	1.23	1.36	± 0.06
LCI/LLI	1.05	0.08	0.91	1.25	1.02	1.08	± 0.03
LCI/LC	1.37	0.22	1.13	2.03	1.29	1.45	± 0.08
RLI/RC	1.29	0.17	0.95	1.66	1.23	1.36	± 0.06
LLI/LC	1.31	0.24	0.97	2.21	1.22	1.40	± 0.09
LI/CI	1.95	0.08	1.80	2.13	1.92	1.98	± 0.03
DC/LI	1.38	0.04	1.29	1.47	1.36	1.39	± 0.01
DC/CI	2.69	0.12	2.45	2.98	2.65	2.74	± 0.04
CC/CI	2.32	0.12	2.15	2.60	2.28	2.37	± 0.04
CC/LI	1.19	0.04	1.12	1.29	1.17	1.20	± 0.01
CC/DC	0.86	0.02	0.81	0.89	0.85	0.87	± 0.01

suggested that, in the upper arch, the relation between the measures: RCI and RLI; LCI and LLI; LI and CI were in divine proportion because the value 1.618 was between the interval limits at 95% (Table 3).

In the lower arch, the real average of proportion between the measures Right Central Incisor (RCI) and Right Lateral Incisor (RLI) was between 0.91 and 0.99. In this estimate, there was no error for more than 0.04 units above or below. The same interpretation applies for the other measures as well. From the trust interval, it was suggested that the relation between the measures of the lower arch was not divine because no value of 0.618, or its exponentials, was contained between the interval limits at 95% for this relation (Table 4).

In the inter-arches evaluation, the divine proportion between the measures was observed when the value 1.618 was obtained between the trust interval limits at 95% for these relations: Upper RCI and Lower RLI; Upper RCI and Lower LLI; Upper LCI and Lower RCI; Upper LCI and Lower LLI. The divine proportion, considering the reference value 0.618^2 was observed between: Upper RC and Lower CI; Upper LC and Lower CI. When the reference value was 1.618^3, the divine proportion measures were: Upper CI and Lower RC; Upper CI and Lower LC. When the reference value was 1.618^4, the divine proportion measures were: Upper LI and Lower RC; Upper LI and Lower LC; Upper DC and Lower RLI; Upper DC and Lower LLI.

There was no substantial significance ($p > 0.05$) of gender over these measures, as determined via the Student's t-test.

Discussion

In terms of perceived sense of well-being, facial aesthetics are extremely important. One paramount aspect is dental composition, including sizes, shapes, colors, proportions, lines and harmonic relations. The harmonic relations between the aesthetics and the function will generate, unconsciously, the perception of ideal shape, of beauty. However, a complete treatment plan should consider facial equilibrium and smile aesthetics, aiming for functional integration[19].

The anterior area of the dental arches is not only the first to be seen when you smile, but also the one that presents the most discrepancies. The importance of the occlusion characteristics of the anterior area of the mouth, of the harmonic alignment of the teeth in aesthetics and the functional maintenance of the stomatognathic system has motivated this study. The orientation supplied by beauty aesthetics references is important for directing case planning; analysis of the dental proportions is one of the fundamental elements for establishment of aesthetic dental composition[2].

For the symmetry analysis, the mesiodistal proportion of the anterior teeth was chosen because study of dental size and proportion are important for diagnosis and case planning in the search for occlusion dynamic equilibrium, stability and facial harmony[1]. Furthermore, the occlusion characteristics of the anterior area of the mouth play a primary role in dental aesthetics[3].

The methodology used followed Ricketts'[16-17], who outlined measures for the evaluation of the divine proportion. These parameters require that measurements must be taken along the dental arch, measuring, in a straight line, the visual appearance of the evaluated elements and not the real mesiodistal size. The measurements were obtained from standardized photographs enabling observation of the aesthetics, and thus facilitating improvement and direction of the diagnosis and treatment plan[18]. However, Preston[14] (1993) has warned about the necessity of establishing a correction rate between the image size and the natural tooth size, using a millimeter rule with this image, as carried out in this work.

This study showed that perfect symmetry between the left and right sides of teeth was observed in 63% of the models between central incisors and canines of the upper arch, and between the central incisors of the lower arch. The upper lateral incisors of the sample studied showed 70% asymmetry according to Proffit *et al.*[15] (1986). who observed a higher rate of dental size decrease in the upper lateral incisors.

The dentition should be in informal balance, that is, not necessarily in perfect symmetry, but similar in weight and direction in both sides[10]. Asymmetry is typically found and represents a natural state of the human face, both anatomically and functionally. This is true at a subclinical level, even in individuals considered beautiful, who seem to have a symmetric face composition[13]. The symmetry alterations make the teeth less attractive not only for dentists, but also for people in general. Nevertheless, the universal desire for symmetry can affect smile attractiveness, making it look artificial; a smile with symmetric upper central incisors and slightly asymmetric lateral incisors and upper canines is usually very attractive because, the more distant from the dental midline, lower is the demand for symmetry.

Elements organized in divine proportion seem to show maximum beauty function and efficiency, the secret for normal morphology. By testing the applicability of the divine proportion in the sample studied in this research, we have confirmed that the aesthetics can be scientific, according to several authors[8,16]. Therefore, we can affirm that the Fibonacci numbers that characterize the divine proportion can also be applied to biology[16]. This proportion has, thus, a dynamic characteristic.

Ricketts[17] (1981) described a series of divine relations in human dentition, offering a relation that starts from the lower central incisors. Therefore, the total measure of the lower central incisors is golden with regard to the measure of the two upper central incisors, starting a series of harmonic units in the occlusion. The next golden proportion long the arch is not the direct width of the teeth, but rather the measures between the upper lateral incisor distals which are related to the measure between the upper centrals. After that, the distance between the vestibular surfaces of the first upper pre-molars is golden in relation to the width between the upper lateral incisors in a normal and beautiful arch. This is not usually present in patients with one of the three types of malocclusion. Another series is observed in the width of the four lower incisors, in the

arch, related in divine proportion to the distance between the upper canines, measured at the cusp tips. These measurements are golden to the width between the mesial tips of the second upper molars, which is helpful in the evaluation of the arch shape. A third relation was found with the distance between the distals of the lower canines in divine proportion to the distance between the first lower molar in their vestibular sulcus. The results of this research have shown that the width of the upper central incisor is in divine proportion to the width of the upper lateral incisor, according to several studies[7-9]. However, this study disagrees with the presence of a divine relation with the width of the upper canine.

Some authors have affirmed that beauty is not associated with the numbers studied[11-12]. Others accepted the use of divine proportion to obtain an aesthetic result even while denying its natural existence in dentition[5,14]. Even so, in Preston's sample, there was no criteria in the selection of the orthodontic models studied, not even regarding the dentition's aesthetic appearance[14]. Nevertheless, Ricketts[17] (1981) reported that the divine proportion is not usually present in any malocclusion. On the other hand, Ward[20] (2007) wrote that dentists prefer smiles under the RED proportion (recurring aesthetic dental proportion)[20].

No differences were found in the comparisons between the genders for the sample studied. Bishara *et al.*[4] (1989) even found a statistically substantial difference between the genders but did not consider it clinically important.

The divine proportion was found in the relationships previously mentioned. The measures used are of simple clinical application and their results add reference data for individualized diagnoses. It contributes to predicting results which will certainly benefit the physical and emotional health of patients because, in the search for facial harmony, the smile is very important and this estimate provides us with a scientific manner of applying aesthetic effects of impact and rhythm to the human physiognomy.

Conclusion

In esthetics, the perfect symmetry is not a fundamental item, but was found in the central incisors, the most apparent teeth of the smile. The asymmetry rate was high in the upper lateral incisors.

This article considers the dental analysis with photography a practical and efficient method to check or restore symmetry and proportion of the anterior teeth. This analysis adds reference data for personalized diagnosis and treatments that bring a pleasant and natural appearance.

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