

Comparative study regarding the evaluation of facial aesthetics using the classical and computerized method

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ABSTRACT

Tempting and disturbing by its purpose to correct dental malocclusions, but also asymmetries facial expressions, to shape smiles and to improve the quality of life, orthodontics has experienced a permanent dynamics in recent decades both by improving the means of diagnosis (digitization) as well as the introduction of increasingly high-performance materials: hybrid springs, mini-implants, etc.

An important diagnostic element in Orthodontics is photography made from the front and profile, which is also a forensic document, on which a series of angular and linear parameters are analyzed at the beginning and end of the treatment.

Orthodontic diagnostic pictures are a non-invasive method of diagnosis and are made in the natural position of the head NHP, which is a standardized, reproducible position of the head in space where the subject is looking at a distant point of the eye level.

The angular and metric values on the photo or teleradiography of the face/profile are essential elements in both establishing a diagnosis and the treatment plan that will aim to achieve a balanced face and a harmonious profile. These values can be transferred to the computer, and with the help of specialized software will be analyzed and interpreted for each clinical case.

This study aimed to perform a comparative analysis of four angles that define the facial profile in a group of 30 patients (15 females and 15 males) patients aged 18-24 years with Angle I class malocclusions and bone growth finished. The values were measured on the profile photograph (after tracing the anthropometric points with an eye pencil) and statistically evaluated for both sexes, and the photos were scanned and important in the DSD software so that the same angles can be evaluated digitally.

Digital orthodontics tends to take up more and more space in the assessment of an orthodontic case. In orthodontic treatments, the thickness of the soft parts that can compensate for an unsightly profile of the bone relief is taken into account.

Keywords: photography, software, angular values, orthodontic treatment

INTRODUCTION

The 20th century was dominated by Angle's occlusive paradigm through which the goal of the orthodontic treatment was to obtain a normal dental occlusion.

Over time, it has been shown that excellent occlusal ratios cannot be obtained to the detriment of unsatisfactory facial proportions.

Thus the orthodontics of the 21st century differs from that of the last century in that it pays special

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attention to the facial and oral soft tissues patients and their parents requesting orthodontic treatment for aesthetic reasons and because of the impact of the aesthetic aspect on the quality of life of the individual. Modern orthodontics is thus shaped by biological, cultural and psychosocial determinants.

Orthodontic treatment is increasingly in demand in recent years due to the changing perception of the population on facial aesthetics and has a high degree of addressability in adulthood, too. Dental alignment must take into account not only the micro aesthetic principle: gum, interdental papillae, tooth texture, but also the macro aesthetic principle, as a whole of facial aesthetics - the shape and symmetry of the face, the shape and size of the nose, forehead, lip thickness, the appearance of facial grooves etc. All this information can be obtained by measurements on face and profile photos. (Figure 1).

It is difficult to predict the image of the face and the smile at the end of a treatment, when the pieces are separated and their rearrangement is difficult without certain landmarks. The human eye is a convex lens and like any lens it has some imperfections. Thus, the perception of the smile line, the symmetry of the lips or the parallelism of the bipupillary line with the commissural line may undergo changes as a result of orthodontic treatment. For these reasons, facial measurements by classical and modern methods, with guides from computer programs are extremely useful both in predicting the end of treatment.

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ics by classical methods, without a guide, compared to modern ones, with a guide (Figure 2).

The current expansion of digital analysis by diagram- network type image transfer - to all three spatial planes, should allow an easy and quick quantitative assessment of the facial features of the soft tissues of patients of orthodontics and maxillofacial surgery. The patient's facial shape and size are compared with specific benchmarks for gender, age and race and provide independent quantifications of each discrepancy.

For the design of dental aesthetics, we need as much information as possible, which can be obtained by the doctor through computer software. This makes our work easier through simplicity and speed and through the perfection of the final aesthetic result. Thus, for the realization of medical software we must define the aesthetics from a mathematical point of view, through mathematical formulas, algorithms necessary for software programming.

The software will automatically detect or guide the symmetrical points of the face to calculate the axes, smile line, black triangles, which we pass on to our colleagues in the dental team. For example, the light from the flashes will be reflected on the front of the eye convexity, and the software will identify the camera flashes on the pupils and determine the most common symmetrical points of the face: the center of the eye pupils.

The biggest problems in the manual or digital evaluation of dental aesthetics are in frontal area, for the entire frontal group. The orthodontist is classically guided by direct view of the patient viewed from the front, analyzing the position of the front teeth, incisal curvature, smile line. The center line of the central teeth is analyzed relative to the center line of the face and normally there should be concordance in both arcades.

The aim of this study was to compare two systems for evaluating dental aesthetics to predict the final results of an orthodontic treatment. The idea was given by the possibility of overlapping two plans and materialized through the solution transfer 2D photo information to an open application on the monitor (Figure 3).

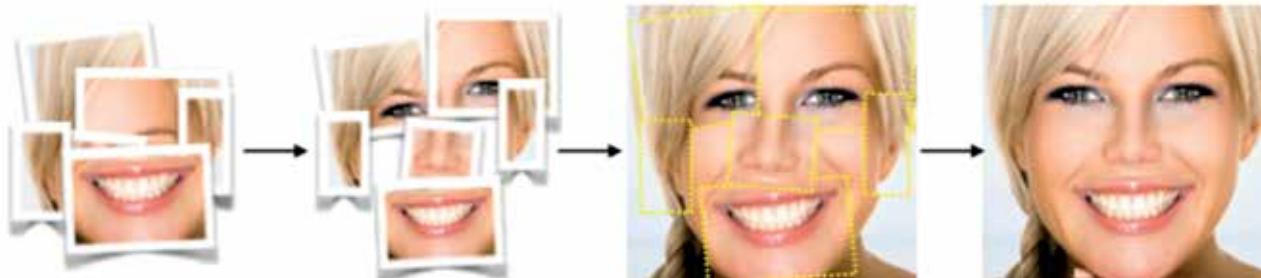


FIGURE 1. Facial examination (frontal norm)

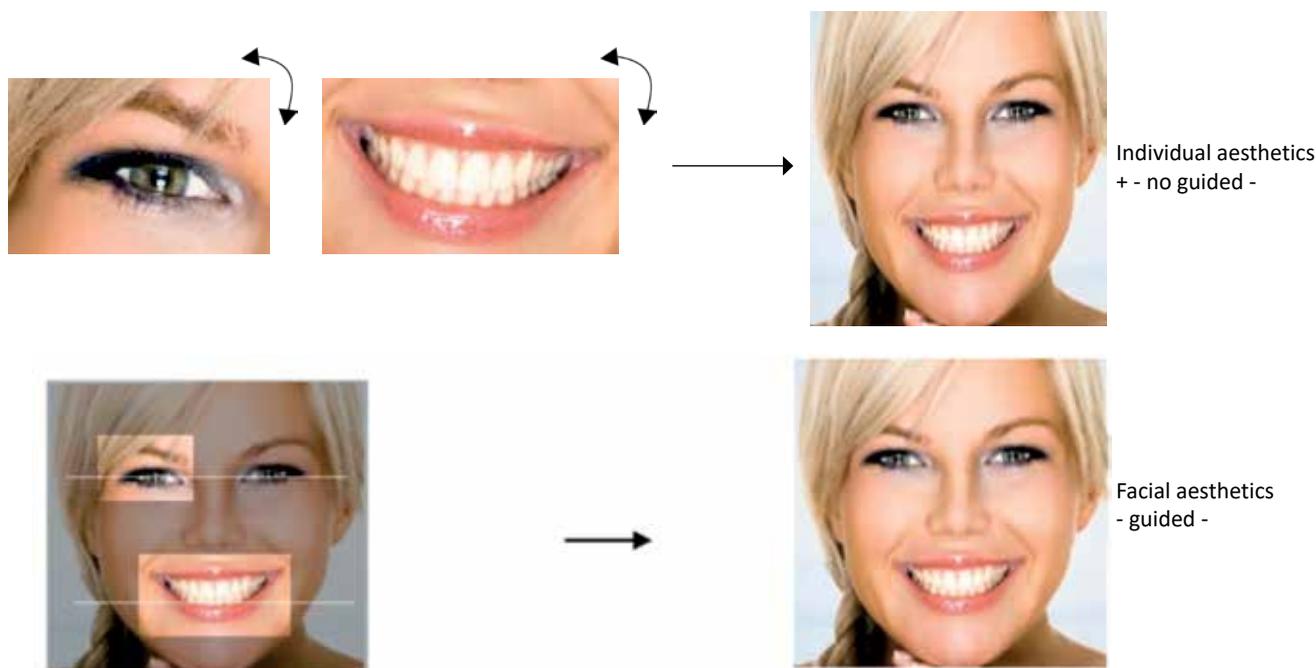


FIGURE 2. Evaluation of facial aesthetics



FIGURE 3. Transferring information from 2D to 3D

MATERIAL AND METHOD

The study was performed on a number of 30 photographs belonging to a number of 30 patients (15 female and 15 male, aged 18-25 years, with skeletal class I malocclusions) analyzed both classically, by drawing anthropometric points, as well as with the help of the computer by transferring information from 2D design to 3D design. To capture the patient's profile, it is placed in front of a neutral background, far enough that no shadows appear. The photos were taken in the natural position of the head (NHP), this was obtained by placing a mirror in front of the subject at 120 cm, the patients being asked to look into their own eyes in the mirror, with relaxed lips, forehead and ears visible [4]. The device has been kept in a horizontal position and supported by a tripod adjustable according to the height of each patient.

The angles to be measured were drawn: naso-frontal angle (GN-Nd), naso-labial (Cm-Sn-Ls), mento-labial (Li-Sm-Pg), facial angle (G-Sn-Pg). All these measurements were made by the same operator. (Figure 4 a, b)

The value of the angles: naso-frontal, naso-labial, mento-labial, facial was recorded and statistically analyzed in both males and females. (Figure 5 a, b)

The same angles were measured using DSD Connect software by capturing the photo image and transposing it to the computer screen.

DSD CONNECT is a software that transfers all DSD design information, facial axes and tooth contour from the projected, simulated and patient-approved position over the 3D model. Initially, the design must be done according to the Digital Smile Design principle, exporting the axes and contours of the teeth from the initial position to the final one simulated and accepted by the patient. In this study we only compared the values of the facial angles

The t-student test was used to compare the mean of the angles measured in girls and boys. The statistical data are presented in Table I-IV. It was used for statistical analysis using the Statistic Analysis module in the Microsoft Excel utility. The whole batch was statistically analyzed using descriptive statistics methods, calculating the average values, weight, distribution, frequency for the parameters followed: the four angles of the profile



FIGURE 4A. Nose-frontal, nasal-labial, chin-labial angles.

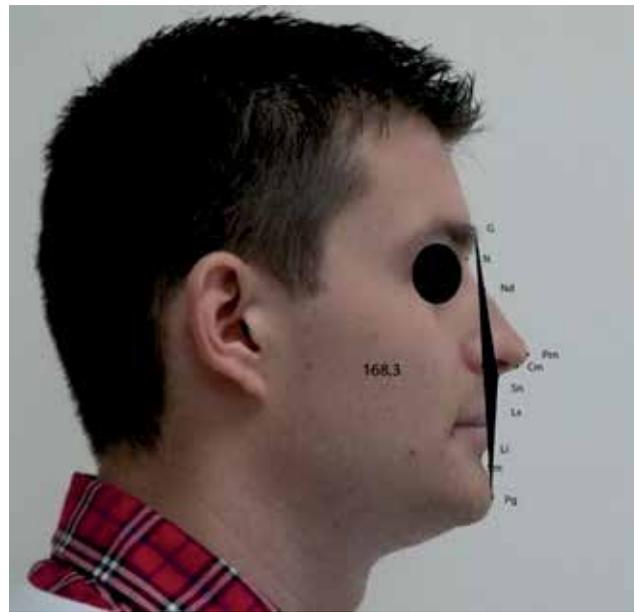


FIGURE 4B. Facial angle.

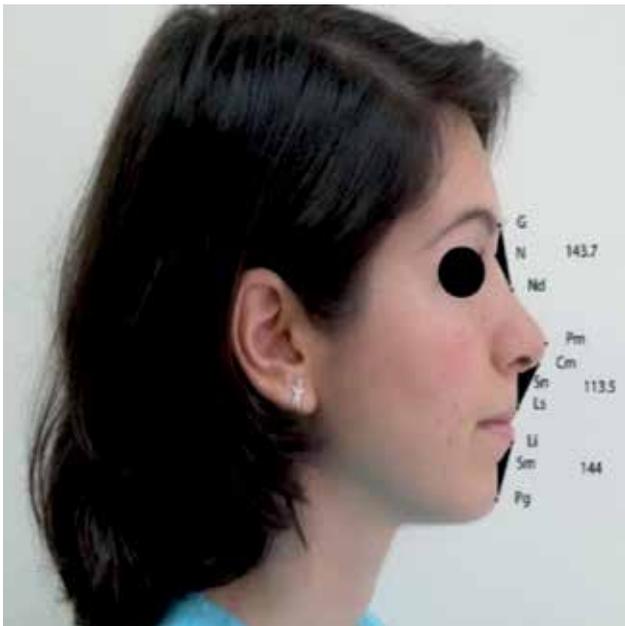


FIGURE 5A. Nose-frontal, nasal-labial, chin-labial angles

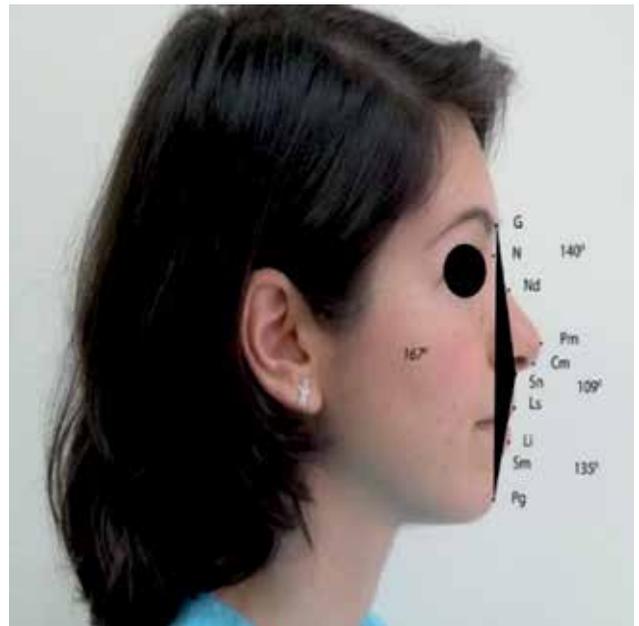


FIGURE 5B. Facial angle



FIGURE 6. 3D image design

TABLE 1. Nose-frontal angle measured on the photograph

	girls	boys	patients
average	137,109	135,832	136,563
standard deviation (standard deviation)	1,49681	1,19705	1,510226
average +/- standard deviation	137,11 +/- 1,49	135,83 +/- 1,19	136,56 +/- 1,51
variance (dispersion)	2,24	1,433	2,281
coefficient of variation	1,09%	0,88%	1,11%
standard error	0,1949	0,1805	0,1488
standard error	134,2	133,1	133,1
standard error	140,0	137,7	140,0
lot size	15	15	30

p <0,0001**TABLE 2.** Nose-labial angle measured on the photograph

	girls	boys	patients
average	105,31	102,181	103,974
standard deviation (standard deviation)	2,66405	1,50554	2,722022
average +/- standard deviation	105,31 +/- 2,66	102,18 +/- 1,50	103,97 +/- 2,72
variance (dispersion)	7,097	2,267	7,409
coefficient of variation	2,53%	1,47%	2,62%
standard error	0,3468	0,227	0,2682
minimum	99,9	99,0	99,0
maximum	109,0	105,0	109,0
lot size	15	15	30

p <0,0001**TABLE 3.** Mento-labial angle measured on the photograph

	girls	boys	patients
average	126,07	118,282	122,743
standard deviation (standard deviation)	2,98082	7,46266	6,596666
average +/- standard deviation	126,07 +/- 2,981	118,28 +/- 7,463	122,74 +/- 6,597
variance (dispersion)	8,885	55,691	43,516
coefficient of variation	2,36%	6,31%	5,37%
standard error	0,3881	1,125	0,65
minimum	120,9	104,6	104,6
maximum	134,0	129,3	134,0
lot size	15	15	30

p <0,0001**TABLE 4.** Facial angle (G-Su-Pg) measured in the photograph

	girls	boys	patients
average	170,314	168,823	169,677
standard deviation (standard deviation)	2,06034	0,69378	1,779304

	girls	boys	patients
average +/- standard deviation	170,31 +/- 2,06	168,82 +/- 0,694	169,68 +/- 1,779
variance (dispersion)	4,245	0,481	3,166
coefficient of variation	1,21%	0,41%	1,05%
standard error	0,2682	0,1046	0,1753
minimum	167,7	167,8	167,7
maximum	180,0	170,5	180,0
lot size	15	15	30

p <0,0001

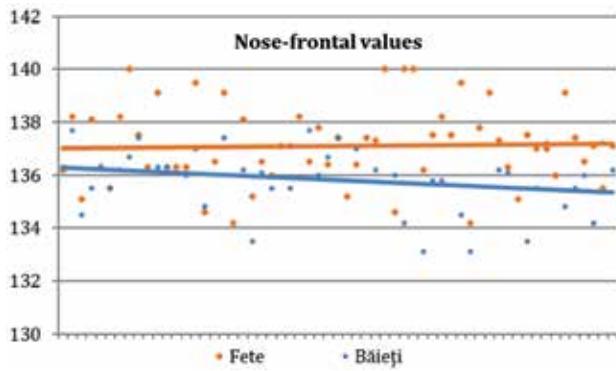


FIGURE 7. Nose-frontal angle values calculated by software

The distribution of the angular values obtained with the help of the software is linear, and the values fall within the threshold of statistical significance for both sexes. (Figure 7-10)

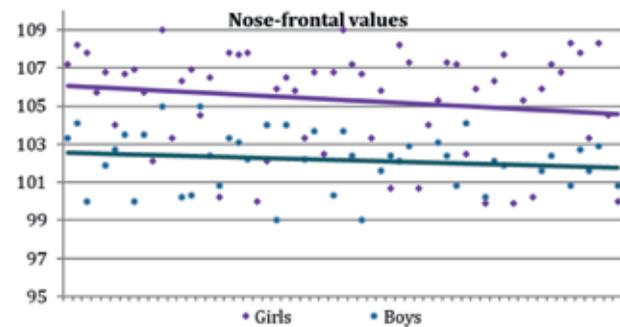


FIGURE 8. The values of the nasolabial angle calculated by the software

The mean values obtained for the naso-labial angle measured with DSD were higher for both girls 126.12 +/- 2.59 and boys 103.41 +/- 1.61, compared to the values measured in the profile. 126.07 +/- 2.66 and 102.18 +/- 1.50, respectively

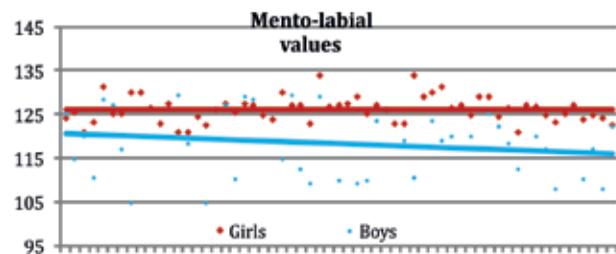


FIGURE 9. The values of the chin-labial angle calculated by the software

There is a large variation in the values of this angle around the average for both girls and boys. This angle has value in the extraction / non-extraction decision to get space on the arcade.

The mean values obtained for the mento-labial angle measured with DSD were higher for both girls 128.12 +/- 1.15 and for boys 119.61 +/- 6.21, compared

to the values measured in the profile photo. 126.07 +/- 2,981 and 118.28 respectively +/- 7,463.

The variation of the values of this angle is almost linear, with no statistically significant differences between the two sexes.

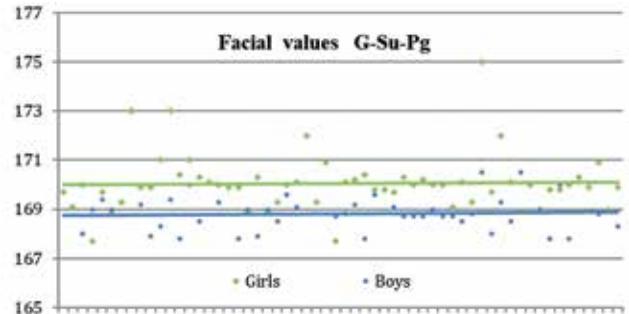


FIGURE 10. Face angle values calculated by the software

The face angle values evaluated by the software have values approximately equal to those measured by the operator on the profile picture. Thus, the average of the values obtained with the help of the software is in the range 170, 45 +/- 2.03 for females and 168.79 +/- 0689 for males, compared to the measured values of 170.31 +/- 2.06 at female, respectively 168.82 +/- 0.694 for male.

The largest variation between the classical and the modern method was obtained at the chin-labial angle (Figure 11 a, b), and the smallest in the case of the facial angle (Figure 12).

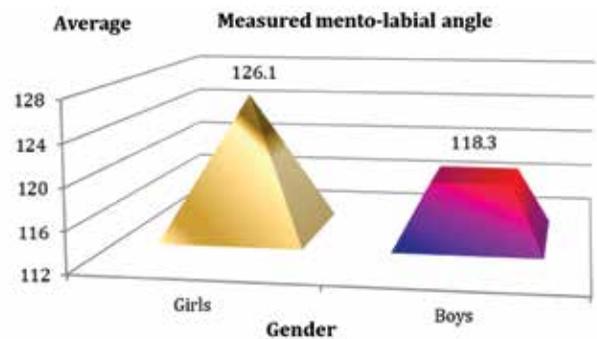


FIGURE 11. Graphical representation of the mean value of the mento-labial angle

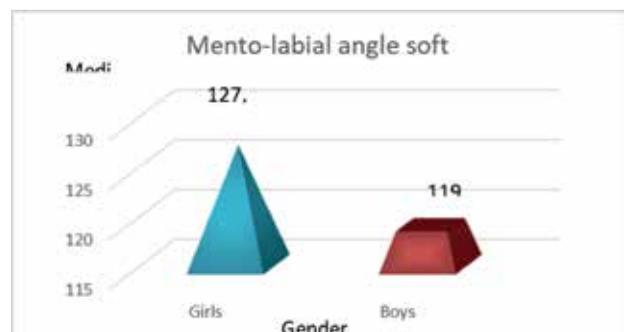


FIGURE 12. Graphical representation of the average value of the facial angle

The facial angle is a value that allows the assessment of the position of the face compared to the base of the skull and is used in both orthodontics and facial cosmetic surgery.

DISCUSSIONS

The growing interest and demand of patients in dental aesthetics has led to a significant increase in interest in researching the shape, position and color of teeth. There is no ideal face and that is why the most important aesthetic goal in orthodontics is to obtain a harmonious, symmetrical Chateau face: there is no fixed and immutable “normal”, but an infinity of types that can be normal [4][5].

In other words, normality involves great variations, and its limits are arbitrary, relative, imprecise. Consequently, normality can be defined as a certain limit of variations around the mean or around the most common shape. It is related to the constitutional type, race and other factors. Similar studies have been conducted by other authors, all using NHP profile photographs (Yuen and Hiranaka, 1989; Arnett and Bergman, 1993; Fernandez-Riviero et al. 2002, 2003; [6][7][8]).

The nose-frontal angle (GN-Nd) of the population investigated in this study has the following values 137.1 ± 1.53 degrees for girls and 135.79 ± 1.2 degrees for boys as opposed to Epker (1992) who did not find differences between nasal-frontal angle values in girls and boys (130 degrees) [8] and by Malkoç et al. (2009) in Turkey which also finds similar values for girls and boys (148.61 ± 6.66 degrees and 146 ± 8.19 degrees) [9].

Anic-Milosevic et al. (2008) found, similar to the results of our study, different values of this angle for the two sexes of a Croatian population (139.11 ± 6.35 degrees for girls and 136.38 ± 6.71 degrees for boys) [10].

Fernandez-Riviero et al. (2003) in Spain, similar to our study, find different values for the two sexes (141.98 ± 6.06 degrees for girls and 138.57 ± 6.81 degrees for boys) [11]. Reddy et al. (2011) for a North Indian population, they also find different values for females and males (144.33 ± 1.75 degrees girls and 136.71 ± 3.64 degrees boys) [12].

Wamalwa et al. (2011) also find different values for the two sexes studying a Kenyan population (137.97 ± 5.21 for girls and 132.44 ± 6.91 for boys) [13]. Differences between the values of the nose-frontal angle of different populations come from racial differences, and the age of the group analyzed.

Nanda et al (1990), similar to our study, reported different values of the chin-labial angle for the two sexes: 125.1 ± 12.9 for males and 127.1 ± 12.9 for females [14]. Lines et al (1978) reported values between 120 and 130 degrees, which is consistent with the values we measured [15]. So men have a lower

lip-chin angle, which corresponds to a deeper lip-chin groove than women with a more pronounced chin. upper frontal (incisor-canine). Its value is important because it indicates the position of the upper lip and influences the decision to treat certain extraction or non-extraction cases.

In the present study, the values obtained were as follows: the mean for girls 105.3 ± 2.71 degrees and for boys 102.19 ± 1.55 degrees indicating a statistically significant difference between the sexes $p < 0.001$. Arnett et al. (1999) also find different values for girls and boys (103.5 ± 6.8 average for girls and 106.4 ± 7.7 average for boys). [16] Uysal T et al. (2009) studying a population of Turkey find, similar to our study, different values for the two sexes (108.1 ± 8.3 average for girls and 106.8 ± 10.6 average for boys) [17].

According to Bergman (1999) its value must be 102 ± 8 degrees without differences between the two sexes. [18] **The nasolabial angle (Cm-Sn-Ls)** depends on the antero-posterior position of the upper frontal group (incisive-canine). Its value is important because it indicates the position of the upper lip and influences the decision to treat certain extraction or non-extraction cases. In the present study, the values obtained were as follows: the mean for girls 105.3 ± 2.71 degrees and for boys 102.19 ± 1.55 degrees indicating a statistically significant difference between the sexes $p < 0.001$. The value of this angle for Caucasians is 90-100 degrees for males and 95-105 for females after Nanda who reports different values for the two sexes [14].

The orthodontist must take into account the beauty rules specific to each patient, the differences between the sexes. The higher values of the angles measured in this study for females can be explained by the fact that the girls have a smoother contour of the soft parts than the boys, especially in the area of the nose, lips and chin [19].

Many analyzes of the facial soft surfaces showed different values of angles, the differences resulting from the criteria for including patients in the study, racial differences, age, the existence of malocclusions, measurement methodology, head orientation when taking photographs [20]. Jefferson stated that the angles of facial profile calculated on the patient's anthropological photograph have indicative values and their values differ from the values of cranial angles measured on profile telerradiography [21]. However, orthodontic treatments take into account the thickness of the soft parts that can compensate for the unsightly profiles of the bone relief.

The analysis of the soft parts of the facial profile by measuring the angles that determine the attractiveness of the profile is a minimally invasive method that can be successfully applied in establishing specific treatment goals, an individualized treat-

ment plan and in assessing the success of orthodontic treatment [22].

The facial angle (G-Ns-Pg) is the angle that appreciates the facial typology in relation to the base of the skull and has normal values between. Cetlin and Down established four types of cephalic depending on the value of this angle: orthognathic, retrognathic, prognathic and prognosticated [5]. We obtained values of 168.85 ± 0.7 degrees for boys in accordance with the values found by Fernandez-Riviero et al. 168 ± 5 degrees and Arnett and Bergman 169.4 ± 3.2 degrees [11][16]. The face angle is the only angle at which the measured values coincided with the values analyzed by the software, after the transfer of the facial image to the computer.

This study is limited by the small number of patients included (60 patients) as well as by the constitutional and anthropological characteristics: normosome, normodivergent with skeletal class I malocclusion and dental class I.

CONCLUSIONS

There are statistically significant differences between the values of the angles that characterize the

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