CONCLUSIONES

La distribución de las clases esqueléticas de la muestra estudiada estuvo compuesta por un mayor porcentaje de clase I, seguida por clase II y una menor cantidad de clase III, independientemente del análisis utilizado. En cuanto a la posición sagital del maxilar, en todos los análisis estudiados se encontró un mayor porcentaje de casos con el maxilar ubicado dentro de la norma, seguido por maxilar protruido, y un menor porcentaje con maxilar retruido. En el establecimiento de la posición sagital de la mandíbula, la distribución de la posición no varió con el análisis empleado, siendo mayor porcentaje con mandíbula retrognática, seguida por mandíbula en norma y un menor porcentaje de mandíbula prognática.

En general, existe una concordancia moderada entre el ángulo ANB de Steiner, la convexidad de Ricketts, el Wits del análisis de Jacobson, para la determinación de la clase esquelética; y una concordancia moderada y débil entre los análisis de Steiner, Ricketts y McNamara para la determinación de la posición sagital del maxilar y la mandíbula respectivamente. Asimismo, se puede concluir que los análisis cefalométricos son efectivos para la determinación de la clase esquelética, la posición sagital del maxilar y la mandíbula respecto a la base del cráneo, independientemente del utilizado por cada especialista. Además, se considera indispensable realizar los análisis cefalométricos en conjunto con otros auxiliares para el establecimiento de un diagnóstico ortodóntico, lo cual permita elaborar un plan de tratamiento adecuado para cada caso.

Original research

Skeletal class concordance and sagittal position of the jaws by different cephalometric measurements

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ABSTRACT

Introduction: There are multiple cephalometric analyses described by several researchers, sometimes with differences between the results obtained from different measurements, consequently, it is difficult to establish the diagnosis and treatment plan of orthodontic patients. **Objectives:** To evaluate the concordance between different measurements that determine the skeletal class, and the sagittal position of the maxilla and jaw. **Material and methods:** For this analytical, observational, transversal and retrospective study, a sample of 75 X-rays of patients aged 14 to 57 was used from the orthodontic department of the Faculty of Dentistry of the Autonomous University of Yucatan. The cephalometric measurements were made in the Dolphin Imaging program by the same previously calibrated operator. The Fleiss Kappa statistical test was applied to the data obtained. **Results:** The distribution of skeletal classes had the highest percentage of class I, followed by class II and a lower amount of class III. As for the sagittal position of the maxilla, a higher percentage of patients with the maxilla located within the norm were found, followed by protruded maxilla, and a lower percentage of patients with retruded maxilla. For the jaw, the position distribution was higher percentage of patients with retro-gothic jaw, followed by normatic jaw and a lower percentage of prognical jaw. The results of the statistical tests of Kappa of Fleiss obtained were: for the determination of skeletal class Kappa-0.53, for the position of the maxilla Kappa-0.47, and for the Kappa-0.31 jaw. **Conclusions:** There is moderate concordance for the determination of the skeletal class between Steiner's ANB angle, Ricketts' convexity, the Wits of Jacobson's analysis, a moderate match for determining the sagittal position of the maxilla, and weak for the jaw between Steiner, Ricketts and McNamara's analyses.

Keywords: Cephalometry, skeletal class, orthodontic diagnosis.

INTRODUCTION

With the discovery of X-rays by Röntgen in 1895[1] the doors to cephalometry[2] were opened, which was introduced in the 1930's by Hofrath in Germany and Broadbent in the United States.[3] Currently there are numerous cephalometric analyses described by different authors, which help determine skeletal, dental dimensions, as well as relate to each other, obtaining an objective interpretation of craniofacial morphology.

The first step for intermaxillary anteroposterior evaluation was the description of Downs of points A and B in their cephalometric analysis.[4,5] Years later, Riedel proposed the ANGLE ANB,[5-7] later used by Steiner, who published a simplified analysis that could be used routinely.[5,8]

Later, new measurements appeared that are used to determine the same relationship, as some orthodontists consider that the nadodontist point (N) of the ANB angle is not an adequate point due to its high variability.[9] Ricketts, unlike Steiner, used point A in conjunction with the facial plane to determine the intermaxillary ratio;[10] Jacobson proposed for this determination of the «Wits» measure, which discards the Silla (S) and N anatomical points, instead using nearby representative points of the apical bases, points A and B projected on the occlusal plane, eliminating the inclination and length variables of

the skull base in the interpretation.[5,11] McNamara, for his part, used the maxyl-mandibular difference (Co-A/Co-Gn) in his analysis to determine the skeletal class using linear measurements. With regard to the sagittal position of the jaws the most commonly used measurements are the SNA and SNB angles of Steiner analysis, the facial depth and maxillary depth of Ricketts analysis, and the NPerp-A and NPerp-Pog distance from McNamara's analysis.[6,12,13]

The results obtained from the different cephalometric measurements for each author often vary from each other, so that the assessment made by the orthodontist, may be skewed by the interpretation of the measurement used, which could be assessed differently by a measurement by some other author. The objective of this study is to evaluate the concordance between different measurements that determine the skeletal class, and the sagittal position of the jaw and jaw.

MATERIAL AND METHODS

The study is observational, analytical, transversal and retrospective. The sample included patients aged 14 to 57 who came to the postgraduate orthodontics department of the Autonomous University of Yucatan (UADY). The sampling type was selected based on a non-probabilistic method, for convenience. A significance level of 95% and a margin of error of 10% were used to obtain the sample size. Subsequently, a correction was made for finite populations obtaining a final sample size of 73.

Information was obtained regarding patient identification data from the UADY orthodontic graduate medical history, as well as skull side X-ray. These X-rays were taken in the radiology department of the UADY Faculty of Dentistry (FOUADY) with the digital cephalometric X-ray equipment (Orthoceph® OC200 D). The images were stored on a computer designated for the study, which featured the Dolphin Imaging program for cephalometric tracing and measurement of the different variables.

The measurements used to determine the skeletal class were: Jacobson's AO-BO (Wits) plane, Steiner's ANB angle, Ricketts' convexity. To determine the sagittal position of the maxilla: Steiner's SNA angle, Ricketts' maxillary depth (Pr-Or/N-A), and The perpendicular Nasion-Point A angle (NPerp-A) of McNamara. The sagittal position of the jaw relative to the skull base was determined by: Steiner's SNB angle, Ricketts' facial depth (Po-Or/N-Pg), and McNamara's perpendicular Nasion-Point B (NPerp-Pog) angle.

Initially 80 skull side X-rays were included in the sample, which were entered into the digital tracing program pointing to the patient's full name, medical history number, date of birth and gender. Subsequently, the X-rays were digitally traced by a single operator, previously calibrated (intraoperative Kappa values > 0.80). The final sample consisted of 75 valid records. From each x-ray the result of the skeletal class assessment (I, II, or III) was recorded according to each of the cephalometric analyses studied, and the sagittal position of the jaw and maxilla was determined, based on the standards established by Steiner, Ricketts and McNamara, classifying the position of the jaw as prognact, retrogenatic or as normate, retracted or as standard.

Statistical analysis was performed using the Fleiss Kappa coefficient in minitab software (Minitab Inc.) to establish the level of concordance between the results obtained for the determination of the skeletal class and the sagittal position of the maxilla and jaw, according to the different cephalometric measurements of the analyses studied. In addition, cephalometric measurements were evaluated one-on-one using Cohen's Kappa coefficient. The match levels for Kappa values found were established according to the rating given by Landis and Koch in 1977[14] *(Table 1)*.

RESULTS

Sample characterization

This study reviewed the skull side X-rays of 75 patients aged 14 to 57 years, with an average of 23 years, a standard deviation of 10 years, a median of 18 years and a fashion of 17; of which 72% (n-54) were X-rays of female patients and 28% (n-21) corresponded to the male sex.

Skeletal class

The distribution of the skeletal classes obtained from each cephalometric analysis is presented in *Table 2*. According to the Kappa coefficient statistical analysis of Fleiss, a moderate concordance force (Kappa-0.53) was obtained for the determination of the intermaxillary anteroposterior ratio, among the three cephalometric analyses studied *(Table 3)*. Similarly, the concordance force was moderate, with each diagnostic possibility being evaluated individually (class I, II, and III).

To better understand the consistency behavior between the cephalometric analyses studied, a review was performed with Cohen's Kappa test between

each pair (one-on-one) of cephalometric analysis, finding that Steiner and Ricketts' analyses presented a very good match, while Steiner and Jacobson's assessments, and Ricketts and Jacobson showed weak concordances *(Table 4)*.

Sagittal position of the maxilla

The distribution of the sagittal position of the maxilla and jaw obtained from cephalometric analyses is presented in *Table 2*. According to the Fleiss Kappa coefficient statistical analysis, a weak concordance force (Kappa-0.31) was obtained for the determination of the sagittal position of the jaw, among the three cephalometric analyses studied, as shown in *Table 3*. When each diagnostic possibility (retrogontic, as standard, prognistic) was individually evaluated, the concordance force was moderate when treated with retruded and protruded jaws, however the concordance was weak when treated as normal jaws.

When Cohen's Kappa was evaluated one-on-one, the analyses studied found that the analyses of Ricketts and McNamara presented a very good match, while the match assessment of Steiner and Ricketts' analyses and Steiner and McNamara had weak matches, as shown in *Table 4*.

Sagittal position of the jaw

The distribution of the sagittal position of the maxilla and jaw obtained from cephalometric analyses is presented in *Table 2*. According to the Fleiss Kappa coefficient statistical analysis, a moderate concordance force (Kappa-0.31) was obtained for the determination of the sagittal position of the maxilla, among the three cephalometric analyses studied *(Table 3)*. When each diagnostic possibility (retrogontic, as standard, prognistic) was evaluated individually, the concordance force was equally weak for each diagnostic possibility.

When one-on-one cephalometric analyses for the determination of the sagittal position of the jaw were evaluated *(Table 4)*, it was found that analysis of Ricketts and McNamara presented moderate concordance, Steiner and McNamara's analyses had weak concordance, and Steiner and Ricketts' analyses had poor concordance.

DISCUSSION

The distribution of the skeletal classes of this study is consistent with some others that have been reported in the literature. Using Steiner's analysis, Zamora in 2013 conducted a study with a sample of 90 patients, in which class I scored the highest with 53%, followed by class II with 37% and last class III with 10%.[15] Tokunaga in 2014 obtained, in a sample of 228 X-rays, a class I percentage of 53.3% of the total sample, followed by 37.1% of class II and 9.6% of class III.[16] In contrast, Aguirre and Pereda in Peru in 2013 reported a sample of 200 X-rays of adolescent patients, and obtained a higher percentage in the determination of class II with 53.5%, followed by class I with 33.5% and class III with 13%;[17] similar distributions have been reported by Acuña and Chávez,[18] and Herreros del Pozo et al.[19]

Using the analysis of Ricketts, Blacksmiths et al. in 2017 in a sample of 399, it achieved a higher percentage in the determination of class I with 63%, followed by class II with 27% and 10% class III.[19] On the other hand, Gul-e-Erun in 2008 used Jacobson's Wits to determine skeletal class and obtained a skeletal class I percentage of 51.8%, for class II 22.4% and for class III 25.9%.[9] By contrast, Zamora in 2013 obtained for class I 35%, for class II 56% and for class III 9%.[15]

No studies were found on the concordance of these three analyses with each other, but several similar studies were found that show the concordance between different cephalometric analyses for skeletal class determination. For example, Aguirre and Pereda in 2011 achieved a moderate match between Steiner's ANB angle and the USP projection.[17] Acuña and Chávez in 2011 obtained a weak concordance between Steiner and the USP projection.[18] Like the latter two authors, Marengo and Roma in 2016 obtained a weak match between the ANB angle and the USP projection.[20] Herreros del Pozo et al.,[19] it achieved a 42% match between Ricketts and McNamara and a Kappa rate of 0.18; between Steiner and McNamara was 43% and with a Kappa rate of 0.20, and between Ricketts and Steiner it was 71% and a Kappa index of 0.5.

As for the concordance between cephalometric analyses that determine the position of the jaws, it has been reported that a moderate concordance was obtained for the sagittal determination of the jaw (Kappa-0.57) and for the maxilla (Kappa-0.52) using the Kappa cohen index. Guerrero and collaborators in Ecuador, conducted research similar to that currently presented, in which based on 44 lateral skull X-rays they sought to determine the sagittal position of maxillal and jaw relative to the base of the skull using the cephalometries of Ricketts and McNamara, as well as to compare the diagnostic

concordance between them. The results showed moderate concordance values in both cases, with the Kappa-index being 0.59 for the maxillary position and Kappa-0.45 for the jaw.[21]

We can say that the results obtained in this research coincide with the literature consulted, and that the levels of concordance obtained are related to the specifications of each analysis, that is, by the fact that each author raises his own anatomical points of references and comparison values, considered as «normal» for the population in which he conducted the original study.

This research is useful for the specialist, because when using different analyses in the same patient, confusion is created by differences in the results of one or the other analysis; so this report seeks to reduce this confusion, as the results are a reference to which cephalometric analyses commonly used by orthodontists today would be most consistent with others. In addition, the data obtained from this research contribute to the general knowledge of diagnosis in orthodontics, and are a precedent, since there is not enough evidence of the degree of concordance between the different cephalometric analyses. It is recommended to continue to validate the matching of different measurements for the determination of other cephalometric characteristics, and to use larger samples.

CONCLUSIONS

The distribution of the skeletal classes of the sample studied was composed of a higher percentage of class I, followed by class II and a lower amount of class III, regardless of the analysis used. As for the sagittal position of the maxilla, in all the analyses studied, a higher percentage of patients with the maxilla located within the norm were found, followed by protruded maxilla, and a lower percentage of patients with retruded maxilla. In the establishment of the sagittal position of the jaw, the distribution of the position did not vary with the analysis used, being the higher percentage of patients with retro-gothic jaw, followed by the jaw in the norm and a lower percentage of progant jaw.

In general, there is a moderate match between Steiner's ANB angle, Ricketts' convexity, the Wits of Jacobson's analysis, for the determination of the skeletal class; and a moderate and weak concordance between Steiner, Ricketts and McNamara's analyses for determining the sagittal position of the jaw and jaw, respectively. It can also be concluded that cephalometric analyses are effective for the determination of the skeletal class, the sagittal position of the maxilla and the jaw relative to the base of the skull, regardless of the one used by each specialist. In addition, it is considered essential to carry out the cephalometric analyses in conjunction with other auxiliaries for the establishment of an orthodontic diagnosis, which allows to develop an appropriate treatment plan for each case.

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