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Cephalometric Norms According to the Harvold´s Analysis

Normas Cefalométricas de Acuerdo al Análisis de Harvold

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ABSTRACT: The purpose of this study was to establish cephalometric norms by age and gender of Harvold´s analysis for people living in the central region of Mexico and compare them with other populations to found morphologic craniofacial differences. One hundred sixteen males and 125 females were studied. The participants were divided into age groups. The parents and grandparents of the participants were born in Mexico. All participants had class I occlusion with normal growth, facial symmetry, no crowding and no previous orthodontic, orthopedic or maxillofacial surgery treatment. Lateral skull x-rays were obtained; each radiograph was analyzed on with a Harvold-like analysis. For statistical evaluation, the Student t´ test was used to compare the age groups between males and females. Significant gender differences were found in the following measurements: maxillary position, mandible position, and the anterior lower facial height in all age groups. Differences were found in the cranial and dental positions with other races respect to facial growth. Because every gender and race have their own characteristics, it is appropriate to use correct cephalometric norms in daily orthodontic practice. It is suggested to use the analysis of Harvold in a complementary way when in diagnosing a patient there is doubt on the alterations in the maxillae.

KEY WORDA: cephalometry, normal occlusion, diagnostic methods.

INTRODUCTION

Three of the most important genetic sources of morphologic variation are ethnic group, age, and gender (Phelan *et al*., 2004). Craniofacial characteristics, such as size, form, and facial patterns, as well as the morphology of the dental arch have been accepted as being genetically-predetermined. These characteristics show variations between types and species, race and sub-race, and are themselves susceptible to modification during the evolution process (Argyropoulus *et al*., 1989; Pereira *et al*., 1998; Wu *et al*., 2007).

Since the development of cephalometric radiography, diverse methods of analysis have been used to identify dental and facial structures of the different populations from diverse ethnic groups. Ethnic group is defined as a nation or population with common characteristics, such as geographic area, culture or language, as well as those who may be historically and/ or racially-related (Sevilla & Rudzki, 2005).

Those cephalometric studies generally have been from Caucasian patients (Evelio *et al*., 2001; Wu *et al.*). One of the first studies to demonstrate the differences between races using craniofacial parameters was developed by Cotton *et al.* (1951). In this study, Down´s analysis was applied to individuals of African heritage, Americans born in Japan, and Americans born in China. Differences, such as the length of the face, the direction of the growth pattern, and protrusion were observed. Engel & Spolter (1981) elaborated comparative facial growth studies between Japanese and Caucasians, adding differences between the age groups.

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In 1972, Bugg, Canavati, and Jeanings (Bishara & García, 1985) investigated the ethnic differences between Caucasians and Latin American children, finding that Latin Americans exhibited greater dental and skeletal protrusion. It is always preferable to compare the cephalometric values of the patient to the norm of their ethnic or racial group. The cephalometric analysis can then be used to accurately identify the deviation found in the patient.

There are a variety of cephalometric analyses, as published in Canada by Harvold in 1955. To contemplate the bimaxillary relationship in which the measurements are not influenced by the growth of the cranial base or some other reference line; the maxillomandibular relationship is based on its own growth relative to the other. This analysis is a complement to the definitive decision of how to treat the patient, since it defines which maxilla is altered (Harvold, 1974; Rojas *et al*., 2001; Wu *et al*.).

The purpose of this study is therefore to establish cephalometric norms by age and gender of Harvold´s analysis for people living in the central region of Mexico and compare them to those with other populations to found morphologic craniofacial differences.

MATERIAL AND METHOD

The cohort included 241 lateral cephalometric radiographs of children and adults from Toluca City (in the central region of Mexico). On the basis of chronological age and sex, the subjects were divided into comparison groups: GI (9-11 years of age); GII (12-14 years of age); GIII (15-17 years of age) and GIV (greater than 18 years of age) (Table I).

Table I. Distribution of the sample studied

Age	Gender		Total
	Male	Female	
GI (9-11 years)	38	32	70
GII (12-14 years)	36	34	70
GIII (15-17 years)	18	33	51
GIV (greater than 18 years)	24	26	50
Total	116	125	241

The subjects were selected who fulfilled the following criteria: natural-born Mexican; with Mexican parents and grandparents; more than 9 years of age; class I occlusion, normal growth and facial symmetry; no crowding; no previous orthodontic, orthopedic, and maxillofacial surgery.

The lateral cephalometric films of all subjects were obtained using the same X-ray unit (Panoura 10C, Yoshida Dental Mfg Co Ltd, Tokyo, Japan) with 3 seconds of exposure time, 88 Kvp, and a standard distance of 60 in (1.50 meters). The patient was seated with the plane of Frankfurt parallel to the floor using a cephalostate to maintain the head. The development of the x-rays was made automatically (Yoshida Dental Mfg Co Ltd, Tokyo, Japan).

All radiographs were traced by hand. The parameters used in this study are extensively reported according to the analysis of Harvold (Jacobson, 1995; Moldez *et al*., 2006) (Fig. 1).

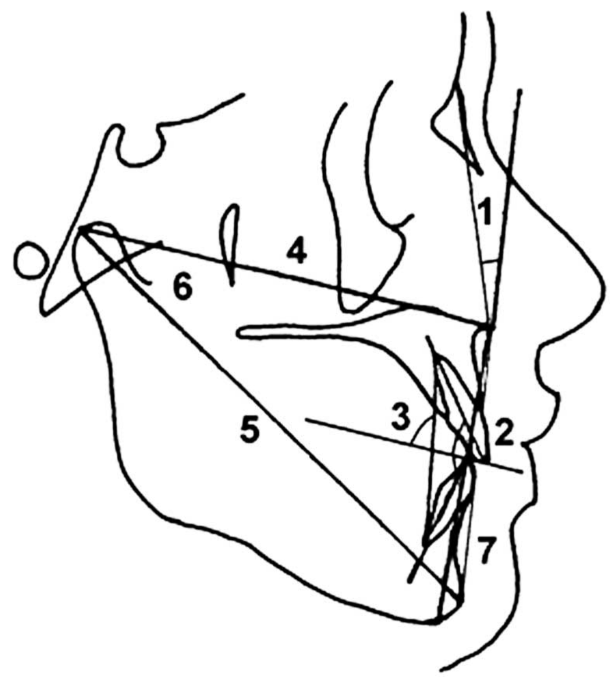

Fig 1. The cephalometric landmarks and definitions (Harvold): 1. Angle of convexity (nasion-anterior nasal spine flat and the anterior nasal spine-pogonion flat; 2.Interincisal angle (axial axes of the incisors superior and inferior); 3. Occlusal plane to the radicular maxillomandibular plane (occlusal plane and the radicular plane); 4. Maxillary position (the distance in millimeters between the condilion point to the anterior nasal spine point); 5. Mandible position (distance that exists between the condilion and pogonion points); 6. Maxillomandibular difference (obtained reducing the length of the condilion-anterior nasal spine of the length condilion-pogonion); and 7. Anterior lower facial high (the distance measured in millimeters of the anterior nasal spine to gnation).

In order to eliminate interexamining variability, one person made the layout and measured all the x-rays twice, repeating them in the parameters in which the differences between the first and second measurement were + 1º or +1 mm.

The averages and standard deviation for each one of the parameters were obtained dividing them by age groups and between females and males. A t-test for independent samples was used, with JMP 5.0.1 program (SAS Institute Inc., Cary, NC, U.S.A).

The polygon developed by age and gender groups consisted of five columns: 1) parameters that were to be analyzed; 2) average obtained; 3)standard deviation; 4) sampled a polygon with the average in the central line with + one standard deviation in the lines of the ends; and 5) the column presented a space toplace the patient's information that we were going to compare (Fig. 2).

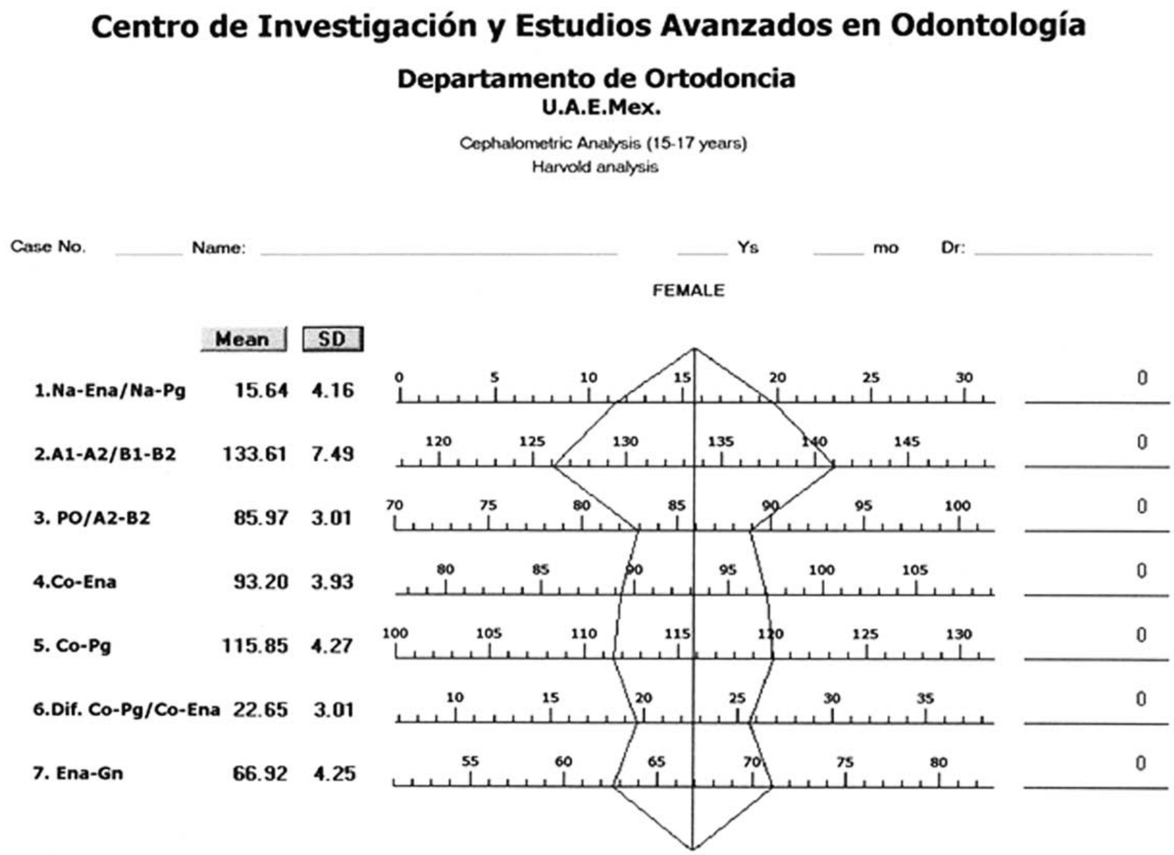

Fig 2. Example of the polygon obtained (Female 15-17 years of age)

RESULTS

Table II shows the measurements for both genders in this Mexican sample. There were significant differences between males and females in the GI only in the maxillary position, mandible position, and anterior lower facial high, with the distances greater in the males than the females by 3 mm.

Similar results were observed in the GII, but the difference detected in the maxillary and mandible position was 5 mm.

In the GIII, skeletal convexity and occlusal plane, with respect to the radicular plane presented significant differences, more noticeable in the male group with a convex profile of 3º. The maxillary position, mandible position, and anterior facial high showed differences by gender; a greater average for the male group was observed.

The convexity angle was the only parameter in the GIV that did not display a significant difference by

Table II. Mean and standard deviation of cephalometric measurements for Mexicans according Harvold's analysis.

Measurement / Age	*Men (n= 116)*	*Women (n= 125)*	*Significance*
GI (9 to 11 years)			
Convexity	20.45 + 4.48	20.02 + 3.66	NS
Interincisal angle	129.72 + 6.87	127.03 + 6.68	NS
Oclusal plane to radicular plane	87.03 + 2.50	87.31 + 2.78	NS
Maxillary position	90.00 + 4.20	87.61 + 4.08	.025
Mandible position	109.64 + 4.86	106.75 + 4.59	.025
Maxillomandibular difference	19.64 + 3.20	19.20 + 2.96	NS
Anterior lower facial high	66.57 + 4.59	62.33 + 3.49	.01
GII (12 to 14 years)			
Convexity	18.93 + 5.31	19.07 + 5.02	NS
Interincisal angle	130.50 + 7.29	131.46 + 6.88	NS
Oclusal plane to radicular plane	86.61 + 3.40	87.13 + 3.63	NS
Maxillary position	96.10 + 5.27	91.75 + 4.02	.01
Mandible position	117.46 + 5.63	112.47 + 5.17	.01
Maxillomandibular difference	21.36 + 4.57	20.72 + 4.30	NS
Anterior lower facial high	70.50 + 5.33	67.62 + 4.94	.025
GIII (15 to 17 years)			
Convexity	18.39 + 3.09	15.64 + 4.16	.05
Interincisal angle	130.78 + 4.75	133.61 + 7.49	NS
Oclusal plane to radicular plane	87.78 + 3.18	85.97 + 3.01	.05
Maxillary position	99.75 + 3.33	93.20 + 3.93	.01
Mandible position	121.36 + 4.45	115.85 + 4.27	.01
Maxillomandibular difference	21.61 + 2.62	22.65 + 3.01	NS
Anterior lower facial high	72.97 + 6.26	66.92 + 4.25	.01
GIV (greater than 18 years)			
Convexity	18.08 + 7.26	20.67 + 4.22	NS
Interincisal angle	130.58 + 7.63	126.77 + 5.93	.025
Oclusal plane to radicular plane	89.44 + 4.47	86.50 + 4.78	.05
Maxillary position	101.38 + 6.31	96.25 + 4.10	.01
Mandible position	128.96 + 6.85	121.04 + 4.69	.01
Maxillomandibular difference	27.58 ± 5.62	24.79 ± 3.10	.05
Anterior lower facial high	75.46 + 5.64	71.08 + 4.84	.01

NS, no significative

gender, whereas the other parameters were greater in the males. The convexity diminished as the age increased in the masculine gender, whereas in the GIV females, the convexity presented a considerable increase.

Variations in the interincisal angle in all age groups of masculine gender were not observed, whereas in the feminine gender an increase in the GI and GIII existed, which was diminished in the GIV.

The angle formed by the union of the radicular plane to the occlusal plane showed slight modifications in the different groups based on age in both genders; in males it diminished slightly in the GII and in the female group it diminished in the GIII. The average was greater in GIII males. A constant increase in the size of the maxilla was observed in each group in both genders, being noticeably greater in the male group (11 mm for males and almost 9 mm for females).

The mandible position displayed the same tendency as the maxillary, being observed values greater in males (19 mm for males and in females 15 mm). With respect to the maxillomandibular difference, significant differences in both genders were not observed, except in the GIV. The anterior lower facial high increased as the age increased. The values were smaller in the feminine group.

DISCUSSION

In this study, the sexual dimorphism was significant, especially in linear measurements.

The literature demonstrates differences and similarities with respect to dental position and the profile. The convexity and the interincisal angle are characteristic of each race; the literature reported a straighter dental position and profile for Caucasian population when compared with other races (Wu *et al*.; Moldez *et al*.; Huang *et al*., 1998).

In European adults, according to Evanko *et al*. (1997), the interincisal angle is similar to that obtained in the current study; in a Turkish study (Ayhan *et al.,* 2004) it was slightly smaller, whereas in Iranian (Hajighadimi, 1981) and Puerto Rican studies (Evanko *et al*.) a more closed interincisal angle was demonstrated.

Despite the fact that a smaller interincisal angle was demonstrated in the feminine gender of our population, it conferred a more convex profile with respect to the European and Turkish females since the latter present minor maxillary protrusions, but a profile straighter than the Puerto Rican and Iranian females because Puerto Ricans present a relative mandible retrognathia, and in both groups a greater dental inclination appears (Evanko *et al*.; Ayhan *et al*.; Hajighadimi *et al*.).

The Asian population of both genders shows bimaxillary characteristics of dental protrusion, according to Wu *et al.* in a Chinese population, Moldez *et al.* in a Japanese population, and Sevilla and Moldez *et al.* in a Philippine population. Similar findings have been reported in the African-American race (Huang *et al*.), the maxillary and alveolar protrusions are greater with more opened interincisal angles, which confers a more convex profile in comparison with any other race.

Nevertheless, in the Greek population, the interincisal angle is similar to the detected one in the current study, but the profile is more concave due to the mandible alveolar protrusion that exists (Argyropoulus *et al*.; Argyropoulus & Sassouni, 1989).

Bishara & García compared children in northern Mexico and children born in the United States, and reported that the dental inclination in the Mexican children is more pronounced with respect to the North Americans. Nevertheless, they didn't find significant differences, but it is important to point out that the characteristics of the inhabitants of northern Mexico are different from the region of our study; similar results have been reported by Kubodera (1992).

The profile assessment demonstrates in the male group a tendency to diminish gradually in form until adult age. In females at the end of growth, the angle was opened and finished in a skeletal profile more convex, which can be due to the shorter mandible size in adult females and more posteriorly placed chin. The adult males subjects showed a tendency toward a counterclockwise rotation of the mandible.

In the interincisal angle, the males did not present significant changes in the age groups because the inclination of the anterior upper teeth compensates for the growth of the mandible with respect to the maxilla. In females, the angle increases progressively until 17 years of age; at the end of the growth, the males show a more open interincisal angle because the women demonstrate a greater dental proclination. The convexity and interincisal angle conferred a more convex profile in the faces of females in the present study.

The angle formed by the union of the radicular plane to the occlusal plane in the GIV was higher in the masculine gender, probably due to the different inclination from the upper and lower incisors between both genders.

The maxillary and mandible positions reflect a constant growth in both genders; both parameters suggest a greater growth in males after 10 years of age since it has been reported previously in the literature. It has also been determined that the differences in the face morphology according to gender appear between 12 and 15 years of age. (Moldez *et al*.; Evanko *et al*.; Bishara & Jakobsen, 1985; Weber *et al*., 1993).

In the studied sample, the average of the growth of the maxilla was greater in comparison with other races and seems to be a factor that influenced the conformation of the convex profile of our population. (Phelan *et al*.; Bishara & García; Rojas *et al*.; Alexander & Perry, 1978).

The bimaxillary growth determined by the maxillary and mandible positions in the studied sample showed significant differences according to the age and gender when contrasting the growth reported by Harvold in Canadians, Rojas in Chilean children, and Ayhan in the Turkish. (Rojas *et al*.; Harvold; Ayhan *et al.*). It is evident that this parameter confers craniofacial characteristics to each race, modifying its profile and facial depth.

The maxillomandibular relation presented a significant difference in the group of adult subjects, by the increase of the mandible growth and the smaller maxilla growth. In males, the averages detected in this study were similar to reported in Puerto Ricans (Evanko *et al*.) and the Turkish (Ayhan *et al*.); but in the Chileans (Rojas *et al*.), Filipinos and Germans (Sevilla & Rudzji) the anterior lower facial high is smaller in comparison with Mexicans.

In females, the anterior lower facial high shows a different variability with other races; it is slightly greater in Puerto Ricans and Chileans, but smaller in Turkish, Germans and Filipinos due to a greater horizontal face growth.

In general, it is observed that the parameters are changing until adult age and is presumed that the amount and direction of these changes are intimately related to the race (Dibbets & Nolte, 2002).

Also, it is indispensable to use a special standard for each age group, genders and population and within a population it is necessary to establish the differences between the diverse regions of a country.

CONCLUSIONS

Particular characteristics of Mexican population studied were determined mainly in the parameters of convexity, interincisal angle, maxillary position, mandible position, and anterior lower facial high with respect to other races, and even people of the same country, but different regions.

It is suggested to use the analysis of Harvold in a complementary way when in diagnosing a patient there is doubt on the presence of alterations in the maxillae.

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RESUMEN: El propósito de este estudio fue establecer normas cefalométricas por edad y sexo de acuerdo al análisis de Harvold, para población de la región central de México y comparar estos patrones con otras poblaciones para encontrar diferencias en las características morfológicas craneofaciales. 116 hombres y 125 mujeres conformaron el estudio, divididos por grupos de edad. Los padres y abuelos de los participantes eran originarios de México. Todos los sujetos tenían clase I molar con un desarrollo normal, simetría facial, sin apiñamiento y sin previo tratamiento ortodóntico, ortopédico o cirugía maxilofacial. Se obtuvieron las radiografías laterales de cráneo; cada una se examinó de acuerdo al análisis cefalométrico de Harvold. Para el análisis estadístico, se aplicó la prueba t' de Student para hacer la comparación entre grupos de edad y sexo. Se encontraron diferencias significativas entre hombres y mujeres en los siguientes parámetros: posición maxilar, posición mandibular y altura facial anteroinferior en todos los grupos de edad. Se demostraron diferencias en la posición dental y craneal con otras razas, respecto al crecimiento facial. Cada género y raza presenta sus características propias, por lo que es apropiado utilizar normas cefalométricas adecuadas en la práctica ortodóntica diaria. Se sugiere utilizar el análisis de Harvold como auxiliar o complemento cuando existe duda en el diagnóstico del paciente debido a alteraciones de los maxilares.

PALABRAS CLAVE: cefalometría, oclusión normal, métodos de diagnóstico.

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