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Cephalometric Characteristics in Chilean Latino Population with Normal Occlusion and Harmonic Profiles in Permanent Dentition. A Retrospective Study

Características Cefalométricas en Población Latina Chilena con Oclusión Normal y Perfiles Armónicos en Dentición Permanente. Un Estudio Retrospectivo

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SUMMARY: Malocclusion is usually treated based on clinical decisions complemented with a cephalometric analysis, allowing the comparison of an individual with standard reference norms. Cephalometric standards have mostly been obtained from Caucasian population, but may not be appropriate for other ethnic groups, becoming a clinically relevant problem in multicultural and multiracial societies. The present study aimed to establish cephalometric norms for Chilean-Latino population, using a representative sample of class I individuals in permanent dentition. A sample of 72 cephalometric x-rays of class I growing individuals (47 women and 25 men) between 10 and 20 years of age with class I occlusion and harmonic profile was obtained from the records of the Universidad de los Andes taken between 2012 and 2019, including 1164 individuals. The radiographs were classified according to their cervical vertebral maturation status, and cephalometrically analyzed, obtaining vertical and sagittal parameters in soft and hard tissues, which were compared with Caucasian cephalometric norms. The statistical analysis was performed using descriptive and inferential statistics (T-test, ANOVA and Bonferroni tests). Cephalometric norms were obtained for hard and soft tissues. Upon comparison with Caucasian norms, the subjects included in the sample present a tendency towards a convex profile, significant incisal proclination, dental protrusion, labial biprotrusion and an acute nasolabial angle. There are cephalometric differences between the Caucasian cephalometric norms and those observed Chilean Latino population, displaying differences at a hard and soft tissue level that should be taken into account for clinical decision making in Orthodontics.

KEY WORDS: Cephalometry; Cephalometric norms; Chilean cephalometric norms; Hard tissues cephalometrics; Soft tissue cephalometrics.

INTRODUCTION

Malocclusion is a highly prevalent condition that can affect function and self-esteem to varying degrees. Several factors may contribute to the occurrence of malocclusion, including heredity and environment (Zou *et al*., 2018). These have anatomical, functional and aesthetic implications at the dentofacial level that frequently justify their treatment based on clinical decisions supported by the diagnostic evaluation of cephalometric x-rays by means of cephalometric analysis (Montt *et al*., 2015).

The use of cephalometric standards allows the comparison of a patient with a normal reference group, based on factors such as age, sex, and race. These standards are mostly obtained from Caucasian population, and may not be appropriate for other ethnic groups, as they may eventually lead to diagnostic and therapeutic errors (Morales *et al*., 1988). Indeed, several studies have demonstrated the existence of such differences in subjects of different ancestry, including African American (Fadeju *et al*., 2013; Ouédraogo

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et al., 2019), Asian (Bronfman *et al*., 2015), Saudi Arabian (Al Zain & Ferguson, 2012), Mexican American (Rivas & Rojas, 2009), among others. These studies have also been performed in Latin America (Rivas & Rojas, 2009; Montt *et al*., 2015), confirming the presence of variations relative to Caucasian norms.

Nowadays, the migratory phenomenon within Latin America is extensive, with a considerable portion of the migrant population of Hispanic descent. It becomes clinically relevant to have updated cephalometric norms suited for population of different ethnic backgrounds in order to optimize therapeutic interventions in orthodontics and dentofacial orthopedics. Although some studies have reported cephalometric norms for the Chilean population, the information available is limited regarding the characteristics of the individuals from which the norms were drawn (Hoffens & San Pedro, 1968; Schulz *et al*., 1985; Morales *et al*., 1988; Montt *et al*., 2015). Usually, the analysis has been restricted to cephalometric values, without considering clinical intraoral and extraoral records.

In a previous study, cephalometric norms were reported for young individuals in mixed and early permanent dentition, considering clinical and cephalometric parameters (Montt *et al*., 2015). However, given the dynamic nature of dentofacial development, normal cephalometric values for growing individuals in permanent dentition could not be clearly identified. The present study was carried out with the objective of identifying cephalometric norms in Hispanic individuals with permanent dentition, class I occlusion and harmonic profiles in San Bernardo, Chile.

MATERIAL AND METHOD

A retrospective descriptive study was carried out using radiological records of patients treated at the Universidad de los Andes University Clinics, San Bernardo, Chile from 2012 to 2019. The database was composed of the clinical and cephalometric records of 1164 subjects in permanent dentition and no missing teeth between 10 and 20 years of age. Inclusion and exclusion criteria were defined to establish the final sample, which are presented in Table I. This study was approved (CPI ODO 2019-15) by the research committee, Faculty of Odontology, Universidad de los Andes, Chile.

The clinical records were consecutively screened for each patient, which included bilateral bitewing, panoramic and lateral cephalometric x-rays, with their respective clinical referral forms from the Dental Clinics to the Radiology Service, including Angle´s classification, clinical Overjet and Overbite values. All individuals with complete records from January 2012 to December 2019 were included (Fig. 1). X-rays were obtained using the same radiological equipment (Ortophos XG Plus, Sirona Dental Salzburg, Austria) in natural head position and with the teeth in maximum intercuspation.

Once the sample was obtained, the cephalometric landmarks were identified by a calibrated operator (CQ). The profile radiographs were analyzed using the NemoCeph® (Madrid, Spain) software. The skeletal maturation of the subjects was also evaluated with the cervical vertebral maturation (CVM) method of Baccetti *et al*. (2005) by the same operator.

The variables analyzed included age, sex, cervical vertebral maturation stage (CVS). The cephalometric variables included in the analysis are presented in Table II and represented in Figure 2. They were measured based on the descriptions of Steiner (1953), Ricketts (1960), Tweed (1946), Jacobson (1975), Bishara & Fernández (1985), and Legan & Burstone (1980).

Statistical analysis. Intra- and inter-examiner calibrations were carried out using the intraclass correlation coefficient. The distribution of the data was tested using the Shapiro-Wilk test. The data distributed normally. Descriptive statistics were obtained for cephalometric norms, sex, and

Table I. Inclusion criteria for the cephalometric study in young people with normal occlusion.

1	Absence of interproximal caries.
2	Absence of anterior cross bite or edge to edge bite.
3	Absence of agenesis or supernumeraries.
4	Absence of interproximal space loss due to caries or premature loss of primary teeth.
5	Absence of previous orthopedic and orthodontic treatment.
6	Harmonic profile (established by adequate lip competence and balance of the facial thirds).
7	Overjet ≥ 1 mm and ≤ to 4 mm.
8	Overbite ≥ to 1 mm and ≤ to 4 mm.
9	Labial gap less than or equal to 4 mm.
10	Absence of cleft lip and / or palate and craniofacial syndromes or malformations.
11	Definitive dentition which implies that all the teeth are erupted and that none are missing.

cervical vertebral maturation stage. The tests used for inferential statistics, were the t-test and ANOVA with Bonferroni post-hoc tests. Statistical significance was set at p-value ≤0.05. The statistical analysis was performed with the SPSS 25 (IBM, Chicago, Illinois, United States) statistical software.

To describe the existence of differences between the averages of the cephalometric measurements found in the sample and the norm used in Caucasian patients, comparative tables were made between the average value obtained in the sample for each cephalometric variable and its respective standard deviation, and the published standards.

Table II. Cephalometric variables included in the analysis.

Variables	
Sagittal	SNA Angle
	SNB Angle
	ANB Angle
Vertical	SN-GoGn Angle
	Facial Axis (NaBa-PtGn)
Dental	Upper Incisor Angle to Palatal Plane (U1-PP)
	Lower Incisor Angle to mandibular plane (L1-MP)
	Upper Incisor to Line A-Po (U1-Apo)
	Lower Incisor to Line A-Po (L1-Apo)
	Overjet (OJ)
	Overbite (OB)
Soft tissue	Upper lip position (UL-SnPg´)
	Lower lip position (LL-SnPg´)
	Nasolabial angle (Cm-Sn-UL)
	Facial angle (Gl´-Sn-Pg´)
	Depth of the mentolabial sulcus (Si-LL-Pg´)
	Exposure of the upper incisor (Stms-U1)

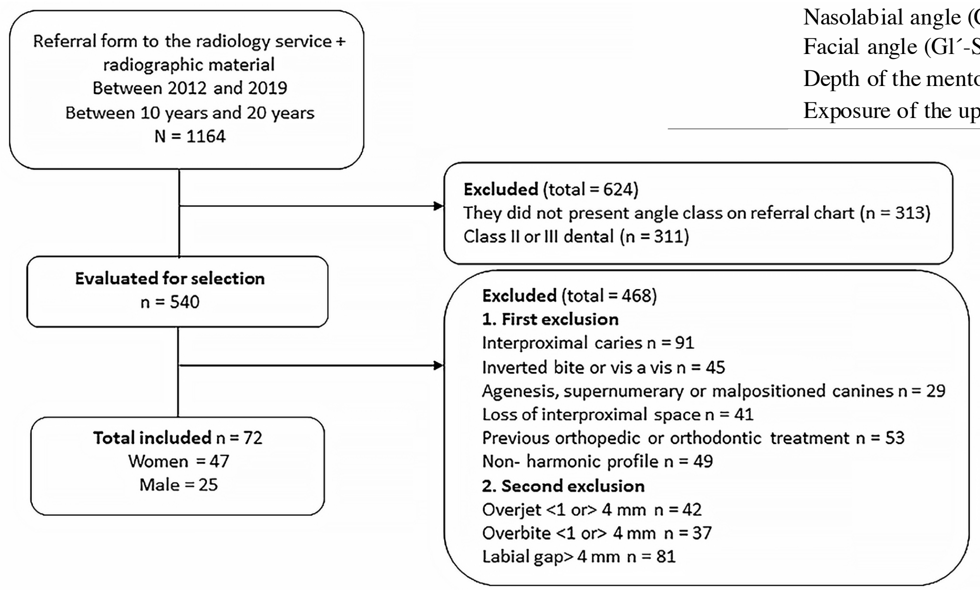

Fig. 1. Flow chart of sample determination. (*"n" indicates the number of patients; The values are not exclusive, with patients meeting more than one exclusion criterion).

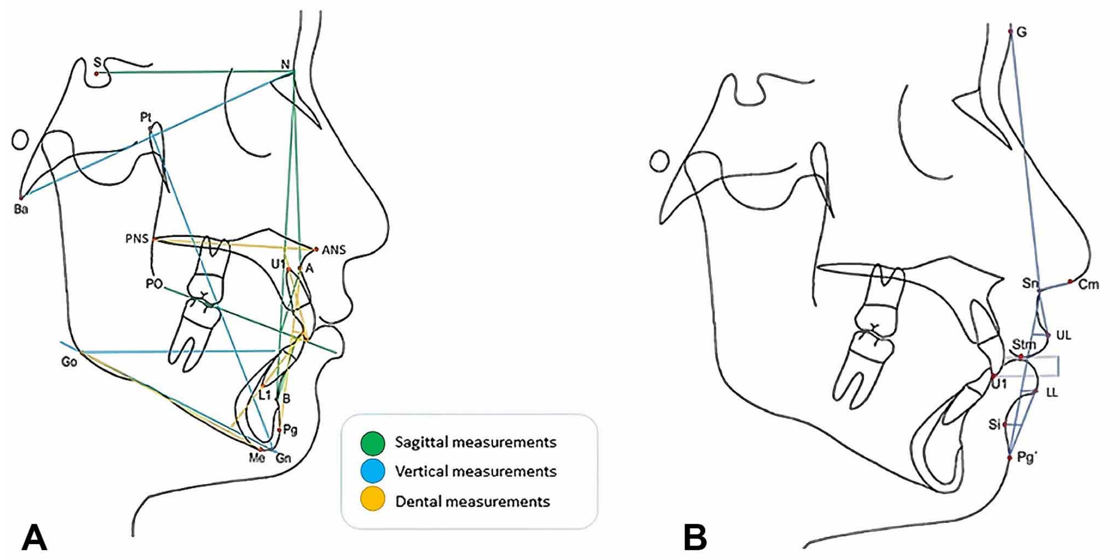

Fig. 2. Figure showing cephalometric tracings in hard and soft tissues. A. Hard tissues. B. Soft tissues.

RESULTS

Intra- and inter-examiner intraclass correlation coefficients were 0.94 and 0.92 respectively. After analyzing the clinical and radiographic records, the final sample included cephalometric x-rays and clinical records of 72 class I individuals in permanent dentition (47 women and 25 men) with harmonic profile, normal Overjet and Overbite, and absence of carious lesions, with an average age of 12.3 years (age range 10 to 20 years).

Table III presents the descriptive statistics for each analyzed cephalometric measurement and a comparison of the average values observed in this study and the norms reported from Caucasian individuals (Tweed, 1946; Steiner, 1953; Ricketts, 1960; Jacobson, 1975; Legan & Burstone, 1980; Bishara & Fernández, 1985). The sagittal measurements that presented statistically significant differences with the norm were the SNB angle (p=0.012) and the ANB angle (p=0.021) (Steiner, 1953). No statistically significant differences were observed for vertical measurements between the sample and the norms

Table III. Measures of central tendency and dispersion of the cephalometric variables and their differences with the Caucasian norm.

Variables		Sample		Caucasian norms	Dif.	*p* value
		Min-Max	Average ± SD	Average ± SD		
Sagittal	SNA (°)	72.9 – 89.3	81.6 ± 3.6	82±2	(-)0.4	0,438
	SNB (°)	71 – 87.3	79 ± 3.4	80±2	(-)1	0.012*
	ANB (°)	-2.1 – 6.5	2.7 ± 1.9	2±2	0.7	0.021*
Vertical	SN-GoGn (°)	21.5 – 41.6	32.3 ± 4.4	32±2	0.3	0.517
	NaBa-PtGn (°)	82.5 – 100.8	90.7 ± 3.8	90±3	0.7	0.76
Dental	U1-PP (°)	99.8 – 121.5	112.9 ± 4.4	110±5	2.5	0.0001*
	L1-MP (°)	80.2 – 111.5	96 ± 5.8	90±5	6.0	0.0001*
	U1-Apo (mm)	0.3 – 11.6	6.5 ± 1.9	5.7±3	0.8	0.009*
	L1-Apo (mm)	-1.9 – 8.4	3.8 ± 1.8	0.5±3	3.3	0.0001*
	OJ (mm)	0.4 - 4	3.1 ± 0.7	2.5±2.5	0,6	0.0001*
	OB (mm)	0.1 – 4	1.8 ± 1.0	2.5±2.5	(-)0.7	0.0001*
Soft tissue	UL-SnPg´ (mm)	2.7 – 9.1	5.6 ± 1.4	3±1	2.6	0.0001*
	LL-SnPg´ (mm)	(-)8.8 – 4.2	(-)3.9 ± 2.1	2±1	(-)5.9	0.0001*
	Cm-Sn-UL (mm)	66.5 – 120.9	95.5 ± 9.9	102±8	(-)6.5	0.0001*
	Gl´-Sn-Pg´ (º)	1.4 – 22.5	11.8 ± 4.8	12±4	(-)0.2	0.82
	Si-LL-Pg´ (mm)	8.2 –3.2	5.1 ± 1.0	4±2	1.1	0.0001*
	Stms-U1 (mm)	-1.1 – 7.4	2.8 ± 1.7	2±2	0.8	0.0001*

SD= Standard deviation. Significance is indicated by * (p≤0.05)

Table IV. Cephalometric Norms by sex.

Variables		Female n=47		Male n=25		Female/Male	
		Average ± SD	Min-Max	Average ± SD	Min-Max	Average Difference ± SD	P value
Sagittal	SNA (°)	81.5±3.5	73.4 - 91.3	82.0±3.8	72.9 - 88	81.75±3.65	0.546
	SNB (°)	78.9±3.2	71.0-87.3	79.0±3.5	72.9 - 85.8	78.95±3.35	0.884
	ANB (°)	2.6±1.9	(-)0.8 – 6.5	2.9±1.9	(-)2.1 - 6	2.75±1.9	0.372
Vertical	SN-GoGn (°)	32.7±4.5	21.5 – 41.6	31.7±4.1	25.1 – 38.4	32.2±4.3	0.375
	NaBa-PtGn (°)	90.7±3.9	82.5 – 100.8	90.8±3.8	83.5 – 97.1	90.75±3.85	0.866
Dental	U1-PP (°)	113.2±4.8	99.8 – 121.5	112.2±3.8	105.6 - 120.1	112.7±4.3	0.415
	L1-PM (°)	95.4±5.7	80.2 – 111.5	97.2±5.9	86.2 - 105.9	96.3±5.8	0.213
	U1-Apo (mm)	6.6±1.9	0.3 – 11.4	7.0±2.0	2.5 - 11.6	6.8±1.95	0.382
	L1-Apo (mm)	3.8±1.7	(-)1.9 – 7.9	3.8±1.9	(-)0.3 - 8.4	3.8±1.8	0.978
	OJ (mm)	3.1±0.6	1.3 - 4	3.1±0.9	0.4 - 4	3.1±0.75	0.877
	OB (mm)	1.7±0.9	0.1 – 3.5	2.0±1.0	0.1 ± 4	1.85±0.95	0.22
Soft tissue	UL-SnPg´ (mm)	5.2±1.3	2.7 – 8.3	6.2±1.6	3.5 – 9.1	5.7±1.45	0.01*
	LL-SnPg´ (mm)	(-)3.9±2.0	(-)8.3 – 4.2	(-)4.1±2.2	(-)8.8 – (-)0.2	(-)4±2.1	0.678
	Cm-Sn-UL (mm)	96.2 ±10.3	66.5 -120.9	94.4±9.1	79.4 – 111.2	95.3±9.7	0.467
	Gl´-Sn-Pg´ (º)	12.1±5.1	2.0 – 22.3	11.4±4.2	1.4 – 18.0	11.75±4.95	0.604
	Si-LL-Pg´ (mm)	4.9±1.0	7.5 – 3.2	5.4±0.9	8.2 – 4.1	5.15±0.95	0.079
	Stms-U1 (mm)	3.06±1.7	(-)0.2 – 7.4	2.5±1.6	(-)1.1 - 5.1	2.78±1.65	0.145

(Steiner, 1953; Ricketts, 1960). Within the dental measurements, U1-PP, L1-MP, U1-Apo and L1-Apo presented statistically significant differences with Caucasian norms (p=0.0001; p=0.0001; p = 0.009; p=0.0001 respectively) (Ricketts, 1960; Bishara & Fernández, 1985). Both Overjet (p=0.0001) and Overbite (p=0.0001) presented statistically significant differences relative to the normal parameters (Zamora Montes de Oca, 2004). Regarding the soft tissues, significant differences were found for nasolabial angle, upper and lower lip protrusion, depth of the mentolabial sulcus and upper incisor exposure (p=0.0001) (Legan & Burstone, 1980).

Table IV presents the cephalometric norms by sex. When comparing both sexes, significant differences were found only for upper lip protrusion (p=0.01). Table V presents the cephalometric differences according to the different cervical vertebral maturation stages (Baccetti *et al*., 2005). No statistically significant differences were observed for any cephalometric variable based on CVM stage.

Table V. Cephalometric differences according to the cervical vertebral maturation stage.

		CVM 1	CVM 2	CVM 3	CVM 4	CVM 5	CVM 6	P value
		n=1	n=7	n=25	n=23	n=9	n=7	
		Average	Average±SD	Average±SD	Average±SD	Average±SD	Average±SD	
Sagittal	SNA (°)	83.0	83.0 ±3.3	81.4± 3.5	82.3 ± 3.7	81.4 ± 2.9	81.8± 4.1	0.784
	SNB (°)	78.9	79.7 ±3.6	78.6± 3.3	80.0 ± 3.1	78.7 ± 3.8	78.9± 4.1	0.495
	ANB (°)	3.1	3.2 ± 1.9	2.7 ± 1.7	2.5 ± 1.9	2.8 ± 2.2	2.9 ± 1.1	0.559
Vertical	SN-GoGn (°)	31.5	31.5 ± 3.9	33.0± 3,2	31.4 ± 5.2	31.3 ± 6.4	33.1± 5.5	0.395
	NaBa-PtGn (°)	90.0	90.0 ± 3.5	90.2± 3.2	91.2 ± 4.4	91.7 ± 5.3	90.1± 3.5	0.718
Dental	U1-PP (°)	112.9	112.9 ± 4.1	112.3 ± 5.0	112.8 ± 5.1	113.2 ± 4.8	113.1 ± 4.0	0.941
	L1-MP (°)	95.3	95.3 ± 5.9	95.7± 5.7	94.3 ± 6.2	97.4 ± 8.1	97.1± 5.0	0.681
	U1-Apo (mm)	7.4	6.2 ± 1.6	6.6 ± 1.5	6.0 ± 2.2	6.7 ± 2.3	8.1 ± 1.9	0.346
	L1-Apo (mm)	3.5	3.5 ± 1.6	3.6 ± 1.4	3.3 ± 2.1	3.8 ± 2.1	4.8 ± 1.8	0.63
	OJ (mm)	3.2	2.8 ± 0.8	3.1 ± 0.7	3.1 ± 0.7	3.1 ± 0.5	3.6 ± 0.3	0.645
	OB (mm)	2.2	1.7 ± 0.9	1.8 ± 1.0	1.8 ± 1.0	1.8 ± 1.3	1.7 ± 0.4	0.611
Soft tissues	UL-SnPg´ (mm)	5.8	6.1 ± 1.2	5.5 ± 1.5	5.4 ± 1.2	5.5 ± 1.6	5.0 ± 1.6	0.274
	LL-SnPg´(mm)	5.1	4.0 ± 1.6	3.8 ± 1.8	3.5 ± 2.3	4.4 ± 2.6	4,2 ± 3.0	0.958
	Cm-Sn-UL (°)	95.3	95.0 ± 7.3	99.2± 9.6	95.5 ± 9.7	90.1 ± 8.9	95,5± 8.7	0.432
	Gl´-Sn-Pg´(°)	11.5	11.5 ± 5.1	12.4± 4.7	11.8 ± 4.3	10.9 ± 5.7	11,5± 4.2	0.687
	Si-LLPg` (mm)	5.0	5.0 ± 1.2	5.0 ± 0.9	5.3 ± 1.4	5.1 ± 0.8	4.7 ± 1.0	0.667
	Stms-U1 (mm)	3.1	2.5 ± 1.5	2.8 ± 2.0	2.7 ± 1.0	3.1 ± 1.7	3.9 ± 0.6	0.486

SD= Standard deviation. Significance is indicated by * (p≤0.05).

DISCUSSION

The present study was carried out in order to describe the cephalometric characteristics in hard and soft tissues of a sample of Latino individuals of both sexes with normal occlusion and harmonic profile, from a University Clinic located in the Metropolitan Region of Chile, in an effort to identify their cephalometric norms for a better orthodontic diagnosis.

The values of the cephalometric measurements obtained in the sample showed similarities and differences compared to the published norms for Caucasian populations, both at the hard and soft tissue level, which is consistent with a previous study of our group (Montt *et al*., 2015). The SNA angle was almost coincident with Steiner's norm of 82°, which is consistent with other reports in Chilean population (Madsen & Paniagua, 1989; Montt *et al*., 2015). The SNB angle (79°) is moderately decreased, while the ANB angle (2.7°) appears slightly increased (Steiner, 1953), both describing mild but statistically significant differences from the norm (Steiner, 1953). The present data differs from our previous report in a younger group of individuals (Montt *et al*., 2015), in which a greater average (ANB angle of 4º) was observed. This reduction likely occurred as the current sample was older. As the dominance of mandibular growth takes place during physical maturation, the ANB Angle should be expected to decrease (Lux *et al*., 2005; Oyonarte *et al*., 2016).

The vertical variables did not show significant differences relative to the Caucasian norms, with the Facial Axis reaching 90.7°, which slightly differs from the results of Montt *et al*. (2015), in a younger sample from the same population, who found a Facial Axis of 86.6º. This variation observed in the present study could be explained by the fact that as mandibular growth occurs, anterior mandibular rotation also occurs (Björk & Skieller, 1972), thus increasing Facial Axis values (Oyonarte *et al*., 2016).

All the analyzed dental variables presented statistically significant differences, with considerably increased values relative to the Caucasian norms. Both, inclination and the position of the upper and lower incisors appeared increased according to previously published norms (Ricketts, 1960; Bishara & Fernández, 1985), displaying marked biprotrusion and incisal proclination despite presenting normal Class I occlusion. This is consistent with other studies carried out in the Chilean population (Hoffens & San Pedro, 1968; Schulz, 1985; Montt *et al*., 2015), and this dental trait is further observed in permanent dentition. This is relevant for therapeutic decision making regarding tooth extractions, since dental biprotrusion would be an expected characteristic, without necessarily representing an indication of treatment in itself.

Despite having found differences for cephalometric Overjet (0.6 mm) and Overbite (-0.7 mm) with respect to the norms established by Ricketts (1960), these were not deemed as clinically significant.

Regarding soft tissues, most of the variables differ relative to Caucasian norms (Legan & Burstone, 1980). The Nasolabial Angle (95.5°) is decreased while a greater labial procumbency and a deeper lower labial sulcus is also observed. These characteristics are consistent with the relatively protruded incisal position already discussed, which has also been observed in samples of different groups of Hispanic (Rivas & Rojas, 2009; Montt *et al*., 2015), Asian (Bronfman *et al*., 2015), African (Fadeju *et al*., 2013; Ouédraogo *et al*., 2019) and Saudi-Arabian descent (Al Zain & Ferguson, 2012).

Finally, cervical vertebral maturation increased with chronological age, which is expected and consistent with previous reports by others (Baccetti *et al*., 2005; Oyonarte *et al*., 2020). No differences were found for the cephalometric values between cervical vertebral maturation stage. Although variations may take place during growth in several cephalometric values, these relate to the expression of an individual growth pattern, and apparently do not generate statistically significant differences attributable to the expression of facial development at a group level.

In general, the cephalometric differences observed between this Latino population with normal sagittal occlusal characteristics and harmonic profile and the Caucasian population, are mild and would not all be clinically significant, since they are within the standard deviation range of Caucasian norms. The greater deviation observed indicates a population with greater labial and dental protrusion, with a slightly retrusive mandible. These characteristics should be considered as normal for the analyzed population and should be taken into account for clinical decision making in Orthodontics.

CONCLUSIONS

The sample of Chilean individuals analyzed in the present study displayed statistically significant differences at a hard and soft tissue level, showing a trend towards a more convex skeletal profile with a slightly retrusive mandible than what is found in Caucasian norms. Dentally, the incisors are considerably more protruded and proclined. At a soft tissue level, a more acute nasolabial angle, biprotruded lips and an increased upper incisor exposure were identified. These aspects may be clinically relevant and should be taken into account for clinical decision making.

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RESUMEN: La maloclusión generalmente se trata con base en decisiones clínicas complementadas con un análisis cefalométrico, lo que permite la comparación de un individuo con normas de referencia estándar. Los estándares cefalométricos se han obtenido en su mayoría de población caucásica, pero pueden no ser apropiados para otros grupos étnicos, convirtiéndose en un problema clínicamente relevante en sociedades multiculturales y multirraciales. El presente estudio tuvo como objetivo establecer normas cefalométricas para población chileno-latina, utilizando una muestra representativa de individuos clase I en dentición permanente. Se obtuvo una muestra de 72 radiografías cefalométricas de individuos en crecimiento clase I (47 mujeres y 25 hombres) entre 10 y 20 años de edad con oclusión clase I y perfil armónico de los registros de la Universidad de los Andes tomados entre 2012 y 2019, incluidas 1164 personas. Las radiografías se clasificaron según su estado de maduración vertebral cervical, y se analizaron cefalométricamente, obteniendo parámetros verticales y sagitales en tejidos blandos y duros, que se compararon con normas cefalométricas caucásicas. El análisis estadístico se realizó mediante estadística descriptiva e inferencial (T-test, ANOVA y pruebas de Bonferroni). Se obtuvieron normas cefalométricas para tejidos duros y blandos. En comparación con las normas caucásicas, los sujetos incluidos en la muestra presentan una tendencia hacia un perfil convexo, proinclinación incisal significativa, protrusión dental, biprotrusión labial y un ángulo nasolabial agudo. Existen diferencias entre las normas cefalométricas caucásicas y las observadas en población latina chilena, mostrando diferencias a nivel de tejidos duros y blandos que se deben considerar para la toma de decisiones clínicas en Ortodoncia.

PALABRAS CLAVE: Cefalometría; Normas cefalométricas; Normas cefalométricas chilenas; Cefalometría de tejidos duros; Cefalometría de tejidos blandos.

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