SEMI-LONGITUDINAL STUDY OF THE MCNAMARA CEPHALOMETRIC TRIANGLE IN CLASS II AND CLASS III SUBJECTS GROUPED BY CERVICAL VERTEBRAE MATURATION STAGE

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ABSTRACT

The aim was to compare the McNamara cephalometric triangle values in untreated normodivergent Class II and Class III malocclusion subjects of Latin American origin grouped by cervical vertebrae maturation stage to an untreated Class I malocclusion normodivergent control group.

The study was conducted on a sample of 610 pretreatment lateral cephalograms (250 male, 360 female), examined and grouped according to their anteroposterior skeletal relationship (Class I, II or III), cervical vertebrae maturation stage (Pre Pubertal Peak P1 = CS1 and CS2, Pubertal Peak P2= CS3 and CS4, and Post Pubertal Peak P3 = CS5 and CS6) and sex. Co-A, Co-Gn and ENA-Me were measured in each lateral cephalogram. ANOVA and Tukey HSD post-hoc tests were performed to determine differences between the groups. The results showed that in males, the greatest maxillary and mandibular dimensional increases occurred during the P3 stage (CS5 to CS6), while in females, they occurred in the P2 stage (CS3 to CS4). The Co-A and Co-Gn showed significant differences between the malocclusion classes (p< 0.05). The maxillary lengths in Class II subjects and the mandibular lengths in Class III subjects were already higher at the beginning of the period evaluated (P1). A worsening trend for the Class II and III malocclusions was identified during the period evaluated.

Finally, changes in the McNamara cephalometric triangle values were markedly different in the three normodivergent skeletal malocclusion classes. In these Latin American subjects the pubertal growth spurt occurred at different times with respect to the Caucasian and Asian norms.

Key words: *Cephalometry; malocclusion; Angle class II; malocclusion; Angle class III.*

ESTUDIO SEMI-LONGITUDINAL DEL TRIÁNGULO CEFALOMÉTRICO DE MCNAMARA EN SUJETOS DE CLASE II Y CLASE III AGRUPADOS POR ESTADIO DE MADURACIÓN DE VERTEBRAS CERVICALES

RESUMEN

El objetivo del estudio fue comparar los valores del triángulo cefalométrico de McNamara en sujetos normodivergentes no tratados con maloclusión de Clase II y Clase III de origen latinoamericano agrupados por estadío de maduración de vértebras cervicales, en comparación con un grupo control sin tratamiento, normodivergentes y con maloclusión de Clase I.

El estudio se realizó sobre una muestra de seiscientos diez cefalogramas laterales de cabeza pretratamiento (250 hombres, 360 mujeres) que fueron agrupados de acuerdo a su relación esquelética sagital (Clase I, II ó III), estadío de maduración vértebras cervicales (pre pico puberal P1 = CS1 y CS2, pico puberal P2 = CS3 y CS4, y post pico puberal P3 = CS5 y CS6) y sexo. Se midió en cada cefalograma el triángulo cefalométrico de McNamara Co-A, Co-Gn y ENA-Me. Se realizaron las pruebas de ANOVA y post-hoc Tukey HSD para determinar las diferencias entre grupos.Los resultados en hombres muestran que los mayores aumentos maxilares y mandibulares se produjeron durante la etapa P3 (CS5 para CS6), mientras que en las mujeres se produjeron en la etapa P2 (CS3 para CS4). Las distancias Co-A y Co-Gn muestran diferencias significativas entre las diferentes clases (p <0,05). La longitud maxilar de los sujetos de Clase II y la longitud mandibular de los sujetos de Clase III estuvieron aumentadas al inicio del período evaluado (P1). Se identificó una tendencia al empeoramiento de las maloclusiones de Clase II y III durante el período evaluado.

Finalmente los cambios en los valores del triángulo cefalométrico de McNamara fueron marcadamente diferentes en las tres clases de maloclusión en sujetos normodivergentes. En estos sujetos latinoamericanos el estirón puberal se produjo en momentos diferentes con respecto a la raza caucásica y las normas asiáticas.

Palabras clave: *Cefalometría; maloclusión; clase II de Angle; maloclusión; clase III de Angle.*

INTRODUCTION

The variation in the amount and direction of craniofacial growth influences the development of the individual's facial form [1-3]. Facial skeletal pattern plays a key role in the prognosis of orthodontic treatment [4]. Therefore, orthodontists should take these factors into account during diagnosis and treatment planning.

The McNamara cephalometric triangle[5] is part of a proposed cephalometric analysis that evaluates three fundamental craniofacial measurements: lower anterior face height, midfacial length, and mandibular length. These measurements allow the clinician to contrast the size of the jaws and know if they are adequate, increased or decreased.

A few cross-sectional studies [6-9] and only a handful of longitudinal studies [10-12] have compared these craniofacial dimensions in subjects with Class I, II and III malocclusion. Some of these studies [10-13] did consider the skeletal maturation as determined by CVM,[14] but none of them specifically considered how the skeletal pattern influences these dimensions grouped by stage of cervical vertebrae maturation. Additionally, some studies were limited in terms of sample size, absence of control of skeletal maturation, and appropriate selection criteria.

For cases of Class III Caucasian malocclusion, craniofacial growth trends towards an accentuated Class III profile with increased vertical facial dimension [13]. In contrast, craniofacial growth in Caucasian subjects with untreated Class II malocclusion is essentially similar to that of untreated subjects with normal occlusion at all developmental intervals, with the exception of significantly smaller increments in mandibular length at the pubertal growth spurt (interval CS3-CS4).[11,12] It is considered that Class II dentoskeletal disharmonies do not tend to self-correct through future facial growth. Actually a worsening of the sagittal and vertical deficiency in the total mandibular length and mandibular ramus height has been identified [12].

Almost all of the published articles [6,8-14] that have evaluated the sagittal and vertical growth of the mandible and maxilla have been conducted in Caucasian groups of European and North American ancestry, and Asian populations [7,15-17], but studies on Latin American samples are scarce.[18] With the growing proportion of the US population with Latin American ancestry, the importance of a better understanding of any potential differences in their craniofacial growth should not be minimized.

Longitudinal studies are ideal for evaluating craniofacial growth; however the availability of large samples and the ethical consideration for annual or semi-annual radiographic records currently makes them more difficult to execute. The use of longitudinal samples taken more than 50 years ago has also been questioned because of the so-called secular trends [9,13]. The next best alternative is to use large cross-sectional studies with subjects matched by skeletal maturation, sex, sagittal facial pattern, facial divergence and malocclusion complexity degree.

Considering the above information, the purpose of this study was to compare the values for the McNamara cephalometric triangle grouped by stage of cervical vertebrae maturation in untreated normodivergent Class II and Class III malocclusion subjects of Latin American origin as compared to an untreated Class I malocclusion control group.

MATERIALS AND METHODS

The study protocol was approved by the ethics committee of the School of Dentistry, Universidad Científica del Sur - UCSUR, Lima, Perú. The sample included 610 pretreatment lateral cephalograms (250 male, 360 female) from a diagnostic imaging center, grouped according to their skeletal relationship (Class I, II or III) [19], stage of cervical vertebrae maturation[14] (P1= CS1 and CS2, P2= CS3 and CS4, P3= CS5 and CS6) and sex (male and female).

A minimum sample size was calculated considering a clinically relevant mean difference of 3mm in mandibular length (Co-Gn) at CG stage between Class I and III malocclusion groups, with a standard deviation of 3.8mm (obtained from a pilot study). With a one-sided significance level of 0.05 and a power of 80%, a minimum of 20 patients per skeletal group, cervical vertebrae maturation stage and sex was required.

All the subjects considered in the sample were Peruvian. Their Latin American origin was determined by their last names (Hispanic American), community sociodemographic characteristics corresponding to indigenous populations, living in Lima, Perú, Spanish speaking, coppery skin color, and black hair.

All the cephalograms were taken at maximum intercuspation. Subjects with previous or current orthodontic treatment at the time of image acquisition and/or with congenitally missing or extracted teeth were not considered. Imaging was performed with digital cephalometric panoramic equipment (ProMax®, Planmeca, Finland). Device settings were set at 16mA, 72 kV and 9.9 seconds.

Group classification

Skeletal pattern

The study sample consisted of three groups categorized according to their sagittal skeletal facial growth pattern. Only normodivergent patterns were considered. (Tables 1 and 2)

- The Class I control group included subjects with ANB 2° ± 2°, bilateral Class I molar relations (Angle Class I malocclusion), Frankfort to mandibular plane angle within 25°± 3°, overjet between 2 and 3mm, overbite between 1 and 4mm and with complete permanent dentition (including third molars).
- The Class II group included subjects with ANB>5°, bilateral Class II molar relations of at least one half cusp (Angle Class II-1 malocclusion), overjet greater than 5mm, Frankfort to mandibular plane angle within 25°± 3°, overbite between 1 and 4mm and with complete permanent dentition (including third molars).
- The Class III group included subjects with ANB<0°, bilateral Class III molar relations of at least one half cusp (Angle Class III malocclusion), overjet lower than -1mm, Frankfort to mandibular plane angle within 25°± 3°, overbite between 1 and 4 mm and with complete permanent dentition (including third molars).

Stage of cervical vertebrae maturation

The sample consisted of three groups categorized according to CVM method.[18] In this study the sample was grouped according to three stages.

- The pre-pubertal growth spurt group (P1) included subjects in the interval CS1 and CS2.
- The pubertal growth spurt group (P2) included subjects in the interval CS3 and CS4.
- The post-pubertal growth spurt group (P3) included subjects in the interval CS5 and CS6.

Table 1: Characteristics of the sample by growth pattern and cervical vertebrae stage.

Group		n	Mean	S.D.	Min	Max
Class I (control group)						
P1	ANB	45	3.45	1.03	1.41	4.50
	F-GoMe	45	26.14	2.73	23.00	29.00
P2	ANB	88	2.71	1.09	0.10	4.60
	F-GoMe	88	26.51	2.74	22.94	29.05
P3	ANB	85	3.12	0.80	1.30	4.11
	F-GoMe	85	26.04	2.34	23.07	29.15
Skeletal Class II group						
P1	ANB	40	6.17	1.05	5.30	9.40
	F-GoMe	40	27.03	3.58	22.78	29.12
P2	ANB	90	6.15	1.02	5.20	10.00
	F-GoMe	90	27.21	3.92	22.15	29.19
P3	ANB	115	6.47	1.19	5.10	9.32
	F-GoMe	115	27.36	4.73	22.34	29.72
Skeletal Class III group						
P1	ANB	41	-1.66	0.82	-3.70	-0.80
	F-GoMe	41	25.96	2.55	22.79	29.44
P2	ANB	49	-0.85	0.54	-2.80	-0.10
	F-GoMe	49	26.20	2.56	22.42	29.00
P3	ANB	57	-1.15	0.59	-4.10	-0.22
	F-GoMe	57	26.75	2.61	23.13	29.28

P1 = Pre-Pubertal Growth, P2 = Pubertal Peak Growth, P3 = Post-Pubertal Growth
Comparisons of the ANB and F-GoMe angles between skeletal patterns at each cervical vertebrae stage
ANB angle: P1, P2, P3 (I,II,III = p<0.001)* (p<0.001, I and II)+ (p<0.001, I and III)+ (p<0.001, II and III)+
F-GoMe: P1 (I,II,III p= 0.453)*, P2 (I,II,III p=0.321)*, P3 (I,II,III p= 0.310)*
Comparisons of the ANB and F-GoMe angles between cervical vertebrae stages by skeletal pattern
ANB angle: Class I (P1, P2, P3 p= 0.334)*, Class II (P1, P2, P3 p= 0.269)*, Class III (P1, P2, P3 p= 0.660)*
F-GoMe: Class I (P1, P2, P3 p= 0.742)*, Class II (P1, P2, P3 p= 0.917)*, Class III (P1, P2, P3 p= 0.852)*
(*) ANOVA test; (+) Tukey test

Sex

The sample was divided according to sex into males and females.

Cephalometric analysis (all in mm)

A McNamara cephalometric triangle analysis was performed including measurements of Co-A, Co-Gn and ENA-Me on each tracing. Cephalometric measurements were performed digitally by two calibrated researchers with the MicroDicom viewer 0.8.1 software (Simeon Antonov Stoykov), without magnification, at a scale of 1:1.

Statistical analysis

All statistical analyses were performed using SPSS ver.20 for Windows (IBM SPSS, Chicago, Illinois, USA). The normality and homogeneity of variance assumptions were satisfied as determined by Shapiro Wilk tests. One-way analysis of variance (ANOVA) test and Tukey HSD post-hoc test were performed to determine whether there were differences between the different groupings (according to their skeletal relationship, cervical vertebrae maturation stage, and sex) with regard to midfacial length, mandibular length and lower anterior face height. Statistical significance was set at $p<0.05$ for all tests.

RESULTS

Reliability

The intra-examiner and inter-examiner reliability was assessed with the Intraclass Correlation Coefficient (ICC), which was greater than 0.90 for all the cephalometric measurements. The Dahlberg method error was less than 1 mm for linear measurements and 1° for angular measurements. All the lateral cephalograms were traced twice by both researchers with a two-month interval between tracings.

The concordance in the stages of cervical vertebrae was evaluated with Kappa statistic. The intra-examiner and inter-examiner concordance values were all greater than 0.80.

Cephalometric measurements (Table 3)

The cephalometric measurements (lower anterior face height, midfacial length, and mandibular length) showed differences between the male and female subjects in both timing and dimensions during the pubertal growth spurt ($p<0.001$).

Table 2: Distribution of the sample by skeletal pattern and sex.

Group	Sex		Total
	Female	Male	
Class I (control group)			
P1	20	25	45
P2	53	35	88
P3	53	32	85
Skeletal Class II group			
P1	20	20	40
P2	54	36	90
P3	78	37	115
Skeletal Class III group			
P1	21	20	41
P2	24	25	49
P3	37	20	57
Total	360	250	610

P1 = Pre-Pubertal Growth, P2 = Pubertal Peak Growth, P3 = Post-Pubertal Growth

Midfacial length (Co-A)

In males, the measurements differed significantly for the Class II group, where an increase of approximately 4mm in comparison with the control group for the phases P1 and P2 ($p<0.001$) was identified. For the final stage of growth, the differences decreased to 1mm. Among Class I and Class III groups, the Co-A distance was very similar in all the tested stages ($p>0.05$) (Tables 3-5).

In females, the distance Co-A showed significant differences among the three classes in all cervical vertebrae maturation stages ($p<0.05$). Class II was larger than the control group by approximately 4mm in stage P1, 2mm in stage P2 and 1.5mm in stage P3 ($p<0.001$). The Co-A distance did not differ significantly between Class I and Class III (Tables 4-6).

Mandibular length (Co-Gn)

In males, the rate of growth differed significantly among the three classes throughout craniofacial growth ($p<0.001$). In Class III it was greater by approximately 5 mm at stage P1, 7mm at stage P2 and 3mm at stage P3 in comparison to the control group. Class II had shorter values for distance Co-Gn than Class III ($p< 0.05$), but with respect to Class I they were shorter only in the final stage (P3) ($p=0.013$) (Tables 3-5).

Table 3: McNamara triangle assessment by stage of cervical vertebrae and skeletal pattern in males.

McNamara Measures	Skeletal pattern	P1				P2				P3			
		n	Mean	SD	p	n	Mean	SD	p	n	Mean	SD	p
Co-A	Class I	25	79.32	3.97		35	81.26	4.22		32	84.42	4.64	
	Class II	20	84.34	3.33	<0.001	36	84.94	4.13	<0.001	37	85.08	4.19	0.381
	Class III	20	78.44	4.56		25	81.38	3.20		20	83.32	4.87	
Co-Gn	Class I	25	99.37	3.78		35	101.75	5.77		32	112.54	8.55	
	Class II	20	100.32	4.15	0.003	36	102.43	5.28	<0.001	37	107.33	6.76	<0.001
	Class III	20	104.13	4.80		25	108.69	7.18		20	115.34	6.48	
ENA-Me	Class I	25	58.81	3.30		35	60.70	4.58		32	66.36	6.83	
	Class II	20	60.56	4.17	0.260	36	63.21	5.34	0.141	37	67.00	6.93	0.877
	Class III	20	58.66	3.64		25	62.56	5.64		20	66.06	7.74	

P1 = Pre-Pubertal Growth, P2 = Pubertal Peak Growth, P3 = Post-Pubertal Growth
ANOVA Test
Tukey multiple comparisons
Co-A P1 = (I,II p=0.002) (I,III p=0.782) (II,III p<0.001)
P2 = (I,II p=0.001) (I,III p=0.994) (II,III p=0.009)
P3 = (I,II p=0.819) (I,III p=0.673) (II,III p=0.347)
Co-Gn P1 = (I,II p=0.797) (I,III p=0.004) (II,III p=0.029)
P2 = (I,II p=0.885) (I,III p=0.001) (II,III p=0.002)
P3 = (I,II p=0.013) (I,III p=0.384) (II,III p=0.001)
ENA-Me P1 = (I,II p=0.360) (I,III p=0.992) (II,III p=0.286)
P2 = (I,II p=0.819) (I,III p=0.673) (II,III p=0.347)
P3 = (I,II p=0.928) (I,III p=0.988) (II,III p=0.883)

Table 4: McNamara triangle assessment by stage of cervical vertebrae and skeletal pattern in females.

McNamara Measures	Skeletal pattern	P1				P2				P3			
		n	Mean	SD	p	n	Mean	SD	p	n	Mean	SD	p
Co-A	Class I	20	76.19	3.84		53	79.69	3.22		53	80.06	3.51	
	Class II	20	80.13	3.56	0.026	54	81.50	4.22	0.002	78	81.49	3.67	<0.001
	Class III	21	77.12	4.50		24	77.77	3.87		37	78.39	3.48	
Co-Gn	Class I	20	95.07	5.28		53	101.50	4.51		53	103.72	5.82	
	Class II	20	97.41	4.44	0.024	54	99.85	6.12	0.196	78	101.22	5.24	<0.001
	Class III	21	101.19	5.47		24	102.03	5.37		37	105.74	4.53	
ENA-Me	Class I	20	55.06	3.65		53	58.99	4.31		53	61.25	4.78	
	Class II	20	60.05	4.30	0.009	54	60.76	4.60	0.328	78	61.99	4.83	0.075
	Class III	21	57.35	4.06		24	59.65	13.42		37	59.81	4.46	

P1 = Pre-Pubertal Growth, P2 = Pubertal Peak Growth, P3 = Post-Pubertal Growth
ANOVA Test
Tukey multiple comparisons
Co-A P1 = (I,II p=0.029) (I,III p=0.843) (II,III p=0.143)
P2 = (I,II p=0.039) (I,III p=0.213) (II,III p=0.004)
P3 = (I,II p=0.068) (I,III p=0.077) (II,III p<0.001)
Co-Gn P1 = (I,II p=0.435) (I,III p<0.018) (II,III p=0.152)
P2 = (I,II p=0.257) (I,III p=0.942) (II,III p=0.370)
P3 = (I,II p=0.024) (I,III p=0.177) (II,III p<0.001)
ENA-Me P1 = (I,II p=0.007) (I,III p=0.393) (II,III p=0.230)
P2 = (I,II p=0.297) (I,III p=0.931) (II,III p=0.819)
P3 = (I,II p=0.659) (I,III p=0.335) (II,III p=0.059)

Table 5: Growth assessment McNamara triangle by stage of cervical vertebrae and skeletal pattern in males.

Skeletal pattern	McNamara Measures	P1			P2			P3			p
		n	Mean	SD	n	Mean	SD	n	Mean	SD	
Class I	Co-A	25	79.32	3.97	35	81.26	4.22	32	84.42	4.64	<0.001
	Co-Gn	25	99.37	3.78	35	101.75	5.77	32	112.54	8.55	<0.001
	ENA-Me	25	58.81	3.30	35	60.70	4.58	32	66.36	6.83	<0.001
Class II	Co-A	20	84.34	3.33	36	84.94	4.13	37	85.08	4.19	0.825
	Co-Gn	20	100.32	4.15	36	102.43	5.28	37	107.33	6.76	<0.001
	ENA-Me	20	60.56	4.17	36	63.21	5.34	37	67.00	6.93	0.001
Class III	Co-A	20	78.44	4.56	25	81.38	3.20	20	83.32	4.87	0.003
	Co-Gn	20	104.13	4.80	25	108.69	7.18	20	115.34	6.48	<0.001
	ENA-Me	20	58.66	3.64	25	62.56	5.64	20	66.06	7.74	0.001

P1 = Pre-Pubertal Growth, P2 = Pubertal Peak Growth, P3 = Post-Pubertal Growth
ANOVA Test
Tukey multiple comparisons
Class I Co-A = (P1, P2 p=0.300) (P1, P3 p<0.001) (P2, P3 p=0.015)
Co-Gn = (P1, P2 p=0.466) (P1, P3 p<0.001) (P2, P3 p<0.001)
ENA-Me = (P1, P2 p=0.471) (P1, P3 p<0.001) (P2, P3 p<0.001)
Class II Co-A = (P1, P2 p=0.872) (P1, P3 p=0.814) (P2, P3 p=0.989)
Co-Gn = (P1, P2 p=0.449) (P1, P3 p<0.001) (P2, P3 p=0.001)
ENA-Me = (P1, P2 p=0.299) (P1, P3 p=0.001) (P2, P3 p=0.020)
Class III Co-A = (P1, P2 p=0.108) (P1, P3 p=0.002) (P2, P3 p=0.369)
Co-Gn = (P1, P2 p=0.074) (P1, P3 p<0.001) (P2, P3 p=0.005)
ENA-Me = (P1, P2 p=0.124) (P1, P3 p=0.001) (P2, P3 p=0.183)

Table 6: Growth assessment McNamara triangle by stage of cervical vertebrae and skeletal pattern in females.

Skeletal pattern	McNamara Measures	P1			P2			P3			p
		n	Mean	SD	n	Mean	SD	n	Mean	SD	
Class I	Co-A	20	76.19	3.84	53	79.69	3.22	53	80.06	3.51	0.002
	Co-Gn	20	95.07	5.28	53	101.50	4.51	53	103.72	5.82	<0.001
	ENA-Me	20	55.06	3.65	53	58.99	4.31	53	61.25	4.78	<0.001
Class II	Co-A	20	80.13	3.56	54	81.50	4.22	78	81.49	3.67	0.398
	Co-Gn	20	97.41	4.44	54	99.85	6.12	78	101.22	5.24	0.030
	ENA-Me	20	60.05	4.30	54	60.76	4.60	78	61.99	4.83	0.170
Class III	Co-A	21	77.12	4.50	24	77.77	3.87	37	78.39	3.48	0.612
	Co-Gn	21	101.19	5.47	24	102.03	5.37	37	105.74	4.53	0.009
	ENA-Me	21	57.35	4.06	24	59.65	13.42	37	59.81	4.46	0.643

P1 = Pre-Pubertal Growth, P2 = Pubertal Peak Growth, P3 = Post-Pubertal Growth
ANOVA Test
Tukey multiple comparisons
Class I Co-A = (P1, P2 p=0.005) (P1, P3 p=0.002) (P2, P3 p=0.840)
Co-Gn = (P1, P2 p=0.001) (P1, P3 p<0.001) (P2, P3 p=0.077)
ENA-Me = (P1, P2 p=0.019) (P1, P3 p<0.001) (P2, P3 p=0.028)
Class II Co-A = (P1, P2 p=0.417) (P1, P3 p=0.392) (P2, P3 p=1.000)
Co-Gn = (P1, P2 p=0.252) (P1, P3 p=0.029) (P2, P3 p=0.341)
ENA-Me = (P1, P2 p=0.850) (P1, P3 p=0.275) (P2, P3 p=0.305)
Class III Co-A = (P1, P2 p=0.908) (P1, P3 p=0.612) (P2, P3 p=0.860)
Co-Gn = (P1, P2 p=0.909) (P1, P3 p=0.030) (P2, P3 p=0.048)
ENA-Me = (P1, P2 p=0.737) (P1, P3 p=0.624) (P2, P3 p=0.997)

In females, the distance Co-Gn also showed significant differences between Classes I, II and III at stages P1 and P3 ($p<0.05$). The Class III dimension was larger than the control group by approximately 6mm at stage P1 and 2mm at stage P3 ($p < 0.05$). There was no significant difference between Class 1 and II at stages P1 and P2 ($p>0.05$), but there was a difference in the final stage (P3) of approximately 2.5mm ($p=0.024$) (Tables 4-6).

Lower anterior face height (ENA-Me)

In males, the anterior facial height did not differ significantly between the grouped classes at any of the growth stages ($p>0.05$) (Tables 3-5).

In females, anterior facial height differed significantly between Class I and II only at stage P1 ($p=0.007$), where it was larger than the control group by about 5mm. Numerically, the anterior facial height during all growth stages was larger in Class II than in Classes I and III (Tables 4-6).

DISCUSSION

Craniofacial growth is influenced by genetic and environmental factors. Environmental factors vary over time because of constant changes in nutrition and lifestyle [1-4,20]. For this reason, updated craniofacial growth studies maybe necessary from time to time. In addition, the proportion of the population with different racial backgrounds keeps changing due to the increased mobility of human populations. The USA does not differ in this regard. The proportion of the US population of Latin American origin keeps increasing; therefore, it is important to have thorough understanding of the craniofacial growth pattern in the Latin American population. The amount of remaining mandibular and maxillary growth is also an important variable for determining the craniofacial growth potential that any given orthodontic patient may have.

Ideally, the amount of growth remaining should be determined over time in the same subject using longitudinal studies [12,13] but due to ethical concerns, longitudinal studies are not a viable option nowadays and cross-sectional studies with adequately matched samples gain relevance. In our study, the groups were matched according to sagittal and vertical skeletal facial pattern, malocclusion, skeletal maturation and sex. This was done with the aim of reducing the possibility of selection bias. Moreover, we compared only the growth of normodivergent subjects in order to avoid the influence of the vertical pattern. This could be taken into account in future studies. Furthermore, it is known that skeletal growth curves differ slightly between longitudinal and cross-sectional studies. Cross-sectional data slightly overestimates midfacial growth, but closely agrees with mandibular length measurements [9,10,13].

In this study, the values for the McNamara cephalometric triangle[8] changed between sagittal skeletal patterns in the different craniofacial development stages. The current results indicate sexual dimorphism in the three measurements. This has been reported previously [9,13]. Our study is also consistent with the suggestion [9,10] that in Class II and III malocclusion with a normodivergent facial growth pattern, the remaining craniofacial growth tends to worsen the facial profile.

Previously published results [9,13] report differential growth in untreated subjects with Class III malocclusion. For Caucasian females with Class III malocclusion, the annualized growth was about 1mm for midfacial length, 3mm for mandibular length and 1mm for lower anterior face height. For males, the differences during the same time interval were 0.5mm greater than for the females. These values were 0.5 to 1mm lower in subjects with Class I malocclusion [20]. In subjects with Class II malocclusion, the craniofacial growth was very similar to that of untreated subjects with normal occlusion with the exception of significantly smaller increases in the mandibular length [10-12]. Our results differ from these reported studies [6,,7, 9, 11, 13, 14] in two situations.

The first difference is related to the time of appearance of peak pubertal growth as related to McNamara measurements. In males, the greatest lengths in maxillary growth occurred mainly during stage P3, while in females, greatest growth occurred at stage P2. This may indicate that craniofacial growth rate in the evaluated Latin American group differs significantly in some aspects from that reported in Asian and Caucasian groups, probably because of the influence of racial, environmental and nutritional factors.

The second difference in our study is related to the amount of maxillary and mandibular growth during the growth stages evaluated. The Class I group had a total increase in the maxilla of 5mm and 4mm in males and females respectively, these differences being lower than those reported by other

authors [9,11,13,14]. We can only assume that this may be due to racial factors. In the Class III group the values were 1mm and 2mm smaller at each stage of growth in males and females respectively compared to the Class I group. In the Class II group the increase during the evaluated growth period was also small, but it should be noted that the initial dimensions were larger than for Class I and III malocclusion groups. Our Class II sample had what most would consider a maxillary protrusion at stage P1, which indicates that the differential maxillary growth may occur in earlier skeletal maturation stages in this sample (before stage P1) in Classes II and III. These results appear to be unique based on previous literature [6, 9, 11, 14].
Previous reports on samples [9,10,13] of Caucasian subjects with Class III found the largest average annual increments or the mandibular length during the adolescent growth spurt were 3.0 and 3.7mm for females and males respectively, with total growth of approximately 18 to 20mm between 8 and 17 years of age [9,13]. In our study, total increase for the Class I group was approximately 12mm. For the Class II group the total increase was 7mm while for the Class III group it was 11mm. It should be noted that this distance was greater in Class III at baseline by about 4mm compared to Class I or II. This also seems to indicate that in this sample the mandibular growth difference largely starts before stage P1 [14].
The growth of the lower anterior face height was similar in all three skeletal classes, showing sexual dimorphism and was slightly higher in the Class II group at the beginning and end of craniofacial growth. Comparing only the length of the lower anterior height with other studies,[9,13] our reported values are lower. It should be kept in mind that only normodivergent cases were considered in this study.

CONCLUSIONS

Changes in the McNamara cephalometric triangle differed markedly among the three distinct skeletal normodivergent classes grouped by cervical vertebrae maturation stage. In these Latin American subjects, the pubertal growth spurt occurred at different times with respect to the Caucasian and Asian norms.
In males, the pubertal growth spurt in the maxilla and mandible dimensions occurred during stage P3, while in females they occurred in stage P2.
The maxillary and mandibular lengths were already increased in Class II and Class III subjects, respectively, at the beginning of the evaluated growth periods (before stage P1) compared to Class I subjects.

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