Original Research
Orthodontics

Assessment of cephalometric characteristics in the elderly

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Abstract: This cross-sectional study aimed at assessing the cephalometric characteristics in the elderly, taking into account differences between genders, age ranges, ethnic groups and dental aspects. The sample consisted of 250 elderly subjects of both genders (163 female, mean age: 68 yr.; 87 male: 70.4 yr.). Conventional lateral cephalograms for cephalometric analysis were scanned and analyzed by Dolphin Imaging software 11.5. The statistical treatment of the data evaluated the influence of gender and age range variables (independent *t* test), as well as ethnic group, facial profile, and dental characteristics (one-way ANOVA), on cephalometric measurements. A confidence interval of 95% and level of significance of 5% were considered for all the tests performed. The results revealed: 1) The cephalometric measurements evaluated showed significantly lower values for the female gender; 2) a significant decrease in the cephalometric values was observed in relation to the growth pattern, with the advancement of age; 3) significant cephalometric differences were observed between the ethnic groups and the facial profiles; 3) dentulous patients had greater absolute values for all the components evaluated, followed by the individuals with partial dental losses and by those who were edentulous. It may be concluded that the cephalometric alterations observed in this study are inherent to facial maturity, and that they represent specific characteristics regarding each of the variables evaluated. These modifications must be taken into account when planning the treatment for younger patients, to minimize the modifications arising from the natural aging process.

Keywords: Orthodontics; Aged; Cephalometry.

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Introduction

Although aging is a natural process, it causes several modifications in the body. Knowing what changes individuals will experience with the advancement of age is an avenue of investigation that has taken on a relevant role in caring for the elderly, whether these changes are systemic, physiological or anatomical, or of health-related factors arising from lifestyle.[1,2]

Dentistry is concerned about promoting a better quality of life for the elderly, and pursues aesthetical and functional results to reestablish dental occlusion, and favor social interaction. Dental services for these patients aim at restoring oral health, according to characteristics particular to this age group, such as absence of teeth, periodontal problems, and malocclusions.[3,4,5,6] Viewed within this perspective, the number of elderly people who need dental treatment has been growing, and requires that professionals undergo adequate training, so that they can assist these individuals.

A relevant aspect of orthodontics is the study of facial aging. This analysis is an important diagnostic resource for establishing references of normality and guiding professionals during orthodontic treatment. However, studies regarding growth have historically been centered on the first two decades of life,[7,8] since it was believed that growth ceased right after puberty.[9] Few studies[9,10,11,12,13,14,15,16] have sought to understand and quantify the craniofacial alterations that occur as a consequence of aging.

Because of the scarce research with patients > 60 yr. of age, this study investigated the cephalometric characteristics in elderly individuals, taking into account differences between genders, age ranges, ethnic groups, and occlusion characteristics.

Methodology

This cross-sectional study was approved by the Human Ethics Committee of the *Universidade Norte do Paraná* - UNOPAR (PP0070/09). The volunteers were informed about the procedures by means of a Written Free and Clarified Consent (WFCC) statement, duly explained by the researchers and signed by the elderly individuals.

The target population was comprised of independent elderly people, with no physical or mental disabilities, aged ≥ 60 yr., of both genders, recruited from 38 primary healthcare centers in the urban region of Londrina,PR, Brazil. Several health indicators were analyzed in the elderly population of this age from the city, as part of a broader investigation by a group conducting an Interdisciplinary Aging and Longevity Study. Note that 85% of the elderly population commonly uses the Brazilian public health system in this city.

The representative sample size was defined as 343 of those selected from a total of 43,610 elderly individuals from Londrina.

The inclusion criteria of the study was elderly subjects who had natural teeth, or teeth rehabilitated by prostheses. Edentulous individuals who were not rehabilitated by prostheses and those with clinically detectable facial asymmetry were excluded. The final study sample was reduced to 250 elderly subjects of both genders, in that 163 were women (mean age: 68 yr.) and 87 men (mean age: 70.4 yr.).

The lateral cephalograms were obtained from the same machine (Orthopantomograph OP 100 Instrumentarium Corp., Tuusula, Finland) (17.6 s, 77 KVP, and 12 to 14 mA), with a 10% rate of magnification and with patients placed at 1.52 m from the cephalostat. The cephalograms were digitalized on a scanner (HP G4050, Palo Alto, USA) (600 dpi) proper for radiographs, using the ruler for 100 mm calibrations, as recommended by the manufacturer of the Dolphin Imaging 11.5™ program (Dolphin Imaging, Chatsworth, USA). Prior to performing the measurements, the examiner was allowed to treat the images to improve brightness and contrast, and thus allow better identification of the structures. Once the images were treated, the measurements were made. One previously calibrated examiner analyzed all the images to assess the cephalometric variables related to skeletal and soft tissue facial characteristics (Table 1, Figure 1).

Study error

Measurements of 40 randomly selected patients were repeated after a 30-day interval to evaluate the examiner's calibration. This afforded the assessment of systematic (paired *t* test) and casual (error calculation as proposed by Dahlberg) errors. Just one angular variable (SN.GoGn) of the 22 measurements assessed had a statistically significant systematic error. The random errors ranged from 0.2 mm (Upper Lip-E) to 1.8 mm (Co-Gn), and from 0.4° (SNB) to 2.8° (Gl'.Pr.Pog'). This level of error is acceptable, and certified the calibration of the examiner for the study.

Statistical analysis

The data were tested regarding normal distribution, applying the Shapiro-Wilk test. Considering the normal distribution of main variables, the data were described by parameters of mean and standard deviation, and parametric tests were used (independent *t* test and ANOVA). Several parameters, such as gender, age, race and occlusion characteristics, were statistically tested to determine their influences on the cephalometric characteristics of the elderly, the main object of the current study. For comparison purposes, the 250 elderly subjects comprising the sample were divided

Table 1. Cephalometric variables assessed.

	Maxillary Component
SNA (°)	Angle formed by line S-N and line N-A
A-Nperp (mm)	Linear distance from point A to the line perpendicular to the Frankfort plane passing through point N
Co-A (mm)	Linear distance between condylion and A points
	Mandibular Component
SNB (°)	Angle formed by line S-N and line N-B
P-Nperp (mm)	Linear distance from point P to the line perpendicular to the Frankfort plane passing through point N
Co-Gn (mm)	Linear distance between condylion and gonion points
	Maxillomandibular Relationship
ANB (°)	Angle formed by line N-A and line N-B
NAP Convexity (°)	Angle formed by line N-A and line A-P
	Vertical Component
FMA (°)	Angle formed by the Frankfort plane and the mandibular plane (GoMe)
SN.GoGn (°)	Angle formed by line S-N and line Go-Gn
LAFH(ANS-Me) (mm)	Lower anterior face height
TAFH (N-Me) (mm)	Total anterior face height
	Dentoalveolar Component
1-NA (mm)	Linear distance from the most anterior point of the crown of the maxillary incisor to line N-A
1-NA (°)	Angle formed by the maxillary incisor long axis and line N-A
1-NB (mm)	Linear distance from the most anterior point of the crown of the mandibular incisor to line N-B
1-NB (°)	Angle formed by the mandibular incisor long axis and line N-B
	Soft Tissue Component
Gl'.Pr.Pog' (°)	Angle of total facial convexity including the nose formed by soft tissue glabella (Gl') to pronasale (Pr) and pogonion (Pog') points
Gl'.Sn.Pog' (°)	Angle of facial convexity excluding the nose formed between the lines from soft tissue glabella to subnasale (Sn) and pogonion (Pog')
N-B.Upper Lip-Pog' (°)	Holdaway's soft tissue angle
Upper Lip-E (mm)	Linear distance between the upper lip anterior point and line E (Pr-Pog': esthetic plane by Ricketts)
Lower Lip-E (mm)	Linear distance between the lower lip anterior point and line E (Pr-Pog': esthetic plane by Ricketts)
Nasolabial angle (°)	Angle formed by a line from the lower border of the nose to one representing the inclination of the upper lip

according to the variable to be tested. The number of subjects included in each variable comparison was stated in Table 2. The independent *t* test was used to compare the influence of gender (male or female) and age range (60-70 yr. and > 70 yr.) on the cephalometric measurements. In addition, one way ANOVA (Post test: Bonferroni) was used to assess the influence of race (white, black and Japanese) and occlusion characteristics (dentulous, edentulous and partial dental losses) on the cephalometric variables. These tests made it possible to determine which of these variables (gender, age, race or occlusion characteristics) statistically influenced the cephalometric measurements made on the elderly.

All statistical tests were carried out with the Statistical Package for Social Sciences (SPSS) software (SPSS Inc., Chicago, USA), version 15.0.

Results

The characterization of the population under study is shown in Table 2.

The comparisons between genders indicate statistically significant differences in the following measurements: Co-A, Co-Gn, LAFH, TAFH, Gl'.Pr.Pog' (Table 3).

When the cephalometric variables were evaluated regarding age ranges, statistically significant differences were found for the following measurements: SNB, ANB, NAP, FMA, SN.GoGn, LAFH, Gl'.Sn.Pog', N-B.Upper Lip-Pog', Upper Lip-E, Lower Lip-E (Table 4).

In verifying the cephalometric variables between ethnic groups, statistically significant differences were found for the following measurements: SNA, A-Nperp,

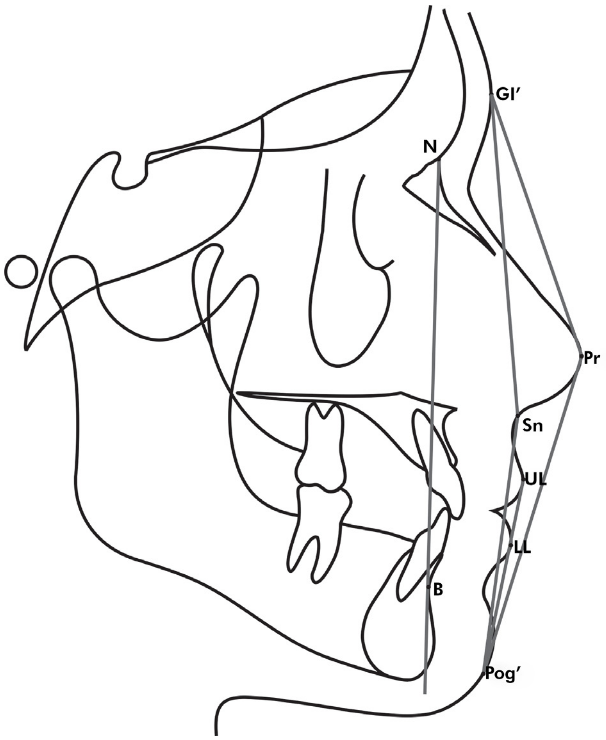

Figure 1. Less usual cephalometric variables: Gl'.Pr.Pog' (°): Angle of total facial convexity including the nose, Gl'.Sn.Pog' (°): Angle of facial convexity excluding the nose; N-B.Upper Lip-Pog' (°): Holdaway's soft tissue angle; Upper Lip-E(mm): Linear distance between the upper lip anterior point and line E (esthetic plane by Ricketts); Lower Lip-E (mm): Linear distance between the lower lip anterior point and line E.

Table 2. Characterization of the study population.

Variable	Frequency	
	Absolute (n)	Relative (%)
Gender		
Male	87	34.8%
Female	163	65.2%
Age		
60-70 yr.	168	67.2%
> 70 yr.	82	32.8%
Ethnic groups		
White	199	79.6%
Black	41	16.4%
Japanese	10	4.0%
Dental characteristics		
Dentulous	49	19.6%
Edentulous	97	38.8%
Partial dental losses*	104	41.6%

*Patients with partial dental losses rehabilitated with various types of prostheses, including total prostheses on one of the arches, removable partial prostheses, fixed prostheses, and prostheses on implants.

ANB, NAP Convexity, N- N-B.Upper Lip-Pog', Upper Lip-E, Lower Lip-E, 1-NB (Table 5).

When the cephalometric variables were compared regarding dental characteristics, statistically significant alterations were found for the following measurements: SNA, A-Nperp, Co-A, SNB, P-Nperp, Co-Gn, ANB, NAP Convexity, FMA, SN.GoGn, LAFH, TAFH, Gl'.Sn.Pog', N-B.Upper Lip-Pog', Upper Lip-E, Lower Lip-E (Table 6).

Discussion

This cross-sectional study investigated the facial profile characteristics of elderly subjects, taking into account differences between genders (male and female), age ranges (60-70 and > 70 yr.), ethnic groups (white, black and Japanese) and dental characteristics.

The comparisons regarding gender indicated statistically significant differences in measurements of the maxillary and mandibular components, and of the growth pattern (Table 3). In this study, lower values were found for the female gender in linear measurements, following the trend described in the literature[9,10,11,12,14]. Thilander *et al.*[17] observed linear measurements with absolute values that were higher in the male gender as compared with the female gender; however, their study was carried out with a younger sample (5 to 31 yr.). Studies by Behrents[10] and by Pecora *et al.*,[9] conducted with samples of older individuals, observed significantly higher mean values for Co-A and Co-Gn measurements for men in relation to women. Likewise, the LAFH and TAFH measurements were also observed with this same relationship between genders in studies by Behrents[10] and Formby *et al.*[14] On the other hand, in this study, the measurement of the angle of the facial profile including the nose (Gl'.Pr.Pog') showed a higher value for the female gender, in disagreement with the results by Formby *et al.*[14] and Bishara *et al.*[11] These results may be explained by the influence of the size of the nose, which tends to be larger for men as compared with women,[18] leading to an angle of the facial profile including the nose that is smaller for males in relation to females.

When the cephalometric variables were compared regarding age ranges, statistically significant differences were found for various measurements (Table 4). Most of the cephalometric measurements

Table 3. Variables that showed significant differences in the comparison between different genders (female and male): Mean, Standard Deviation (SD), independent *t* test (*p*).

Cephalometric Variables	Gender (n)	Mean	SD	*p*
		Maxillary Component		
Co-A (mm)	Female (163)	83.9	5.1	0.001*
	Male (87)	89.8	5.7	
		Mandibular Component		
Co-Gn (mm)	Female (163)	120.7	6.2	0.0001*
	Male (87)	130.9	6.3	
		Vertical Component		
LAFH (mm)	Female (163)	65.0	6.9	0.0001*
	Male (87)	71.0	8.3	
TAFH (mm)	Female (163)	115.9	7.9	0.0001*
	Male (87)	125.7	8.8	
		Soft Tissue Component		
Gl'.Pr.Pog' (°)	Female (163)	135.2	9.8	0.01*
	Male (87)	131.9	10.0	

*Statistically significant difference.

Table 4. Variables that showed significant differences as to age range: Mean, Standard Deviation (SD), independent *t* test (*p*).

Cephalometric Variables	Age (n)	Mean	SD	*p*
		Maxillary Component		
SNB (°)	60-70 yr. (168)	80.9	4.7	0.007 *
	> 70 yr. (82)	82.6	4.5	
		Maxillomandibular Relationship		
ANB (°)	60-70 yr. (168)	0.6	4.5	0.01 *
	> 70 yr. (82)	-0.8	3.8	
NAP Convexity (°)	60-70 yr. (168)	-1.0	10.6	0.003 *
	> 70 yr. (82)	-5.2	9.6	
		Vertical Component		
FMA (°)	60-70 yr. (168)	26.8	6.8	0.000 *
	> 70 yr. (82)	23.5	6.2	
Sn.GoGn (°)	60-70 yr. (168)	31.7	7.8	0.000 *
	> 70 yr. (82)	26.9	6.8	
LAFH (mm)	60-70 yr. (168)	68.0	8.0	0.008 *
	> 70 yr. (82)	65.2	7.6	
		Soft Tissue Component		
Gl'.Sn.Pog' (°)	60-70 yr. (168)	171.21	5.18	0.007 *
	> 70 yr. (82)	173.03	4.54	
N-B.Upper Lip-Pog' (°)	60-70 yr. (168)	5.17	8.10	0.000 *
	> 70 yr. (82)	1.26	7.23	
Upper Lip-E (°)	60-70 yr. (168)	-5.98	4.04	0.000 *
	> 70 yr. (82)	-8.07	3.89	
Lower Lip-E (°)	60-70 yr. (168)	-3.24	4.06	0.005 *
	> 70 yr. (82)	-4.80	4.17	

*Statistically significant difference.

Table 5. Comparison between the ethnic groups and the variables of maxillary component maxillomandibular relationship, and dentoalveolar component: Mean, Standard Deviation (SD), ANOVA (*p*).

Cephalometric Variables	Ethnic Group (n)	Mean	SD	*p*
	Maxillary Component			
SNA (°)	White (199)[a]	81.1	4.7	0.007 *
	Black (41)[b]	83.7	5.0	
	Japanese (10)[a,b]	82.6	5.2	
A-NPERP (mm)	White (199)[a]	-1.5	5.1	0.001 *
	Black (41)[b]	1.7	5.2	
	Japanese (10)[a,b]	-1.4	5.3	
	Maxillomandibular Component			
ANB (°)	White (199)[a]	-0.2	4.2	0.005 *
	Black (41)[b]	2.0	4.1	
	Japanese (10)[a,b]	1.2	4.7	
NAP Convexity (°)	White (199)[a]	-3.6	10.3	0.001 *
	Black (41)[b]	2.8	9.3	
	Japanese (10)[a,b]	-1.2	12.1	
	Dentoalveolar Component			
1-NB (mm)	White (199)[a]	6.7	3.56	0.002*
	Black (41)[a,b]	9.7	3.58	
	Japanese (10)[a,b]	6.0	2.70	

*Statistically significant difference.
Different letters indicate the differences between the groups (one-way ANOVA, posttest: Bonferroni).

Table 6. Comparison between the occlusion pattern and the variables of maxillary component, mandibular component, and maxillomandibular relationship: Mean, Standard Deviation (SD), ANOVA (*p*).

Cephalometric Variables	Occlusal Characteristics (n)	Mean	SD	*p*
	Maxillary Component			
SNA (°)	Dentulous (49)[a]	83.5	3.7	0.006*
	Edentulous (97)[b]	80.9	5.3	
	Partial dental losses (104)[b]	81.3	4.7	
A-NPERP (mm)	Dentulous (49)[a]	2.5	4.4	0.000*
	Edentulous (97)[b]	-2.4	5.1	
	Partial dental losses (104)[b]	-1.2	5.1	
Co-A (mm)	Dentulous (49)[a]	89.6	6.4	0.000*
	Edentulous (97)[b]	84.7	5.6	
	Partial dental losses (104)[b]	85.4	5.5	
	Mandibular Component			
SNB (°)	Dentulous (49)[a]	80.1	3.4	0.000*
	Edentulous (97)[b]	83.3	5.3	
	Partial dental losses (104)[a,b]	80.3	4.0	
P-NPERP (mm)	Dentulous (49)[a]	-0.9	7.8	0.000*
	Edentulous (97)[b]	3.0	8.6	
	Partial dental losses (104)[a]	-2.6	8.7	
Co-GN (mm)	Dentulous (49)[a]	128.1	8.0	0.000*
	Edentulous (97)[b]	122.8	7.5	
	Partial dental losses (104)[b]	123.8	7.7	

Continue

Continuation

		Maxillomandibular Relationship		
ANB (°)	Dentulous (49)[a]	3.4	2.8	0.000*
	Edentulous (97)[b]	-2.4	3.6	
	Partial dental losses (104)[b]	1.0	4.1	
NAP Convexity (°)	Dentulous (49)[a]	5.9	5.9	0.000*
	Edentulous (97)[b]	-9.2	8.9	
	Partial dental losses (104)[c]	-0.1	9.5	
		Vertical Component		
FMA (°)	Dentulous (49)[a,c]	28.0	6.1	0.000*
	Edentulous (97)[b]	22.8	5.8	
	Partial dental losses (104)[c]	27.3	7.0	
Sn.GoGn (°)	Dentulous (49)[a,c]	33.8	6.4	0.000*
	Edentulous (97)[b]	26.4	7.5	
	Partial dental losses (104)[c]	31.8	7.3	
LAFH (mm)	Dentulous (49)[a]	72.7	6.9	0.000*
	Edentulous (97)[b]	62.7	7.4	
	Partial dental losses (104)[c]	68.4	6.7	
TAFH (mm)	Dentulous (49)[a]	126.0	7.9	0.000*
	Edentulous (97)[b]	114.8	8.8	
	Partial dental losses (104)[c]	120.3	8.5	

* Statistically significant differences ($p<0.05$).
Different letters indicate the differences between the groups (one-way ANOVA, post test: Bonferroni).

related to growth pattern (FMA, SN.GoGn, LAFH) had significantly lower mean values according to advancing age (> 70 yr.), thereby showing a vertical loss from aging. Moreover, a significant increase in the average value of the SNB measurement and a significant decrease in the ANB and NAP convexity measurements were observed in the > 70-yr. age range. This indicates a mandibular displacement in the anti-clockwise direction. This same tendency of increased facial concavity was observed for soft tissues (Gl'.Sn.Pog', N-B.Upper Lip-Pog', Upper Lip-E, Lower Lip-E). These results can be explained by the decrease in the vertical dimension due to progressive bone loss common to the elderly[19,20,21,22], especially taking into account that most of the individuals analyzed in this sample had multiple dental losses. Bone reduction is a physiological process that generally starts in the third and fourth decades of life, that is more expressive in women than men[22,23] and that is greatly influenced by the presence of teeth. Dental losses cause an irreversible vertical resorption of the alveolar bone.[19,20] These changes regarding dental losses are more readily and significantly observed in the maxilla, in relation to the mandible.[24] In this study, the probable bone loss in the maxilla and mandible due to aging and to the high degree of edentulism in this sample were determining factors for the reduction in the vertical dimension, and for the increase in facial concavity, in accordance with the measurements studied.

Considering the ethnic groups in the sample, some statistically significant differences were found. Freitas *et al.*[25] showed that the various cephalometric measurements evaluated had higher values for blacks, followed by Japanese and whites. Although the present study comprised a sample with a higher age range (> 60 yr.), the values found followed the same trend for young patients (Table 5).

Comparing the cephalometric variables regarding dental characteristics, statistically significant alterations were found for the majority of the measurements assessed (Table 6). The cephalometric measurements obtained from dentulous patients showed greater absolute values for all the components evaluated, probably due to higher integrity of alveolar processes, resulting in retaining of the same vertical dimension.

Individuals with partial dental losses had intermediate cephalometric values, whereas edentulous individuals had lower values. This is most likely explained by alveolar bone loss resulting from the dental loss.[19,20,21,22] In this study, edentulism was detected in 38.8% of the sample, a datum similar to that of the study by Salonen *et al*.,[26] in which edentulism was observed in 35% of the individuals 60-69 yrs. old, 70% in the 70-79-year range, and 80% in elderly subjects > 80. This high dental loss was also observed in other studies with the elderly population,[26,27] including developed countries such as Japan, where 50% of elderly individuals 65 yr. old make use of total prostheses; moreover, this percentage is even greater in elderly subjects >80 yr. of age.[28]

Taking into account the cephalometric aspects observed in this study regarding elderly subjects, it is worth emphasizing that professionals should avoid orthodontic treatments that promote excessive retraction of the facial profile, especially in cases of individuals with a straight profile who require dental extractions. A better understanding of the alterations inherent to the aging process will contribute to establishing more conservative treatment protocols that will minimize the effects of aging on facial characteristics.

Conclusion

The cephalometric alterations shown in this study are inherent to facial maturity, and present specific characteristics for each of the variables assessed. These modifications must be taken into account when planning treatments for young patients, to minimize the modifications arising from the natural aging process.

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