Comparison of soft tissue size between different facial patterns

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Abstract

Objective: This study was designed to compare the soft tissue morphology of individuals according to their facial patterns. **Methods:** Were used cephalograms of 90 patients of both genders, aged 12 to 16 years, which were divided into three distinct groups, according to their morphological patterns, i.e., mesofacials, dolichofacials and brachyfacials. The groups were compared in terms of thickness and height of the upper and lower lips, and thickness of the soft tissue chin. Correlations between soft tissue variables and dental and skeletal cephalometric measurements were also investigated. **Results and Conclusions:** Thickness of upper lip, lower lip and soft tissue chin showed no differences in all morphological groups. However, upper and lower lip heights were significantly greater in dolichofacials. Brachyfacials showed smaller upper lip height compared with mesofacials, although no differences were found between those two groups in terms of lower lip height. Assessment of the correlations between soft and skeletal/dental variables evidenced vertical development of the upper and lower lips, commensurate with the vertical development of the skeleton. The vertical positioning of upper incisors significantly correlated with the same parameters related to the lips, which ensured a similar exposure level of these teeth in all groups.

Keywords: Vertical pattern. Cephalometry. Lip. Chin.

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INTRODUCTION

The orthodontic literature often describes and classifies the different facial types according to their vertical skeletal features.[15,20,23,24,25] This skeletal pattern classification stems from the need to ensure the use of discrete approaches based on the diagnosis, treatment and prognosis of each group.

On the other hand, less emphasis is given to the description and comparison of aspects related to the soft tissue of different morphological classes. Most research in this area focuses on investigating soft tissue responses to movements resulting from orthodontic treatment.[1,5,8,17,22,28] Some correlate soft tissue characteristics with malocclusions of horizontal origin.[6,11] However, few address soft tissue characteristics of malocclusions from a vertical perspective. Moreover, investigations that do address these issues[3,4,13] fail to conduct an in-depth examination of the origin or possible causes of any differences that may be found. Thus, we need to generate further information about these morphological groups and their soft tissue characteristics. The provision of such information may also assist in planning orthodontic cases according to these characteristics while helping to establish a specific soft tissue prognosis for each pattern.

Therefore, this study was designed to compare facial groups classified according to their vertical skeletal characteristics (mesofacial, dolichofacial and brachyfacial) and to their respective soft tissue morphological features, particularly those relating to the lips and chin. Moreover, it also aims to determine the skeletal and/or dental features of the sample, which correlate more significantly with the morphology of the lips and chin, thereby allowing inferences to be made regarding the origin and possible causes of any differences detected between groups.

MATERIAL AND METHODS

This is a cross-sectional, comparative and descriptive study approved by the Ethics in Research Committee of the institution where it was conducted (File Nº. 2003. 1. 1045. 58. 4).

Were used lateral cephalograms of patients aged between 12 and 16 years of both genders whose records were archived at the Orthodontics Clinic of the university where the study was conducted. Were excluded from the final sample those patients who had undergone orthodontic treatment in the period prior to when the radiographs were taken. Furthermore, subjects who had made obvious efforts towards achieving a lip seal were also excluded from the study.

Once selected, the radiographs were divided into three groups consisting of 30 subjects each, according to the morphological patterns displayed by the patients (mesofacial, dolichofacial and brachyfacial). The criterion used to divide the sample into groups was the measurement of the facial axis (BaN.PtGn), whose normal value[18] is 90°. The groups were defined taking into account the 3° variation proposed by McNamara,[14] as explained below.

- Mesofacials: facial axis equal to or above 87° and equal to or below 93°.
- Dolichofacials: facial axis above 93°.
- Brachyfacials: facial axis below 87°.

VARIABLES	
Skeletal	Dental
SNA	1-NA
SNB	1.NA
ANB	1-NB
SNGoGn	1.NB
LAFH (ENA-Me)	1-PP
TAFH (N-Me)	1.PP
	IMPA
	1-St_s

TABLE 1 - Skeletal and dental cephalometric variables.

The radiographs were then traced and subsequently dental and skeletal cephalometric measurements were determined (Table 1).

The following assessments of soft tissue dimensions were also performed (Fig 1).

- Upper lip thickness (ULT): distance between the junction of the contour of the maxillary incisor and the pre-maxilla, and point UL, located in the anterior-most region of the upper lip contour.
- Upper lip height (ULH): distance between the palatal plane (ANS-PNS) and a parallel line going through St_u (located at the bottom of the contour of the upper lip).
- Lower lip thickness (LLT): distance between the junction of the contour of the lower incisor and the anterior contour of the chin, and point LL, located in the anterior-most contour of the lower lip.
- Lower lip height (LLH): distance between the mandibular plane and a parallel line going through St_l (located at the upper border of the contour of the lower lip).

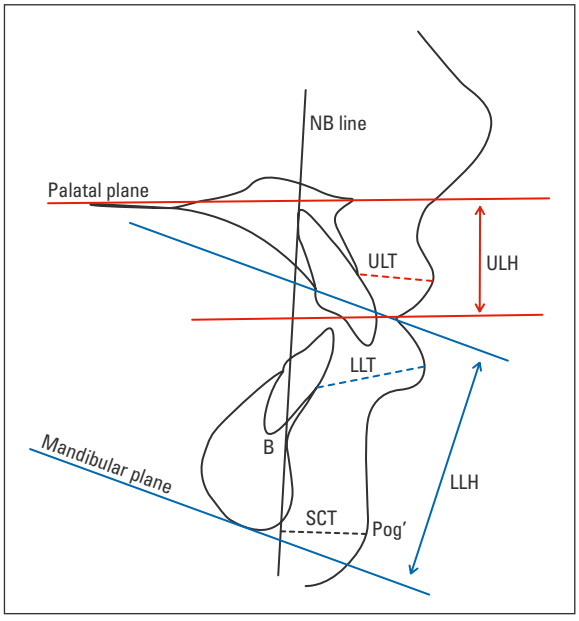

FIGURE 1 - ULT, ULH, LLT, LLH and SCT.

- Soft chin thickness (SCT): shortest distance between Pog' and NB line.

The measurements were performed by a single orthodontist trained for this purpose, who did not know to which group each radiograph belonged.

Statistical Analysis

Group characterization was conducted through descriptive data analysis. To check data normality the Shapiro-Wilk test was applied. Due to the presence of normal distribution of data, parametric tests were used for inferential analysis.

Once assessed, the measurement values were compared between the groups. To check for differences in sample characterization in terms of gender, the Chi-square test was applied, and for age, analysis of variance (ANOVA). Comparisons between groups for each cephalometric measurement were assessed using ANOVA. For variables whose ANOVA value was significant ($p < 0.05$), the Tukey test for multiple comparison analysis was used. To check the correlation between soft tissue variables and skeletal and dental parameters the Pearson correlation coefficient was applied. Correlation strength was analyzed using the values proposed by Santos.[19] The level of significance for statistical tests was 5% ($\alpha \leq 0.05$). All tests were performed by the computer program SPSS (10.0, SPSS Inc., Chicago, USA).

RESULTS

Most of the subjects in the mesofacial, dolichofacial and brachyfacial groups were male (60.0%, 56.7% and 53.3%, respectively), with mean age between 13 and 14 years (13.73 years, 13.43 years, 13.37 years, respectively). The three groups showed no statistical differences regarding composition by gender ($p = 0.873$) and age ($p = 0.555$).

The means, standard deviations, maximum and minimum values as well as the comparative

TABLE 2 - Comparison between morphological patterns in terms of skeletal measurements.

Variables	Morphological pattern	Mean	SD	Minimum	Maximum	ANOVA (p-value)	Tukey	
SNA (degrees)	MESO	81.883	4.586	70.5	91.0	**0.003**	M-D	0.137
	DOLICHO	79.667	3.909	70.5	85.0		M-B	0.253
	BRACHY	83.717	4.815	73.5	92.0		B-D	**0.002**
SNB (degrees)	MESO	79.317	3.800	72.0	86.5	**< 0.001**	M-D	**0.001**
	DOLICHO	75.983	3.019	68.0	82.5		M-B	**0.001**
	BRACHY	82.817	3.497	75.0	91.0		B-D	**< 0.001**
ANB (degrees)	MESO	2.733	1.770	-0.5	7.0	**< 0.001**	M-D	0.294
	DOLICHO	3.683	2.419	-1.0	8.0		M-B	**0.013**
	BRACHY	0.900	2.995	-6.5	5.0		B-D	**< 0.001**
SN.GoGn (degrees)	MESO	31.317	7.023	24.0	60.0	**< 0.001**	M-D	**< 0.001**
	DOLICHO	36.617	3.662	28.5	42.0		M-B	**0.002**
	BRACHY	26.750	3.674	17.0	33.0		B-D	**< 0.001**
LAFH (mm)	MESO	66.800	6.400	58.0	85.0	**< 0.001**	M-D	**0.003**
	DOLICHO	71.600	4.773	61.500	82.0		M-B	0.232
	BRACHY	64.450	5.297	55.000	75.0		B-D	**< 0.001**
TAFH (mm)	MESO	119.067	7.011	108.0	136.0	**< 0.001**	M-D	**0.043**
	DOLICHO	123.500	6.994	109.0	134.0		M-B	0.099
	BRACHY	115.300	7.011	102.0	132.0		B-D	**< 0.001**

Level of significance = 5%.

analysis relating to skeletal and dental cephalometric measurements are depicted in Tables 2 and 3, respectively.

Soft tissue measurements (Table 4)

There was no statistical difference between the facial groups with regard to the thickness of both upper and lower lips.

However, the groups were considered different from each other in terms of upper lip height. Dolichofacials exhibited significantly longer lips, followed by mesofacials and brachyfacials, who displayed significantly shorter lips.

Regarding lower lip height, there were no significant differences between mesofacials and brachyfacials. However, the dolichofacial group exhibited significantly higher means compared with the other groups, indicating that dolichofacials have lips that are vertically longer.

Regarding soft chin thickness, differences were detected in the analysis including all groups. In paired analysis, however, this difference did not reach a statistically significant level although it was more significant when dolichofacial and brachyfacial groups were confronted with each other. In this comparison, dolichofacials had thinner soft chin than brachyfacials, although this difference was not significant.

TABLE 3 - Comparison between morphological patterns in terms of dental measurements.

Variables	Morphological Pattern	Mean	SD	Minimum	Maximum	ANOVA (p-value)	Tukey	
1-NA (mm)	MESO	6.433	1.911	2.5	11.0	0.243	M-D	-
	DOLICHO	7.467	2.655	3.0	14.0		M-B	
	BRACHY	7.017	2.472	2.5	14.0		B-D	
1.NA (degrees)	MESO	23.167	7.091	9.5	39.0	0.128	M-D	-
	DOLICHO	23.317	6.051	10.0	33.0		M-B	
	BRACHY	26.467	7.843	4.0	44.5		B-D	
1-NB (mm)	MESO	6.117	3.042	2.0	19.0	**< 0.001**	M-D	**0.005**
	DOLICHO	8.033	1.875	5.0	12.0		M-B	0.076
	BRACHY	4.767	1.746	1.5	8.0		B-D	**< 0.001**
1.NB (degrees)	MESO	26.800	6.257	17.0	38.5	**< 0.001**	M-D	**0.028**
	DOLICHO	31.400	6.896	15.5	44.0		M-B	0.198
	BRACHY	23.583	6.890	7.0	34.5		B-D	**< 0.001**
1-PP (mm)	MESO	28.633	3.620	21.0	37.0	**< 0.001**	M-D	**0.002**
	DOLICHO	31.550	3.133	26.0	37.0		M-B	**0.026**
	BRACHY	26.417	2.758	22.0	32.0		B-D	**< 0.001**
1.PP (degrees)	MESO	112.433	9.119	93.5	140.5	**0.016**	M-D	0.818
	DOLICHO	110.200	5.609	97.0	120.5		M-B	0.224
	BRACHY	116.083	8.342	93.0	132.5		B-D	**0.014**
IMPA (degrees)	MESO	95.350	7.186	82.0	107.0	**0.016**	M-D	1.000
	DOLICHO	96.933	6.611	81.0	110.0		M-B	0.155
	BRACHY	91.933	6.302	79.5	102.0		B-D	**0.015**
1-St_s (mm)	MESO	4.033	2.117	-2.0	8.0	0.085	M-D	-
	DOLICHO	5.100	2.966	-2.0	10.5		M-B	
	BRACHY	3.783	2.012	-0.5	7.5		B-D	

Level of significance = 5%.

Correlation between soft tissue, skeletal and dental variables (Table 5)

Soft tissue variables were compared among themselves as well as with all dental and skeletal variables. The correlations that reached statistical significance are shown below.

Upper lip thickness correlated moderately with lower lip, so that as one increased, so did the other.

Upper and lower lip heights correlated with each other positively and with similar strength. Positive and stronger correlations were found between these two variables and the anterior lower and total facial heights. Lower lip height correlated very strongly with the anterior lower and total facial heights. The upper lip exhibited a strong correlation with the anterior lower facial height and only moderate with total anterior facial height.

TABLE 4 - Comparison between morphological patterns in terms of soft tissue measurements.

Variables	Morphological Pattern	Mean	SD	Minimum	Maximum	ANOVA (p-valor)	Tukey	
ULT (mm)	MESO	17.033	2.810	11.0	23.5	0.262	M-D	-
	DOLICHO	16.750	2.417	11.5	20.5		M-B	
	BRACHY	17.817	2.541	11.0	24.0		B-D	
ULH (mm)	MESO	25.267	3.919	19.0	33.0	**< 0.001**	M-D	**0.037**
	DOLICHO	27.417	3.135	22.5	35.0		M-B	**0.050**
	BRACHY	23.217	2.559	19.0	28.5		B-D	**< 0.001**
LLT (mm)	MESO	18.483	2.164	16.0	26.0	0.576	M-D	-
	DOLICHO	18.133	1.814	14.0	21.0		M-B	
	BRACHY	17.917	2.301	15.0	25.5		B-D	
LLH (mm)	MESO	44.633	3.924	38.0	56.0	**< 0.001**	M-D	**0.012**
	DOLICHO	47.617	3.718	40.5	40.5		M-B	1.000
	BRACHY	43.850	4.052	34.0	54.0		B-D	**0.001**
SCT (mm)	MESO	15.800	2.575	12.0	20.5	**0.046**	M-D	0.124
	DOLICHO	14.483	2.284	10.0	19.5		M-B	1.000
	BRACHY	15.933	2.515	12.0	23.0		B-D	**0.075**

Level of significance = 5%.

TABLE 5 - Significant correlations between soft tissue, skeletal and dental measurements.

		Soft tissue measurements				
		ULT	ULH	LLT	LLH	SCT
Skeletal measurements	SNA	-	-0.229*	-	-	-
	SNB	-	-0.286*	-	-	-
	ANB	-0.278*	-	-	-	-
	SN.GoGn	-	**0.307***	-	**0.327***	-0.246*
	LAFH	-	**0.800*****	**0.309***	**0.829*****	-
	TAFH	**0.270***	**0.654****	**0.341***	**0.732****	-
Dental measurements	1-NA	**0.251***	**0.329***	-	-	-
	1.NA	**0.364***	-	-	-	-
	1-PP	-	**0.811*****	-	**0.613****	-
	1.PP	**0.302***	-0.256*	-	-	-
	1-St_s	-	-	-	-	-
	1-NB	-	**0.333***	**0.210***	**0.460***	-0.241*
	1.NB	-	**0.329***	-	**0.386***	-0.249*
	IMPA	-	-	-	-	-
Soft tissue measurements	ULT		-	**0.549****	**0.335***	**0.471***
	ULH	-		-	**0.590****	-
	LLT	**0.549****	-		**0.492***	**0.415***
	LLH	**0.335***	**0.590****	**0.492***		-
	SCT	**0.471***	-	**0.415***	-	

Level of significance = 5%.
*Weak correlation level (± 0.1 ≤ r <± 0.5)[19]. ** Moderate correlation level (± 0.5 ≤ r <± 0.8)[19]. *** Strong correlation level (± 0.8 ≤ r <± 1)[19].

The degree of upper incisor extrusion, as given by the shortest distance from its incisal point to the palatal plane (1-PP), established moderate and positive correlation with lower lip height, and strong and positive correlation with upper lip height.

Regarding soft chin thickness, although significant correlations were observed, these were not so strong. All other measurements pertaining to soft tissue also displayed low strength correlations.

DISCUSSION

The literature states that the dimensions of facial soft tissues vary considerably as a result of sexual dimorphism and age.[7,9,11,16] However, the groups compared in this study were uniform with respect to the distribution of both variables, which enabled us to undertake comparative studies.

Although the parameter used for determining the facial groups in this research (BaN.PtGn), departs from the criterion adopted by Blanchette et al,[3] Lai, Gosh and Nanda[13] and Boneco and Jardim,[4] it was considered suitable for the morphological classification of patients. This is due to the fact that the groups determined by this criterion, especially the facial patterns at the two opposite extremes (brachyfacials and dolichofacials), differed significantly from the parameters used by the aforementioned authors[3,4,13] to group their respective samples. We, therefore, found it appropriate to compare their results[3,4,13] with those achieved in this study.

According to data obtained in this investigation, the facial groups did not differ significantly with respect to the thickness of the upper lip, lower lip and soft tissue chin. These data are consistent with research by Boneco and Jardim[4] and Lai, Gosh and Nanda.[13] These findings, however, differed from a study by Blanchette et al.[3] According to the latter authors,[3] the thickness of the soft tissues of the lip and chin vary to compensate for an absence or excess of underlying hard structure. Thus, dolichofacial individuals, whose basal bones are usually more retruded, exhibit greater thickness of the lip and soft tissue chin. Moreover, according to these researchers,[3] brachyfacials display lower horizontal soft tissue profile magnitudes given their significantly sturdier underlying structure. Although the results of this study demonstrate an effective distinction in the level of horizontal projection of the maxillary bones, as noted by Blanchette et al,[3] no differences were found between the morphological types with respect to the thickness of both the upper and lower lip and the soft tissue chin. According to data derived from this study, the soft tissue is not able to compensate for any bone discrepancy through differential horizontal growth. This finding is corroborated by the fact that this study did not disclose relevant correlation levels between lip and soft chin thickness variables and horizontal skeletal magnitudes, such as SNA, SNB and ANB.

Blanchette et al[3], Lai, Gosh and Nanda,[13] as well as Boneco and Jardim[4] confirmed that dolichofacials have longer lips, whereas brachyfacials' lips are shorter. These observations—although stemming from measures that diverge slightly from those employed here—agree with the data from this study. According to Blanchette et al[3] and Boneco and Jardim,[4] the size of dolichofacials' lips is greater in the vertical direction in order to compensate for lip seal difficulties, as these individuals are more prone than others to develop lip incompetence.[26,29]

Lip "elongation", observed particularly in dolichofacials in this study was large enough to prevent the upper incisor of these patients from being overexposed. As noted, dolichofacials' upper incisors are more extruded than those of other facial groups (1-PP), which has also been observed by other authors.[10,21] However, the different facial groups did not differ in terms of incisor exposure at rest (1-St_u). This can be explained by the larger size

of dolichofacials' upper lips, which proved sufficient to compensate for the extrusion, or the lower position of the upper incisors. The reverse was observed in brachyfacials. These individuals had shorter lips and more superiorly positioned teeth, which ensured a level of incisor exposure similar to that of dolichofacials. With regard to this hypothesis, we highlight the fact that the variables that correspond to the vertical incisor position (1-PP) showed a positive and strong correlation with the height of the upper lip. According to data from this study and confirmed by Peck, Peck and Kataja,[16] the greater the vertical length of the upper lip, the greater the "extrusion" of upper incisors. It is not advisable, however, to establish a cause and effect relationship between the level of extrusion of the upper incisors and upper lip height, although such link could be suggested.

The anterior lower and total facial height variables also strongly correlated with upper lip height. Both are significantly higher in dolichofacials and lower in brachyfacials, as reported in other studies.[10,15,20,24] It is our opinion that the upper lip tends to follow the underlying vertical skeletal development. Therefore, dolichofacials—whose skeletal structure stands out in the vertical direction—exhibit upper lip dimensions also characterized by excessive vertical development. Brachyfacials, in turn, tend to display relatively smaller vertical bone structure as well as smaller upper lips.

This hypothesis is further reinforced in view of the vertical dimensions of the lower lip. This variable was significantly higher for dolichofacials than for brachyfacials. Furthermore, it exhibited a relevant correlation with the same vertical skeletal variables (LAFH and TAFH). Therefore, the dimensions of the lower and upper lips are commensurate with their underlying skeletal dimensions. Vig and Cohen[27] agree with this relationship and further report that—proportionately—the combined growth of the upper and lower lips may even exceed the growth of the lower facial height.

Given its plasticity,[2] the stomatognathic system is highly capable of developing adaptive patterns. Therefore, above and beyond mere comparisons, we need to understand the interactions established between the hard and soft tissues in the different facial patterns. Although other authors[6,8,12] have suggested that the soft tissues of the face are dynamic structures and, as such, can develop independently of the hard structures, data from our sample show evidence that the lip develops vertically in line with both the vertical skeletal development and vertical positioning of the upper incisors.

The analysis performed in this study allowed us, therefore, to disclose the morphological similarities and differences that should inform orthodontists and professionals from related areas in their approach to the different facial types.

The uniformity we noted in the thickness of the lips and soft tissue chin rules out the hypothesis of soft tissue compensation and recommends the adoption of therapies focused on the preservation of the soft tissue profile of patients with inherent maxillomandibular retrusion, such as dolichofacials.

Lip "elongation" was found to correlate with excessive vertical skeletal development, which reinforces the dominant paradigm and points to a favorable treatment prognosis for dolichofacial patients in terms of their motor and labial rehabilitation.

CONCLUSIONS

Through a comparative analysis of the different facial pattern groups, we were able to conclude that:

- Thickness of upper lip, lower lip and soft tissue chin did not differ significantly between groups.
- Upper lip height showed significant dif-

ferences between the three groups. It was greater for dolichofacials and lower for brachyfacials, when these two groups were compared between themselves, and with mesofacials.

- Lower lip height was significantly greater for dolichofacials when these were separately compared with the other morphological groups.
- Mesofacials and brachyfacials did not differ with respect to lower lip height.

In checking the correlations established between the soft and hard tissue variables, the main findings should be highlighted:

- Upper lip height was very strongly correlated with lower anterior facial height. Furthermore, lower lip height correlated strongly with lower anterior and total facial heights. This indicates a tendency towards an "alignment" between upper lip and lower vertical facial development.
- Upper lip height correlated strongly with the vertical positioning of the upper incisors, which ensured—to a certain extent—a constant exposure of these teeth across the different morphological groups.

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