IS MOUTH-BREATHING RELATED TO ALTERATIONS IN FACIAL SOFT TISSUES?

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RESUMO

Objetivo: Comparar os tecidos moles faciais de respiradores nasais (RN) e bucais (RB), utilizando imagens de tomografia computadorizada de feixe cônico (TCFC). **Métodos:** Foi realizado um estudo comparativo composto por quatro variáveis cefalométricas angulares e oito lineares, obtidas de tecidos moles faciais de indivíduos RN e RB, em uma amostra composta por 43 indivíduos jovens de ambos os sexos, com idades entre 11 e 24 anos, submetidos ao exame tomográfico anteriormente ao tratamento ortodôntico. Os indivíduos foram previamente divididos em dois grupos por um otorrinolaringologista, de acordo com o padrão respiratório. O diagnóstico da respiração bucal foi feito em conformidade com os resultados de exames específicos: exame clínico, rinoscopia e endoscopia nasal. Os dados obtidos a partir do software InVivo 5.3 Dental (Anatomage - San Jose, Califórnia) foram avaliados através da comparação dos valores das medições das variáveis dos grupos RN e RB, além da comparação das diferenças entre esses valores. **Resultados:** Houve diferenças estatisticamente significativas entre os grupos com relação às variáveis, "ângulo nasolabial", "inclinação do incisivo central superior" e "convexidade dos tegumentos faciais". **Conclusão:** Os respiradores bucais adolescentes e adultos jovens apresentam ângulo nasolabial mais aberto, devido à maior inclinação lingual do longo eixo dos incisivos superiores, além de maior convexidade dos tecidos moles faciais.

Keywords: Mouth Breathing. Nasal Obstruction. Integumentary System. Cephalometry. Cone-beam Computed Tomography.

ABSTRACT

Objective: To compare the facial soft tissues of nasal breathers (NB) and mouth breathers (MB) using cone-beam computed tomography (CBCT).
Methods: This was a comparative study of four angular and eight linear cephalometric variables obtained from the facial soft tissues of 43 young men and women aged between 11 and 24 years. Subjects had tomographic examination prior to the orthodontic treatment and were previously divided into two groups by an otolaryngologist according to the respiratory pattern of nasal or mouth breathing. The selection was made in accordance with the results of: clinical examination, rhinoscopy, and nasal endoscopy. The data obtained from the software InVivo Dental 5.3 (Anatomage - San Jose, California) was evaluated by comparing values measured between MB and NB groups. **Results:** There were significant differences between groups for variables, "nasolabial angle", inclination of upper central incisor" and "convexity of the facial soft tissues". **Conclusion:** Adolescent and young adult mouth breathers present an open nasolabial angle due to the retroinclination of their upper incisors. In addition to greater convexity of the facial soft tissues.

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INTRODUCTION

Respiratory function and its influence on the development of the orofacial structures have been thoroughly studied.[1-4] Moss[5] observed that nasal breathing promotes harmonious growth and development of the maxilocraniofacial complex. It interacts with other physiological functions such as chewing and swallowing in addition to setting tongue and lips in a normal position.[3] In contrast, mouth breathing does not provide normal conditions for the development of the nasomaxillary complex. It provokes the lowering of the jaw, leading to extrusion of the posterior teeth and alveolar process remodeling. The increase in vertical proportions was observed in both humans and animals, significantly changing the morphology of the face.[4]

Another consequence of mouth breathing is the flexion of the head in relation to the cervical spine, which allows the jaw to remain in its correct position while the skull is flexed back. The flexion of the head causes stretching of the teguments which, in turn, acts as a restrictive force to facial development.[4,6]

This restriction to the facial development of mouth breathers probably results in alterations of the teguments as well. Souki et al[7] noted differences in the facial soft tissues of children who breathe through the mouth compared to those who breathe predominantly through the nose. However, it is unknown if these findings extend to older age groups.

Therefore, the purpose of this study was to compare the facial soft tissues of adolescent and young adults who breathe through the nose or the mouth to confirm the hypothesis that there are differences, using CBCT images.

MATERIALS AND METHODS

This comparative observational cross-sectional retrospective study was approved by the local ethics committee by the number 2.108.748. The material was composed of cone beam CT scans obtained prior to orthodontic treatment of patients belonging to the orthodontic clinic of the Universidade Federal Fluminense. These individuals were previously evaluated by an otolaryngologist. They were divided into two groups based on their respiratory pattern: mouth breathers (MB) or nasal breathers (NB), according to the results of their clinical exam (direct view), rhinoscopy, and nasal endoscopy. As this was a retrospective study, no exams were conducted specifically for the research.

Sample size calculation was performed using the formula described by Pandis[8] to determine the number of individuals required for each research group. Using an assumed power level of 80%, α of 0.05, and the standard deviation described in the article by Souki et al,[7] at least 16 subjects would be needed in each group.

The MB group was composed of 27 CT scans (mean age 14 years and 7 months), and the NB group was composed of 16 CT scans (mean age 15 years and 6 months).

The inclusion criteria for CT scans and patients were: 1. tomographic images from individuals between 11 and 24 years of age from both sexes; 2. in the permanent dentition stage; 3. no suggestive image of sinusitis; 4. without recent head and neck surgery (up to six months before the evaluation); 5. without inflammation or infection of the airways.

The exclusion criteria were: 1. orthodontic treatment; 2. sucking habits (finger and pacifier); 3. upper airway disorders perceived in the image exams; 4. syndromes; 5. neurological problems; 6. craniofacial anomalies.

Cone-beam computed tomography (CBCT) was performed using a 3D i-CAT scanner (Imaging Sciences International Inc., Hatfield, USA) and processed using native software (Xoran Technologies, Ann Arbor, Michigan) to create a DICOM file.

Participants were instructed to remain with a natural head posture by looking at a fixed point during the examination and to maintain maximum intercuspation. The CBCT was obtained in the complete FULL 220-mm mode, where the scanner performs two rotations (20+20 seconds; 0.4 voxel), allowing to scan the entire skull.

The images of the tomographic exams were stored in Digital Imaging and Communications in Medicine (DICOM) file format and imported into the InVivo Dental 5.3 software (Anatomage, San Jose, California).

The Super Ceph tool created images in the sagittal view like those of cephalometric radiographs. These images were evaluated by two examiners (one specialist in orthodontics and one dental radiology specialist). The objective was to reproduce an image similar to the lateral cephalometric radiograph. A 21.5" LCD widescreen monitor with 1920 × 1080-pixel resolution was used in the evaluation. The angular and linear measurements were carried out at random and blinded to the identity of the subjects. The measured variables are described in Table 1. Examples of three measurements are showed in Figure 1 (A, B and C).

Table1: *Description of the cephalometric variables.*

Variables	Definition
GSn.Pog' (convexity of the facial soft tissues)	Angle formed by the plans glabella (G) – subnasal (Sn) and subnasal (Sn) – integumentary pogonion (Pog')
ColSn.UL (nasolabial angle)	Angle formed between the plan that touches the base of the nose, passing through the subnasal (Sn) and columela (Col) points, and the plan that touches the outermost point of the upper lip (UL)
ColUL-Np (nasal prominence)	Distance between the columela (Col) – upper lip (UL) plan and the most prominent point of integumentary nose profile (Np)
UL-SnPog' (upper lip protrusion)	Distance between the plane formed by the subnasal point (Sn) and integumentary pogonion (Pog') with the upper lip
LL-SnPog' (lower lip protrusion)	Distance between the plane formed by the subnasal point (Sn) and integumentary pogonion (Pog') with the lower lip
UI-Vertical border 1(upper lip thickness)	Distance between the most prominent point of the contour of the upper central incisor (UI) and the vertical border 1 (perpendicular to the Frankfurt horizontal plane passing through the outermost point of the upper lip)
LI-Vertical border 2 (lower lip thickness)	Distance between the most prominent point of the contour of the lower central incisor (LI) and the vertical border 2 (perpendicular to the Frankfurt horizontal plane passing through the outermost point of the lower lip)
STO^u-Sn (upper lip length)	Distance between the innermost point of the contour of the upper lip (upper stomium; STO^u) and the subnasal point (Sn)
STO^l-Me' (lower lip length)	Distance between the innermost point of the contour of the upper lip (lower stomium STO^l) and the lowest point of the mandibular symphysis in soft tissue (Me')
Pog-Pog' (chin thickness)	Distance between the most anterior point of the outline of the chin in the sagittal plane (Pog) and its equivalent in soft tissue (Pog')
GoGN.SN (mandibular plane angle)	Determined by the intersection of the mandibular plane (Go-Gn) with the line SN
Inclination of the 1	Angle formed between the long axis of the upper central incisor and the palatal plane

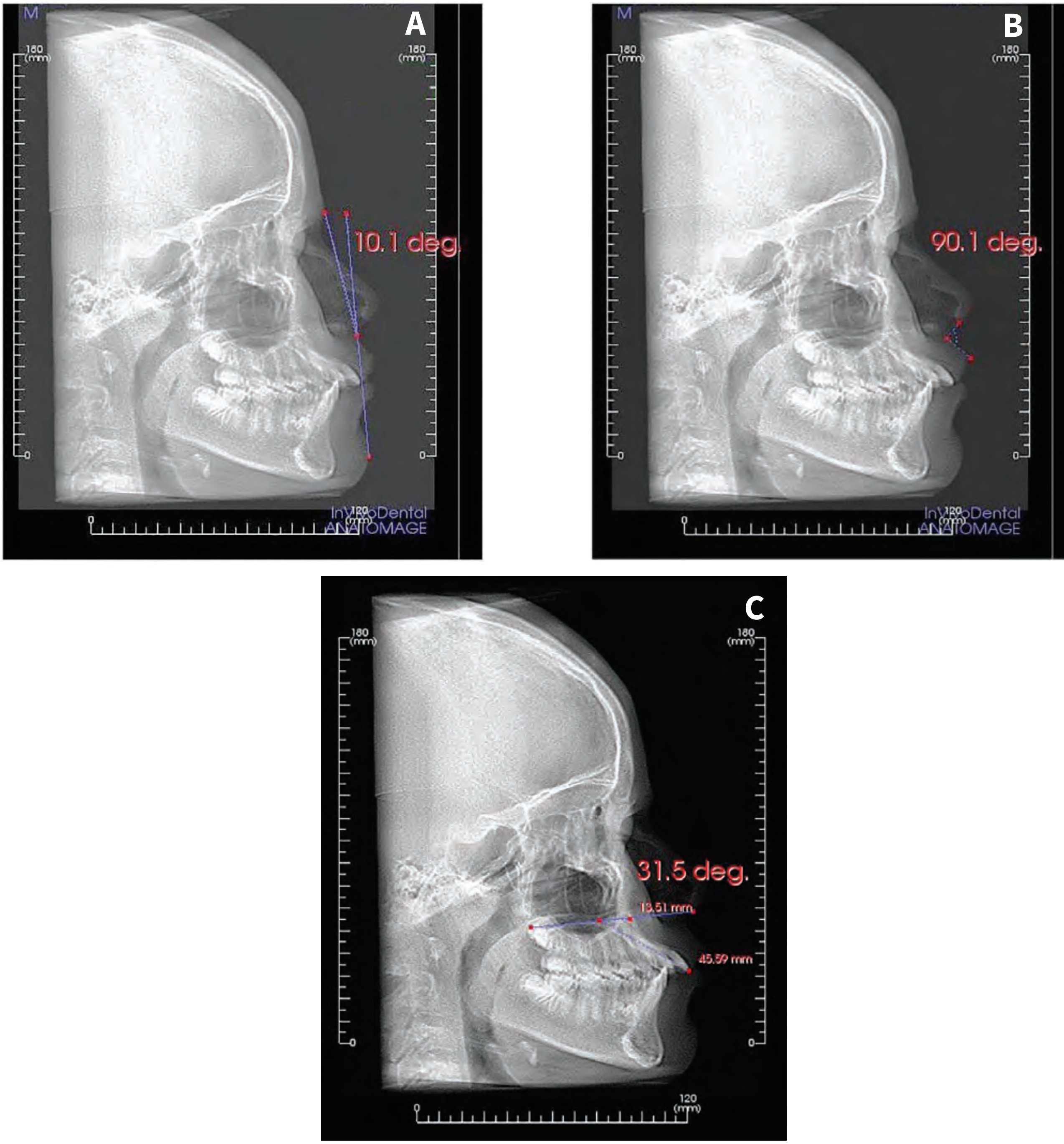

Figure 1*: Measurement of the variables using the software InVivo Dental 5.3. A: Convexity of the facial soft tissues (degrees); B: Nasolabial angle (degrees); C: Upper incisor inclination (degrees).*

All statistical analysis was performed using SPSS for Windows (version 20.0, IBM, Armonk, NY). The level of 5% of probability was adopted as a statistically significant difference.

RESULTS

The Angle Class II malocclusion affected 40.7 % of the mouth breathers and 12.5 % of the nose breathers.

Table 2 shows the ICC and the paired *t*-test results. For both inter- and intra-examiner, the reproducibility of eight variables were considered excellent (ICC $\geq$ 0.75), while

Statistical Analysis

All measurements were repeated by both examiners within a 30-day interval. The intraclass correlation coefficient (ICC) and paired *t* test were used to evaluate inter- and intra-examiner error of the method.

The normality of the data distribution was checked using the Kolmogorov–Smirnoff test. The independent samples *t*-test was used to perform the inter-groups comparison.

four were considered satisfactory (0.5 ≤ ICC < 0.75)[9]. The variable of "lower lip thickness" presented a statistically significant difference in inter- and intra-examiner comparisons (p = 0.039 and p = 0.018, respectively). The variable of "upper lip length" showed statistically significant difference in the intra-examiner comparison (p = 0.001). These values obtained were therefore considered unreliable and were dropped from the research.

Table 3 presents the means, standard deviations, and range of values for each variable in the MB and NB groups. According to the results of the independent samples *t* test, significant differences were observed for the variables "convexity of the facial soft tissues" (p = 0.017), "nasolabial angle" (p = 0.034), and "inclination of the 1" (p = 0.010). In other words, mouth breathers present greater convexity of the facial soft tissues with higher values for the nasolabial angle and their upper incisors are more retroinclined.

Table 2: *Intraclass correlation coefficient (ICC) and paired t test with the significance level for each variable for the intra and inter-examiner comparison.*

Variable	ICC		*t* test			
	Intra-examiner	Inter-examiner	Intra-examiner		Inter-examiner	
			Difference	p	Difference	p
Convexity of the facial soft tissues (°)	0.938	0.882	1.69	0.519	0.06	0.896
Nasolabial angle (°)	0.630	0.688	1.03	0.602	0.48	0.791
Nasal prominence(mm)	0.667	0.666	0.22	0.411	0.34	0.255
Upper lip protrusion (mm)	0.869	0.836	0.08	0.698	0.23	0.339
Lower lip protrusion (mm)	0.911	0.926	0.13	0.459	0.03	0.835
Upper lip thickness(mm)	0.682	0.752	0.21	0.373	0.08	0.656
Lower lip thickness (mm)	0.807	0.651	0.42	0.039*	0.59	0.018*
Upper lip length (mm)	0.830	0.835	0.87	0.001*	0.33	0.175
Lower lip length (mm)	0.495	0.862	1.16	0.180	0.13	0.721
Chin thickness (mm)	0.813	0.698	0.13	0.504	0.24	0.405
Inclination of the 1 (°)	0.871	0.802	0.07	0.664	0.05	0.912
Mandibular plane angle (°)	0.849	0.852	0.77	0.087	0.31	0.352

Note: * = p < 0.05

Table 3: *Arithmetic means (Mean), standard deviations (SD), minimum and maximum values of the variables related to mouth and nasal breathers, and the independent t test significance level (p-value).*

	Mouth breathers (n = 27)				Nasal breathers (n = 16)				Significance
	Mean	SD	Minimum	Maximum	Mean	SD	Minimum	Maximum	(*p*-value)
Age	14y07m	03y00m	11y00m	22y06m	15y06m	03y04m	11y02m	24y05m	0.327
Convexity of the facial soft tissues (°)	17.07	6.15	9.10	35.30	11.81	7.57	-12.10	20.40	0.017*
Nasolabial angle (°)	103.00	15.82	66.30	130.00	92.85	12.29	70.60	113.10	0.034*
Nasal prominence (mm)	7.63	2.29	3.38	11.76	8.18	2.41	3.41	13.15	0.457
Upper lip protrusion (mm)	4.90	2.79	1.08	12.20	4.92	2.57	0.23	10.37	0.986
Lower lip protrusion (mm)	5.14	3.12	0.15	10.81	5.39	2.82	2.09	12.70	0.789
Upper lip thickness (mm)	9.42	1.78	6.42	12.50	9.63	2.10	6.43	14.08	0.736
Lower lip length (mm)	50.20	4.33	43.43	60.45	49.56	5.23	41.99	58.44	0.670
Chin thickness (mm)	12.03	2.39	8.30	18.14	12.45	1.94	9.73	16.69	0.551
Inclination of the 1 (°)	65.70	8.00	53.80	85.30	58.38	9.92	31.50	71.50	0.010*
Mandibular plane angle (°)	34.83	5.99	23.50	45.00	32.53	4.43	24.50	38.50	0.190

Note: * = p < 0.05

DISCUSSION

Several studies have been conducted to clarify the consequences of mouth-breathing on craniofacial growth.[3,10,11] However, very little work has been performed on the changes of the facial soft tissues of mouth breathers.

For many years, severe nasal obstruction was believed to cause "adenoid facies," characterized by a half-open mouth, raised upper lip, unexpressive physiognomy, and tendency to drool. Currently it is known that, this condition affects only a small portion of mouth breathers.[4]

Significant differences in the facial soft tissues were observed between nasal and mouth breathing children,[7] aged two to ten years (mean age six years and seven months). The present study aimed to verify which changes would be expected in teenagers and young adults, aged between 11 and 24 years.

The convexity of the facial soft tissues of mouth breathing teenagers and young adults was larger than NB. This result can be explained by the difference in the selection of the groups. In the MB group, the percentage of individuals who had dental Class II relationship (Angle) was 40.7%, compared to 12.5% in the NB group. In fact, a previous study found that the prevalence of Class II is higher among mouth breathers.[12] In contrast, Souki et al[7] found no significant difference in children, likely because the two groups selected by these authors presented an equal number of individuals with a tendency toward Class II.

The nasolabial angle of mouth breathers was significantly higher than NB. This finding is associated with the larger lingual inclination of upper incisors, which is significantly higher in mouth breathers. Various authors[4,13,14] reported that nasal obstruction and consequent mouth breathing, has the effect of retroinclination of these teeth, which produces a more obtuse nasolabial angle. In contrast, Souki et al[7] found opposite results, explaining this by a compensation of a more anterior position of the upper lip which would facilitate better air flow.

The other variables studied showed no significant differences between groups. However, it is interesting to note that the inclination of the mandibular plane angle was higher in the MB group (34.83^o) than in the NB group (32.53^o), consistent with previous literature.[4,13]

"Chin thickness" was higher in the NB group, although not statistically significant. On the other hand, the study by Souki et al[7] has shown a significant difference in chin thickness in children groups of mouth and nose breathers, which is likely explained by the difference in the number of Class I and II components between groups selected by those authors.

Other discrepancies were observed when the results of this survey were confronted with those recorded in the youngest group.[7] Mouth breathing children presented significant differences for "nasal prominence", "upper lip protrusion", "lower lip protrusion", and "lower lip length" compared with NB. One possible explanation is that the thickness and the length of the lips become larger over the years,[15] which proportionally decreases the difference in older age groups. In our research, despite a non-statistical significance, the values for these variables tended to be higher in the NB group.

Perhaps the aesthetic perception of the adolescent/young adult about their facial profile can lead to unconscious lip closure. This habit could likely change the profile characteristics.

A limitation of the research was the non-inclusion of the skeletal pattern as one of the sample selection criteria. Therefore, the realization of further studies on this subject is highly recommended.

CONCLUSION

Adolescent and young adult mouth breathers present greater convexity of the facial soft tissues. They also have an open nasolabial angle due to the retroinclination of the upper incisors, but there are still many unanswered questions regarding facial integuments of mouth breathers.

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