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Facial soft tissues of mouth-breathing children: Do expectations meet reality?

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ABSTRACT

Objective: To quantify the differences between the facial soft tissue morphology of severely obstructed mouth breathing (MB) and that of predominantly nasal breathing (NB) children.
Methods: Soft tissue measurements were performed in the lateral cephalograms of 64 severely obstructed MB children (mean age 6.7 ± 1.6) compared with 64 NB children (mean age 6.5 ± 1.3). Groups were paired by age, gender, skeletal maturation status and sagittal skeletal pattern. Based on the assumption of normality and homoscedasticity, comparison of the means and medians of soft tissue measurements between the two groups was performed.
Results: The facial convexity and anterior facial height ratio of MB were similar to NB children. The upper lip of MB children was protruded, and its base was thinner compared with NB; however, the length was not affected. The lower lip was shorter and more protruded in MB children. The nasolabial angle, nasal prominence, and chin thickness were smaller in MB children.
Conclusions: The facial soft tissue of severely obstructed MB children is different than in NB children. Changes in lips, nasolabial angle, nasal prominence, and chin thickness are associated with severe airway obstruction in children.

1. Introduction

The first report on the association between mouth breathing (MB) and facial deformities is now 150 years old [1]. Despite the knowledge gathered since on the dentoskeletal pattern [2–6], the literature on the soft tissue pattern of nasal-impaired children is scarce and contradictory [4,7–10].

Anecdotal comments on aberrant facial soft tissue development have marked the last decades of the 19th century and first half of 20th century and contributed to the establishment of an adenoid face stereotype in the minds of health science professionals [11]. Clinical and animal studies thereafter helped to build the concept that the obstruction of upper airway airflow leads to a disrupted facial muscular framework in mouth breathers. Harvold' [12] studies on monkeys with nasal obstructions demonstrated that under such conditions, upper lips develop a notch due to muscle activity that keeps the mouth open. However, the response was not uniform among the animals.

The adenoid face soft tissue profile after the change in the mode of respiration are clinically described in textbooks. However, these descriptions are based on clinical aspects without quantitative measurements. A literature review on this topic showed that soft tissue evaluations are neglected and that objective data are rare. The upper lip of MB children was found to be thicker than nasal breathing (NB) children [13]. No association was found between lip posture and anterior face height with nasal airflow resistance [7], however lip posture was associated with backwardly rotated face and larger lower facial height in mouth-breathers [10]. Other previous publications have concluded that breathing patterns did not influence facial soft tissue measurements [8,9]. However, sampling problems related to size, definition of MB and lacking a matched control group may explain these results.

At this point, some questions have no objective answers: (1) Is the facial profile balance of MB different than NB? (2) Is the upper lip actually shorter, thinner and more protrusive in MB children? (3) Is the lower lip in MB children longer, thicker and everted? (4) Is

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the nasolabial angle affected? (5) Do nasal prominence and the chin compensate their forms and positions following a change in breathing pattern? Knowing the soft tissue morphology of MB children is an important diagnostic tool for pediatric dentists because they hold the best position to screen and to indicate treatment to patients who suffer from upper airway obstruction.

Therefore, this study aimed to quantitatively measure the soft tissue pattern of severely obstructed children, evaluating if the expected soft tissue facial morphology of MB meet reality.

2. Materials and methods

Approval for this study was obtained from the Institutional Review Boards at Pontifical Catholic University of Minas Gerais and at Federal University of Minas Gerais, Belo Horizonte, Minas Gerais, Brazil. All procedures, possible discomforts or risks, and possible benefits were explained to the parents of all patients involved, and informed consent was obtained from each parent.

2.1. Population

The sample size of each group was calculated based on an alpha significance level of 0.05 and a beta of 0.2 to achieve a power of 80% to detect a mean difference of 2° or 1 mm between the groups, with a median estimated standard deviation of 4° or 1.67 mm, according to Saglam and Gazilerli [14]. The sample size calculation showed that 63 patients in each group were needed.

The MB population involved 749 children who were consecutively referred by pediatricians or primary care physicians to the Outpatient Clinic for Mouth-Breathers at the Clinics Hospital from the Federal University of Minas Gerais, between November 2002 and November 2010. Patients, whose parents presented a chief complaint of MB, were systematically evaluated in a single visit by a multidisciplinary team comprising physicians, dentists, and speech pathologists.

Children in whom MB could not be confirmed, those who had previous orthodontic treatment, had permanent dentition, had any craniofacial anomaly, including an Angle Class III malocclusion, were younger than 2 years of age or older than 10 years of age, had severe dental decay, had behavior limitations precluding a cephalometric examination, or who had any history of persistent finger and pacifier sucking habits were excluded from the analysis. To be included, all children were required to have a high-quality lateral cephalometric radiograph taken at the first consultation and severe nasopharyngeal obstruction requiring adenotonsillectomy to normalize breathing. This evaluation was based on the clinical and endoscopic ENT examination performed by two of the authors, who were previously calibrated. Only severely obstructed children (nasopharynx obstruction ≥75% [15] and/or tonsils of Brodsky and Koch's [16] grades 3–4) with a surgery indication were included in the present investigation. Therefore, the MB sample consisted of 64 patient cephalograms. The mean age of patients in this group was 6 years, 7 months ± 1 year, 6 months. Thirty-one girls and 33 boys were included. Eleven MB children had a Class II dental malocclusion, and 53 presented a Class I pattern.

The corresponding control group was composed of 64 cephalograms from predominantly NB who had been included in the Pontifical Catholic University of Minas Gerais Growth Study (Ethics Committee approval CAAE 2001/03), and from a pediatric dentistry private practice at the same city. Their parents were questioned about the children's medical history to exclude any subject with chronic mouth breathing, permanent snoring and tonsillectomy or adenoidectomy. Nasal breathers with evident hyperplasia of the tonsils and adenoids on cephalometric film were excluded from further analysis. The mean age of the NB children was 6 years, 5 month ± 1 year, 3 months; the sample comprised 32 girls and 32 boys. These children lived in the same city as the MB group and were matched by gender, age group, sagital dental relationship (Class I $n = 53$ vs. Class II $n = 11$) and skeletal maturation status ($P > 0.05$) [17]. Therefore, the total number of children in this study was 128.

2.2. Cephalometric analysis

Standard lateral cephalometric radiographs were obtained to evaluate the soft tissue characteristics of the two groups. Children's teeth were in centric occlusion, and the lips were relaxed. Cephalometric landmarks were identified on all radiographs (Figs. 1 and 2) and hand-traced on acetate paper with a 0.3 mm HB lead pencil on a standard light box by one investigator. Radiographs were scanned and imported into a commercially available software system (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA) using a conventional table scanner (HP Officejet J4660 All-in-One Multifunctional Printer, Palo Alto, CA, USA) with an open lid and room light only. Standard scanning resolution was set to 300 dots per inch (dpi) gray scale.

Sixteen cephalometric soft tissue measurements were chosen based on previous publications [8,18–21] and their construction is illustrated in Figs. 1 and 2. They were grouped in 6 evaluation fields: facial convexity, facial height, nose, lips, sulcus and chin.

2.3. Skeletal maturation status

The maturation status was evaluated based on the appearance of cervical vertebrae C2, C3 and C4 [17]. All 128 children were in the prepubertal CS1 stage of maturation.

2.4. Statistical analysis

The data were analyzed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). Based on the results of the Kolmogorov–Smirnov and Levene tests, the assumptions of normality and homoscedasticity were evaluated to decide whether to use parametric (independent t-test) or non-parametric (Mann–Whitney) comparison of the means and medians of the two groups. Chi-square test and independent i-test were used to verify the similarity of MB and NB samples. A P-value less than 0.05 indicated statistical significance.

To determine errors in landmark identification and measurements, 25 randomly selected head films were retraced, and repeat measurements were taken by the same orthodontist after an interval of at least one month. Random error was calculated using Dahlberg's equation [22]. Systematic error (bias) was assessed using the paired t-test, for $P < 0.05$.

The systematic error in measurement did not exceed 0.30° or 0.45 mm. The correlation was higher than 0.938 for all measures; thus, systematic reading errors were considered to be of no further importance. The random error ranged between 0.38 and 0.50 mm for the linear measurements and between 0.19° and 0.28° for the angular measurements. There were no statistically significant differences between the two measurements in the error analysis.

3. Results

Figs. 1 and 2 illustrates in red the soft tissue measurements where significant differences were found between MB and NB. Measurements in black are those where no differences were detected. Fig. 3 illustrates the soft tissue pattern of severely obstructed MB children. Comparisons between the mean, standard deviation, medians and range of the soft tissue cephalometric