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Are distinct etiologies of upper airway obstruction in mouth-breathing children associated with different cephalometric patterns?

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ABSTRACT

Objective: To test the null hypothesis that mouth-breathing (MB) children by distinct obstructive tissues present a similar cephalometric pattern.
Methods: The sample included 226 prepubescent children (113 MB and 113 nasal breathing (NB) controls). An ENT clinical examination, including flexible nasal endoscopy, orthodontic clinical and cephalometric examinations, was performed on the MB population. MB children were grouped into three categories, according to the obstructive tissues: 1) adenoid group (AG), 2) tonsillar group (TG), and 3) adenotonsillar group (ATG). The NB controls were matched by gender, age, sagittal dental relationship and skeletal maturation status. Lateral cephalometric radiography provided the cephalometric pattern comparisons between the MB and NB groups.
Results: MB cephalometric measurements were significantly different from those of NB children, exception in the SNB° ($P = 0.056$). All comparisons between the three groups of MB children with the NB children showed a significant difference. Finally, even among the three groups of MB children, a significant difference was observed in the measurements of the SNB° ($P < 0.036$), NSGn° ($P < 0.028$) and PFH/TAFH ratio (posterior facial height/total anterior facial height) ($P < 0.012$).
Conclusions: The cephalometric pattern of MB and NB children was not similar. Cephalometric measurements of the MB group differed according to the etiology of upper airway obstruction. Children with isolated hypertrophy of the palatine tonsils presented with a mandible that was positioned more forward and upward compared to children obstructed only by the enlarged adenoid.

1. Introduction

Mouth breathing (MB) is associated with facial skeletal changes [1–8], and thus, a cephalometric stereotype of mouth breathers has been built in the clinicians' mind [9,10]. MB children compared with nasal breathers (NB) are expected to have a more backward mandibular rotation, an increased lower anterior face height, a steeper mandibular plane, a reduced ratio of the posterior face height/total anterior face height, and an increased sagittal maxilla-mandibular discrepancy [5,8,11]. However, changes in the mode of breathing from nasal to oral are a consequence of several etiological factors. Combinations of distinct obstructive tissues from the Waldeyer's lymphatic ring play an important role in the MB process [12]. In young children, adenoids and palatine tonsils hypertrophy, which can be identified isolated or in combination, are highly prevalent [13,14]. The vast majority of previous investigations considered all MB subjects as if the etiology of the upper airway obstruction would not be a confounding factor, and no distinction was provided.

Studies assessing the facial morphological patterns of MB children according to etiological factors are rare in the literature [15–18] and have shown contradictory conclusions. It has been suggested that MB children with palatine tonsil hypertrophy present a more anterior posture of the tongue and a distinct facial morphology compared with pharyngeal tonsil-obstructed children [15,17], but such a statement was not consistent with other reports [16,18]. However, in those investigations, the sample size was small and/or the diagnosis of MB was based on radiography exams rather than on ENT nasoendoscopy. In addition, the cutting-point for the classification of obstruction was only 50%, which may not

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adequately identify a severe airway obstruction. Such factors might have biased the conclusions and created divergence between the results.

Thus, the primary objective of this study was to test the null hypothesis that MB children with distinct obstructive etiologies (adenoid and/or tonsil hypertrophy) present a similar cephalometric pattern. In addition, we aimed to compare the cephalometric pattern of those MB children with NB controls.

2. Materials and methods

The sample in this retrospective cross-sectional study consisted of 226 prepubescent children (113 MB and 113 NB) with deciduous (51.3%) and mixed dentitions (49.7%). Male were 58.8% (NB 57.5%; MB 60.2%). Subjects with previous orthodontic treatment, with any craniofacial anomaly, including an Angle Class III malocclusion, presenting neuromuscular disorders, aged younger than 3 years or older than 10 years, having severe dental decay, exhibiting behavior problems that precluded a cephalometric examination and with deleterious oral habits (non-nutritive sucking and bruxism) were excluded from the study. Approval for this study was obtained from the Institutional Review Boards at Federal University of Minas Gerais (ETIC 488/06 and ETIC 612/08) and the Pontifical Catholic University of Minas Gerais (CAAE 2001/02).

to achieve a power of 80% to detect a mean difference between groups of 1.5° for ANB°, 3.0° for SNGoGn° and NSGn°, according to the median estimated standard deviation previously described by Baroni et al. [15]. The sample size calculation showed that at least 26 subjects in each group were required.

The MB population involved 876 children who had been 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 2011. The main reason for children's referral by their physicians was to a comprehensive ENT evaluation and treatment of the breathing pattern. Children presented sleeping disorders and MB. All of the children's parents presented the chief complaint of MB. The patients were systematically evaluated in a single visit by a multidisciplinary team consisting of physicians, dentists, and speech pathologists. A clinical and endoscopic ENT examination, which was performed by two of the authors, allowed the classification of MB children according to the obstructive tissues into three groups: (1) adenoid group (AG), (2) tonsillar group (TG), and (3) adenotonsillar group (ATG). Only severely obstructed children (nasopharynx obstruction ≥80% [19] and/or children with tonsils of Brodsky and Koch's [20] grades 3 and 4 with a surgery indication were included in the present investigation. The mean age of the MB patients was 6.3 ± 1.10 years. The lateral cephalometric radiographies of all patients who met the inclusionary criteria were analyzed in this investigation.

The NB group, which served as controls, consisted of 113 cephalograms from predominantly NB children 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 in the same city. The parents were questioned regarding their 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 6.4 ± 1.2 years. MB and NB children were matched by gender, age group, sagittal dental relationship, and skeletal maturation status ($P > 0.05$) [21].

Cephalometric analysis was performed by a single examiner using the Cephalometric Tracing module of Dolphin Imaging software (version 11.5, Dolphin Imaging & Management Solutions, Chatsworth, CA, USA). Six cephalometric measurements were selected according to previous publications [15,22] to characterize the vertical and sagittal sample pattern, and the results are illustrated and described in Fig. 1.

To determine the errors in the identification of landmarks and cephalometric measurements, 25 radiographs were randomly selected, retraced, and re-measured by the same examiner after a 2-month interval. The random error was measured using the Dahlberg's equation [23]. The systematic error (bias) was assessed using a paired *t*-test ($P < 0.05$).

The data were statistically analyzed using SPSS software version 16.0 (SPSS Inc., Chicago, IL, USA). The results of the Kolmogorov–Smirnov and Levene tests showed compliance with the assumptions of normality and homoscedasticity by all measurements (angular and ratio measurements). Thus, inter-group parametric tests (*t*-test and ANOVA) were used. Post hoc Dunnett's test for multiple comparisons between the NB and three MB groups (AG, TG, and ATG) and Tukey's test for multiple comparisons among AG, TG, and ATG were performed. The significance level was set at 5%.

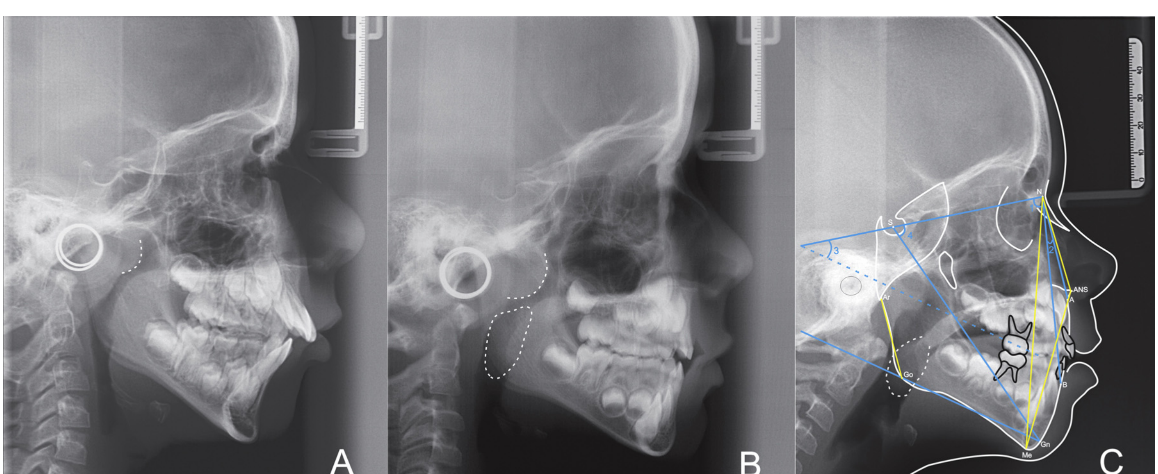

Fig. 1. (A) Lateral cephalometric radiography of a 8-year-old mouth-breathing girl presenting adenoid's obstruction; (B) lateral cephalometric radiography of a 6-year-old mouth-breathing boy presenting adenoid and tonsils obstruction; and (C) lateral cephalometric radiography and cephalogram of a 5-year-old mouth-breathing girl presenting tonsil's obstruction. Sagittal skeletal relationship: (1) SNB°, (2) ANB°. Vertical skeletal relationship measurement: (3) SNGoGn°, (4) NSGn°, (5) PFH/TAFH ratio, (6) LAFH/TAFH ratio. Note: PFH: Ar-Go; LAFH: ANS-Gn; TAFH: N-Me.