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Craniocervical posture and hyoid bone position in children with mild and moderate asthma and mouth breathing

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ABSTRACT

Introduction: The objective of the present study was to assess the craniocervical posture and the positioning of the hyoid bone in children with asthma who are mouth breathers compared to non-asthma controls.
Methods: The study was conducted on 56 children, 28 of them with mild ($n = 15$) and moderate ($n = 13$) asthma (14 girls aged 10.79 ± 1.31 years and 14 boys aged 9.79 ± 1.12 years), matched for sex, height, weight and age with 28 non-asthma children who are not mouth breathers. The sample size was calculated considering a confidence interval of 95% and a prevalence of 4% of asthma in Latin America. Eighteen variables were analyzed in two radiographs (latero-lateral teleradiography and lateral cervical spine radiography), both obtained with the head in a natural position. The independent *t*-test was used to compare means values and the chi-square test to compare percentage values ($p < 0.05$). Intraclass correlation coefficient (ICC) was used to verify reliability.
Results: The Craniovertebral Angle (CVA) was found to be significantly smaller in asthma than in control children (106.38 ± 7.66 vs. 111.21 ± 7.40, $p = 0.02$) and the frequency of asthma children with an absent or inverted hyoid triangle was found to be significantly higher compared to non-asthma children (36% vs. 7%, $p = 0.0001$). The values of the inclination angles of the superior cervical spine in relation to the horizontal plane were significantly higher in moderate than in mild asthma children (CVT/Hor: 85.10 ± 7.25 vs. 90.92 ± 6.69, $p = 0.04$ and C1/Hor: 80.93 ± 5.56 vs. 85.00 ± 4.20, $p = 0.04$).
Conclusions: These findings revealed that asthma children presented higher head extension and a higher frequency of changes in hyoid bone position compared to non-asthma children and that greater the asthma severity greater the extension of the upper cervical spine.

1. Introduction

Asthma is a chronic inflammatory disease causing episodes of air flow obstruction, hypersensitivity, responsiveness to several stimuli [1], as well as the persistence of respiratory symptoms such as cough, wheezing, reduced thoracic mobility and increased respiratory rate [2]. The prevalence of asthma in Latin America ranges from 4% to 26% among children of school age [3].

Asthma patients present increased resistance of the lower airways and hyperinflation. The maintenance of this pattern can lead to flattening of the diaphragm dome and shortening of the cervical respiratory muscles which in turn, could lead to the development of altered head and cervical spine posture [4,5].

Mouth breathing habit could either contribute to head and cervical spine posture changes [6–8] deflagrated by nasal allergic diseases (such as rhinitis, sinusitis and nasal polyps) commonly verified in asthma children reaching prevalence as high as 100% [9]. Moreover, a series of changes in the musculoskeletal structures of the face may occur due to mouth breathing like as elongated facial pattern [10,11] and changes in hyoid bone position [12–14].

However, few studies determining the changes in craniocervical posture in asthma children are available in the literature. Wenzel et al. [8] conducted one of the few studies assessing the

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influence of nasal obstruction on the craniocervical posture of asthma children. On the other hand, in a later study, Wenzel et al. [15] did not detect difference in craniocervical posture between asthma and healthy controls. However, the authors only assessed cervical posture up to the C4 vertebra.

Since there is a scarcity of studies determining cervical posture as a whole and hyoid bone position by radiographic measurement in asthma subjects with mouth breathing, the aim of the present study was to assess craniocervical, neck posture and hyoid bone position in asthma children who are mouth breathers by a radiographic method and to compare the results to those obtained for non-asthma children.

The first hypothesis of this study was that children with asthma and mouth breathing are more likely to have head and cervical spine posture, as well as, hyoid bone position changes than non-asthma children. And the second hypothesis was that asthma severity could aggravate head and cervical posture changes.

2. Methods

2.1. Sample

Sample size was calculated considering a 95% confidence interval and a prevalence of 4% of asthma in Latin America [3]. We evaluated 56 children aged 7–12 years, 28 of them with asthma and 28 non-asthmatic and non-mouth breathers matched for age, sex, weight and height. The group of asthma children (14 boys and 14 girls) consisted of 15 subjects with mild asthma and 13 subjects with moderate asthma and the control group consisted of 14 boys and 14 girls without the disease. The groups did not differ significantly in anthropometric data (Table 1).

The 28 asthma children were selected at random at the Pediatrics outpatient clinic of a local tertiary hospital. Asthma severity was classified according to the criteria of the Global Initiative for Asthma (GINA) [16] and all subjects were supposed to have Forced Expiratory Volume in the first second (VEF_1) > 60% in relation to predicted values for age, sex and height, and a clinical diagnosis of asthma. Children with severe asthma were excluded from the study to the presence of comorbidities [17,18]. The clinical diagnosis of asthma was complemented with the criterion of the American Thoracic Society (ATS) [19] of a variation of at least 12% in FEV_1 in the spirometry test (Koko Spirometer, PDS Instrumentation, Inc., Louisville, CO, USA) before and after the use of a bronchodilator. All patients had been treated only with an inhaled corticosteroid (budesonide, 400–800 μg/d) and β2-agonists, as required, for at least 6 months before the beginning of the study.

The sample was selected from January 2004 to May 2006. Only mouth breathers were included in the asthma group. To be considered a mouth breather, the child had to meet at least two of the following criteria [20]: (1) the parents reporting that the child breathed through the mouth during the day or night; (2) lip incompetence posture observed during the interview, and (3) a clinical diagnosis of mouth breathing by and otorhinolaryngologist or a dentist.

Table 1
Anthropometric data of the sample studied. Data are reported as means ± standard deviation.

Sex	Age (years)	Height (m)	Weight (kg)
Asthma children group			
Females (n = 14)	10.79 ± 1.31	1.46 ± 0.13	39.70 ± 11.76
Males (n = 14)	9.79 ± 1.12	1.41 ± 0.07	37.88 ± 9.13
Entire group (28)	10.29 ± 1.30	1.43 ± 0.10	38.79 ± 10.37
Control group			
Females (n = 14)	10.50 ± 1.16	1.45 ± 0.10	39.56 ± 8.47
Males (n = 14)	9.96 ± 2.03	1.39 ± 0.26	37.94 ± 9.69
Entire group (28)	10.25 ± 1.21	1.43 ± 0.09	38.94 ± 8.22

Student's t-test, $p < 0.05$.

The control group consisted of non-asthma children who were nose breathers and who obtained a score of less than 4 on the ISAAC questionnaire (International Study of Asthma and Allergies in Childhood) [21]. Control children were selected among the students at a local public school and matched for weight and age to asthma children from the same school. The exclusion criteria for this group were: presence of mouth breathing during the interview or a clinical diagnosis of mouth breathing (allergic rhinitis, hypertrophic palatine tonsils or adenoid tissue, choanal atresia, and nasal polyps).

Children were also excluded from both groups in the presence of the following items: use of orthodontic braces or previous orthodontic treatment, presence of rheumatologic diseases, history of musculoskeletal trauma, musculoskeletal malformations, and previous adenoidectomy or tonsillectomy. The study was approved by the Ethics Committee of the Institution (protocol no. 8562/2003) and parents or persons responsible gave written informed consent for the participation of the children in the study.

2.2. Radiographic procedures

The children were radiographed in lateral profile in the standing position, with their feet separated by a distance of 7.5 cm and resting on the floor on a point corresponding to the cephalostat center, and with their arm stretched out. Before being positioned, the volunteers were instructed to move around the examining room and then to position themselves naturally on the previously marked site. The volunteers were instructed to look at themselves in a mirror positioned at a distance of 1 m [12] to guarantee a natural head position (NHP). All radiographs were obtained by the same technician.

A latero-lateral teleradiography for the evaluation of craniocervical posture was obtained with the patient in the position of centric dental occlusion (chassis with 18 cm × 24 cm T MAT G Kodak film) and the chassis positioned adjacent to the face of the volunteer. The auricular rods of the radiography apparatus were not positioned inside the hearing conduits but, after the determination of NHP, they were placed close to the external acoustic meatus in order to stabilize the head in the latero-lateral position.

For the assessment of cervical posture a lateral cervical radiography was obtained (chassis with 24 cm × 30 cm T MAT G Kodak film) and the patient was instructed to keep mandibular postural position and the chassis was positioned immediately adjacent to the shoulder of the volunteer in order to guarantee visualization of the seventh cervical vertebra. If the child opted to keep his mouth open, this position was maintained at the time of the radiographic determination of cervical posture.

Latero-lateral teleradiography was obtained with the Orthophos Plus apparatus (Siemens, Germany) and a lateral cervical radiography was obtained with a Salgado & Hermann apparatus (São Paulo, Brazil). Both radiographs were obtained with a focus-film distance fixed at 1.52 m, obeying the radioprotection protocol issued by decree 453 of 01/06/1998 (Health Ministry, Sanitary Surveillance Secretariat).

2.3. Cephalometric tracings

All angles were traced manually on acetate paper by the same trained examiner, who was blinded to the identity of the volunteers.

A total of ten variables related to craniocervical posture were evaluated on the latero-lateral teleradiography. Seven Solow and