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Research Article

Cervical Mobility in Mouth Breathing Children

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Abstract

Mouth breathing is a breathing pattern of multifactorial etiology. The persistence of oral breathing brings a number of changes that characterize the Mouth Breathing Syndrome. Prioritization of oral airway associated with adaptative cervical protrusion can cause an imbalance of muscle forces by changing all postural axis. The aim of the study was to measure the cervical spine range of motion (ROM) in children diagnosed with mouth breathing (MB) and compare the values reported in the literature of healthy children. The sample consisted of 174 male children and 119 females with age between 3 and 12 years old (6.97 ± 2.42 years) and BMI of 17.00 ± 3.85. In order to measure cervical range of motion was used Cervical Range of Motion (CROM). Anthropometric variables and ROM were described as mean and standard deviation and ANOVA test was used to evaluate the influence of age on cervical mobility. The measures for cervical ROM showed an average of 51.290 ± 11.42 bending; 58.400 l ± 14.14 extension; 58.220 ± 12.83 right rotation; 57.390 ± 13 left rotation; 46.340 ± 10.69 right lateral bending ; and 47.480 ± 11.39 left lateral bending. There is a reduction in all planes of cervical range of motion and no interference of age in the range of motion in mouth breathing children.

Keywords: *Posture; Cervical Range of Motion; Children; Mouth Breathing*

Introduction

Mouth breathing (MB) is a breathing pattern of multifactorial etiology, whose main cause is the presence of allergic rhinitis and/or the hypertrophy of lymphoid structures - pharyngeal amygdala, tubal, palatine and lingual - besides the presence of deleterious oral habits [1]. The maintenance of this breathing pattern leads to the development of a set of alterations that characterize the Mouth Breathing Syndrome (MBS) [2]. The signs and symptoms are the predominance of mouth breathing and absence of passive lip sealing for a period longer than six months; head position compensatory adaptations [3] changes in dentocraniofacial morphology [4,5]; speech and chewing disorders [6], as well as nocturnal sleep disorders that cause daytime sleepiness, besides reduced memory and learning capacities [7]. Some Brazilian studies [8,9] have described the prevalence of MBS as around 56%. Other studies in the world described the prevalence of mouth breathing associated with oral habits harmful to sleep and the presence of nocturnal snoring, being 4.4% in India and 80% in Albania [10,11].

Considering the postural disorders resulting from MBS, the greatest alteration can be observed in the head positioning [12-15]. In order to increase the pharyngeal dimension and reduce the resistance of the airways, there is a compensatory tendency of the forwarding of the head and extension of the neck in children with MB, especially during the night [16]. This adaptation can trigger a muscular force imbalance changing the entire postural axis [2].

Prioritizing the oral air access route, the MB child recruits the nasal airway a little, compromising the filtration, humidification and heating functions of the inspired air. As a result, lung hypersensitivity, accompanied with volume and capacity reductions, occurs [17]. Nasal nerve afferent disorders are also consequences of upper airway obstruction that can lead to changes in lung ventilation [16]. The low diaphragmatic activity associated with abdominal hypotonia are muscle changes already found in Mb children [3] and trigger the supporting use of the accessory breathing muscles - sternocleidomastoid (ECM), scalene and pectoral muscles. The ECM and scalene muscles are individually or jointly responsible for flexion, extension, rotation and lateral inclination movements of the cervical spine. Thus, changes in the tension length curve of this musculature may reflect on the cervical range of motion (ROM) in MB children. Cervical ROM limitation is also related to the presence of neck pain, headache, osteomioarticular dysfunctions and temporomandibular disorders that negatively affect MB children's function and quality of life [18]. Therefore, it is necessary to give more attention to these symptoms during the MB child's evaluation and treatment.

The Inclinometer, used by physiotherapists in clinical practice, is an evaluation instrument that measures the cervical ROM and allows monitoring the evolution, as well as efficacy of the treatment. There are not many studies quantifying the ranges of flexion, extension, lateral rotation and lateral inclination motions in children, particularly in MB children [19].

Aim of the Study

The aim of this study was to measure the flexion and extension ranges of motion, as well as lateral inclination and lateral rotation of the cervical spine ROM in children with MB diagnosis, in order to compare with the values obtained for healthy children referenced in literature.

Materials and Methods

A cross-sectional observational study was carried out, in which 293 children received MB otorhinolaryngological diagnosis through videonasopharyngolaryngoscopy and immediate-reading cutaneous test, due to upper airway obstruction and/or allergic rhinopathy. Children of both sexes, aged from 3 to 12 years, were evaluated and those who presented previous history of adenotomy and/or tonsillectomy, diagnosis of congenital heart diseases, neurological disorders, abnormalities that compromised the normal development of growth, syndromes or were unfit to perform the proposed procedures, were excluded from the study. The calculation of the sample was based on the effect size of 0.5 with power of 90%, totalizing 267 children. All participants signed the free and informed consent form approved by the research ethics committee of the Federal University of Minas Gerais (CAAE: 08516312.9.0000.5149).

Data collection was carried out at the Mouth Breather Outpatient Clinic belonging to the Clinics' Hospital (Hospital das Clínicas) of the Federal University of Minas Gerais (HC-UFMG), whose team is composed of multidisciplinary professionals from the otorhinolaryngology and pediatrics departments of the UFMG Medicine School, in addition to physiotherapists, speech therapists, orthodontists and volunteer academics.

The Cervical Range of Motion instrument (CROM) was used to measure the children's cervical ROM. This instrument consists of a plastic rod in the form of glasses, with three fixed gravitational inclinometers: two lateral and one anterior. The lateral inclinometers measure the cervical spine flexion and extension ROM, whereas the one fixed on the anterior glasses, measures the lateral inclination ROM. At the children's data collecting position, a weight bar was used in the clavicular region, symmetrically connected to another bar of equal weight in the posterior thoracic region, in order to dissociate the cervical movements from the thoracic movements. As the inclinometer is magnetic, the movement is in the transverse plane for rotational measurements. The reproducibility of measurements with this instrument was tested in an earlier study [19].

In order to standardize the data, the children in this study were instructed to sit on a seat with a backrest and adjustable height, keeping their backs supported and their hands on their thighs. The positioning of the lower limbs varied according to the height of the children. After showing the desired movements, the cervical ROM was measured by the examiner using the Cervical Range of Motion (CROM) (Performance Attainment Associates, 958 Lydia Drive, Rosseville, MN 55113). The obtained values were presented in degrees and recorded in the medical records from which other information was also obtained as mouth breathing diagnosis, gender, weight, height and age.

Statistical analysis

The Kolmogorov Smirnov test was used to determine the studied sample normality. Anthropometric and evaluated ROM variables' data were presented as mean and standard deviation. Variance analysis (ANOVA) was used to evaluate the influence of age on cervical mobility. The obtained data were analyzed using Statistical Package for Social Sciences software (SPSS, Chicago, IL, USA) version 11.0, considering the value of $p < 0.05$. Epiinfo20 program was used to calculate the Z Score.

Results

The sample of this study was composed of 174 male children and 119 female children, with a mean age of 6.97 ± 2.42 years and BMI of 17.00 ± 3.85 (Table 1).

Age (Years)	Weight (Kg)	Height (Meters)	Z-score Weight/age	Z score Height/age	BMI
3 to 5	19,03	1,06	1,07	-0,22	17,53
	5,34	0,08	2,05	2,04	3,29
6 to 8	24,71	1,21	-0,30	-0,45	16,44
	5,52	0,08	1,78	1,54	3,61
9 to 12	36,28	1,39	-0,87	-0,50	17,18
	10,34	0,09	1,99	1,27	4,62

Table 1: Anthropometric data of Mouth Breathing children stratified by age.

Data records in mean and standard deviation.

BMI: Body Mass Index.

The cervical ROM measurements showed an average flexion of 51,290 ± 11,42; extension 58,400 ± 14,14; right rotation 58,220 ± 12,83; left rotation 57,390 ± 13,00; right inclination 46,340 ± 10,69; and left inclination 47,480 ± 11,39 (Table 2).

Variables	Values in Degrees
Flexion	51,29 ± 11,42
Extension	58,40 ± 14,14
Right Rotation	58,22 ± 12,83
Left Rotation	57,39 ± 13,00
Right Lateral Inclination	46,34 ± 10,69
Left Lateral Inclination	47,48± 11,39

Table 2: Range of cervical movement in mouth breathing children.

Results expressed as mean ± standard deviation.

The results of age-stratified ROMs are shown in table 3 and there is no age influence on cervical ROMs (p > 0.05).

Studies	Age (years)	Flexion	Extension	Rotation R Lateral	Rotation L Lateral	Inclination R Lateral	Inclination L Lateral
This Study 2016	3 to 5 n = 98	52,85 ± 11,02	57,48 ± 13,32	56,85 ± 12,11	54,72 ± 11,71	46,28 ± 11,75	47,93 ± 11,54
	6 to 8 n = 116	48,16 ± 11.49	57,24 ± 14,52	57,47 ± 11,84	58,24 ± 12,99	46,22 ± 10,92	47,43 ± 12,08
	9 to 12 n = 79	52,82 ± 10,97	57,61 ± 13,31	60,31 ± 13,61	58,44 ± 13,22	46,22 ± 11,71	47,85 ± 11,50
	Total	51,29 ± 11,42	58,40 ± 14,14	58,22 ± 12,83	57,39 ± 13,00	46,34 ± 10,69	47,48 ± 11,39
	p	0,76	0,8	0,9	0,35	0,43	0,45
Arbogaste., *et al.* 2007	3-5 n = 26	55.8 ± 5.5	75.3 ± 7.2	68.1 ± 8.8	68.8 ± 9.2	51.3 ± 6.7	47.6 ± 7.1
	6-8 n = 22	60.3 ± 5.0	77.2 ± 6.6	74.2 ± 9.6	73.8 ± 10.3	51.4 ± 5.6	50.2 ± 5.5
	9-12 n = 19	62.8 ± 9.1	75.3 ± 12.1	76.6 ± 9.2	76.1 ± 8.7	48.1 ± 5.5	47.3 ± 6.1
	Total	59.3 ± 7.1	75.9 ± 8.6	72.5 ± 9.8	72.5 ± 9.8	50.4 ± 6.1	48.4 ± 6.4

Table 3: Age effect on the Range of Cervical Movement in Mouth Breathing children, with stratified age ranges.

Results expressed in degrees as mean ± standard deviation.

R: Right; L: Left; *p < 0.05 ANOVA


NORTH

Discussion

The results found in this study show that the highest percentage of the sample (60.2%) is composed of male children and with low body mass index. Studies with MB children whose etiology is mechanical obstruction have already reported low weight as an anthropometric characteristic, due to the asynchrony between breathing and swallowing [21]. Regarding gender (the highest percentage being of boys in this study), it is known that IgE serum protein levels are usually higher in males compared to females. This may be a result of shorter lower respiratory tract and increased prevalence of allergic rhinitis in boys, despite that, during puberty, the incidence of this allergic disease becomes similar for both sexes [12]. Considering that the etiology of mouth breathing is multifactorial and the allergen is the main causing factor during childhood, male sex is considered, by some authors, a risk factor for the development of allergic diseases [17,18].

There is no consensus about the influence of sex on cervical ROM in literature. Youdas., et al. [22] found higher values of cervical ROM related to female sex, when assessing the active cervical ROM of 337 individuals aged from 11 to 97 years, a difference that tends to decrease through aging. Feipel., *et al.* [23] did not find a significant difference between females and males after comparing 250 individuals aged from 14 to 70 years.

The results in this study show that there are reductions in flexion, extension, rotation and lateral inclination cervical ROM in MB children in comparison with values that are referenced in literature [19,24]. As for cervical flexion ROM, the study that used CROM with normal children and similar age ranges showed higher ROM values than in this study (57,300 ± 7.1 x 51.290 ± 11.42). The same behavior was shown related to cervical extension (75.90 ± 8.6 x 58.400 ± 14.14), R lateral rotation (72.50 ± 9.8 x 58.220 ± 12.83), L lateral rotation (72.50 ± 9.8 x 57.390 ± 13.00), and R lateral inclination (49.40 ± 6.3 x 46.340 ± 10.69) [24].

Considering age stratification (3 - 5 years, 6 - 8 years and 9 - 12 years), the results in this study showed that there was no influence of age on cervical ROMs ($p > 0.05$). These results were similar to the results of Arborgast., et al. [24], when evaluating extension ($p = 0.71$), R lateral inclination ($p = 0.15$) and L lateral inclination ($p = 0.26$) ROMs in healthy children. In the referred study, the children presented a significant increase in flexion ($p = 0.002$), R lateral rotation ($p = 0.007$) and L lateral rotation ($p = 0.032$) cervical ROM degrees, with the increase in age. According to the authors, children elder than 5 years have better muscle coordination and greater motivation during movement performance. For this reason, they become biomechanically more developed to perform the proposed cervical movements. Youdas., et al. [22], after evaluating the influence of sex and age on cervical ROM, stated that there was a 3-degree decrease in lateral inclination and cervical rotation active ROM every 10 years in both sexes. Ohman and Beckung [25] evaluated lateral inclination and cervical rotation passive ROM in children aged from 3 to 5 years, using protractors. A 10-degree decrease in rotational ROM was observed and no significant difference was found between lateral inclination values.

In this study lower values of flexural ROM were observed compared to the values of extension ROM. The flexion ROM was about 7 degrees lower than the extension ROM. There was small variation between the R and L sides in the rotation and lateral inclination measures. In other studies, children, as well as adults, also presented lower values of flexion ROMs compared to extension ones [24,26].

Considering the cervical flexion ROM degrees, the results of this study (51,290 ± 11,42) are lower than those found by Neiva and Kirkwood [19] (58,010 ± 14,46) in MB children and by Arbogast., *et al*. [24] in their study (57.30 ± 7.1 years) with healthy children. Regarding the mobility of cervical extension, the results of this study (58,400 ± 14,14) are similar to those found in the study by Neiva and Kirkwood [19] (59.00 ± 10.79), who found restriction of cervical extension ROM in MB children. In both studies, the cervical extension values of MB children are lower by about 17 degrees, compared to the values in studies with healthy children. Ribeiro., *et al.* [27], when evaluating the surface electromyography of two accessory breathing muscles - sternocleidomastoid (ECM) and upper fiber trapezius - of MB children and nasal breathing children, found greater electrical activity during relaxation and less activity during voluntary maximal contraction of the musculature in MB children. ECM muscles, when bilaterally activated, perform cervical flexion, in addition to the accessory action of breathing. The scalene, as well as ECMs, when contracted unilaterally, perform joint homolateral inclination and contralateral cervical rotation. Thus, the hyperactivity of such muscles causes a decrease in the tension-length curve of this musculature, causing muscle shortening capable of restricting the extension, rotation ROM and the lateral inclination of the head.

The cervical protrusion posture performed through low cervical spine flexure, associated with the high cervical spine extension, is commonly found as a postural adaptation in MB children and may also cause changes in the curve length strain of the neck flexor and extensor muscles. By flexing the lower cervical spine, the levator scapula and semi-spinal muscles of the head are distended. However, the higher posterior rectus muscles of the head and suboccipital increase the activity of the high cervical extension, trying to horizontalize the head and functionally position the eyes, also leading to the shortening of this musculature [28]. Except for rotational movements, the ROM of the high cervical spine is relatively limited [29]. Thus, the results in this study, where a greater limitation of flexion movement was observed compared to the values related to cervical extension ROM, can be justified.

There is not any standardization of the cervical ROM measurement forms, considering the diversity of instrumentation and the difficulty of accurately measuring cervical movements. This region's complex anatomical structure results in synchronized and synergic movements, which makes it difficult to palpate individual anatomical marks. In addition to the accuracy and reproducibility of the used measuring instrument, it is also necessary to consider its ease of use, portability and cost [30]. Physiotherapists can estimate the amount of movement through observation, the use of simple inclinometers or gravitational goniometers, such as the CROM. The measurement of the cervical ROM with this instrument uses three planes - sagittal, frontal and transverse - and a scale in degrees. Measurement errors can be minimized, for it is not necessary to identify bone markers in the cervical spine. The instrument measures the cervical spine flexion movement arc, not considering the extension of the high cervical spine, a compensatory positioning generally adopted in MB children. To correct these small variations of anatomical positions, it was necessary for the examiners to consider this position as a reference and to add or subtract values to the measured value. Moreover, whereas some articles use measures with the upper limbs in fundamental position, that is, hanging along the body [22], other authors have already placed them at rest on the lower limbs in sitting position [24]. This positioning may have influenced the results, mainly the lateral inclination measurements, since the positioning of the arms in flexion causes a relaxation of the shoulders' position and, consequently, of the periscapular muscles, which are synergistic of the head rotation's lateral and contralateral inclination homolateral movements [28].

Regarding the psychometric properties of the CROM, studies that evaluated the relationship between ROM and cervical pain in adults, considered the reproducibility of intra-examiner measurements ranging from 0.84 to 0.95 (ICC) [22]. The inter-examiner reliability presented values between 0,73 to 0.92 (ICC) [31]. Assessing different methods of cervical ROM measurement, Youdas., et al. [22] found high intra-test reliability for flexion (ICC = 95) and extension (ICC = 90) cervical movements, measured by CROM, as well as when compared to the reliability of the Universal goniometer (Flexion/ICC = 83 - Extension/ICC = 86). Regarding the inter-test reliability, the CROM evaluation instrument also presented a higher value (Flexion/Extension ICC = 86), compared to both universal goniometer (Flexion/ICC = 57 - Extension/ICC = 79) and visual estimation technique for ROM measuring (ICC = 42). Studies carried out with children are few; instrumentation diversity and age stratification make result comparison difficult [24,32].

It is known that the lack of systematization in the procedures, presented among the studies, can have repercussions on the validity of the study and contribute to the diversity of cervical spine ROM values found in literature.

One of the limitations of this study was not comparing cervical ROM considering gender, as well as not repeating inter-rater reliability, considering the descriptions of previous studies [33,34]. Moreover, we observed that the children's data collection position, with a weight bar in the clavicular region, partially inhibited trunk interference in the lateral and inclination movements. In some studies, examiners used their hands to dissociate the cervical movement from the thoracic one.

Conclusion

The study showed that there are reductions in all the ranges of cervical movements in MB children compared to healthy children and that there is no age interference in cervical mobility. The prioritization of the oral airway causes postural compensations that may change the strain length curve of the cervical musculature, restricting the ROM in this segment of the spine.

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