

MEASUREMENT OF NECK RANGE OF MOTION AMONG MOUTH-BREATHING CHILDREN

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ABSTRACT

Introduction: By clinical definition, mouth breathers use the mouth as their main air pathway during breathing. This results in modifications to tongue and head positioning and may have an influence on craniofacial mechanics during development. Bringing the head forward is also common among mouth breathers and may lead to misalignments in adjacent segments of the human body. **Objective:** To evaluate neck (cervical) range of motion (ROM) among mouth-breathing children and compare this with a group of nose-breathing children. **Method:** Ten mouth-breathing children of both sexes aged 6.90 ± 1.37 years and ten nose-breathing children aged 7.70 ± 1.42 years participated in this study. The ROM for neck flexion, extension and protrusion of the head were evaluated. Student's t test for independent samples was used for the statistical analysis, considering $p < 0.05$ as the statistical significance level. **Results:** The mouth-breathing children had a significantly smaller ROM for neck extension ($59.0^\circ \pm 10.79^\circ$), compared with the nose-breathing group ($72.9^\circ \pm 8.82^\circ$) ($p = 0.001$). The ROM for flexion and protrusion was not statistically different between groups ($59.0^\circ \pm 10.79^\circ$). **Conclusion:** The mouth-breathing children presented smaller neck extension ROM than the nose-breathing children did, but for protrusion and flexion ROM there was no difference between the groups.

Key words: mouth breathing; cervical spine; joint arthrometry.

RESUMO

Mensuração da Amplitude de Movimento Cervical em Crianças Respiradoras Orais

Introdução: Por definição clínica, respiradores orais (RO) utilizam a boca como maior via de acesso de ar durante a respiração. Isso resulta em alterações na posição da língua e cabeça e pode influenciar a mecânica craniofacial durante o desenvolvimento. A anteriorização da cabeça também é comum em RO, podendo levar a desalinhamentos em segmentos adjacentes do corpo humano. **Objetivos:** Avaliar a amplitude de movimento (ADM) cervical em crianças RO e comparar com crianças respiradoras nasais (RN). **Métodos:** Dez crianças RO, de ambos os sexos, com idade de $6,90 \pm 1,37$ anos e dez RN, de ambos os sexos, com idade de $7,70 \pm 1,42$ anos, participaram do estudo. O *Cervical Range of Motion (CROM)* foi utilizado para medir a ADM de flexão, extensão e protrusão da cabeça. Para a análise estatística foi utilizado o teste *t Student* para amostras independentes, considerando nível de significância estatística o valor de $p < 0,05$. **Resultados:** Crianças RO apresentam uma ADM de extensão cervical significativamente menor ($59,0^\circ \pm 10,79^\circ$) quando comparadas ao grupo RN ($72,9^\circ \pm 8,82^\circ$) ($p = 0,001$). A ADM de flexão e protrusão não foi estatisticamente diferente entre os grupos. **Conclusão:** As crianças RO apresentaram menor ADM de extensão cervical do que as crianças RN, no entanto, em relação às ADM de protrusão e flexão, não há diferença entre os grupos.

Palavras-chave: respirador bucal; coluna cervical; artrometria articular.

INTRODUCTION

The act of breathing through the nose is inherent to the human being, who is, at birth, a physiological nasal breather¹. When air passes through the nose, three distinct functions are performed: heating, moisturizing, and filtering, called air-conditioning functions of the upper airway². Anatomical and functional integrity of the upper airway allows nasal breathing to be physiological, establishing an air flow resistance of 50% of the total airway resistance¹. According to Moss's functional matrix theory, nasal breathing allows not only the functions of suction, mastication and swallowing, but also adequate growth and development of the craniofacial complex². Any factor that impedes air passage through the nose will allow the access way to be replaced by the mouth. Oral breathing is an adaptive feature with a multifactorial etiology, and its persistence may be harmful^{3,4}. In the literature, there is little consensus on the definition of mouth-breather (MB)^{5,6}. Some studies consider as mouth-breathers those individuals which present upper airway mechanical obstruction, others as those with the simple habit of breathing through the mouth or those individuals that breathe through the mouth for periods of time or spend a certain amount of time with the mouth open (open mouth posture - OMP)⁷. However, studies conducted by otorhinolaryngologists⁶, taking into account dental-craniofacial alterations in general, classify as Mouth Breathing Syndrome any postural alterations^{8,9}, daytime sleepiness, migraines, night-time anxiety, enuresis, frequent tiredness, problems at school, and bruxism. MB children display vertical increase of the lower third of the face, narrow maxillary arch, high-arched palate, changes in hyoid bone position¹⁰, short upper lip and inverted lower lip, labial incompetence without passive lip closure, hypotonia of the masticatory muscles, changes in tongue position at rest and while swallowing⁶. Mouth breathing is a clinical condition common in school-aged children, and some studies already relate this clinical entity to the persistence of postural alterations⁸.

Forward head posture characterized by lower cervical spine flexion and occipital extension is a common clinical finding in MB children¹¹. Adoption of this posture may be influenced by airway interference in the craniofacial development¹²⁻¹⁴. Although the literature is controversial regarding the association of head posture and cranial morphology^{15,16}, a progressive increase of the craniovertical angle and a forward head posture were observed in patients with upper airway obstruction^{13,17}. Head posture is defined by the craniovertical angle, which is the angle between the vertical (gravitational) line and the line formed by two points marked on the face of the individual. This method was described by Vig et al.¹³. Head extension decreases the value of this angle, and

head flexion increases it. Vig et al.¹³ observed a two-degree reduction in the craniovertical angle two months after the removal of the adenoids in MB children. In a longitudinal study, Wenzel et al.¹⁸ observed that, with the decrease in nasal resistance after corticoid therapy, there was a decrease in the craniovertical angle, that is, the reversal of upper airway obstruction minimized forward head posture.

Range of motion (ROM) measures are routinely included in vertical and especially cervical spine assessments, a conduct justified by the relationship between ROM and the functional limitations of patients with cervical pain. Cervical spine ROM is obtained in physical therapy practice by measuring the movement of the head in relation to the trunk¹⁹. The different instruments used, as well as the lack of systematic procedures presented by the studies, reduce data reproducibility and contribute to a strong variation in the active and passive ROM values of the cervical spine²⁰. Therefore, the aim of this study was to measure the cervical ROM in 5-12 year olds with MB diagnosis, and compare these measures with those of nose-breathing (NB) children.

MATERIALS AND METHODS

An observational study was carried out. We assessed twenty children of both genders, aged 5 to 12 years, of which ten were clinically diagnosed as MB by the otorhinolaryngologist through nasopharyngoscopy, and ten were NB. The NB group did not undergo nasopharyngoscopy. Diagnosis was made by the otorhinolaryngologist through a clinical observation of the airway, closed lip position, normal occlusion, normal facial dimensions and a questionnaire applied to relatives by a physical therapist. This questionnaire assessed the absence of harmful oral habits, sleep disorders, intense sialorrhea and night-time snoring. Children with a diagnosis of cerebral palsy or the inability to assume the orthostatic position were excluded from the study. There was no randomization, and three participants were excluded from the study. All participants signed the informed consent approved by the Committee of Research Ethics of the Pontificia Universidade Católica of Minas Gerais (CEP 2004/129).

The Cervical Range of Motion (CROM) instrument (Performance Attainment Associates, 958 Lydia Drive, Roseville, MN 55113) was used in order to measure the cervical spine ROM. The CROM is a system of inclinometers with gravitational reference capable of measuring the flexion, extension and rotation of the cervical spine on the sagittal, frontal, and transverse planes, as well as head protrusion and retraction. This instrument consists of an eyeglass-shaped plastic frame with three fixed inclinometers (two lateral and one anterior). The lateral inclinometers measure the flexion and extension ROM of the cervical spine on

the sagittal plane. The anterior inclinometer measures the ROM of lateral flexion on the frontal plane. These inclinometers are gravitational. For the rotation measures, the inclinometer is magnetic and moves along the transversal plane. For the protrusion and retraction measures, a ruler is used^{21,22}. The protrusion and retraction are described as a forward head motion on the sagittal plane. Anatomically, it consists of a combination of lower cervical flexion and upper cervical extension¹⁹. The CROM is an easy-to-use instrument and its intertest and intratest reproducibility was established with excellent results, especially in flexion and extension measurements^{20,22}.

For data collection and measurement standardization, the children were instructed to sit on a chair with standardized seat adjustment, positioning the hip and knee at ninety degrees and preventing thoracic spine movement. The head was aligned at neutral (zero degree) rotation and lateral flexion, and the participants were asked to fix their gaze at eye level. The tester stood to the left of the child, stabilizing the scapulas with their right hand in order to avoid thoracic rotation.

The tester taught the participant how to actively perform the head flexion, extension and protrusion movements (Figure 1). After the learning session, a one-minute rest was allowed, after which the movements were recorded. Flexion and extension (degrees) were recorded first, followed by head protrusion measurement (centimeters; cm) (Figure 2). Three movements were performed for each measure.

Next, weight and height measurements were taken in order to determine the Body Mass Index (BMI). The purpose of this measure was to characterize the NB and MB groups.

STATISTICAL ANALYSIS

The Kolmogorov-Smirnov test was applied in order to determine whether the variable studied had a normal distribution.

To analyze the anthropometric differences and the variables investigated between the groups, the Student t-test was used for independent samples, considering a significance level of 95% ($p < 0.05$). The statistical analyses were performed with Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) 11.0.

RESULTS

The five male and five female MB children presented an average age of 6.9 ± 1.37 years and BMI of 18.54 ± 7.18 . The five male and five female NB children had an average age of 7.70 ± 1.42 and BMI of 21.72 ± 5.14 . The differences between the groups were not significant.

Regarding the cervical extension measure, the MB



Figure 1. Cervical range of motion instrument (CROM) correctly positioned on a mouth-breathing child.



Figure 2. Side view of correctly positioned cervical range of motion instrument (CROM).

children presented significantly lower cervical extension ROM ($59.0^\circ \pm 10.79^\circ$) ($p = 0.001$) when compared to the NB children ($72.9^\circ \pm 8.82^\circ$) (Table 1). There was no sta-

tistically significant difference in flexion ROM between the MB group ($58.1^\circ \pm 14.46^\circ$) and the NB group ($50.0^\circ \pm 6.77^\circ$) ($p = 0.07$) and in cervical protrusion between the MB group ($16.26^\circ \pm 1.24^\circ$) and the NB group ($15.7^\circ \pm 0.94^\circ$) ($p = 0.20$).

Table 1. Cervical ROM of nasal breathers (NB) and mouth breathers (MB).

Variables	NB	MB	<i>p</i>
Head Extension ($^\circ$)	72.9 ± 8.82	59.0 ± 10.79	* $p = 0.0017$
Head Flexion ($^\circ$)	50.0 ± 6.77	58.1 ± 14.46	$p = 0.070$
Head Protrusion (cm)	15.7 ± 0.94	16.26 ± 1.24	$p = 0.216$

Results in Mean \pm Standard Deviation * $p < 0.05$ to compare NB and MB groups.

DISCUSSION

The results from the study showed a decrease in cervical extension ROM in MB children when compared to the NB children. These findings are in accordance with a study by Farah & Tanaka²³, which assessed individuals of both genders with myofunctional alterations using goniometry. The flexion and extension ROM values varied between $47.88^\circ \pm 10.58^\circ$ and $57.34^\circ \pm 11.88^\circ$, respectively. Despite the fact that the measuring instruments were not the same, the measurement principles of the studies were similar, strengthening the findings of extension ROM loss in MB children.

Extension ROM limitation in MB may be attributed to the imbalance between the muscular activity of neck flexors and extensors. While assessing surface electromyography of the sternocleidomastoid and trapezius muscles in MB individuals, Ribeiro et al.²⁴ found a higher electrical activity during relaxation and a lower electrical activity during maximal voluntary contraction, when compared to NB individuals. The hyperactivity of the sternocleidomastoid and trapezius upper fibers decreases the length-tension curve of these muscles, yielding a shortening of the neck extensors, thus limiting cervical spine extension²⁴. Together with muscular hyperactivity, head extension and lower mandible position may be determining factors in the craniofacial morphology of growing individuals with nasal obstruction¹³.

While studying the development of the cervical lordosis in MB children aged 8, 11, and 15, Hellsing et al.¹⁷ observed a decrease in lordosis as age increased. Similarly, Muto et al.²⁵ used cephalometry to assess 10 young NB individuals aged 20 to 35 with full dentition, no bad occlusion and no mastication disorders. The authors observed less cervical lordosis, but a 4 mm increase in pharyngeal space with head extension. Similar associations between craniovertical angulation and smaller pharyngeal diameter in normal individuals have already been shown

in experimental studies in which the individuals were assessed with their head positioned at different degrees of flexion and extension. The percentage of increase in pharyngeal diameter with head extension depends on the way the individuals extend their head. The results showed that the airway became wider when the extension occurred in the high cervical segment. These findings may justify the compensatory forward head posture that the MB children adopt to facilitate breathing. By means of clinical observations, it is well established that cervical spine movement decreases with age due to degenerative changes²⁶.

There is no consensus in the literature with regard to normal flexion/extension ROM values of the cervical spine. Dvorak & Panjabi^{26,27} describe ROM by cervical spine segments, with higher ranges between 15 and 20° in the C5-C6 and C6-C7 segments, and lower ranges between the C1-C2 and C2-C3 segments (5 to 10°). Total ROM is around 110°, with extension ROM (75°) being higher than flexion ROM (35°). Furthermore, ROM values for active flexion ($35^\circ \pm 70^\circ$) and active extension ($50^\circ \pm 93^\circ$) differ from those for passive flexion ($59^\circ \pm 76^\circ$) and passive extension ($53^\circ \pm 77^\circ$)²⁸.

The different instruments used to measure the cervical ROM may justify the differences in the described ranges. All measuring instruments must be capable of indicating correct and reliable values, thus insuring their validity and reproducibility, respectively. In the present study, the CROM was used as the measuring instrument because it is easy to handle, low-cost, and has good clinical practice acceptance. Moreover, the literature shows that the CROM presented reliable intratester and intertester results²². The instrument is placed on the patient's head, and the tester does not need to move the instrument to take measurements, thus avoiding errors caused by handling and manual adjustments. A previously trained tester took all the cervical movement measurements for the present study.

We determined the children's age group based on previous studies^{8,29} that also worked with this age group; however, we cannot exclude interferences by craniofacial and motor development changes, which tend to increase in the pre-pubertal phase.

One of the limitations of the measurement system is the difficulty in keeping the children in a static position, which hampered instrument reading. However, the children were asked to fix their gaze at eye level. Therefore, possible errors such as reading difficulty and imprecision, as well as the effort and the erroneous perception of the end of ROM, were mitigated^{30,31}.

A possible limitation of the study would be the absence of the fiber-optic nasopharyngoscopy examination in the NB group. However, this group did not show any clinical symptom that justified such an exam.

CONCLUSION

The present study observed a statistically significant decrease in cervical extension ROM between MB children compared to NB children. It is believed that their head forward posture causes biomechanical damage between the extensor and flexor neck muscles, limiting extension ROM.

The use of simple measuring instruments should be included in physical therapy practice in order to help physical therapists systematize their intervention.

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