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Cervical Range of Motion and Spinal Curvature Changes among Children with Mouth Breathing

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ABSTRACT

Purpose: *this study was conducted to evaluate the cervical range of motion (CROM) and spinal column curvatures among mouth-breathing (MB) children and compare this with a group of nose-breathing (NB) children.* ***Subjects:*** *50 mouth-breathing children of both sexes aged 7.63±0.59 years and 50 nose-breathing children aged 7.51 ± 0.64 years were referred from the out patient's clinic of Pediatric (Abo-Elreesh teaching) hospital to participate in this study.* ***Procedure:*** *the ROM for neck flexion, extension, lateral flexion and rotation were evaluated by using CROM instrument and postural assessment was recorded using photographs in left lateral view which then analyzed using SAPO postural assessment software. Student's t test for independent samples was used for the statistical analysis, considering P< 0.05 as the statistical significance level.* ***Results:*** *Regarding the cervical range of motion, the MB children presented significantly lower cervical extension, rotation and lateral flexion ROM (P< 0.05) when compared to the NB children. MB exhibited reduced cervical lordosis, increased thoracic kyphosis, increased lumber lordosis, and anterior pelvic tilt.* ***Conclusion:*** *The mouth-breathing children presented smaller neck extension, rotation and lateral flexion ROM than the nose-breathing children did, they also exhibited alteration of spinal curvatures.*

Key words: *mouth breathing, cervical motion, children, spine.*

INTRODUCTION

Breathing is a priority function in life and is normally made through the nose to filter, warm and humidify the inhaled air. In general, the mouth is only used temporarily when there is extra effort or any other situation in which the air inspired through the nostrils is not enough. If exclusive nasal breathing is not possible and breathing through the mouth is permanently maintained, changing the normal dynamics of the process, an abnormal breathing type is defined, named mouth breathing (MB). Mouth breathers are individuals who breathe through the mouth because of nasal obstruction or bad habit[1].

Some studies consider mouth-breathers are those individuals who 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)[2].

Mouth breathing can be related to a variety of causes including enlarged adenoids, tonsils and nasal concha, obstructive nasal septum displacement, allergic rhinitis, nasal or facial deformities and, more rarely, by foreign bodies[3].

Mouth breathing is a clinical condition common in school-aged children, and some studies already relate this clinical entity to the persistence of postural alterations. Forward head posture characterized by lower cervical spine flexion and occipital extension is common clinical finding in MB children[4].

It has also been demonstrated that the respiratory pattern imposed by MB implies the need for postural adaptations. In order to facilitate the flow of air through the oral cavity, individuals bend the head forward and extend the neck. By doing so, they increase the amount of air passing through the pharynx, reducing airway resistance[5].

Various studies have assessed body posture in mouth-breathing subjects, and revealed that forward head posture is the major change[4].

An understanding of the harmful effects of bad posture on children with MB could guide patient management and reduce the costs involved[6].

The objective of this study was to evaluate the cervical ROM and spinal curvatures in 5-10 year olds children with (MB) diagnosis, and compare these measures with those of nose breather (NB).

METHDOLOGY

Subjects:

One hundred children of both genders, aged from 5 to 10 years were participated in this study and divided into two groups, of which 50 children were clinically diagnosed as mouth breather (mouth breathing group) by the otorhinolaryngologist, and referred from the out patient's clinic of Pediatric (Abo-Elreesh Teaching) Hospital and 50 children were nose breather (control group). The study had local research and ethics committee approval and all subjects, guardians gave written consent.

Exclusion criteria: cranio-facial malformations, musculoskeletal disease, orthopedic traumas, and neurological disease. Children with a diagnosis of cerebral palsy or the inability to assume the orthostatic position were also excluded from the study.

Procedure:

Cervical range of motion assessment

Cervical Range of Motion (CROM) instrument was used 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.

This instrument consists of an eyeglass-shaped plastic frame with three fixed inclinometers (two laterals 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[7].

For data measurement, the children were instructed to sit on a chair with standardized seat adjustment, with 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 (Fig 1).

The tester taught the participant how to actively perform the head flexion, extension, left and right lateral flexion and left and right rotation.

After learning, five minutes rest was allowed. Flexion and extension (degrees) were recorded first, followed by right and left lateral flexion and left and right rotation measurement. Three movements were performed for each measure.

Fig. (1): CROM instrument correctly positioned on a mouth breathing child.

Postural assessment

Postural assessment for all subjects was performed with the aid of a photographs taken by digital camera in left lateral view[8], ensuring that the spinal curvatures were visible in sagittal profile. Small balls of polystyrene were attached to specific anatomical points with double-sided tape at the: acromion, seventh cervical vertebra (C7), the tragus of the ear, seventh thoracic vertebra (T7), first lumbar vertebra (L1), anterior superior iliac spine (ASIS), greater trochanter and lateral condyle of the femur.

All participants were photographed wearing swimwear, barefoot, with feet together and parallel and, when necessary, hair was tied back to ensure the cervical region was visible. The volunteers were instructed to keep their eyes open looking at the horizon. A 1 m plumb line was hung on the left-hand side close to the participant[8].

Photographs were taken with the children in orthostatic positions, in front of a white wall as background. A Sony Cyber Shot 20 mega pixel digital camera was fixed at 90º to horizontal in order to focus at the subject lengthways. This camera was positioned 4m from the wall, on a 1.5m high tripod and adjusted so that the lower horizontal guideline in the camera view finder corresponded with the patient position[8].

Analysis of photographs

Postural analysis was carried out using the SAPO (Software postural analysis package) Analysis of photographs consisted of the following steps: open photograph, zoom to 40%, calibrate image based on plumb line, and mark the anatomic points on photograph.

Cervical lordosis was determined by drawing the angle formed by three anatomic points, the tragus of the ear, the acromion and C7, where the acromion was the apex of the angle. The larger this angle, the further forward the position of the head and the lower the degree of cervical lordosis.

In order to determine thoracic kyphosis, an angle was drawn from the acromion to L1 and from L1 to T7, where L1 was the apex of the angle. The larger this angle, the greater the degree of thoracic kyphosis.

Lumbar lordosis was measured using an angle drawn between three anatomic points: L1, anterior superior iliac spine (ASIS) and the greater trochanters, where ASIS was the apex of the angle. Here, the larger the angle, greater the degree of lumbar lordosis.

To determine the position of the pelvis, an angle was drawn between three anatomic points: the ASIS, the midpoint of the knee joint on the lateral face and the greater trochanters where the midpoint of the joint line was the apex of the angle. The greater the angle, the greater the pelvic tilt.

Statistics

To analyze 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).

RESULTS

Table (1): General characteristics of MB and NB groups.

Variable	(MB) n=50	(NB) n=50	P- value	Significance
Age (yr)	7.63±0.59	7.51±0.64	0.070	NS
Weight (Kg)	28.00±1.41	27.06±1.87	0.201	NS
Height (Cm)	125.53±3.19	123.72±5.05	0.216	NS

Results in Mean ± Standard Deviation

Table (2): Cervical ROM of mouth breathers (MB) and nose breathers (NB).

variable (degree)	Mouth breathers (MB) n=50	Nose breathers (NB) n=50	P- value	Significance
Flexion	68.35±7.72	71.04±10.85	0.20	NS
Extension	52.63±3.91	68.46±8.91	0.00*	Sig.
Lateral Flexion (Right)	36.75±5.28	48.31±7.49	0.002*	Sig.
Lateral Flexion (Left)	41.19±7.00	54.96±8.45	0.00*	Sig.
Rotation (Right)	53.60±10.54	69.42±9.55	0.001*	Sig.
Rotation (Left)	51.75±8.95	65.08±5.75	0.00*	Sig.

Results in Mean ± Standard Deviation, * P< 0. 05 to compare NB and MB groups

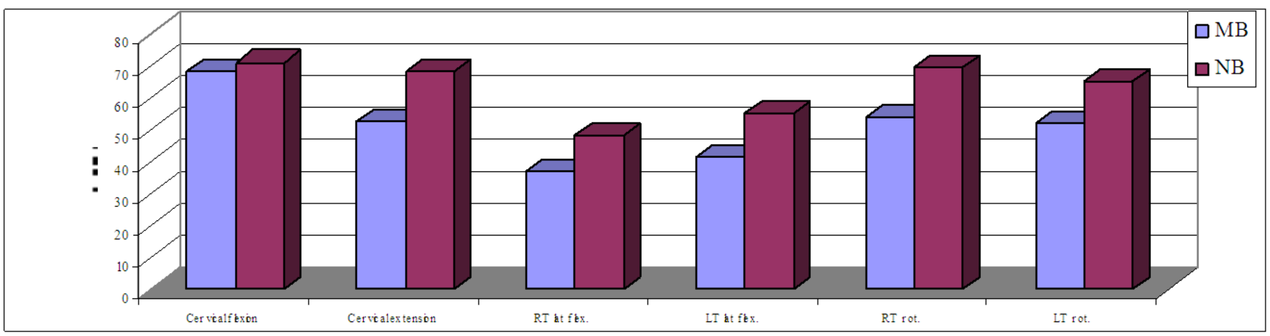

Fig. (2): Cervical ROM of mouth breathers (MB) and nose breathers (NB). (RT lat flex: right lateral flexion, LT lat flex: left lateral flexion, RT rot: right rotation, LT rot: left rotation).

Table (3): Measurement of spinal curvature in mouth breather (MB) and nose breathers (NB).

Variable(degree)	Mouth breathers (MB) n=50	Nose breathers (NB) n=50	P- value	Significance
Cervical lordosis	60.18±8.43	51.25±9.33	.000*	Sig.
Lumber lordosis	102.55±8.66	118.77±5.56	.000*	Sig.
Thoracic kyphosis	46.98±5.25	41±4.55	.002*	Sig.
Position of pelvic	9.97±1.43	6.88±1.00	.001*	Sig.

Results in Mean ± Standard Deviation, * P< 0.05 to compare NB and MB groups

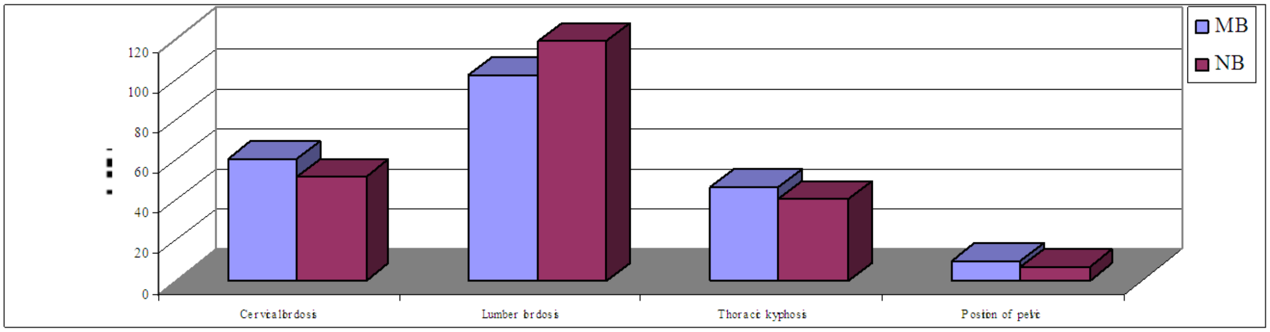

Fig. (3): Results of spinal curvatures and position of pelvic in MB and NB children.

DISCUSSION

Respiration is one of the body's vital functions and under physiological conditions, breathing takes place through the nose. The mouth breathing syndrome (MBS) is when a child stops breathing exclusively through the nose and begins mixed breathing i.e. the nose is supplemented by the mouth. Mouth breathing is a common disease in childhood and has a multifactorial etiology[9].

Mouth breathers project their heads forwards to facilitate and accelerate airflow. The postural equilibrium of the head is the most important factor in achieving good posture[10].

The results of our study showed a decrease in cervical extension, right and left lateral flexion, right and left rotation ROM in MB children when compared to the NB children. These findings are in accordance with a study of Neiva & Kirkwood[7]. Who assessed the neck rang of motion among mouth breather children. Their results were similar in strengthening the findings of extension ROM loss in MB children.

Range of motion 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.,[11] 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 range of motion[11].

In the current study it was observed that all spinal curvatures and the position of the pelvis behaved differently in the mouth breathing group from in the nose breathing group. Our results were similar to those reported by Yi et al.,[12] who used postural assessment and demonstrated a reduction in cervical lordosis and increased thoracic kyphosis in 80% of a sample of 176 mouth breathing children aged 5 to 12 years of age, while an increase in lumbar lordosis was observed in 60% of this sample and anterior pelvic tilt in 75% of them. However, in that study no nose breathing control group was employed in order to compare body segments. Furthermore, no tool was used that was capable of quantifying and analyzing in an objective manner the behavior of postural variables, in contrast with our study.

Krakauer[10] assessed body posture in mouth breathing and nose breathing children aged 5 to 12 years of age by means of the visual analysis of photographs. That study demonstrated that postural abnormalities were common in children aged 5 to 8 years of age in both groups. After 8 years of age these postural abnormalities were predominantly observed in the mouth breathing group.

Forward head posture is the major change in mouth-breathing subjects, this forward head posture will lead to disorganization of the muscle blocks (anterior, posterior, and transverse muscles), impairing diaphragm muscle mobility and, consequently, diaphragmatic function[8] This postural change also leads to accessory muscle recruitment, with increased sternocleidomastoid muscle activity, causing rib cage elevation, reducing thoracoabdominal mobility, and compromising the ventilatory efficacy of the diaphragm. This mechanical disadvantage intensifies the inspiratory effort and increases the work of breathing. Inefficient respiratory muscle function decreases respiratory muscle strength, resulting in reduced chest expansion, which impairs pulmonary ventilation during physical activity. Therefore, altered posture with increased thoracic convexity also present[13,14].

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 results[7,15]. 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.

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[16,17].

Conclusion

The mouth-breathing children presented decreased cervical extension, rotation and lateral flexion ROM than the nose-breathing children did, also they exhibited alteration of spinal curvatures, which suggest that early intervention can reduce the harmful effects of bad posture on children with MB, could guide for patient management and reduce the costs involved.

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الملخص العربي

تغيرات المدى الحركي للفقرات العنقية ومنحنيات العمود الفقري بين الأطفال الذين يتنفسون عبر الفم

تهدف الدراسة إلى تقييم كلا من المدى الحركي للفقرات العنقية ومنحنيات العمود الفقري في الأطفال الذين يتم تنفسهم عبر الفم بدلا من الأنف قد تم اختيار 50 من الأطفال الذين يتنفسون عبر الفم والذين تراوحت أعمارهم بين 5 إلى 10 عاما (مجموعة الدراسة) ، كما تم ضم 50 متطوعا من الأطفال المتوافقين مع المرضى في السن والوزن والطول (المجموعة الضابطة) . وقد تم قياس المدى الحركي للفقرات العنقية كما تم قياس منحنيات العمود الفقري في المناطق العنقية والصدرية القطنية وقياس وضع الحوض . وقد أوضحت النتائج قلة المدى الحركي للفقرات العنقية لدى الأطفال الذين يتنفسون عبر الفم كذلك تغير انحناءات العمود الفقري ووضع الحوض بالمقارنة بقرنائهم من الأطفال الذين يتنفسون عبر الأنف . وقد استخلص من هذه الدراسة أن الأطفال الذين يتنفسون عبر الفم يظهرون قلة المدى الحركي للفقرات العنقية في جميع الاتجاهات ماعدا الثني الأمامي ، كما يظهرون تغيرات في منحنيات العمود الفقري و وضع الحوض .