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Comparison of hyoid bone position, head posture and pharyngeal airway space in mouth breathers and nasal breathers - A cephalometric study.

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Abstract

Background: The study is aimed at strengthening the evidence for association between the mouth breathing and cranio-cervical anomalies and to check whether or not there are differences between mouth breathers and nasal breathers with regard to their hyoid bone position, head posture and pharyngeal airway space.

Methods: A total of 70 subjects were selected for our study based on the inclusion and exclusion criteria. Out of the total 70 subjects, Group-I consisted of 20 males and 15 females and Group-II consisted of 17 males and 18 females. Lateral cephalometry was used in all the subjects for the evaluation and analysis of the hyoid bone position, head posture and pharyngeal airway space.

Results: The mean values of Upper pharyngeal airway and Lower pharyngeal airway were lower in Group I (Mouth Breathers) and were statistically significant with p- value of <0.05. The mean values of CVT-SN, OPT-SN, OPT-PP and CVT-PP were higher for Group I (Mouth Breathers) and the difference was not statistically significant as the p- value was >0.05. The mean values of H- MP, H- MP° and H- C4 were: higher for Group I (Mouth Breathers) and the difference was not statistically significant with the p- value of >0.05.

Conclusion: Normal pattern of breathing has a marked effect on the craniofacial growth and development, resulting in a series of functional transformations that may affect the cranio-cervical as well as dentofacial complex. A significant difference was observed between mouth breathers and nasal breathers when the craniofacial morphology and pharyngeal airway space were compared.

Keywords: Cephalometrics, Hyoid Bone Position, Airway, Head Posture Mouth Breathing and Nasal Breathing.

Introduction

Respiration is one of the body's vital functions. Under normal conditions breathing takes place through nose.(1) According to Moss's theory of functional matrix, normal nasal respiratory activity influences the development of craniofacial structures, favouring their harmonious growth and development by adequately interacting with mastication and swallowing and other components of the head and the neck region. (2)

Respiratory airway function affects both facial and cranio-cervical morphology as well as cervical functions. Chronic nasal obstruction leads to mouth breathing resulting in an anterior or lower position of the tongue, incompetent lips, retro lined mandibular incisors, a steep mandibular plane angle, an increased anterior open bite, increased anterior facial height and lowered position of the mandible. It also results in reduced Oro-facial muscle tonicity, which compensates for decrease in nasal airflow and also facilitates respiration.(4) All these characteristics are typical of the so called "adenoidal facies".(3)

Mouth breathing is also associated with low tongue posture and the absence of a contact surface between the tongue and the soft palate, which is also known as posterior oral incompetence. The enlarged adenoid tissue reduces the airway space and that leads to postural adaptations at the level of oropharynx. Therefore in order to facilitate breathing the tongue gets lower down.(3) The hyoid bone in relation to the mandible drops down and creates a relatively constant air space diameter in antero-posterior direction. This neuro-muscular recruitment may cause changes in the neck extension and mandibular resting position. Thus a major factor that underlines the hyoid bone position is the breathing pattern.(5) Behlfelt et al. indicated that a lowered tongue position, a narrower nasopharyngeal space and greater craniocervical inclination were the main causes of a lowered hyoid bone position.(6)

The head posture is a result of the complex and delicate balance between the muscles involved in the cervical mandibular cranial system. This system is designed to maintain the pharyngeal airway. The extended head posture related to mouth breathing is described as an adaptation to expand and facilitate the airflow through the oro-pharynx and this change in head position results in the whole body posture change.(7) Tecco et al reported that RME is able to increase the capacity of the nasopharyngeal airways and leads to significant changes in the craniocervical angles.(8)

The crani-cervical complex can therefore be effectively analysed by using cephalometry, as it is an important tool for studying cranio-cervico-facial growth pattern, anatomic anomalies in patients and their diagnosis and treatment planning.(9)

Literature search revealed that there are many studies comparing cranio-cervical morphology between mouth breathers and nose breathers yet there are controversies regarding a clear association between mouth breathing and cranio-cervical anomalies. Thus more research and that too with standardized protocols/methods is required to clarify the effects of mouth breathing on the cranio-cervical complex. Our study is hence aimed at strengthening the evidence for association between the mouth breathing and cranio-cervical anomalies.

The research hypothesis was that there is no statistically significant difference in the hyoid bone position, head posture and pharyngeal airway space between mouth breathers and nasal breathers.

Materials and methods

The present cross-sectional cephalometric study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, D.A.V. Dental College, Yamuna Nagar. The present study was planned to assess the comparison of hyoid bone position, head posture and pharyngeal airway space between mouth breathers and nasal breathers.

All the subjects of the study were approved by the members of the institutional ethical committee and University review board. Informed consent was obtained from all the subjects after explaining the nature and purpose of the study. Only those subjects who agreed to participate and allowed their radiographs to be taken were included in the study.

Each individual's basic information about name, age, gender, history of trauma, surgery or craniofacial deformities and previous orthodontic treatment was taken and only those subjects fulfilling the following criteria of age between 11- 18 years; no history of orthodontic treatment and/or maxillary functional orthopaedic treatment; no history of naso-respiratory complex surgery; no vestibular or equilibrium problems; and no visual, hearing or swallowing disorders and facial or spinal abnormalities (i.e., torticollis, scoliosis, or kyphosis); were included in the study.

For the current study, the probability of type 1 error(α) was fixed at 5% and that of type 2 error(β) was fixed at 20%. The power of the study was set at 80%. The sample size for the study was determined scientifically and a minimum of 70 subjects were selected based on the inclusion criteria.

The subjects were further divided into two groups based on their breathing pattern as: Group-I Mouth breathers and Group-II Nasal breathers. Each group consisted of equal number of subjects i.e., 35 subjects in Group-I and 35 subjects in Group-II.

The age range of the subjects was between 11- 18 years, with the mean age of 13.5 ± 2.21 years in Group-I [Mouth Breathers] and 14.1 ± 2.22 years in Group-II [Nasal Breathers]. Out of the total 70 subjects, Group-I consisted of 20 males and 15 females and Group-II consisted of 17 males and 18 females.

Thorough history of the subjects was taken and breathing pattern of the patients was assessed with the help of the following methods:

Visual assessment

The presence of the extraoral and intraoral characteristics typical of mouth breathers (e.g. Long face, dark eye circles, short lip, narrow and high arched palate, cross bites, etc.) was examined to distinguish them from nasal breathers while the patient was sitting in the rest position.

Questionnaire

The following questions were directed to the patients or their parents:

Do You:

- Sleep with your mouth open?
- Keep your mouth open when you are at rest?
- Snore?

- Drool on your pillow?
- Wake up with a headache?
- Get tired easily?
- Often have allergies?
- Often have a stuffy nose and/or running nose?

Breathing tests

The breathing tests performed were as follows: (at least two tests were performed in the sitting position).

A. Mirror test

In mirror test the patients were made to sit in a resting position for 3 minutes with a double-sided mirror placed in front of the nasal fossa, and the mirror were observed for the presence of fogging or water vapour.

B. Water retention test

The patients were asked to hold approximately 15 ml of water in their mouth for 3 minutes without difficulty in breathing.

C. Lip seal test

It was performed by sealing the patient's mouth completely with a tape for 3 minutes and observed if the patient can resist the tape and can breathe through the nose normally.

Lateral cephalometry was used in all the subjects for the evaluation and analysis of the hyoid bone position, head posture and pharyngeal airway space.

A total of 10 parameters (4 for hyoid bone and head posture and 2 for pharyngeal airway space) were selected and measured for both mouth breathers and nasal breathers. Further a comparison of cephalometric values was done between both mouth and nasal breathers.

The parameters measured are depicted in Figure 1(a - c).

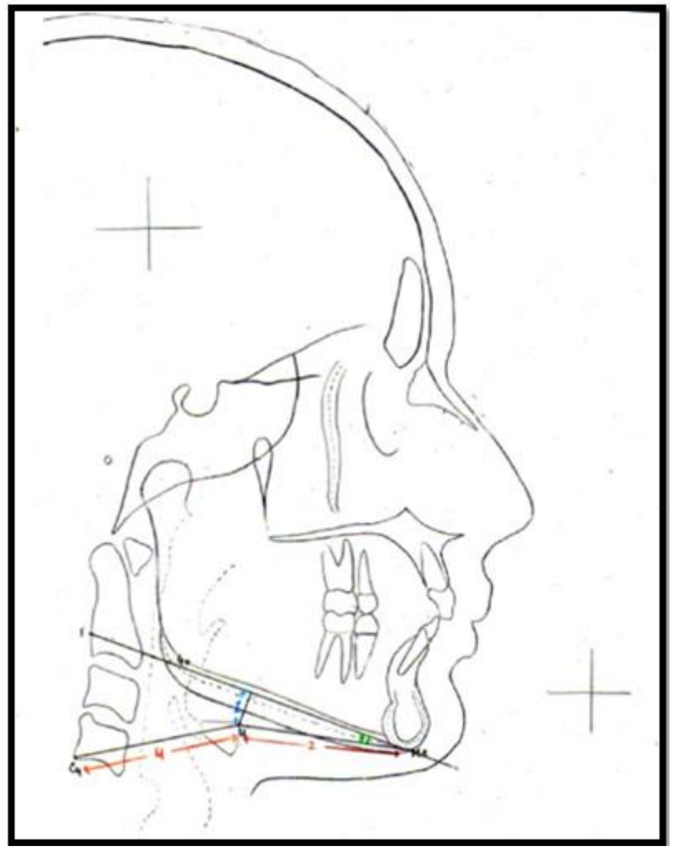

Fig 1a: Parameters for Hyoid Bone Position

H-MP, (2) H-Me, (3) H-MP, (4) H-C4

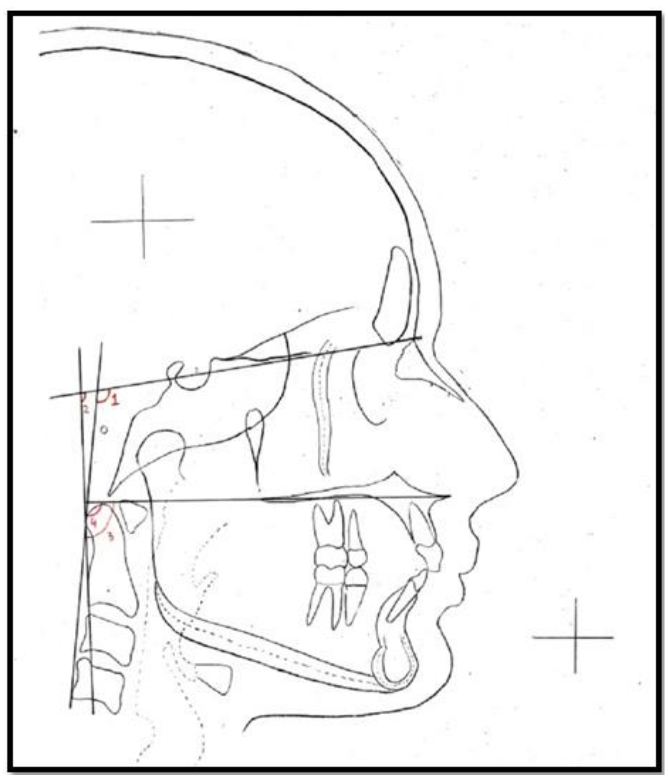

Fig 1b: Parameters for Head Posture

(1) CVT-SN, (2) OPT-SN, (3) OPT-PP, (4) CVT-PP

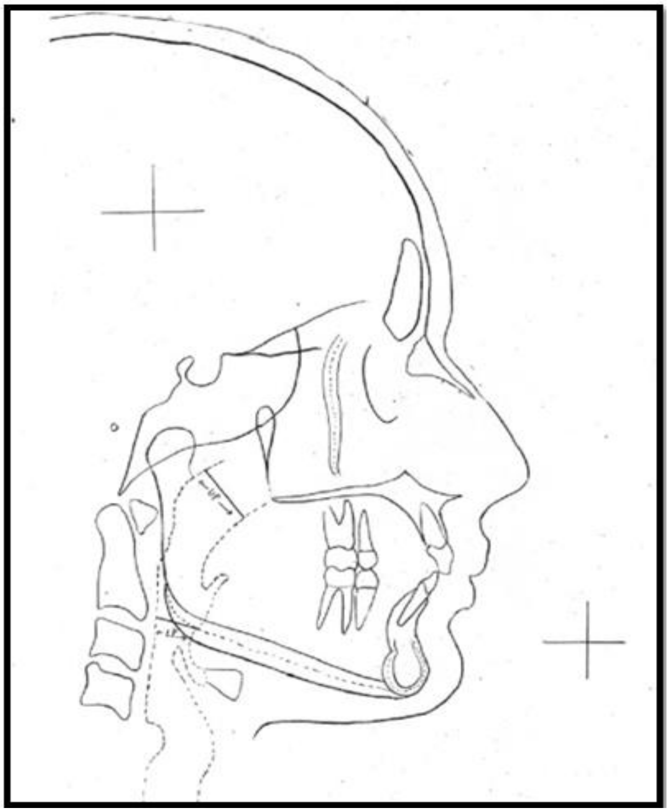

Fig 1c: Parameters for Pharyngeal Airway Space Upper Pharyngeal Airway Space (UP), Lower Pharyngeal Airway Space (LP).

Statistical analysis

After all the measurements were made, compilation of the data was done and appropriate statistical tests were applied. All the statistical analysis were done using SPSS version 22.0. All the statistical tests were performed at the significance level of 0.05.

Descriptive statistics was performed by calculating mean and standard deviation for the continuous variables. The statistical tests used were; Unpaired or Independent t-test, used for comparison of mean value between the two groups when the data follows normal distribution and Pearson's correlation coefficient (r) test, used for calculating the correlation between the two variables when the data follows normal distribution. Intra-operator error was calculated using the Dahlberg's formula. Cephalograms of 25% of the total sample size were retraced after a period of 3 weeks to check for the intra-operator error.

Results

The mean values of H-MP, H-Me, H-MP° and H-C4 were compared between Mouth breathers and Nasal breathers using the Unpaired t-test.

The mean values of H- MP, H- MP° and H- C4 were: higher for Group I (Mouth Breathers) and the difference was not statistically significant with the p- value of >0.05. (Table 1).

Table 1: Comparison of parameters of hyoid bone position between the two groups.

	Mouth breathers		**Nasal breathers**				
	Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	**Mean Difference**	**t-test value**	**p-value**
H-MP	14.31	4.61	12.66	3.90	1.65	-0.052	0.103
H-Me	38.94	5.02	41.69	6.94	-2.74	-2.823	0.062
H-MP°	19.71	7.39	18.66	5.98	1.06	0.658	0.513
H-C4	50.34	3.72	49.37	3.96	0.97	-4.527	0.294

comparison of head posture parameters between the two groups

The mean values of CVT-SN, OPT-SN, OPT-PP and CVT-PP were compared between Mouth breathers and Nasal breathers using the Unpaired t-test.

The mean values of CVT-SN, OPT-SN, OPT-PP and CVT-PP were higher for Group I (Mouth Breathers) and the difference was not statistically significant as the p-value was more than 0.05. (Table 2)

Table 2: Comparison of parameters of head posture between the two groups.

	Mouth breathers		Nasal breathers				
	Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	**Mean Difference**	**t-test value**	**p-value**
CVT-SN	106.34	10.64	104.66	7.38	1.69	0.770	0.444
OPT-SN	101.40	9.89	100.00	8.25	1.40	0.643	0.522
OPT-PP	94.31	9.39	92.43	7.77	1.89	0.915	0.363
CVT-PP	98.97	10.13	97.49	6.77	1.49	0.722	0.473

Comparison of pharyngeal airway parameters between the two groups

The mean values of Upper pharyngeal airway and Lower pharyngeal airway were compared between Mouth breathers and Nasal breathers using the Unpaired t-test.

The mean values of Upper pharyngeal airway and Lower pharyngeal airway were lower in Group I (Mouth Breathers) and were statistically significant with p- value of <0.05.(Table 3)

Table 3: Comparison of parameters of pharyngeal airway space between the two groups.

	Mouth breathers		Nasal breathers				
	Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	**Mean Difference**	**t-test value**	**p-value**
Upper pharyngeal airway	8.49	2.66	12.76	2.40	-4.27	-7.057	< 0.001*
Lower pharyngeal airway	8.66	2.80	11.49	2.51	-2.83	-4.451	< 0.001*

Discussion

Nasal breathing is essential for the stomatognathic system to function normally and for the maxillo-cranio-facial complex to grow and develop correctly. (10) The hyoid bone provides connections to pharynx, mandible and cranial muscles, ligaments and fascia. Adenoid tissue may reduce the air space and cause postural adaptations at the level of the oropharynx. A drop in hyoid bone in relation to the mandible would represent an attempt to assure a relatively constant air-space diameter in the antero-posterior direction. This neuromuscular recruiting could cause changes in mandibular rest position and neck extension, thus influencing the craniofacial growth pattern.(11)

In the present study, the mean value of H-Me, H-MP (mm), H-C4 and H-MP^0 were insignificantly higher for mouth breathers. These values depicted that mouth breathers had lower position of hyoid bone when compared to nasal breathers. These results were similar to that of the findings of Ucar at el.(3) They found that mouth breathing has no effect on the hyoid bone position during rest, which indicates that there is no permanent alteration in skeletal morphology due to mouth breathing as far as the hyoid bone and its relation to the mandible are concerned.

In concurrence with our results, Tourne studied that the hyoid bone did not entirely follow the posterior movement of the chin, as one would expect, but dropped considerably in relation to the mandible. This downward hyoid movement was probably due to contraction of the infrahyoid musculature, and the stylohyoid ligament acts as a limiting factor. Thus it appears that, as the mandible is moved posteriorly in relation to the other craniofacial structures, the tongue and hyoid do not follow this movement, if they did, they would encroach upon the vital oropharyngeal and laryngeal spaces. To alleviate this problem the hyoid-associated structures are guided to an inferior position to avoid compromising the airway. This suggested that stability and patency of the pharyngeal airway are primary factors in hyoid positioning.(5)

The present study showed the mean values of OPT-SN, CVT-SN, OPT-PP and CVT-PP to be higher for mouth breathers but the mean values were not significantly different. In accordance to our findings, a study by Chambi Rocha et al reported that mouth breathers develop cranio-cervical hyperextension, whereby postural problems are significantly more common among the mouth breathers. They showed a cervical spine postural change in 90.3% of mouth breathers but, as both mouth breathers and nasal breathers presented high percentages of craniofacial hyperextension, differences were not statistically significant.(12) Cuccia et al reported that cranio-cervical hyperextension causing postural problems are significantly more common among mouth breathers. They concluded that an abnormal posture of the head changes the load in several joints of the craniovertebral region, resulting in unfavourable dentofacial and craniofacial growth but their main finding is that in mouth breathers, a well-defined postural picture is often evident: reduction of cervical lordosis and increased extension of the at lento-occipital joint to maintain the Frankfurt plane horizontal. They also showed that mouth breathing is connected with a variation in the head posture and with an increased craniocervical extension in order to increase the dimension of the airway and the oropharyngeal permeability with mandibular and lingual postural modifications, and of the soft palate as well. (13)

The present study showed a significant relationship between breathing pattern and the nasopharyngeal air space. The pharyngeal airway space was more reduced in the mouth breathing children than in the nasal breathing group. These results concur with previous evidence where the linear measurements of the nasopharyngeal air space were markedly reduced in the mouth breathing children, and this has also been observed in apnoeic patients. (14) Santos- Pinto et al observed that a nasopharyngeal space less than or equal to 4mm, results in important dentofacial alterations that compromise the morpho-functional development of the child. The results were also in coherence with a study by Munoz et al. They found that children who were mouth breathers had a more reduced airway space than children with nasal breathing, probably caused by hypertrophic tonsils and adenoids, which are common in these children.[4] Some authors have affirmed that the proliferation of the adenoid tissue can be detected on a lateral teleradiography with a reduction in pharyngeal airway space at the height of the maxillae plane, and in severe cases the adenoids, can cause the total obstruction of the pharyngeal space at this level.(9)

There were few strengths and limitations of our study. The strengths being that our study is one of the few studies that generated evidence on all the major parameters (craniofacial morphology, hyoid bone position, head posture and pharyngeal airway space) together needed for comparison between mouth breathers and nasal breathers and having a broader age group of 11 -18 years gave us an advantage of comparing the effects of mouth breathing during and after the growth phase. However, the limitations of our study were being a cross- sectional study, the after-treatment changes in the cranio-cervico-facial pattern of the subjects could not be evaluated. Also, Naso-respiratory function can be better evaluated using objective diagnostic aids (such as Rhinometry, video endoscopy and 3D volumetric comparison) but due to the non- availability of such techniques at our end, we could not perform such tests.

Conclusion

In most of the mouth breathing subjects, the hyoid bone was placed in a position that was inferior with regard to the cervical spine and mandible. The mouth breathers showed an extended head posture when compared to nasal breathers. Mouth breathers exhibited a predominantly reduced upper and lower pharyngeal airway space as compared to nasal breathers.

Hence, it can be deduced that changes in normal pattern of breathing has a marked effect on the cranio-cerical growth and development, resulting in a series of functional transformations that may affect the cranio-facial as well as dentofacial complex. A significant difference was observed between mouth breathers and nasal breathers when the pharyngeal airway space was compared.

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