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RESEARCH

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Influence of mode of breathing on pharyngeal airway space and dento facial parameters in children: a short clinical study

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Abstract

Background: Mouth breathing is considered as a mode of breathing modality that presents as a replacement to normal nasal breathing. This persistent pattern of mouth breathing have considerable influence on the development of dentofacial structures. This altered pattern of breathing have resulted in exhibiting considerable changes in pharyngeal airway space in children thereby hampering the child's normal respiration which influences the developing occlusion in the child. Hundred subjects were selected following responses obtained from a provided questionnaire detailing the breathing modalities. They were divided into two groups of fifty each namely nasal breathers and mouth breathers and subjected to adequate clinical and cephalometric evaluation and their study casts were obtained for carrying out definitive conclusion. This study was undertaken to evaluate the influence of mouth breathing on dentofacial growth and pharyngeal airway space in children.

Results: The values showed positive correlation between mouth breathers with increase in palatal height ($P < 0.05$), narrowing of the intermolar width ($P < 0.05$), reduction in pharyngeal airway space (< 0.05) and subsequently an increased incidence of Class II malocclusion.

Conclusions: Mouth breathing have undeniable influence on the growth of pharyngeal airway space and associated dental and skeletal structures in children.

Keywords: Mouth breathing, Cephalometric analysis, Pharyngeal airway space

Background

Respiration is one of the important body's vital functions which under normal physiologically active scenarios, breathing process is considered to take place through nose. This normal naso respiratory function is hampered under certain habitual or obstructive hindrances whereby the nasal respiration is substituted or compensated by altered practice of mouth breathing (Vianna-Lara and Caria 2006). Mouth breathing is thus defined as an inflammatory process of nasal cavity that results in unilateral or bilateral nasal obstruction (Frasson et al. 2006). The reported incidence and prevalence of unavoidable mouth breathing among children is found to be in the range of 50–56% (Bianchini et al. 2007). Mouth breathing is considered to have a multifactorial etiology which can be classified into functional, structural, pathological, postural and highly variable behavioral consequences. Well defined knowledge about identifying the causative factors leading to mouth breathing will thus help the pediatric dentist in planning the appropriate treatment strategies for the child (Cattoni et al. 2007).

The increased prevalence of mouth breathing among children is considered to have detrimental effects on child's quality of life spanning from short term health hazards such as persistant avoidance of receiving dental care there by increasing the incidence of gingivitis, dental caries and profounding prevalence of untreated dental infections (Basheer et al. 2014). The long term health

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effects of continuous and prolonged mouth breathing habit include long face syndrome, wide open hypotonic and extremely dry lips, high arched palate and occlusal relation transcending in to Angle's Class II along with imperative behavioral alterations which include constant irritability, difficulty in concentration resulting in reduced school performance and impaired skills (Lee et al. 2015). Thus identifying children with mouth breathing habit at an early age will help in devising the most appropriate and adequate treatment plan that would prevent the detailed future complications in the child's life. Among the various multifactorial etiologies contributing to mouth breathing the primary and significant factors are adenoid or tonsillar hypertrophy, deviated nasal septum, rhinitis, otitis media, sinusitis and nasopharyngitis which restricts the child's physical cognitive growth and development (Franco et al. 2015). Children with chronic mouth breathing habit have an increased tendency to developing evident speech disorders, facial and dental developmental anomalies and abnormal body maintenance ability (Laganà et al. 2013 Dec).

Evidence-supported techniques such as breathing exercises and use of visual diagnostic aids should be adapted to meet the needs and aid in creating an effective diagnosis and treatment plan (Feres et al. 2012). Therefore, mouth breathing habit is considered as a syndrome in today's scenario and one of the most preoccupying public health problems possessing debilitating deleterious effects among the growing children (Feres et al. 2012). On the basis of undeniable hypothesis that mouth breathing the mode will result in dental relationship alterations, the aim of the present study undertaken was to compare the dental pattern dimensions of the nasal-breathing children and mouth breathing children with the demulsifying objective to determine the relationship between the pattern of breathing and the resultant dentofacial growth in children in addition to the effects on pharyngeal airway space.

Methods

The present study was conducted at the Department of Pedodontics and Preventive Dentistry, Palakkad, Kerala, India.

Selection of cases

Inclusion criteria

Children both males and females of 9-11 years of age.
Children visiting the department with their parents.
Children with no carious teeth.

Exclusion criteria

Children with a known congenital anomaly, developmental, and/or systemic disorders.
Children with a history of prolonged illness.

Study design

Initially a brief profile well defined breathing assessment questionnaire signifying the need for understanding the pattern of mouth breathing and its associated effects were distributed among parents of children visiting the department (Table 1). Based on their responses hundred children of both genders with ages ranging from 9 to 11 years were selected as per inclusion criteria from the out patient facility in the Department of Pedodontics and Preventive Dentistry, Palakkad, Kerala, India. Of these 100 children 50 were nasal breathers and 50 were mouth breathers. Depending on their age the children were considered to belong to single group of 9–11 years. Detailed explanation were given to the parents regarding the procedure and consent was obtained. The various steps in the procedure included nasal function assessment, cephalometric analysis and study cast evaluation.

Assessment of nasal function

The accurate adequacy of nasal breathing was assessed by asking the children to breathe through their nose for 1 min by holding water in their mouth and by fogging on mirror which was placed both near nose and mouth simultaneously. They were then referred to the ENT (Ear, Nose, Throat) Department where a detailed clinical and physical examination was done. The children underwent otorhinolaryngologic evaluation to diagnose the respiratory mode and the mouth-breathing etiology. This led to further classification of mouth breathers into habitual mouth breathers and obstructive mouth breathers. Following which a PA(Posterior anterior) view nasopharynx radiograph was taken to analyze the pharyngeal airway space.

Table 1 Breathing assessment questionnaire

1. Does your child usually breathe through mouth?	Yes	No
2. Is your child's mouth normally kept open at times of sleep or periods of inactivity?	Yes	No
3. Does your child struggle to breathe during sleep	Yes	No
4. Does your child experience dry mouth while waking up	Yes	No
5. Does your child have frequent incidences nasal congestion?	Yes	No
6. Does your child experience sore throat frequently?	Yes	No
7. Does your child have bad breath?	Yes	No
8. Are the gums of your child's front teeth often red and swollen?	Yes	No
9. Is your child's front teeth easily discolored?	Yes	No
10. Does your child have an excessive overbite?	Yes	No

Assessment of dentofacial changes

The selected children were instructed to stand in the cephalostat (rotagraph plus) with the Frankfort Horizontal plane parallel to the floor and teeth held in centric occlusion position as demonstrated by the dentist. Agfa digital X-ray film ($8'' \times 10''$; speed E) were exposed at 72 kVp, 10 mA for 0.8 s from a fixed distance of 60 inches in the Department of Oral Medicine and Radiology, Royal Dental College and lateral cephalograms were taken. All cephalograms were taken with the same X-ray device in this standardized position in which the teeth are in centric occlusion and the head was aligned with the Frankfort horizontal plane parallel to the floor. This position was noted and was standardized with ear rod stabilization and with adequate nasal as a prevention to persistent tendency of head movement among children during exposure. The children were asked to refrain from swallowing during the radiological examination. Tongue posture was checked appropriately to ascertain that the children did not swallow and remained in the stable position. The cephalometric assessment was done manually. The anatomic structures were manually digitized and points were demarcated and the pharyngeal airway space was determined using Mc Namara's analysis (McNamara 1984 Dec 1).

McNamara pharyngeal airway analysis

The upper and lower pharyngeal airway width was assessed using the given method. For the assessment of the dimension of the airway, two distances were evaluated as described in other airway studies (Fig. 1).

Upper pharyngeal width

Point on the posterior outline of the soft palate to the closest point on the pharyngeal wall.

Lower pharyngeal width

Point of intersection of the posterior border of the tongue and the inferior border of the mandible to the closest point on the posterior pharyngeal wall.

Assessment of study casts

Maxillary and mandibular were made with alginate impression material. The study cast for evaluation was then prepared and the following points were evaluated by using vernier calipers. Reference points for measurements were as follows.

Intermolar distance

Distance measured between the central fossa of the right and left first maxillary and mandibular molars.

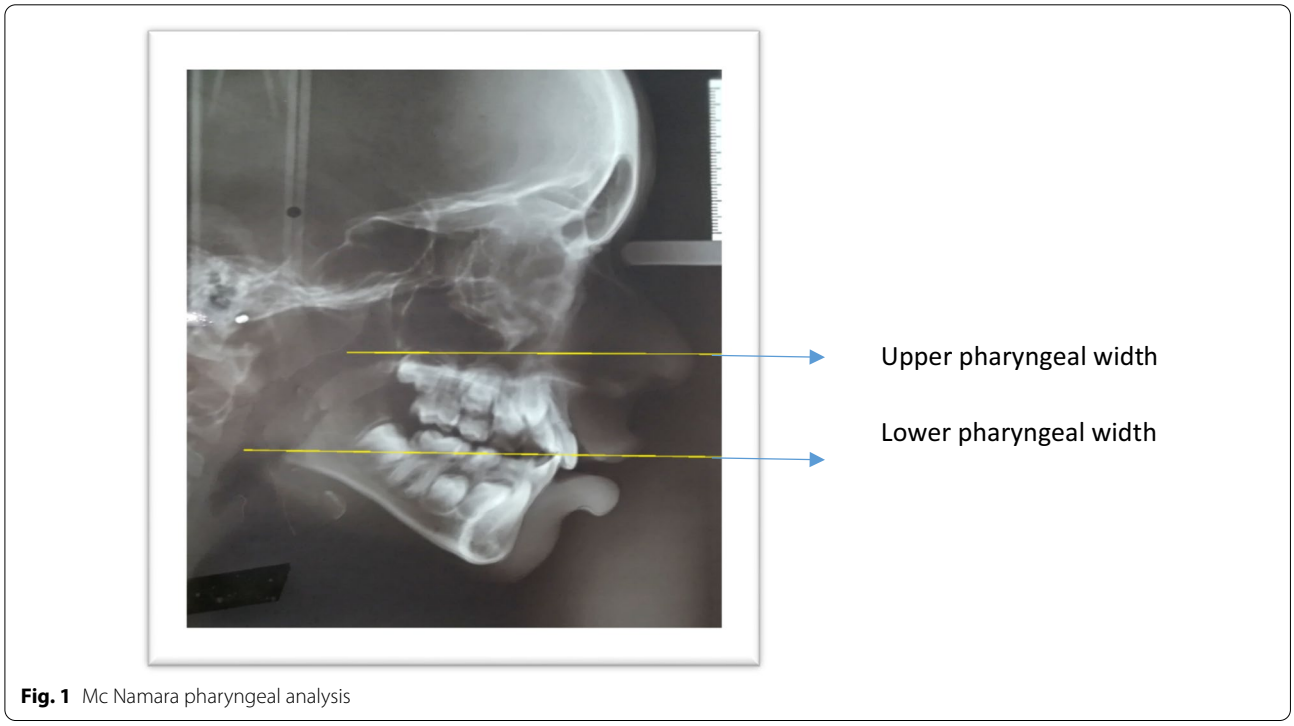

Fig. 1 Mc Namara pharyngeal analysis

Palate depth

Two points on the palatal surfaces of the second upper primary molars at the cervical margin and a vertical rule in millimeters touching lightly on the palate.

Overjet

The distance between the incisor edges of the upper central incisor and labial surface of lower central incisor.

Overbite

The distance by which the crown of the upper central incisors overlaps with the crowns of lower central incisors.

Statistical analysis

The data were entered into a computer using Statistical Package for Social Sciences (SPSS) version 22.0 (Chicago, IL, USA). The comparison between nasal breathers and mouth breathers was performed using an independent sample *"t"* test for parametric data. A *P* value equal or less than 0.05 was considered as statistically significant (Tables 2, 3, 4).

Results

Interpretation

Statistical Analysis was done using independent "t" test which showed a positive correlation between the defined parameters and the mode of breathing among the subjects. The *P* value is 0.001, and the result is significant at $P < 0.05$.

Interpretation

Statistical Analysis was done using independent "t" test which showed a positive correlation between the defined parameters and the mode of breathing among the subjects. Further more the about results also defines that mouth breathing of obstructive origin have found to have severe deleterious effects on palatal parameters and pharyngeal airway space when compared to habitual mouth breathing. The *P* value is 0.001, and the result is significant at $P < 0.05$.

Table 2 Comparative evaluation of mean and standard deviation of nasal breathers and mouth breathers

Parameters	Nasal breathers		Mouth breathers		*t* value
	Mean	SD	Mean	SD	
Upper pharyngeal airway width	12.7	1.08	9.7	0.48	1.6
Lower pharyngeal airway width	15.4	1.07	8.9	0.73	2.1
Maxillary intermolar width	45.3	2.3	43.7	2.1	2.3
Mandibular inermolar width	40.1	2.1	38.6	2.0	1.2
Palatal height	10.4	1.5	13.4	1.8	3.0
Over jet	2.5	1.01	4.5	1.6	6.8
Over bite	3.5	1.02	3.1	1.0	2.6

The *P* value is < 0.001. The result is significant at $P < 0.05$

Table 3 Comparison of dimensional parameters between nasal breathers and mouth breathers with obstructive and habitual etiological causes

Parameters	Nasal breathers	Mouth breathers (H)	Mouth breathers (O)
	Mean	Mean	Mean
Upper pharyngeal airway width	12.7	9.7	9.9
Lower pharyngeal airway width	15.4	8.9	8.9
Maxillary intermolar width	45.3	43.7	43.8
Mandibular inermolar width	40.1	38.6	39
Palatal Height	10.4	13.4	13.8
Over jet	2.5	4.5	4.8
Over bite	3.5	3.1	3.1

The *P* value is < 0.001. The result is significant at $P < 0.05$; H- habitual; O-obstructive

Interpretation

Statistical Analysis was done using independent student "t" test. The *P* value is 0.001, and the result is significant at $P < 0.05$. The above values depict the fact that mouth breathers have a greater tendency to developing Class II malocclusion than nasal breathers thereby creating a discrepancy in the existing generalized stable occlusion. There exists a subsequent correlation between the habit of consistent mouth breathing and an increased palatal vault, over jet, intermolar width and pharyngeal airway space thereby contributing to more severe dento facial problems thereby effecting the child's life.

The practical applicability of the resultant correlation is that an early diagnosis and identification of children with continuous habit of mouth breathing by utilizing available manual and digital methods will help the Pediatric dentists in devising an ideal treatment plan to prevent the habit from creating unwanted effects on the child.

Table 4 Sagittal dental relationship with respect to mode of breathing

Parameters	Nasal breathers	Mouth breathers
Class I	43	35
Class II	5	12
Class III	2	3
Total	50	50

This can also create awareness among parents regarding the importance of consulting the professional when they discover that child is being constantly affected with sleep problems or that the child has been suffering from frequent nasal congestions or the child has been experiencing breathing difficulties. This would create an alarm among the parents to consider the importance of identifying these earlier signs prior to the mishap thereby helping and reviving their child from developing any of the dentofacial defects. Further more the dentist along with the ENT specialist can devise appropriate techniques in correcting the child's mode of respiration thereby enhancing an ideal growth and development of the dentofacial structures.

Discussion

The inherent ability to maintain the normal respiratory pattern is of utmost importance for promoting the ideally favorable growth of dentofacial complex. The consistency of exposure to mouth breathing shows evident differences in developing malocclusions. The mode of respiration plays a significant pathway in craniofacial growth and development. Nasal breathing determines the ideal and recommended physiological position of orofacial structures thereby favoring the appropriate performance of the other functions of the oral sensorimotor system. In these ideally existent condition the muscles act in coordinated equilibrium thereby becoming a stimulative pattern for the harmoniously subsequent craniofacial growth and development (McNamara 1984).

The respiratory tract is divided into upper and lower part of which upper part consists of the mouth, nose, pharynx, and larynx, and the lower respiratory tract which comprises of trachea, bronchi, bronchioles, alveolar duct, and alveoli. The pharynx is a fibromuscular tube lined by the mucous membrane with an approximate length of 12–14 cm. It is divided into three sections namely the nasopharynx, oropharynx, and laryngopharynx. The oral part is continuous behind the oral cavity, while the laryngeal portion is localized behind the laryngeal inlet. Hence its dimensions are affected by the relative growth and patterns of persistent breathing mechanisms (McNamara 1984).

It has been made evident through studies that oral respiration, lowly placed tongue and lower anterior facial height elongation are apparently seen at at 3 years of age, but more commonly detected after age five. These were the findings substantiated by Abreau et al. in his study which explained that 9–11 years showed maximum variation with their dependence on oral habits. Hence, the age group 9–11 years was considered for this present study as well (Abreu et al. 2008). In the present study no particular division or subgroup was created for gender specifications as Juliano et al. in his study evaluated 27 children and also did not find difference between mouth and nasal breathers regarding sex ratios (Juliano et al. 2009). Sheng et al. also showed no statistically significant differences ($P > 0.05$) between sexes which corresponds to our present study (Sheng et al. 2009). Mc Namara et al. have detailed in his studies the pharyngeal airway changes in mouth breathing children (McNamara 1984). In the present study, McNamara's analysis was used due to the fact that though no consensus exists concerning the measurements of the nasopharynx, this distance is the only one with some validation from multiple studies predominantly conducted by Major et al. (2006).

In the present study, cephalometric radiographs were used to accurately measure the upper and lower airway dimensions. Parkkinen et al. in his studies conducted explained and supported the reliability of utilizing lateral cephalometric radiography technique in measuring the pharyngeal airway dimensions (Pirilä-Parkkinen et al. 2011). In this study two-dimensional cephalometric films were used to evaluate pharyngeal airway width however more advanced techniques including cone-beam computed tomography (CBCT) is required only on air flow analysis studies. Similarly Malkoc et al. also noted that cephalometric films were accurate in determining the pharyngeal airway width to a great extent and is a considerably cost effect method (Malkoc et al. 2005). Cameron et al. compared computed tomography and cephalometric films and found a positive correlation between nasopharyngeal airway size on cephalometric films whereas CBCT scan determined its true volumetric size in adolescents, thus determining the validity cephalometric films (Aboudara et al. 2009).

The current study revealed that the mean upper airway dimensions were the highest in mouth breathers with obstructive etiology, followed by mouth breathers with habitual etiology and finally the nasal breathers. Ucar et al. also simulated the fact that the upper posterior airway space was considered to be constricted in mouth breathers when compared to nasal breathers (Ucar and Uysal 2011). He also explained that mouth breathing increases the tendency towards narrow pharyngeal airway space in children. Mouth breathers showed reduction in upper airway space dimensions with narrowed area at the nasopharynx, which confirms with our present study. Despite the patients who had adenoid and tonsillitis hypertrophy indicates that the absence of lip seal and lower tongue position, often found in the mouth breathers, interfere the airway permeability and could subsequently result in lymphatic-tissue increase of the pharynx and consequently result in deleterious effects.

Examining the selected parameters in maxillary and mandibular cast models, it has been observed that

inter-molar distance was found to be statistically smaller in mouth breathing subjects when compared to nasal breathers. This corresponds to results obtained by Berwig et al. in their studies who observed similar results. Berwig et al. validated the fact that mouth breathing children was confirmed to have significantly higher and narrow arched hard palate values when compared to nasal breathers which confirms the fact that mode of respiration influences palatal dimensions (Berwig et al. 2011). Due to relative absence of a negative pressure in mouth breathing children this results in morphological changes in the hard palate and associated facial musculature thereby creating a restricted maxillary arch. This can finally be attributed to relative alteration in tongue placement and perioral musculature. Palatal depth was increased and statistically significant in mouth breathers in our study. This result corroborated with the finding of Martinez et al. who defined considerable increase in palatal depth in mouth breathers when in comparison to nasal breathers (Martínez Esteinou and Omaña 1988). The present study also depicted that there exited a significant increase in overjet of mouth breathers which is evidently similar to findings explained by Cheng et al. who stated that mouth breathing could lead to an increased overjet thereby increasing the incidences of Class II malocclusions (Cheng et al. 1988). Harari et al. explained that continuous and prolonged incidences of mouth breathing can have deleterious effects on the craniofacial morphology, such as the obstruction of the upper airways resulting in changes in normal craniofacial growth and development. This results in classical features of mouth breathers which includes long face, maxillary arch constriction, high-arched palate and dental malocclusion of Class II (Harari et al. 2010). Though there have been several studies that had compared the various parameters of mouth breathers and nasal breathers no relevant studies have so far been conducted where there had been a comparative evaluation of dental cast parameters and cephalometric analysis of pharyngeal airway space. Appropriate decisions about designing the treatment plan should not be confined only to dental diagnosis but also to adjunct definitive evaluations. An assessment and management of the mouth breathing habit at an earlier age may be necessary to adequately manage the child to in manner thereby promoting the normal growth and development.

Conclusions

The present study led to the conclusion that mouth breathing has got considerable influence on the dento facial structures of a growing child. Based on the above study it is confirmed that mouth breathing causes a higher palatal vault, narrow pharyngeal airway space and possess the greatest tendency of developing Class II malocclusion among growing children. Hence, earlier recognition of the changed mode of breathing would help in curtailing the development of muscular and dentofacial alterations. These alternations cause difficulty in restoring and providing stability to acceptable occlusion which possess a challenge to the dentists. After maximum facial growth has occurred, management of deviant dental patterns become increasingly complex and irreversible. Therefore, identifying the pertaining mouth breathing habit can help the clinician in designing the management strategies for the child accordingly.

Abbreviations

Mouth breathers (H): Mouth breathers habitual; Mouth breathers (O): Mouth breathers obstructive.

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Author contributions

The authors have stated that "All authors have read and approved the manuscript". LT, the first author have made substantial contributions to the conception design of the work; have contributed to definition of intellectual content, the data acquisition, data and statistical analysis, interpretation of data; have drafted the work substantively and revised it accordingly AND have approved the submitted version (and any substantially modified version that involves the author's contribution to the study); AND have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature. MSS, the second author have made substantial contributions to the conception design of the work; have contributed to definition of intellectual content, the data acquisition, data and statistical analysis, interpretation of data; have drafted the work substantively and revised it accordingly AND have approved the submitted version (and any substantially modified version that involves the author's contribution to the study); AND have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature. All authors read and approved the final manuscript.

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Availability of data and materials

All data generated or analysed during this study are included in this published article and its supplementary information files.

Declarations

Ethics approval and consent to participate

Not applicable as this was done as a non invasive methodology of examining routine patients visiting the department for treatment.

Consent for publication

Consent was obtained for publication from department and parents.

Competing interests

The authors declare that they have no competing interests.

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