Research Article

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EVALUATION OF PALATAL DEPTH AND WIDTH IN MOUTH BREATHERS WITH PRIMARY DENTITION

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It is frequently assumed that impeded nasal respiration produces an undesirable effect on the morphology of the dento-skeletal complex. It is generally accepted that nasal obstruction leads to mouth breathing resulting in altered resting postures of the tongue and lips. Mouth breathing that persists during the period of active facial growth seems associated with the development of characteristics of adenoid facies. These patients have an increase in height of the middle third of the face, a narrow nasal base, hypotonic lips, and a narrow palatal arch, disproportionate with the mandibular angle, which is typically larger than normal. These dento-facial characteristics have been attributed, by various authors (Vig et al., 1981, McNamara, 1981, Joseph, 1982, Linder-Aronson, 1963, Rickets, 1968, Hartsook, 1946), to impaired nasal respiratory function.

Also widely accepted is the concept that functional alterations, such as occur during mouth breathing, may exert mild or severe effects on dento-alveolar morphology, depending on intensity, duration and stage of occurrence.

The purpose of the present study is to investigate whether during the primary dentition stage, morphological alterations might occur in the dental arches of mouth breathing children. Otolaryngologists and pediatricians are generally reluctant to recommend surgical intervention such as the removal of tonsils and adenoids.

Review of the Literature

A review of the literature was conducted with particular reference to analyses of effects of impaired nasal respiration on facial morphology. Contending that a strong tendency to breathe nasally is innate, James and Hastings (1932) report that if the nostrils of a newborn child are gently closed during sleep the baby will continue sleeping for only a few seconds. Unable to begin breathing through the mouth, the baby will start to cry and become agitated. It appears that, although many babies sleep with the mouth open, their breathing is totally nasal.

Montcrieff (1936), confirming the work of another author (Richardson, 1914) asserts that even when there is congenital narrowing of the nasal passages (bilateral atresia of the choanae), the newborn continues to breathe, albeit with difficulty, through the nose instead of through the mouth.

Sillman (1942) published results of a serial study on malocclusion in primary dentition, from birth to the age of five years. Only eight of the 40 children studied were

mouth breathers. He found no correlations between mouth breathing and occlusal change in the primary dentition.

Reviewing the literature of that period, Hartsook (1946) concluded that mouth breathing is not a primary determinant of malocclusion. He added that mouth breathers exhibit different types of malocclusion; there is not one type that characterizes all mouth breathers.

Studying the development of the dentition, Baume (1950), concluded that after the primary dental arches have been completely formed, they do not undergo antero-posterior or transverse changes unless subjected to influences of unfavorable environments. He warned that alterations can occur in the primary dentition as a result of habits such as digit or pacifier sucking. He does not make reference to mouth breathing.

In a study on antero-posterior abnormalities of the maxillae, Humphrey and Leighton (1950) evaluated 1,033 children between the ages of two and five and a half years. They found only six of the 1,033 children breathed exclusively through the mouth. They postulated that there is a strong familial component in the determination of antero-posterior abnormalities.

Emslie, et al. (1952) studied the effects of mouth breathing on facial growth during the mixed dentition stage. They found the following characteristics in children forced to mouth breathe in response to chronic nasal airway obstruction: The superior dental arch and the maxillae acquire the form of a V; the palate is deeper and the mandible is retruded.

Massler and Zwemer (1953) asserted that mouth breathing results from an anatomical predisposition and from local or pharyngeal nasal obstructions. They also add that the habit of mouth breathing in individuals with narrow faces tends to continue after the removal of the naso-pharyngeal obstructions. Finally, they point out that whereas mouth breathing is not a determining factor of malocclusion per se, it can be an aggravating factor.

Seeking to make a comparison between individuals with normal respiration and those with mouth breathing, Linder-Aronson and Backstrom (1960), took facial and dental occlusal measurements during the mixed dentition stage. They found a significant correlation between the morphology of the palate and facial type.

Bosma (1963) set forth the concept that incorrect postures of the head and neck are related to the passage of pharyngeal air. He affirms that the maturation of the pharynx as an airway precedes the establishment of postures of the head and neck.

Comparing facial dimensions and palatal height and width in normal breathers and habitual mouth breathers, Linder-Aronson (1963) found that in the mixed dentition stage, until the age of nine, the height of the palate was significantly different, but after that age, the rate of growth of the palate was not different between the two groups.

Nanda, et al. (1972) reviewed the literature and concluded that studies of primary dentition have not been given enough emphasis because orthodontic problems typically become most apparent at subsequent developmental stages. They add that the majority of oral habits are developed during infancy and that their effects on the dentition may be profound. They analyzed the effects of oral habits on the occlusion of 2500 children of preschool age, found mouth breathing to be present in 27 percent of them and that incidence increased between the ages of two and six years.

Harvold, et al. (1973) observed monkeys in mixed dentition stage, whose nasal passages had been previously obstructed and found consequent skeletal alterations in the faces of the animals. They reported an increase in facial height in animals forced to breath orally compared to a control group.

Evaluating functional morphological changes and swallowing patterns, Hanson and Cohen (1973) investigated, among other characteristics, palatal height in children in the primary dentition phase. Of the 178 children in the study, 56 were mouth breathers. After a four year longitudinal study, the mouth breathers were more likely to still display atypical swallowing and greater palatal height.

Linder-Aronson (1974), studying the effect of adenoidectomy on the dental arches, or rather the subsequent developmental changes following improvement of the airway, found an increase in the transverse dimensions of the superior arch. Experimental and control subjects were eight years old, in the mixed dentition stage.

White (1979), found that children with nasal obstructions demonstrated less vertical growth in the nasomaxillary area. He explained that when respiratory function is altered sufficiently, some change in the type of growth in the region is to be expected. Mouth breathing over a long period of time, he stated, will lead to a narrowed maxillary arch and consequently to a lingual crossbite.

In a longitudinal study of males from six to 20 years, Woodside and Linder-Aronson (1979) examined the relationships between anterior facial height and nasopharyngeal capacity. They concluded that antero-superior and antero-inferior facial heights are independent of one another. They postulated a relationship between nasal obstruction and anterior inferior facial height.

Employing the same procedures utilized in previous experimental work (1973), Harvold, et al. (1981) reported that animals with induced obstructions of the nasal passages also experience changes in dental occlusion. They added that mouth breathing leads to alterations in neuromuscular postures and functions and that these modifications affect muscular development and bony growth. These animals adapted in individual, different

ways to establish an oral airway. These different adaptive postures seemed related to the type of malocclusion that developed. Studying the influence of respiratory patterns on facial growth, McNamara (1981) found the most significant result of mouth breathing to be the change of mandibular posture that can cause undesirable changes in facial growth.

Miller, et al. (1982), studying primates, found that after six months of induced mouth breathing, a specific pattern of activity of the neuromuscular system resulted in adaptation to the airway obstruction. They added that any skeletal alteration related to changes in neuromuscular activity should be investigated, but that differences between humans and monkeys in craniofacial and oropharyngeal morphology suggest caution in extrapolations of findings from primates to humans.

Analyzing the literature dealing with the relationship between nasal respiratory function and dento-facial morphology, O'Ryan, et al. (1982) found no cause and effect relationship between these factors. They posited a complex interaction between heredity and environmental influences on dento-facial morphology.

Scaramella and Quaranta (1984), discussing the influence of hypertrophied adenoid tissue and consequent mouth breathing on the maxillary structure, report that the most evident repercussions are: Dental disharmony in the superior arch, transverse diminution of the maxilla and a deep, narrow palate.

In a discussion of the usefulness of orofacial myofunctional therapy, Mikell (1984) concluded that malocclusions are related to myofunctional abnormalities and that in cases of mouth breathers, the earlier the detection and intervention the less will be the undesirable consequences.

Hypotheses

The literature, in general, supports the following hypotheses in subjects with nasal and with oral respiration: 1. There will be a significant between-group difference in: (a) distance between second superior primary molars; (b) distance between the superior primary canines; (c) palatal depth; (d) mean distances between second primary molars; (e) mean distance between primary canines. 2. There will be a significant correlation among the various measurements studied.

Subjects

Subjects were sixty white, Brazilian children of both sexes, between four and six years of age, 30 of whom were mouth breathers and 30 normal breathers. Children with normal breathing and good occlusion for their dental developmental stage, constituted the control group of our study. The experimental group was comprised of mouth breathing children selected from an initial sample of 400 children from Sao Paulo nurseries. Selection and determination of mouth breathing status was based on direct observations and medical records. In conformity with the objectives of this research, children selected for the mouth breathing group exhibited complete primary dentition, with low carie indices, and no undesirable oral habits.

These children were tested for nasal respiration capacity by means of a lip closure reminder (Figure 1). Figure 2 shows the child in a relaxed position without the reminder. In figure 3 the child, relaxed, seated in a vertical position, has the lip closure reminder in place. He was instructed to hold the appliance between his lips. During this time the eyes, thorax and abdomen are observed for changes in expression, behavior or exaggerated physical movement.

Figure 1
Lip closure reminder.

Figure 2
Typical labial posture of mouth breather.

Figure 3
Test of nasal respiration capacity using the lip closure reminder.

We define the *typical* mouth breathers as those children who are not able to keep the reminder appliance between the lips due to nasal obstruction which prevents nasal breathing (for example: Hypertrophied adenoids). *Habitual* mouth breathers are able to retain it with some difficulty. They are unobstructed nasally, but breathe orally out of habit. Those children who can keep the reminder between the lips for three minutes without strain are defined as nasal breathers, those children who breathe predominately through the nose.

We selected for inclusion in the experimental group the *typical* mouth breathers and the *habitual* mouth breathers. A questionnaire was devised for purposes of the study which included the following items: 1. Does the child suffer frequent/constant colds, sore throats, hearing disturbances or allergies? 2. Has any surgery been recommended by the doctors? 3. Does the child keep the mouth open or breathe through the mouth? 4. Does the child snore? Drool on the pillow? 5. Does the child choke frequently? 6. Is there difficulty with breathing at night? 7. Is there digit sucking or use of a pacifier? 8. Does the child lean the head more to one side than to the other during sleep?

Formulation of this questionnaire was based on information from the literature and personal consultation with Dr. Aroldo Miniti, Titular Professor, Department of Otolaryngology of the Hospital of Clinics. Also noted were other features characteristic of infantile mouth breathing: Chronic runny nose, oral or nasal irritation, "strawberry tongue," salivary incontinence, labial interposition and gingival inflammation.

Methods

Models of the dental arches were taken, using alginate molds prepared with utility wax. The models were then trimmed and identified according to occlusal type.

Measurements. The following measurements, in millimeters, were taken from the superior primary dental arch: Inter-molar distance, inter-canine distance, and palatal depth. To measure inter-molar distance, a point located at the gingival border, at the mesio-palatine cusps of the crowns of the second primary molars, was used as a reference point. For inter-canine distance, the most central palatal points of the crowns of the primary canines, at the gingival border were used as reference points. To measure palatal depth, a line that joins the two points of the gingival border of the mesial palatine cusps of the second superior deciduous molars was used as a reference. The distance from the central point of this line to the palate, in the region of the median raphe, was measured.

To obtain these measures a worktable was specially constructed in the Department of Experimental Physics of the Physics Institute of the University of Sao Paulo. This worktable has a flat aluminum plate (25 x 18, 5 x 0.5 cm). To the plate is fixed perpendicularly a brass rod (14.5 x 1.9 x 1.9 cm). This rod supports horizontally, a Mitutoyo caliper that remains perpendicular and parallel to the plane at the base.

To lift the models to the measuring level of the caliper, in order that the plane of the table, the occlusal plane and

the points of the caliper be parallel, there is a support, adjustable at three points, corresponding to the two regions of the molars and the interincisal region of the models.

To measure inter-canine distance, each model was positioned on the worktable over the adjustable support and the calibration points located on the points of reference for the measurements. The caliper was fixed and the reading of the measured value was taken (Figure 4). The same procedure was followed to establish inter-molar distances. At the same time, the palatal depth was measured with a specially constructed device adapted to the caliper. This device consists of a moveable cylindrical rod, that releases and lowers to the center of the palate as close as possible to the midline, in the inter-molar region (second deciduous molar; Figure 5). Once the point of the metal rod establishes contact with the palate, it is fixed, and a depth reading is taken, with the help of the other caliper.

Figure 4
Measuring intercanine distance.

Figure 5
Simultaneous measurement of intermolar distance and palatal depth.

Results

Results of analyses of variance show significant differences between mean values for the two groups with respect to inter-canine distance and palatal depth. Both

differences are significant at the .01 level ($F = 13.08$, and 108.24 , with 59 d.f., respectively). However, the means of inter-molar distances do not differ significantly between the groups (Table 1).

TABLE 1
MEAN DISTANCES (mm) IN THE ORAL AND NASAL BREATHERS

	NASAL	ORAL	SIGNIFICANCE
Inter-Molar Distance	28.8	27.9	N.S.
Inter-Canine Distance	23.0	21.3	.01*
Palatal Depth	9.6	13.0	.01*

NS: Not significant.

* Significant at $P < .01$

Among correlations between inter-molar and inter-canine distance and palatal depth, across both groups, the only significant relationship was that between inter-molar distances and palatal depth in the mouth breathers group (at the .05 level; $r = 0.38$).

Discussion

Mean values for the two groups are significantly different in inter-canine distance and palatal depth. It may be inferred that palatal depth is different between oral and nasal breathers in the populations in the present study. Clinical observation had led us to the premise that the palatal depth would be greater in oral breathers. However, we did not find any research on primary dentition to empirically support or refute this observation. In the mixed dentition stage, on the other hand, many investigations had demonstrated that in mouth breathers that palate is deeper and narrower, (e.g., Linder-Aronson (1979), references of McNamara (1981), O'Ryan (1982), Ricketts (1968), Scaramella and Quaranta (1984). Besides these, Hanson and Cohen (1973), studying children with deep palates in primary dentition call attention to the possibility of inadequate nutrition in the newborn and the influence of upper respiratory problems.

In Table 1 are found the means of the distances studied in the two groups. We find no significant difference between the means of inter-molar distances between oral and nasal breathers. Perhaps the fact that the second molars are the last teeth to erupt might explain this unexpected finding; the stability of the posterior transverse dimensions of the arch is well known. However, the absolute value of the means of the inter-molar distances for oral breathers (27.9 mm) is less than for the nasal breathers (28.8 mm). Although not statistically significant, this result suggests a tendency for the inter-molar distance in the primary dentition to be less in mouth breathers.

There is a significant difference between mean values of oral and nasal breathers in inter-canine distance (Table 1). Clinically this fact deserves attention, since in many cases with a lessening of the inner-canine distance crossbites occur in primary canine teeth. Based on this data we would consider it prudent, especially in cases of bilateral crossbites, to screen for airway problems before initiating interceptive orthodontic treatment. To clarify, it is common to conclude that when a crossbite is only unilateral the problem is related to inadequate postural habits.

With respect to palatal depth, we see in Table 1 a significant difference between the means of the nasal and oral breathers. Palatal depth is greater in the mouthbreathing group, which can be interpreted to mean that as vertical growth occurred in the region of the roof of the mouth, the palate did not accompany it, that is, did not descend, but narrowed instead. We know that the incidence of mouth breathing increases between the ages of two and six years (Nanda, 1972). So, this alteration could have begun in earlier stages before the complete definition of the superior primary dental arch.

Studies of subjects in the mixed dentition stage have demonstrated that the superior arch remains high and narrow in the mouth breather. Apparently transverse growth does not adequately accompany vertical dental alveolar growth. It is thought that posturing the tongue in the palate and breathing through the nose in a normal manner provides a stimulus for the palate to develop appropriately. Keeping the mouth open the greater part of the day, deprives the arch of the many molding effects of the tongue at rest and during speech, chewing, and swallowing. These neuromuscular changes in posture and function seem to contribute to the atresia of the maxilla. If the palate has experienced alterations in depth, (measurable in the primary dentition), it may be anticipated that these early deviations will be aggravated during the mixed dentition stage.

We can report that for the nasal breathers, there is no significant correlation between inter-molar, inter-canine distances and palatal depth. In the group of oral breathers, no correlation was found between palatal depth and inter-canine distance. Curiously, there is a positive correlation between palatal depth and inter-molar distance in the mouth breathing group. "Curiously" because when we observe patients with mouth breathing in the 10 to 11 year age group, with very narrow palatal arches, we generally find a significant atresia in the superior dental arch. It would seem logical to expect an inverse correlation between palatal height and inter-molar distance, that is, the greater the palatal depth the smaller the inter-molar distance.

Having found the positive correlation to be between palatal depth and inter-molar distance for mouth breathers, statistically significant at the .05 level, we made some interpretations. In the first place, the level of correlation found is not very rigorous statistically. Another factor may be that our inter-molar distance measurements were taken at a given point in the palate close to the cervical lingual border of the mesial cusps of the second superior deciduous molars. That being the

case, even in those patients who already had unilateral or bilateral crossbite at the second primary molars, the value of the measurement was not affected. Additionally in the age group of our sample, four to six years, the influence of mouth breathing on palatal height may not yet be sufficient to alter the transverse dimension of the maxillae in this region. We are supported in this interpretation by Linder-Aronson (1963), who emphasized that growth in maxillary width ceases early in relationship to growth of its height, which continues until approximately adulthood. Nanda (1972) agrees with our initial premise when he affirms that in primary dentition orthodontic problems are present in very incipient stages. This means that even when a functional alteration, such as mouth breathing, causes no readily apparent clinical changes, it deserves special attention. Mouth breathing is typically associated with atypical swallowing, incorrect rest posture of the tongue, hypotonia of the peribuccal musculature, or interdental positioning of the lip, which may have a negative influence on the developing occlusion. In addition there may be a genetic predisposition for long narrow facial type in some individuals. In this case, environmental factors could still aggravate the familial tendency in determining morphologic alterations. It seems reasonable to suggest that resolving airway problems and so improving the neuromuscular influence on development, might lessen the severity of a developing dentofacial problem. Moss (1969) emphasizes the importance of balance between functional matrices in normal development.

It is important to remember that mouth breathing has repercussions on general health of the individual. As early as 1934, Dickin reported that there was a surprising improvement in psychic aspects of behavior following normalization of nasal respiration.

Summary

This research project was conducted to discover if mouth breathing is associated with any measurable skeletal changes in the primary dentition stage of development. Measurements revealed that inter-canine distance was reduced and palatal depth was greater in the mouth breathing children when compared to a group of nasally breathing children. These differences were found to be statistically significant. However, there was no significant difference for the inter-molar distance, when comparing the two groups. There was a positive correlation between the depth of the palate and the inter-molar distance for the mouth breather group.

The results of this study suggest that mouth breathing can have a negative influence on the developing maxilla in the primary dentition stage. These authors therefore encourage early detection and appropriate treatment of nasal airway problems to reestablish nasal breathing with all its attendant benefits for the developing child.

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