Relationships between Variation of Mandibular Morphology and Variation of Nasopharyngeal Airway Size in Monozygotic Twins

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INTRODUCTION

The adenoids are located in the nasopharynx which has as its most posterior and inferior bony boundaries the body of the sphenoid, the basilar portion of the occipital bone and the arch of the atlas. The distances from these bony landmarks and the posterior nasal spine, with its soft palate attached to it, can vary greatly depending on the size of the adenoidal mass.

The nasopharyngeal airway size can be defined as the shortest distance from the most anterior aspect of the adenoids to the most posterior aspect of the soft palate, in a relaxed position. This airway space can thus be small or nonexistent if the adenoids are hypertrophied and large if the adenoids have regressed.

The size of the nasopharyngeal airway space is of importance in its relationship to the morphology of the face, the mandible included, because with reduction of the nasopharyngeal airway space nasal breathing becomes difficult or impossible, and mouth breathing becomes necessary. It is with chronic mouth breathing that the normal balance of oral and paraoral structures is upset and changes of both structures can be expected.

Because morphological changes are a normal part of growth processes, the determination of the extent of environmental and genetic influences on morphological traits is difficult. By using a sample of monozygotic twins, hypotheses concerning environmental change relationships can be more readily tested, because each twin in a pair theoretically has the same genetic determinants of growth.

The aim of this investigation was to study the relationship between variations in pharyngeal airway size and the morphology of the mandible using two groups of monozygotic twins. Group I consisted of twins with airways differing less than 1.5 mm in size; Group II of twins with intrapair differences of 1.5 mm or more in airway size. Various measurements of the mandible were taken to determine if the intrapair variation in mandibular morphology was significantly different in Group I as compared with Group II.

REVIEW OF THE LITERATURE

The adenoids as viewed on lateral cephalometric radiographs appear as a convex prominence located in the nasopharynx facing the superior surface of the soft palate. They are attached to the inferior body of the sphenoid and basilar portion of the occipital and the posterior pharyngeal wall. The anterior attachment of the adenoids may extend

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as far forward as the posterior choanae, and the posterior attachment may extend inferiorly to just below the level of the anterior tubercle of the atlas. Enlarged adenoids may appear to contact or nearly contact the superior aspect of the soft palate.

Subtelny[1] studied the growth of the adenoids and contiguous structures and found that the adenoids grow at a rapid rate from age six months to one year (when first seen radiographically) until by age two or three years they occupy about one half of the nasopharyngeal cavity. Thereafter, the adenoids continue to grow in a downward and forward direction but at a somewhat slower rate until they reach a peak at about age ten or eleven years, or sometimes as late as fourteen to fifteen years. After the peak is reached, the adenoids begin to regress and are completely regressed by adulthood.

While this is going on, the other structures in the area are also growing. The relationship between the posterior nasal spine and the atlas is established by age two years and remains stable for life. The width of the nasopharynx is also thought to be stable after age two years; however, the vertical dimension of the nasopharynx continues to increase until age seventeen to eighteen years. Its increase is due to the palate growing downward and forward in a parallel manner carrying the soft palate with it away from the cranial base thereby increasing both nasal and nasopharyngeal heights.[1]

These two contiguous independently growing areas indicate that a fine state of equilibrium in their growth is required, and there is a possibility for imbalance. Such imbalance is likely to occur when the adenoids develop too fast or the palate grows away too slowly and results in nasal obstruction.

The instability of the relationship of the two growing areas was seen up until age twelve years, meaning obstruction was common up to this age. After twelve years, the nasopharyngeal depth increased when the adenoids began regressing, thus reducing the number of cases of nasal obstruction seen after age twelve.[2]

Leech[3] and Moyers[4] noted that enlargement of the adenoids can cause mouth breathing, a point not debated, but there is evidence which supports the idea that the absolute size of the adenoids is not as important as the size of adenoids relative to the nasopharynx. Lubarth,[5] Ricketts,[6] Linder-Aronson,[7] and Emslie et al.[8] all found that nasal obstruction leading to mouth breathing was related to the size of the nasopharynx; the smaller the nasopharynx, the less the amount of adenoidal enlargement needed to obstruct the nasopharyngeal airway.

When there is nasal obstruction, mouth breathing often results; the jaw is held apart and the tongue is lowered. Whether or not this sequence causes dental and facial changes is debated. Linder-Aronson,[7] Moyers,[4] Hawkins,[9] and Graber[10] suggested that mouth breathing causes malocclusion and facial deformity. Because of the abnormal muscle function the maxilla is contracted having a "V" shape and a palate which appears higher than normal. The occlusion is usually Angle's Class II, Division 1. The lower lip is hypertrophic and the upper lip is hypotonic. The tongue is habitually postured low in its relationship to the palate. The child's face is long and the chin receded. The expression of their face is said to look vacant or dull, and is referred to as "adenoidal facies."

Emslie et al.[8] and Ballard and Gwynne-Evans[11] reported that the "adenoidal facies" were not caused by nasal obstruction, but were genetically determined. They found those children with long narrow faces, high gonial angles, and narrow arches showed a high incidence of adenoidal obstruction of the nasopharynx because the nasopharynx was narrow as was the rest of the face, and thus was easily blocked.

Ricketts[6] did not support either contention but indicated that either condition was plausible.

Most studies concentrated on the maxilla and dentition. However, Linder-Aronson[7] included some mandibular measurements. He found that there was a significant difference in the angle formed by the mandibular line and the nasal line (a line through anterior and posterior nasal spines) between those patients indicated for surgery due to adenoidal enlargement or recurrent ear infection and all control groups. The same was found to be true in the angle formed by the mandibular line and the sella-nasion line. In both cases the angle was greater for the children indicated for surgery.

Linder-Aronson studied air flow as related to adenoid size and found that the adenoids as seen on x-ray films are correlated with the amount of nasal breathing.

In a study comparing the variance of the facial skeleton of monozygotic twins with dizygotic twins, Lundstrom[12] found that variance is twice as likely to be caused by heredity than environment.

The literature to date shows much difference of opinion and little research into the effects of adenoids on facial growth. As far as the mandible is concerned, it has just been touched upon so far.

Methods and Materials

The material for this study comes from the collection of twin study material at State University of New York at Buffalo, Orthodontic Department. The frontal and lateral cephalometric radiographs of thirty-three monozygotic twin pairs were used. The ages of the twins ranged from seven to twelve years. The zygosity for each twin pair was determined by concurrence of six blood factors: ABO, Rh, MNS, F, Kell, and Duffy. Group I consisted of sixteen twin pairs, ten males and six females and Group II consisted of seventeen twin pairs, eight females and nine males.

The difference of the intrapair airway size, measured from the anterior aspect of the adenoids to the posterior aspect of the soft palate, was used to place the twin pairs into either Group I or Group II. If the absolute intrapair difference of the airway size was less than 1.5 millimeters, the twins were placed into Group I; if it was 1.5 millimeters or greater, the pair was placed into Group II.

To make sure that the differences seen in airway size in the groups was not temporary, the difference was seen in at least two films representing a two-year interval.

Mandibular measurements were taken twice for eighteen twin pairs, with at least one week between the two measurements. From these repeated measurements a reliability coefficient was determined for each trait.

The mandibular traits as defined by cephalometric points were as follows: 1) Ramal height—from articulare to gonion, 2) Mandibular length—from gonion to menton, 3) Gonial angle—the angle formed by articulare, gonion, and menton, 4) Antegonial notch height—the greatest height in the notch area measuring perpendicular from a mandibular plane which is drawn tangentially to the lower border of the mandible, 5) Bigonial width—from gonion to gonion, 6) Antegonial notch distance—distance from gonion to the point of greatest antegonial notch height, measured along a mandibular plane which is drawn tangentially to the lower border of the mandible. (Figs. 1, 2, 3)

The hypothesis was based on the assumption that if there is a significant difference between the variances in the mandibular traits of the two groups, it is possibly related to the size differences of the adenoids. The F statistic was used to test the hypotheses at the 0.05 level of significance.

Results

The reliability of the measurements, using two independent determinations, was consistently high, as judged from the following reliability coefficients (r):

1. Ramal height—.965
2. Mandibular length—.983
3. Gonial angle—.987
4. Nasopharyngeal airway size—.994
5. Antegonial notch height—.945
6. Bigonial width—.961
7. Distance to antegonial notch—.954

The F test was used to compare the variance of the two groups of twin pairs to determine if the groups were significantly different for the following mandibular variables:

1. Ramal height
2. Mandibular length
3. Gonial angle
4. Antegonial angle
5. Bigonial width
6. Distance to antegonial notch

Only gonial angle and bigonial width were significant at the 0.05 level. The findings indicated that the gonial angle increased with decreasing nasopharyngeal airway. Bigonial width also increased with decreased nasopharyngeal airway size (Table 1).

Discussion

The question of whether the features of the "adenoidal facies" are genetic or are a result of environmental factors, as noted in the review of the literature, is still open to question. Monozygotic twins were selected as the subjects of this investigation under the assumption that the variances of two groups of

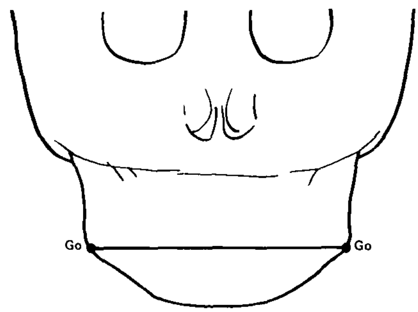

Fig. 1 Mandibular bigonial width.

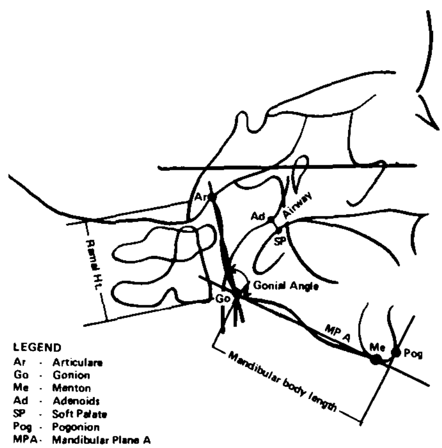

Fig. 2 Landmarks, angular and linear measurements.

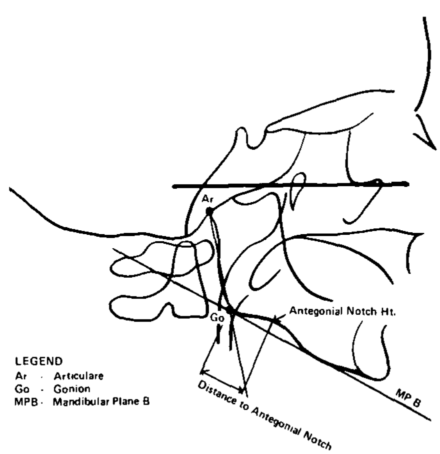

Fig. 3 Landmarks and linear measurements.

TABLE I

The Results of F Tests for Differences Between the Intrapair Variances of Mandibular Traits for Two Groups of Monozygotic Twins Categorized on the Basis of Nasopharyngeal Airway Size.

Mandibular Traits	df Group I	df Group II	Intrapair Variances s^2dI	Intrapair Variances s^2dII	Significance
Mandibular length	16	15	4.330	4.964	NS
Gonial angle	16	15	15.435	3.125	**
Ramal height	16	15	10.199	6.365	NS
Antegonial notch height	16	15	0.527	0.462	NS
Gonion to Antegonial Notch	16	15	8.968	9.233	NS
Bigonial width	14	15	15.362	5.560	*

NS non-significant
* $p<0.05$
** $p<0.01$

monozygotic twins should have intrapair variances which are not significantly different. By using the intrapair airway size differences to group the twins, it was assumed that if any of the mandibular morphological trait variables were significantly different for Group I as compared with Group II then airway size was somehow related to the morphology of the mandible.

Only two of the mandibular variables (gonial angle and bigonial width) so tested were significant. The findings indicated that both gonial angle and bigonial width tended to be larger when nasopharyngeal airway size was small. The gonial angle finding supports those reported previously by Linder-Aronson.[7] He noted an increase in the angles between the mandibular line and the sella-nasion line and the nasal line in children indicated for surgery due to nasal obstruction by adenoidal enlargement. The finding of increased bigonial width had not been previously reported.

The literature seems to suggest that the size of the adenoids may not be as strong an indicator of nasal obstruction and mouth breathing as is its size relative to the size of the nasopharynx. By using airway size, neither the absolute size of the nasopharynx or the adenoids was needed. The nasopharyngeal airway space is a measure of the space of the nasopharynx remaining as a result of adenoidal enlargement.

The changes in the morphology of the face which have been attributed to the adenoids are interpreted as changes related to the oral breathing, low tongue positioning and other accompanying habits. In this investigation the mode of breathing and tongue position was not directly investigated, the assumption being that the effects, if any, be evident without identifying the children with abnormal breathing and tongue position. The design of this study utilized the airway size differences in twin pairs as the independent variable, and attempted to determine if the differences might be related to differences in intrapair mandibular dimension. It was not ascertained whether the mode of breathing or tongue position was different within the pairs, but it was recognized that variations in airway size could possibly influence the variation in the manner of breathing and tongue position.

The findings of this study did not offer a direct explanation for the mechanisms by which changes of the mandibular gonial angle or bigonial width occur. However, it can be assumed that these changes are the results of changes in oral function due to nasal obstruction. According to Moss[13] the gonial angle area of the mandible is influenced by the functional matrix of the masseter and medial pterygoid muscles. When the function of these two muscles is altered, the morphology of the gonial angle is altered. The changes detected in this study may represent just such a change due to change in function.

The increase in bigonial width detected in this study could result from either the lowered position of the tongue or the maintenance of the mouth in an open position. With the tongue in an abnormally low position, the normal balance of the buccinator mechanism would be upset. The maxilla would be collapsed because of the lack of lingual support and the mandible may be overly wide because the full force of the tongue would be exerted on it.

In mouth breathing the jaws are held farther apart than the normal rest position. This results in the gonial angle area encroaching more on the pharynx and the pharyngeal muscles. This would add to the functional matrix of the gonial angle area some of the muscles of the pharynx; their effect may well be to increase the width of the angle so that the pharyngeal airway space is not constricted.

This investigation indicated that nasopharyngeal obstruction is related to changes in mandibular morphology, thus supporting the opinion that functional and environmental factors are important determinants of facial morphology and, because of possible concomitant changes in the morphology of other facial structures, a facial pattern such as "adenoidal facies" could result.

Conclusion

The findings of this study support the opinion that nasal obstruction is related to changes in the morphology of the mandible. The relationship is such that with decreased nasopharyngeal airway size the gonial angle tends to increase and bigonial width increases. These changes occur with no significant change in the height of the ramus, the length of the body of the mandible, or the height and position of the antegonial notch.

Summary

The question of whether nasopharyngeal airway obstruction and mouth breathing caused by enlarged adenoids are related to facial changes has been disputed because of the difficulty of separating normal genetically caused growth changes from changes due to the habit of mouth breathing. By utilizing a sample of monozygotic twins, who theoretically have the same genetic growth determinants, those changes in mandibular morphology related to nasopharyngeal airway obstruction were determined.

Frontal and lateral cephalometric radiographs of thirty-three pairs of monozygotic twins were used to investigate the relationship between the size of the nasopharyngeal airway and the morphology of the mandible. The twins were divided into two groups according to the nasopharyngeal airway size. By utilizing the intrapair variances of some mandibular morphological traits it was found that: 1) Bigonial width and gonial angle variations are inversely related to nasopharyngeal airway size variations. 2) Ramal height, antegonial notch height and position, and mandibular body length variations were not related to nasopharyngeal airway size variations.

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