The Nasopharynx, Face Height, and Overbite

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Analysis of correlations between nasopharyngeal dimensions and face height and overbite in 44 consecutive male growth study subjects, none of whom was a mouthbreather. Using lateral cephalometric films taken at 5, 10 and 15 years, only moderate correlations are found, supporting the view that stronger correlations reported in mouthbreathers are related to function.

KEY WORDS • Growth • Nasopharynx • Respiration •

It has been suggested by Todd (1936) that adenoid growth, by constricting the nasopharyngeal passage and mechanically impeding breathing, might affect facial development in early childhood. It has been postulated that a functional adaptation which facilitates mouthbreathing occurs where there is difficulty in nasal breathing. Forward positioning of the head on the neck, and a lowered position of the mandible with low and forward tongue position are commonly described in this context.

Those adaptations have been linked in turn with the *long face syndrome.* While these relationships have been investigated in some detail in mouthbreathers (Linder-Aronson 1970 and 1979, Bushey 1979), less has been done to investigate the possibility of a broader relationship between nasopharyngeal morphology and the components of occlusion and facial development. Might occlusion and facial development be affected by minor degrees of nasopharyngeal restriction in nasal breathers?

— Objectives of the Investigation —

This investigation was undertaken to study the following relationships of nasopharyngeal dimensions —

- Correlations between nasopharyngeal dimensions and overbite and face height in a random male sample of non-mouthbreathers.
- Comparisons of nasopharyngeal dimensions in Class I and Class II occlusion groups.

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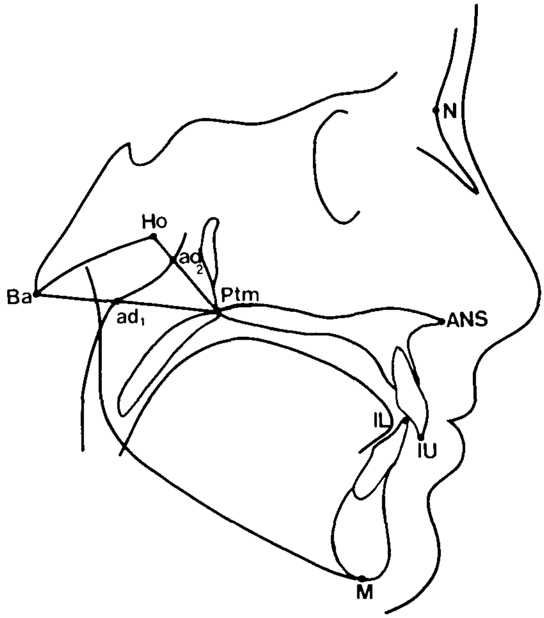

Fig. 1
Points and constructed lines

— Material and Method —

The study sample consisted of the same individuals who had been used in a previous study (Adams and Kerr 1981), consisting of 44 consecutive male growth-study subjects with lateral cephalometric radiographs available at approximately 5, 10 and 15 years of age (Table 1).

None of the subjects was a mouth-breather, nor had tonsillectomy or adenoidectomy been performed during the period of study, although two subjects had undergone adenoidectomy 1 and 2 years respectively prior to the exposure of the first study film.

Each of the three films was traced twice, plotting and digitizing the mean positions of the points shown in Fig. 1. The outline of the adenoid area was also traced. Measurements were derived using a procedure similar to that used by Linder-Aronson (1970) (Table 2).

It was not possible to consistently measure the overbite on the first film because of the absence of deciduous incisors in some cases, so this dimension was omitted.

Table I

Sample		
44 male subjects		
no mouth breathers		
Occlusion		
I/Normal	II^1	II^2
25	10	9
Mean Age (years)		
Film 1	5.5 ± 0.3	
Film 2	10.5 ± 0.3	
Film 3	15.5 ± 0.3	

— Results and Discussion —

The results are presented in three groups.

1. Correlations between the anterior dimensions and the nasopharyngeal dimensions at 5, 10 and 15 years (table 3).

Overbite

Correlation coefficients for overbite were calculated at 10 and 15 years only. All were weak, and only two were statistically significant at the 5% level at 15 years. Correlations showed an inverse relationship between overbite and height of the nasopharynx (−0.31) and adenoid area (−0.34). Although statistically significant, their clinical importance appears to be minor, as they account for only 10% and 12% respectively of overbite variation.

Total Face Height

Significant correlations are seen between total face height and the height of the nasopharynx, Hormion–Pterygomaxillare, roof angle of the bony nasopharynx, nasopharyngeal area and adenoid area. These correlations were strongest at 10 years, and all were positive except for the inverse relationship between face height and roof angle.

The strongest correlations were at 10 years, between face height and height of the nasopharynx (0.64), roof angle (−0.52), nasopharyngeal area (0.58) and adenoid area (0.48), all significant at the .001 level.

By 15 years, only the height of the nasopharynx (0.55) and the nasopharyngeal area (0.52) were still significantly correlated at the .001 level.

Even with a correlation of 0.64, the height of the nasopharynx accounts for only 41% of the variation in total face height, so that most of these correlations must be of limited clinical significance. Nevertheless, the dimensions which correlate most consistently with total face height at all ages are the height of the nasopharynx and the nasopharyngeal area.

Table 2

Dimensions and terminology

	Linear	
Hormion to Ba–Ptm	=	Height of Nasopharynx
Basion–ad_1	=	Ba–ad_1
Basion–Pterygomaxillare	=	Ba–Ptm
Basion–Hormion	=	Ba–Ho
Hormion–Pterygomaxillare	=	Ho–Ptm
Nasion–Menton	=	Total Face Height
ANS–Menton	=	Lower Face Height
Incisal tip U1–Incisal tip L1	=	Overbite (Films 2 & 3)
	Angular	
Basion–Hormion–Pterygomaxillare	=	Roof Angle
	Area	
Basion–Hormion–Pterygomaxillare	=	Nasopharyngeal Area
Ba–ad_1–ad_2–Hormion	=	Adenoid Area
Nasopharyngeal Area minus Adenoid Area	=	Airway
Airway as % of Nasopharyngeal Area	=	Airway %

Lower Face Height

Significant correlations with lower face height closely follow those with total face height, with slightly weaker positive relationships with height of the nasopharynx, nasopharyngeal area and adenoid area, and an inverse relationship with the roof angle. The peak is again at 10 years.

Again, the relationship with the height of the nasopharynx seems reasonably consistent, as does that with the roof angle and the nasopharyngeal area.

Correlations between some nasopharyngeal dimensions and face height and overbite are moderate, while others are negligible — notably airway, as measured in this study on lateral cephalometric films. This could be interpreted as an indication that no correlations exist, but it could also indicate that cephalometric radiographs alone may not give a completely accurate representation of three-dimensional airway size in two dimensions.

The finding that the depth of the nasopharynx (Ba–Ptm) in males correlates only weakly with face height (total and lower) at all stages is in agreement with Linder-Aronson and Woodside (1977), suggesting that this dimension varies relatively independent of anterior facial dimensions.

The moderate correlations between face height and nasopharyngeal dimensions confirm only the logical premise that subjects with tall faces generally have tall nasopharynges. It would also appear that these subjects have more acutely-angled nasopharyngeal roofs than those with small faces.

2. Changes in Dimensions (Table 4)

The second group of results show the changes in dimensions between 5, 10 and 15 years. In no period were *changes* in nasopharyngeal dimensions accompanied by proportional changes in face height or overbite.

Table 3

Correlations (r) between Nasopharyngeal Dimensions and Overbite, Total Face Height, and Lower Face Height

○ P<.05 • P<.05 ▪ P<.001

Film	Height	Ba/ad$_1$	Ba/Ptm	Ba/Ho	Ho/Ptm	Roof Angle	Nasopharynx Area	Adenoid Area	Airway Area	%
					Overbite					
2	−0.09	−0.25	0.03	0.02	−0.08	0.12	−0.05	−0.25	0.26	0.18
3	−0.31○	−0.12	−0.05	−0.01	−0.29	0.25	−0.28	−0.34○	0.06	0.17
					Total Face Height					
1	0.44•	0.27	0.26	0.31○	0.25	−0.27	0.47•	0.41•	−0.07	−0.17
2	0.64▪	−0.10	0.12	0.27	0.43•	−0.52▪	0.58▪	0.48▪	0.02	−0.015
3	0.55▪	−0.08	0.13	0.21	0.34○	−0.43•	0.52▪	0.27	0.13	0.05
					Lower Face Height					
1	0.42•	0.19	0.10	0.25	0.17	−0.36○	0.40•	0.32○	−0.02○	−0.10
2	0.56▪	0.01	0.04	0.29	0.25	−0.51▪	0.47•	0.45•	−0.06	−0.16
3	0.52▪	−0.09	0.04	−0.17	0.29	−0.43•	0.44•	0.27	0.16	0.01

This confirms that when function is normal, the relationships between changes in nasopharyngeal morphology and anterior facial and dental dimensions are weak. It may be that the postural relationships described by LINDER-ARONSON (1970) become a factor leading to an associated change in facial form only when the mode of breathing is predominantly oral.

3. Comparison of Class I and II subjects (Table 5).

To test the hypothesis that a Class II relationship might be caused to some degree by mandibular posture in response to nasopharyngeal constriction, the area measurements for the nasopharynx in Class I and Class II Groups were compared.

This comparison showed a general trend for the nasopharyngeal and adenoid areas to be smaller, and for the airway and the airway as a percentage of the total Nasopharynx to be larger in the Class II group. The differences were statistically significant at 10 and 15 years for adenoid area and airway percentage, and at 10 years for the airway.

These findings would tend to rule out airway restriction (as measured on lateral cephalometric radiographs) as a general factor in the etiology of these malocclusions. However, it must be stressed that the standard deviations of the means were extremely large, greater than the differ-

Table 4

Correlations between *Changes* in Nasopharyngeal Dimensions and *Changes* in Overbite, Total Face Height, and Lower Face Height

○ P<.05

Film 1 to 2	Height	Ba/ad	Ba/Ptm	Ba/Ho	Ho/Ptm	Roof Angle	Naso-pharynx	Adenoid Area	Airway Area	%
TFH	−0.04	0.29	0.018	−0.09	0.19	0.18	0.03	0.25	−0.24	−0.31○
LFH	−0.014	0.17	0.26	−0.07	0.09	0.29	−0.07	0.16	−0.22	−0.15
2 to 3										
O/B	−0.06	−0.30○	0.01	0.05	−0.5	−0.01	−0.05	−0.18	0.11	0.23
TFH	0.05	0.26	0.20	−0.01	0.20	0.00	0.15	0.03	0.10	−0.09
LFH	0.19	0.28	0.10	0.18	−0.01	−0.14	0.22	0.22	0.00	−0.15

Table 5

Differences in Mean Areas of Class I/Normal and Class II
(Class I/Normal minus Class II)
mm^2

• P<.01 ▪ P<.001

Film	Nasopharyngeal	Adenoid	Airway	%
1	8.0	11.4	−3.2	−2.3
2	8.1	44.9•	−35.9•	−12.3•
3	32.7	63.2▪	−30.5	−10.4•

ences between the means except in the case of the adenoid area at 15 years. When the Class II subjects were subdivided into Division 1 and Division 2, similar trends were shown for each group, although all areas were generally larger in Division 1.

The finding that the nasopharyngeal area is smaller in the Class II group than Class I is in agreement with the study of females by MERGEN AND JACOBS (1970).

On the other hand, SOSA ET AL (1982), using a combined male and female sample with a mean age of 10.5 years, suggested that the nasopharyngeal airway might be larger in Class I than in Class II, division 1, although the difference was not statistically significant. Obviously, the mean differences between nasopharyngeal areas in Class I and Class II malocclusion groups are small, and individual variation is at least as important as occlusion type.

If anything, these comparisons and correlations tend to emphasize the relative independence of morphology and growth of the nasopharynx and anterior dentofacial dimensions in those who *do not* exhibit a breathing problem.

— Summary and Conclusions —

1. In lateral cephalometric films of a group of male subjects, none of whom was a mouth breather, the statistical relationships between overbite and nasopharyngeal dimensions were weak. Moderate relationships were found between face height and nasopharyngeal dimensions. Strongest correlations, with a peak at 10 years, were between —

- Face height and nasopharyngeal height (+)
- Face height and nasopharyngeal area (+)
- Face height and roof angle (−)

2. Dynamic correlations between overbite, face height and nasopharyngeal dimensions were weak.

3. Class II malocclusion subjects on average showed —

- Smaller Nasopharyngeal and Adenoid Areas.
- Larger Airways in both real and proportional terms, compared with Class I and normal occlusion subjects.

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