ORIGINAL ARTICLE

Upper and lower pharyngeal airways in subjects with Class I and Class II malocclusions and different growth patterns

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Introduction: Associations of Class II malocclusions and vertical growth pattern with obstruction of the upper and lower pharyngeal airways and mouth breathing have been suggested. This implies that these malocclusion characteristics have a predisposing anatomical factor for these problems. Therefore, the purpose of this study was to compare upper and lower pharyngeal widths in patients with untreated Class I and Class II malocclusions and normal and vertical growth patterns. **Methods:** The sample comprised 80 subjects divided into 2 groups: 40 Class I and 40 Class II, subdivided according to growth pattern into normal and vertical growers. The upper and lower pharyngeal airways were assessed according to McNamara's airways analysis. The intergroup comparison of the upper and lower airways was performed with 1-way ANOVA and the Tukey test as a second step. **Results:** The results showed that the upper pharyngeal width in the subjects with Class I and Class II malocclusions and vertical growth patterns was statistically significantly narrower than in the normal growth-pattern groups. **Conclusions:** Subjects with Class I and Class II malocclusions and vertical growth patterns have significantly narrower upper pharyngeal airways than those with Class I and Class II malocclusions and normal growth patterns. However, malocclusion type does not influence upper pharyngeal airway width, and malocclusion type and growth pattern do not influence lower pharyngeal airway width. (Am J Orthod Dentofacial Orthop 2006;130:742-5)

Some authors associated mouth breathing and Class II malocclusions,[1-4] and others[5-12] reported associations of vertical growth pattern with obstruction of the upper and lower pharyngeal airways concurrently with mouth breathing. If this relationship actually exists, Class II malocclusions and vertical growth patterns must have natural anatomical predisposing factors. Among the predisposing factors for obstruction of the pharyngeal airways such as allergies, environmental irritants, and infections, which are amenable to adequate treatment,[5,7] there is also the natural anatomical predisposition of narrower airway passages.[5-7,13] Consequently, healthy patients with Class II malocclusions and vertical growth patterns might have narrower airway passages than healthy patients with normal occlusions and growth patterns, or Class I malocclusions. Therefore, to further investigate this assumption, our objective in this study was to compare the widths of the upper and lower pharyngeal airways in healthy Class I and Class II patients with normal and vertical growth patterns.

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Based on research by the second author in partial fulfillment of the requirements for the degree of master of science in orthodontics.
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Submitted, October 2004; revised and accepted, January 2005.
0889-5406/$32.00
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doi:10.1016/j.ajodo.2005.01.033

MATERIAL AND METHODS

The sample comprised lateral cephalograms of 80 untreated patients, with a mean age of 11.64 years (SD, 1.85), without previous surgery of palatine or pharyngeal tonsils, who sought orthodontic treatment at 3 private practices in Maringá, Pr, Brazil. The primary inclusion criteria were no pharyngeal pathology, no clinical signs or symptoms, and no complaints of nasal obstruction at the initial visit. Subjects with horizontal growth patterns or Class III malocclusions were not included in the sample. The sample was divided into 4 groups with 20 subjects each: group 1, Class I malocclusions and normal growth patterns; group 2, Class I malocclusions and vertical growth patterns; group 3, Class II malocclusions and normal growth patterns; and group 4, Class II malocclusions and vertical growth patterns. All subjects in groups 1 and 2 had Class I malocclusions, and all in groups 3 and 4 had full-cusp

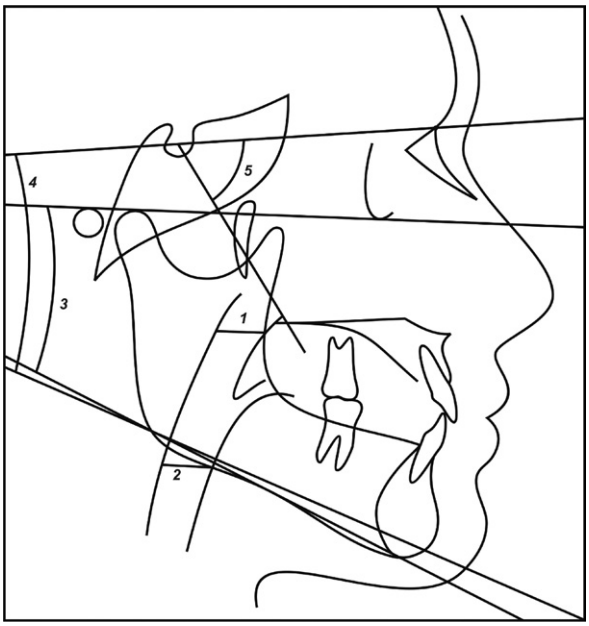

Fig. Measurements on lateral cephalograms. *1,* Upper airway width, measured from point on posterior outline of soft palate to closest point on posterior pharyngeal wall, taken on anterior half of soft palate outline because area immediately adjacent to posterior opening of nose is critical in determining upper respiratory patency; headfilm outline of nasopharynx is 2-dimensional representation of 3-dimensional structure. *2,* Lower airway width, measured from intersection of posterior border of tongue and inferior border of mandible to closest point on posterior pharyngeal wall. *3,* FMA. *4,* SN.GoGn. *5,* NS.Gn.

Class II malocclusions (molar relationship)[14-16] as evaluated on dental casts.

Each group comprised 8 boys and 12 girls. The mean ages were 12.35 (SD, 1.34), 10.75 (SD, 2.02), 11.68 (SD, 2.03), and 11.78 (SD, 1.70) years for the 4 groups, respectively.

Lateral cephalograms were obtained for each subject. The cephalometric tracings, landmark identifications, and measurements[17] were performed on acetate paper by 1 investigator (N.M.P.V.A.) (Fig).

The growth patterns were classified from the lateral cephalograms (Fig). FMA, SN.GoGn, and NS.Gn angles were used to divide the subjects into normal and vertical growers, according to previously established standards.[18,19] The normal range was considered to be within ± 1 SD of the mean, and a vertical grower would have a value larger than the mean + 1 SD simultaneously for the 3 parameters. This criterion provided subgroups of 20 subjects in the normal and vertical, and Class I and Class II groups (Table I). The upper and lower pharyngeal airways were measured according to the method of McNamara[17] (Fig).

Table I. Measurements of craniofacial growth pattern

	FMA (°)		*SN.GoGn (°)*		*NS.Gn (°)*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Group 1 (n = 20)	25.47	1.24	33.09	2.68	66.15	1.65
Group 2 (n = 20)	32.27	3.63	42.43	4.19	71.29	2.76
Group 3 (n = 20)	24.53	2.06	32.46	1.95	66.49	1.08
Group 4 (n = 20)	30.52	2.64	39.76	2.43	71.81	2.06

Within a week after the first measurement, 20 (5 from each group) randomly selected radiographs were retraced and remeasured by the same examiner. The casual error according to Dahlberg's formula ($Se^2 = \Sigma d^2/2n$)[20] and the systematic error with dependent *t* tests at $P < .05$ were calculated.

Statistical analysis

In each group, means and standard deviations for the ages, and upper and lower airways, were determined. The intergroup comparisons of the ages, and upper and lower airways, were performed by using 1-way ANOVA, with the Tukey test as a second step, at $P < .05$.

RESULTS

No systematic errors were found, and random errors varied from 0.12 mm for the upper airway to 1.67° for NS.Gn.

The Class I and Class II groups with vertical growth patterns had significantly smaller upper pharyngeal airways than the Class I and Class II groups with normal growth patterns. No significant intergroup differences were found for the lower pharyngeal airway (Table II).

DISCUSSION

Although the number of subjects in each group can be criticized, there was great compatibility for age and sex (Table II). Because of the retrospective design of the study, a direct assessment of the nasorespiratory pattern of each patient was not possible. Therefore, selection criteria were based on clinical chart information at their initial visits about pharyngeal pathology, clinical signs and symptoms, and complaints of nasal obstruction. Any of these factors could have been related to enlarged adenoids or tonsils.[8,21] The selected patients had none of these factors and consequently were considered to have healthy pharyngeal functions.

Table II. Means and standard deviations of ages, upper and lower pharyngeal airways, and results of ANOVA, followed by Tukey tests

	Group 1 (Class I, normal growth)		*Group 2 (Class I, vertical growth)*		*Group 3 (Class II, normal growth)*		*Group 4 (Class II, vertical growth)*		
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	P
Age (y)	12.35[A]	1.34	10.75[A]	2.02	11.68[A]	2.03	11.78[A]	1.70	.050
Upper airway (mm)	12.58[A]	2.04	9.33[B]	3.92	12.61[A]	3.61	9.56[B]	2.19	.000*
Lower airway (mm)	9.44[A]	1.71	10.83[A]	3.62	9.99[A]	2.97	8.97[A]	2.07	.165

Same letters mean no intergroup difference.
*Statistically significant at $P < .05$.

Evidently, this is not the ideal. This procedure eliminated patients with severe pathologic pharyngeal obstructions because they would have had some signs and symptoms mentioned above; but this strategy would not detect mild to moderate pharyngeal obstructions.[21] However, because these selection criteria were applied to all groups, we believed that they were compatible. Consequently, because only relatively healthy pharyngeal patients with malocclusions were selected, we expected that the pharyngeal widths would reflect only their natural anatomical conditions with no pharyngeal pathology.

Subjects with Class I and Class II malocclusions and vertical growth patterns had significantly narrower upper pharyngeal airways than Class I and Class II subjects with normal growth patterns (Table II), confirming previous results in the literature.[10-12,22] Analyzing these results, we can infer that upper airway width is influenced by the craniofacial growth pattern, as previously suggested.[5-7,11,22] However, some studies found weak relationships between growth pattern, facial morphology, and nasopharyngeal airway.[2,23] Probably, this is because those studies evaluated the influence of the nasopharyngeal airway on facial form and occlusion; this was the opposite of our study.

This study was conducted with 2-dimensional headfilms to evaluate only pharyngeal airway widths, and not airway flow capacities, which would have required a more complex 3-dimensional and dynamic evaluation.[8,9] Therefore, these results do not suggest that patients with vertical growth patterns have smaller airway flow capacities than those with normal growth patterns. Perhaps, vertical-growth patients are larger, transversely, than normal growers; this should be further investigated. Nevertheless, Ricketts,[24] Dunn et al,[10] and Linder-Aronson[25] found that nasal obstruction leading to mouth breathing was related to the width of the nasopharynx; the narrower the nasopharynx, the less adenoidal enlargement was needed to obstruct the nasopharyngeal airway. This helps to explain the prevalence of mouth breathing in subjects with vertical growth patterns.[5,26]

The upper airway intergroup comparisons in the same growth patterns (groups 1 and 3, and groups 2 and 4) showed no significant differences, with no association of upper airway space with type of malocclusion; this corroborated previous findings[9,27,28] (Table II). However, our findings contradict some studies[1,4] that found relationships between upper airway and type of malocclusion, showing narrower nasopharynges in subjects with Class II malocclusion. Additionally, Paul and Nanda[4] found greater prevalences of mouth breathing and nasopharyngeal airway obstruction in subjects with Class II malocclusions. These contrasting results might be caused by differences in sample selection. Our study included only patients without obvious pharyngeal pathology, but others used randomly selected subjects,[2,9,27,28] and the contrasting studies compared nasal with mouth breathers.[1,4] More mouth breathers were found among Class II patients, who consequently had narrower nasopharynges.[1]

No statistically significant difference in lower pharyngeal airways between groups was found, showing no association of lower pharyngeal airway space with craniofacial growth pattern and malocclusion type. This corroborates previous studies.[3,23,28] However, additional studies are necessary to clarify this issue because Linder-Aronson and Leighton[13] and Linder-Aronson and Backstrom[22] suggested that oropharyngeal space appears to be larger than normal when the nasopharyngeal airway is smaller, although they did not evaluate this correlation directly.

This study showed that the nasopharynx was found to be narrower in the vertical than in the normal growth pattern in both Class I and Class II malocclusions in obvious pharyngeal pathology-free patients. However, the prevalence of pharyngeal obstruction in various growth patterns and malocclusions was not addressed and should be considered in future studies.

CONCLUSIONS

Patients with Class I and Class II malocclusions and vertical growth patterns have significantly narrower upper pharyngeal airways than those with Class I and Class II malocclusions and normal growth patterns. However, malocclusion type does not influence upper pharyngeal airway width, and malocclusion type and growth pattern do not influence lower pharyngeal airway width.

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