UPPER AND LOWER PHARYNGEAL AIRWAYS IN SKELETAL CLASS-I AND CLASS-II MALOCCLUSIONS WITH DIFFERENT CRANIOFACIAL PATTERNS

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ABSTRACT

Objective: Associations of Class II malocclusions and vertical growth pattern demonstrate decreased upper airway width. This implies that these malocclusion characteristics have a predisposing anatomical factor for these problems. The objective of this study was to compare upper and lower pharyngeal airways width in patients with untreated Class I and Class II malocclusions with different craniofacial patterns

Materials and Method: Sample comprised 150 subjects divided into 2 groups: 75 Class I and 75 Class II, subdivided according to different craniofacial patterns. The upper and lower pharyngeal airways were assessed according to McNamara's airways analysis. Statistical analysis was performed by using 1-way ANOVA and the Tukey test as a second step.

Results: 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 and horizontal growth-pattern groups.

Conclusions: Sagittal malocclusion type does not influence upper pharyngeal width. However, hyperdivergent subject have statistically significant narrower upper pharyngeal width when compared to other two vertical patterns.

KEY WORDS: Growth Pattern, Lower Pharyngeal Width, Malocclusion, Upper Pharyngeal Width.

Introduction

Respiratory function is highly relevant to orthodontic diagnosis and treatment planning. The growth and function of the nasal cavities, the nasopharynx, and the oropharynx are closely associated with the normal growth of the skull. In addition, the nasopharynx and the oropharynx have important locations and functions as they both form part of the unit in which respiration and deglutition are carried out.[1-3]

Several studies have reported significant relationship between pharyngeal structures and both Dentofacial and craniofacial structures.[4,5] Furthermore, numerous researchers reported the interaction between pharyngeal dimensions and various sagittal and vertical facial growth patterns at varying degrees.[6,7] Skeletal features such as retrusion of the maxilla and mandible and vertical maxillary excess in hyperdivergent patients may lead to narrower anterioposterior dimensions of the airway.[8]

Nasal obstruction secondary to hypertrophied inferior turbinates, adenoidal pad hypertrophy, and hypertrophy of the faucial tonsils can cause chronic mouth breathing, loud snoring, obstructive sleep apnea, excessive daytime sleepiness, and even corpulmonale. In this situation, a number of postural changes, such as open mandible posture, downward and forward positioning of the tongue, and extension of the head, can take place. If secondary postural changes continue for a long period, especially during the active growth stage, dentofacial disorders at different levels of severity can be seen, together with the inadequate lip structure, long face syndrome, and adenoidal facies.

There are various predisposing factors reported in the literature for obstruction of pharyngeal airways such as allergies, environmental irritants and infections. According to the Balters philosophy, Class II malocclusions are a consequence of a backward position of the tongue, disturbing the cervical region. The respiratory function is impeded in the region of larynx and there is thus a faulty deglutition and mouth breathing. Alves*et al*. refuted a significant relationship between airway obstruction and frequency of malocclusion.[9] Other reported association of vertical growth patterns with obstruction pharyngeal airways concomitantly with mouth breathing.[10,11] However, several authors found that there is natural predisposition of narrower airway passages.[4-7] As there is close association between pharynx and dentofacial structures, a mutual interaction is expected to occur between pharyngeal structures and the various dentofacial patterns, thus justifying orthodontic treatment.

Many reports have demonstrated that a significant relationship exists between airway space and facial morphology.[4-7]Also, airway space may be affected by conditions such as functional anterior shifting head posture, sagittal skeletal relation, and vertical growth patterns. Thus the knowledge of the pharyngeal dimensions amongst the various sagittal and vertical facial types is very important and can help an orthodontist in various ways, especially during orthodontic diagnosis and treatment planning.

The aim of this study was to compare upper and lower pharyngeal widths in subject with skeletal class-I and class-II malocclusion with different craniofacial pattern.

Materials and Method

This cross-sectional analytical study was conducted using data from pre-treatment lateral cephalographs of patients and Data was collected using nonprobability purposive sampling technique.

- **Following inclusion criteria were used for patient selection**
  1. Subjects of Indian origin,
  2. Aged between 14-25 years
- **Following exclusion criteria were used for patient selection**
  1. Patients having craniofacial syndromes
  2. Patients having pharyngeal pathology or complaints of nasal obstruction at the initial visit

As per departmental protocol, an informed written consent was obtained from the parents before the subjects entered the study. Lateral cephalograms were obtained for each subject. The cephalometric tracings, landmark identifications, and measurements[12] were performed on acetate paper by 1 investigator.

The sample comprised a total of 150 subjects which was further divided into 2 groups: skeletalClass I (n=75) and skeletal Class II (n=75) subdivided according to vertical pattern into normodivergent (n=25), hyperdivergent (n=25), and hypodivergent (n=25), facial patterns. ANB angle and WITS Appraisal was used to group the skeletal Class I and II subjects (Table A).

Skeletal	ANB	WITS Appraisal
Class I	ANB of 0°to4°	WITS of 2mm to -2mm
Class II	ANB>4°	WITS analysis >2mm

Table A: - Diagnostic criteria for skeletal Class I and Class II

SNGoGn, FMA and Y axis was used to divide the sample into hypodivergent, normodivergent, hyperdivergent facial patterns (Table B).

Growth Pattern	FMA (Tweed's)	Sn-Gogn (Steiner's)	Y-Axis (PP-(Go-Me)
Hypodivergent	<22	<32	<53
Normodivergent	22-28	32-38	53-66
Hyperdivergent	>28	>38	>66

The upper and lower pharyngeal airways was assessed according to **McNamara's airway analysis**[12] (Figure 1).

Upper pharynx

Upper pharyngeal width is measured form a point on the posterior outline of the soft palate to the closest point on the pharyngeal wall. The average upper pharyngeal width is approximately 15 to 20 mm in width. A width of 2 mm or less in this region may indicate airway impairment.

Lower pharynx

Measured from the 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. The average lower pharyngeal width is approximately 11 to 14 mm in width.

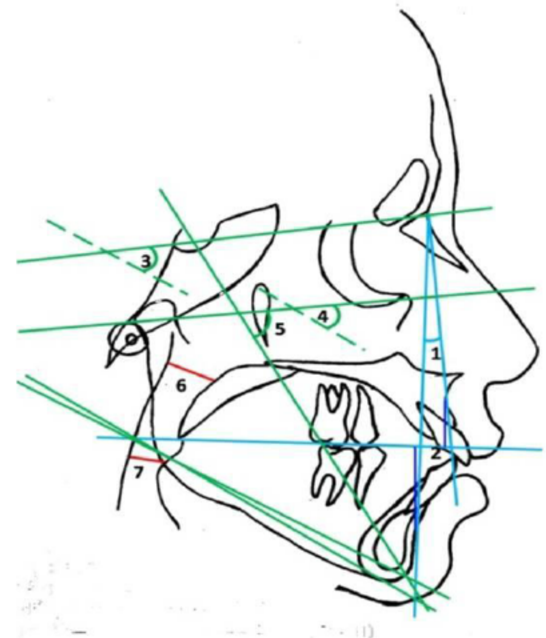

Figure 1: Angles and measurements used in the study

1. *ANB Angle*
2. *WITS Appraisal (AO-BO)*
3. *Mandibular plane angle(Sn-GoGn)*
4. *Frankfort horizontal plane angle(GoMe-FH)*
5. *Y-axis*
6. *Upper pharyngeal airway width*
7. *Lower pharyngeal airway width*

Within a week after the first measurement, 30 (5 from each group) randomly selected radiographs were retraced and remeasured by the same examiner. The casual error according to Dahlberg's formula ($Se^2=\Sigma d2/2n$) and the systematic error with dependent t tests at $P <.05$ were calculated.

Statistical Analysis

In each group, means and standard deviations for the upper and lower airways were determined. Descriptive statistical analysis has been carried out in the present study. Analysis of variance (ANOVA) has been used to find the significance of study parameters between three or more groups of patients. Student t testhas been used to find the significance of study parameters on continuous scale within each group. Post–hoc Tukeytesthas been used to find the pairwise significance.

Results

The study sample comprised a total of 150 subjects. Subjects belonging to skeletal Class I were subdivided according to vertical pattern into normodivergent (n=25), hypodivergent (n=25) and hyperdivergent (n=25) facial patterns. Similarly, skeletal Class II subjects were also subdivided according to the vertical pattern into normodivergent (n=25), hypodivergent (n=25) and hyperdivergent (n=25) facial patterns.

The means and standard deviations of upper and lower pharyngeal airways was determined for the sample. The intergroup comparison of upper and lower airways was performed with one-way ANOVA and statistically significant difference was found for upper airways (Table I and II).

In Table III and IV pair wise comparison amongst various vertical facial patterns by using tukeys multiple Post hoc tests was done for skeletal Class I and II subjects. Hyperdivergent facial pattern subjects belonging either to skeletal Class I or Class II malocclusions showed a statistically significant narrow upper pharyngeal airway width as compared to normodivergent and hypodivergent facial pattern. However, no statistically significant difference was found in upper pharyngeal airway width between normodivergent and hypodivergent facial pattern of skeletal Class I and II subjects. Furthermore, no statistically significant difference was found in lower pharyngeal airway widths in sagittal and all three vertical facial growth patterns. The comparison Class I and Class II malocclusion using t-test however did not yield significant results (Table V, VI and VII)

Discussion

Abnormal development of the upper airway is related to airway constriction, and the relationship relevance between reduced respiratory function and craniofacial growth has long been of interest to orthodontists. A number of researchers during last 50 years used variety of radiographs to study the association between the obstruction of upper

Table I: Means and standard deviations of upper and lower pharyngeal airways in different vertical facial patterns of skeletal Class I subjects

Group	Upper Airway (mm)			Lower Airway (mm)		
	Mean	SD	SE	Mean	SD	SE
Hypodivergent	13.92	2.34	0.47	10.52	1.52	0.30
Hyperdivergent	11.08	2.52	0.50	10.84	3.46	0.69
Normaldivergent	13.12	2.20	0.44	10.08	1.75	0.35
F-value		13.869			0.628	
P-value		0.000*			0.536	

N = 75

One-way ANOVA for comparison amongst vertical patterns.

Level of significance 0.05; SD: Standard Deviation.

Table II: Means and standard deviations of upper and lower pharyngeal airways in different vertical facial patterns of skeletal Class II subjects

Group	Upper Airway (mm)			Lower Airway (mm)		
	Mean	SD	SE	Mean	SD	SE
Hypodivergent	14.94	2.92	0.58	11.20	2.57	0.51
Hyperdivergent	11.70	1.97	0.39	9.83	2.16	0.43
Normaldivergent	13.66	2.22	0.44	10.20	2.20	0.44
F-value		12.629			2.5952	
P-value		0.000*			0.0816	

N = 75

One-way ANOVA for comparison amongst vertical patterns.

Level of significance 0.05; SD: Standard Deviation.

Table III: Comparison amongst various vertical patterns for skeletal Class I subjects.

Pharyngeal Airway	***Vertical Patterns***	***p-Value***
Upper Airway	Hypodivergent&Hyperdivergent	0.0001*
	Hypodivergent&Normodivergent	0.3268*
	Hyperdivergent&Normodivergent	0.0014*
Lower Airway	Hypodivergent&Hyperdivergent	0.8856
	Hypodivergent&Normodivergent	0.7950
	Hyperdivergent&Normodivergent	0.5071

N= 75; *p-value is < 0.05;
Pair wise comparison of three groups by Tukeys multiple post hoc procedures

Table IV: Comparison amongst various vertical patterns for skeletal Class II subjects.

Pharyngeal Airway	***Vertical Patterns***	***p-Value***
Upper Airway	Hypodivergent&Hyperdivergent	0.0001*
	Hypodivergent&Normodivergent	0.1269
	Hyperdivergent&Normodivergent	0.0098*
Lower Airway	Hypodivergent&Hyperdivergent	0.0772
	Hypodivergent&Normodivergent	0.2532
	Hyperdivergent&Normodivergent	0.8167

N= 75; *p-value is < 0.05;
Pair wise comparison of three groups by Tukeys multiple post hoc procedures

Table V: Comparison of upper airway and lower airway in Class I and Class II hypodivergent growth pattern by t test

Sides	Class	Mean	SD	t-value	P-value
Upper	Class I	13.92	2.34	-1.3610	0.1799
	Class II	14.94	2.92		
Lower	Class I	10.52	1.52	-1.1393	0.2602
	Class II	11.20	2.57		

Table VI: Comparison of upper airway and lower airway in Class I and Class II hyperdivergent growth pattern by t test

Sides	Class	Mean	SD	t-value	P-value
Upper	Class I	11.08	1.12		
	Class II	11.70	1.53	-1.6392	0.1077
Lower	Class I	10.84	3.46		
	Class II	9.83	2.16	1.3063	0.1977

Table VII: Comparison of class I and class II of normal group with growth scores at upper and lower sides by t test

Sides	Class	Mean	SD	t-value	P-value
Upper	Class I	13.12	2.20	-0.8629	0.3925
	Class II	13.66	2.22		
Lower	Class I	10.08	1.75	-0.2133	0.8320
	Class II	10.20	2.20		

and lower pharyngeal airways with mouth breathing.[6-13] The present study used lateral head cephalometric films for pharyngeal airway width measurement, according to the findings of Cameron *et al*.[13]

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 means that these malocclusion characteristics have a predisposing anatomical factor for these problems.[1,6-8,14] Raffat and Hamid evaluated the dentofacial morphology of adenoidal faces via linear and angular measurements on lateral cephalometric tracings and compared the extent of changes with control group normal (Class I and orthognathic profile).[15]

They concluded that the subjects with upper airway obstruction displayed excessive vertical dentofacial development, leading to a long face appearance. They suggested that this condition needs to be prevented by early recognition and treatment of the causative factor. Batool *et al*. compared the widths of the upper and lower pharyngeal airways in Class II malocclusion patientswith low and high vertical growth patterns.[16] They found subjects with Class II malocclusions and vertical growth patterns have significantly narrower upper and lower pharyngeal airways than those with Class II malocclusions and horizontal growth patterns. Freitas *et al*. used in their study McNamara's airway analysis to compare upper and lower pharyngeal airway widths in subjects with untreated Class I and Class II malocclusions, and normal and vertical growth patterns.[17] They reported that the upper pharyngeal width in the subjects with Class I and Class II malocclusions and vertical growth patterns were significantly narrower than in the normal growth pattern groups. Yang-Ho Park *et al*. showed in their study that vertical growth patterns have significant correlations with the upper part of pharyngeal airways.[18] Ucar*et al*. reported a decrease in upper airway space with functional anterior shifting.[19] This reveals a close relationship between the upper airway passage and positioning of the jaws. Akcam*et al*. found a decrease in the upper airway dimensions of subjects who had posterior mandibular rotation.[20] Ucar in another study reported that nasopharyngeal airway space and upper pharyngeal airway space in Class I subjects were larger in low angle subjects than in high angle subjects.[21] In thepresent study, we found that the hyperdivergent facial pattern subjects belonging either to skeletal Class I or Class II malocclusions showed a statistically significantly narrow upper pharyngeal airway width as compared to normodivergent and hypodivergent facial patterns.

Several other researchers found that there is no relationship between upper airway space and the type of malocclusion.[22,23] Gwynne-Evans concluded that facial growth is constant regardless of mode of breathing.[22] Leech, in a study of 500 patients with upper airway problems discovered that 60% of the mouth breathing patients were Class I and concluded that mouth breathing has no influence on craniofacial growth.[23] However, in the present study no statistically significant difference was found in upper pharyngeal airway width between normodivergent and hypodivergent facial pattern of skeletal Class I and II subjects. Kerr reported that Class II malocclusion subjects showed narrow nasopharyngeal airway space compared with Class I and normal occlusion subjects.[24] However, in his study, the vertical skeletal pattern was not emphasized. In the present study, vertical pattern affected the upper airway space, and greater upper pharyngeal airway width was found in low angle subjects than in high angle subjects. In this study, no association of the lower pharyngeal airway space was seen with a different vertical growth pattern. This confirms the findings of previous studies of Freitas*et al*. and Ucar and Uysal.[17,21]

Batool *et al*. reported subjects with Class II malocclusions and vertical growth patterns have significantly narrower lower pharyngeal airways than those with Class IImalocclusions and horizontal growth patterns.[16] When diagnosing and treating pre-adolescent children with malocclusion, orthodontists should recognize pharyngeal airway morphologies that might be predisposing factors of undesirable craniofacial development in order to provide stability of the treatment results.

The upper airway intergroup comparisons in the same growth patterns showed no significant differences, with no association of upper airway space with type of malocclusion; this corroborated previous findings [5,25,26] (Table V, VI and VII). However, our findings contradict some studies[27,28] that found relationships between upper airway and type of malocclusion, showing narrower nasopharynges in subjects with Class II malocclusion. Additionally, Paul and Nanda[28] found greater prevalence 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 [5,25,26] and the contrasting studies compared nasal with mouth breathers.[27,28] More mouth breathers were found among Class II patients, who consequently had narrower nasopharynges.[27] 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.[26] However, additional studies are necessary to clarify this issue because Linder-Aronson and Leighton and Linder-Aronson and Backstrom[4] 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

1. 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 or horizontal growth patterns.
2. Sagittal 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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