

The Association between Maxillomandibular Sagittal Relationship and Pharyngeal Airway Passage Dimensions

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ABSTRACT

Objectives: To test the hypothesis that there is no association between sagittal maxillomandibular relationship and pharyngeal airway passage dimensions.

Materials and methods: Lateral cephalograms of 90 subjects were used to measure the upper pharyngeal airway. The subjects were divided into three groups (each group included 30 subjects) according to ANB angle: Class III (ANB < 0.7°); Class I (ANB ≥ 0.7° and ≤ 4.7°); Class II (ANB > 4.7°). All lateral cephalograms were traced manually.

Results: The results showed a significant reduction in the upper airway at the level of nasopharynx and oropharynx and the airway showed a tendency to decrease from Class III to Class I and Class I to Class II.

Conclusion: Sagittal skeletal pattern had a close association between the pharyngeal airway passage and the dimensions of the pharyngeal airway passage. The dimensions of pharyngeal airway passage were decreased from Class III to Class I and Class I to Class II subjects.

Keywords: Lateral cephalometry, Sagittal skeletal pattern, Pharyngeal airway passage.

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INTRODUCTION

Normal airway is one of the important factors for the normal growth of the craniofacial structures.¹ Nasorespiratory function and its relation to craniofacial growth is of great interest not only for orthodontist but for pediatricians, otorhinolaryngologists, speech pathologists and other members of health care community as well. The growth and function of the nasal cavities, the nasopharynx, and the oropharynx are closely associated with the normal growth of the skull. Because of the close relationship between the pharynx and the dentofacial structures, a mutual interaction is expected to occur between the pharyngeal structures and the dentofacial pattern and therefore justifies orthodontic interest. The pharynx is a tube-shaped structure that extends superoinferiorly from the cranial base to the level of the inferior surface of the sixth cervical vertebra. It is divided into three parts: Nasopharynx, oropharynx and laryngopharynx. Narrowing of the pharyngeal airway

passage (PAP) is common feature in patients with breathing problems.²⁻⁵ There are significant relationships between the pharyngeal dimensions and craniofacial abnormalities. Craniofacial abnormalities, such as mandibular deficiency, bimaxillary retrusion, steep occlusal plane, increased mandibular plane angle, and a more caudally positioned hyoid bone result in narrowing of the pharyngeal airway passage.⁶⁻⁸

It has been demonstrated that there are statistically significant relationships between the pharyngeal structures and both dentofacial and craniofacial structures at varying degrees.⁹⁻¹³ According to the Balter's philosophy,³ 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. Class III malocclusions are due to a more forward position of the tongue and to cervical overdevelopment. Thus, it might be considered to be useful that the assessment of the pharyngeal structures be included with the orthodontic diagnosis and treatment planning, as the functional, positional and structural assessments of the dentofacial pattern.³ It has been reported by authors that the midsagittal nasopharyngeal area and the nasopharyngeal depth are significantly larger in subjects with normal occlusion than in those with Class II malocclusion. According to Sorensen et al¹⁴ airway adequacy was related to the size and position of the mandible rather than maxillary variables. Ceylan and Oktay³ reported that the pharyngeal structures were not affected by changes in the ANB angle. So, this study was conducted to evaluate the association between the maxillomandibular sagittal relationships on the dimensions of pharyngeal airway passage.

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AIMS AND OBJECTIVES

1. To analyze whether upper airway dimensions differed among different sagittal groups.
2. To analyze any sex-related or age-related difference among different sagittal groups.

MATERIALS AND METHODS

The study was carried out on patients visiting the Department of Orthodontics and Dentofacial Orthopedics. A total of 90 subjects in the age range of 11 to 16 years were selected for the study. All the selected subjects met the following inclusion criteria:

- To breathe comfortably through the nose
- No previous history of orthodontic treatment
- To have normal vertical occlusal relationship
- No wound, burn and scar tissue in the neck region
- No deglutition disorder or visual or hearing disorder.

However, subjects with cleft lip and palate, history of chronic mouth breathing, snoring and tonsillectomy or adenoidectomy were excluded from the study.

Based on the sagittal skeletal pattern, all the subjects were divided into three groups of each group containing 30 subjects; Class III group (M = 14, F = 16 and subjects in whom ANB < 0.7°), Class I group (M = 14, F = 16 and subjects in whom ANB ≥ 0.7° and ≤ 4.7°) and Class II group (M = 11, F = 19 and subjects in whom ANB > 4.7°).

Lateral cephalograms were exposed with teeth in centric occlusion, lips relaxed and the head in the natural head position (Fig. 1). The radiographs were obtained with Planmeca X-ray machine with model no: 2002. All of the cephalograms were recorded with the same exposure parameters and in the same machine. All lateral cephalograms were traced manually by the same investigator. Various cephalometric landmarks (Fig. 2), linear and angular parameters (Fig. 3) used for the measurement of pharyngeal airway passage and soft palate dimensions are shown in Figure 4.

Statistics

Data was analyzed using SPSS software. Student’s t-test was performed to control the age and sex distribution. The mean, standard deviation and p-values were calculated using the one way analysis of variance (ANOVA). Multiple comparisons were done using the HSD test (honestly significant difference).

RESULTS

The variables representing the dimensions of pharyngeal airway passage among three groups of subjects are described in Table 1. There was a statistically significant difference among the groups in the palatopharyngeal area as measured at the level of SPP-SPPW. Also, significant differences were found at the level of oropharynx, i.e. U-MPW and TB-TPPW (Table 2). The sagittal dimension of the inferior part of the upper airway decreased from Class III to Class I to Class II, and these differences were



Fig. 1: Patient positioned in natural head position



Fig. 2: Radiographic landmarks

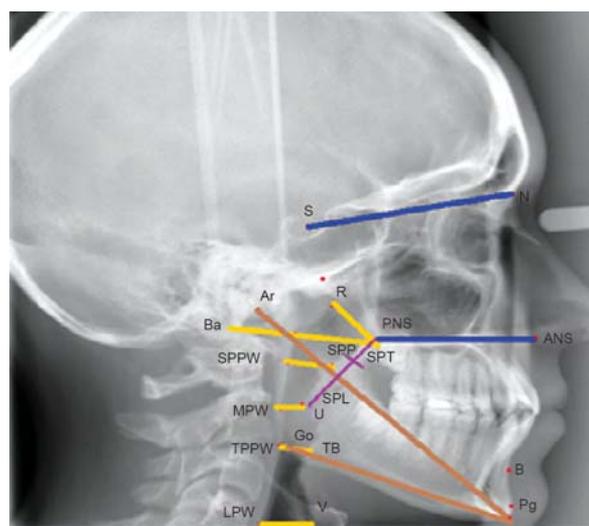


Fig. 3: Radiographic measurements

significant. The most significant difference existed at the TB-TPPW level of the low oropharynx (Tables 3 and 4). Multiple comparisons among the groups are described in Table 1. There

Table 1: Cephalometric variables for the evaluation of pharyngeal airway passage dimension

Variables	Groups			Significance (p-value)	Intergroup comparison		
	Class-III (Mean ± SD)	Class-I (Mean ± SD)	Class-II (Mean ± SD)		I-II	I-III	II-III
PNS-R	19.97 ± 4.537	20.47 ± 2.874	19.50 ± 4.377	0.647(NS)			
PNS-Ad1	24.17 ± 4.488	26.20 ± 4.063	24.20 ± 4.172	0.111(NS)			
SPP-SPPW	14.47 ± 3.235	14.20 ± 3.408	12.17 ± 3.312	0.016*	NS	NS	*
U-MPW	12.47 ± 3.491	11.43 ± 3.025	10.03 ± 2.356	0.009**	NS	NS	**
TB-TPPW	14.30 ± 2.996	12.73 ± 2.815	10.50 ± 2.825	0.000***	*	NS	***
V-LPW	16.03 ± 3.316	16.30 ± 3.789	14.37 ± 3.690	0.085(NS)			
Soft palate thickness	8.17 ± 1.315	7.90 ± 1.494	8.20 ± 1.186	0.637(NS)			
Soft palate length	33.60 ± 3.191	34.10 ± 3.772	35.27 ± 4.571	0.279(NS)			

NS: Nonsignificant; *p < 0.05; **p < 0.01; ***p < 0.001

Table 2: Sex distribution

Sex		Class			Total
		I	II	III	
M	Count	16	11	16	43
F	Count	14	19	14	47
Total		30	30	30	90

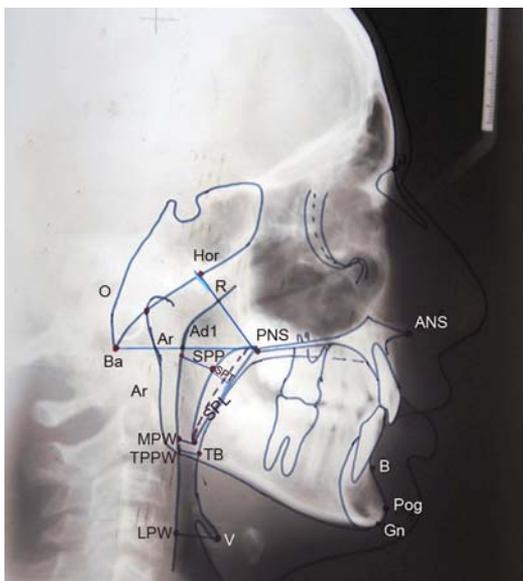


Fig. 4: Various cephalometric landmarks and variables for the measurement of pharyngeal airway passage and soft palate dimensions. **Landmarks:** Hor, most inferior point of sphenooptic synchondrosis; R, point of intersection of line from Hor to PNS and posterior pharyngeal wall; Ba, lowermost point on anterior margin of foramen magnum; Ad1, point of intersection of posterior pharyngeal wall and line Ptm-Ba; SPPW, point of intersection of line from soft palate and center perpendicular to posterior pharyngeal wall and posterior pharyngeal wall; SPP, point of intersection of line from soft palate center perpendicular to posterior pharyngeal wall and posterior margin of soft palate; U, the tip of the uvula; MPW, foot point of perpendicular line from point U to posterior pharyngeal wall; TPPW, point of intersection of posterior pharyngeal wall and extension of line B-Go; TB, point of intersection of base of the tongue and extension of line B-Go; V, the most posterior inferior point on the base of the tongue; LPW, foot point of perpendicular line from point V to posterior pharyngeal wall. **Variables:** PNS-Ba, distance between PNS and Ba; PNS-R, distance between PNS and R; PNS-Ad1, distance between PNS and Ad1; SPP-SPPW, distance between SPP and SPPW; U-MPW, distance between U and MPW; TB-TPPW, distance between TB and TPPW; V-LPW, distance between V and LPW; **Soft palate thickness**, maximum thickness of soft palate and **Soft palate length**, linear distance between U and PNS

was a significant difference between Class II and Class III groups at the levels of the palatopharynx (SPP-SPPW) and oropharynx (U-MPW and TB-TPPW) (Table 4).

DISCUSSION

Normal respiration is dependent on sufficient anatomic dimensions of the airway. In recent years, studies have been done concluding that variations in skeletal pattern could predispose to upper airway obstruction.³⁻⁹ Cephalometric radiographs have been used for many years to evaluate facial growth and development. Cephalometry enables analysis of dental and skeletal anomalies as well as soft tissue structures and form. Many studies have assessed the anatomic conformation of the upper airway with more sophisticated and expensive techniques, including cine-computed tomography,¹⁵ fluoroscopy,¹⁶ acoustic reflection,¹⁷ fiberoptic pharyngoscopy¹⁸ and magnetic resonance imaging.¹⁹ Cephalometry is, however, less expensive, more useful, easily achieved with reduced radiation, and correlates with other investigations such as computed tomography (CT) or somnofluoroscopy carried out during wakefulness or sleep.²⁰

Factors affecting the normal nasal breathing and pharynx size have been excluded in our study so that anteroposterior relationship can be correctly analyzed.

The ANB angle, which is the most commonly used in the determination of anteroposterior dentofacial discrepancy^{21,22} is used to classify the subjects according to their skeletal configuration.

When the airway dimensions were compared (Table 3), the significant differences were found between Class II and Class III at the level of SPP-SPPW (palatopharynx), U-MPW and TPP-TPPW (oropharynx) and the results of the study seemed to suggest that the dimension of the oropharynx decreased markedly from Class III to Class I to Class II subgroups. The difference in SPP-SPPW can be explained by: ‘Balter’s philosophy’³ according to which, 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. Class III malocclusions are due to a more forward position of the tongue and to cervical overdevelopment.

Table 3: Values of various cephalometric parameters

Measurements	Subgroups	Mean	SD	p-value
Upper airway PNS-R	I	20.47	2.874	0.647
	II	19.50	4.377	
	III	19.97	4.537	
PNS-Ad1	I	26.20	4.063	0.111
	II	24.20	4.172	
	III	24.17	4.488	
SPP-SPPW	I	14.20	3.408	0.016*
	II	12.17	3.312	
	III	14.47	3.235	
U-MPW	I	11.43	3.025	0.009**
	II	10.03	2.356	
	III	12.47	3.491	
TB-TPPW	I	12.73	2.815	<0.001**
	II	10.50	2.825	
	III	14.30	2.996	
V-LPW	I	16.30	3.789	0.085
	II	14.37	3.690	
	III	16.03	3.316	

*P < 0.05; **P < 0.01; ***P < 0.001

Table 4: Multiple comparison tests of upper airway

Measurements	Subgroups	Mean	p-value
SPP- SPPW	I-II	2.033	0.051
	I-III	-2.67	0.948
	II-III	-2.300	0.023*
U-MPW	I-II	1.400	0.172
	I-III	-1.033	0.379
	II-III	-2.433	0.006*
TB-TPPW	I-II	2.233	0.010*
	I-III	-1.567	0.094
	II-III	-3.800	< 0.001**

*P < 0.05; **P < 0.01; ***P < 0.001

Ceylan and Oktay³ found that pharyngeal structures were not affected by the ANB angle, although they found a significant difference in the oropharyngeal area between Class I and Class III, as well as between Class II and III. Akcam et al²³ also reported a decrease in the upper airway dimensions of subjects who had posterior mandibular rotation.

The difference at the level of U-MPW and TPP-TPPW (oropharynx) can be because of the decreased size and posterior position of the mandible that leads to palatopharyngeal and hypopharyngeal obstruction. This is in accordance with the study conducted by Zhe Zhong et al²⁴ and Lam et al.²⁵

When difference in size and position of mandible as measured among various subgroups was compared (Table 5), the same reduced tendency was seen from Class III to Class I to Class II subgroups and significant difference was found between Class II and Class III subgroups. It seems that a close association exists between pharyngeal obstruction and size and position of the mandible.

The same sagittal skeletal pattern was followed from Class III to Class I and Class I to Class II when our population was compared with other populations (North Indian⁵ and Chinese population).²⁴

An inverse correlation was found between the length of the soft palate and sagittal mandibular development in a study conducted by Jena et al.⁵ It was suggested that the backward

Table 5: Cephalometric comparison of mandible size and position

Measurements	Subgroups	Mean	p-value
Ar-Gn	I-II	1.407	0.858
	I-III	-5.626	0.093
	II-III	-7.033	0.025*
Go-Gn	I-II	2.400	0.222
	I-III	-2.733	0.144
	II-III	-5.133	0.002*

*P < 0.05; **P < 0.01; ***P < 0.001

position of the tongue compressed the soft palate and resulted in decreased thickness and increased length of the soft palate. Muto et al²⁶ also reported a similar observation. However, in our study although no significant finding was seen in relation to soft palate thickness and length, a thinner soft palate among Class I subjects was seen compared with Class II and III. This is in accordance with the study conducted by Allhaja and Al-Khateeb.²⁷ The reason for difference could be due to the difference in the criterion for the selection of the subjects. In the study conducted by Jena et al,⁵ SNB angle was considered for the segregation of subjects whereas in our study ANB angle²⁴ was used for the segregation of subjects.

As a result, sagittal skeletal pattern can be suggested as a potential explanation for the discrepancy in the dimensions of the upper airway as a result of mandibular size and position.

CONCLUSION

The null hypothesis was rejected. There was a positive association between sagittal maxillomandibular relationship and the dimensions of pharyngeal structures. The following conclusions were drawn from the present study:

1. The sagittal skeletal pattern may be a contributory factor in variations in the upper airway dimension.
2. Dimensions of the pharyngeal airway passage were decreased markedly from Class III to Class I to Class II subjects.
3. There was no significant difference in the dimension of pharyngeal airway passage among males and females.

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