

Correlation between Pharyngeal Airway Space and Craniofacial Morphology - A Cephalometric Study

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Abstract:

Introduction: The aim of the present study was to evaluate the effect of craniofacial morphology on pharyngeal airway space (PAS) in individuals with normal sagittal skeletal pattern.

Materials and Methods: A total of 30 adult female patients with skeletal Class I jaw relationship were included in the study. Lateral cephalograms were obtained and hand traced. Various soft and hard tissue points identified and linear and angular measurements carried out to evaluate the pharyngeal airway space. The data thus collected were subjected to statistical analysis.

Result: The linear variables LAFH (lower anterior face height) and Na-Se-Ba (cranial base length) did not show statistically significant correlation with PAS. Among angular variables, although MPA (mandibular plane angle) showed a negative correlation however it was statistically insignificant. Other angular variables like Na-Se-Ba angle (cranial base angle), SNA and SNB did not correlate with the posterior airway space.

Conclusion: The study concluded that craniofacial morphology does not have any significant bearing on the pharyngeal airway space. At best its role in pharyngeal airway discrepancies can be defined as secondary and contributory.

Keywords: Pharyngeal Airway Space, Craniofacial Morphology, Skeletal Class I

I. Introduction

The pharyngeal airway space is an organ composed of 20 or more muscles that are attached proximally to skeletal structures and whose size and form are affected by the developing craniofacial skeleton.¹⁻² It is composed of three parts: the nasopharynx, oropharynx, and hypopharynx. Respiratory function and upper airway morphology are greatly relevant to orthodontic diagnosis and treatment planning as altered breathing function could influence facial growth and morphology.³ More importantly, breathing disturbances could lead to increased morbidity and mortality in a condition like obstructive sleep apnoea (OSA).⁴ Many reports have demonstrated a relationship between various malocclusion patterns and variations in the size and form of the oropharyngeal airway. The relationship between craniofacial morphology and respiratory function has been the focus of investigation since the 19th century.⁸ A number of studies have been published on the relationships between the pharyngeal airway and the facial pattern.⁹⁻¹⁴ Several of these studies have found that pharyngeal airway dimensions and/or volumes are affected by sagittal skeletal patterns.¹⁰⁻¹⁴ Thus, it can be assumed that the findings reported previously might be affected by sagittal skeletal pattern distribution of the patients.

The aim of the present study was to evaluate the effect of craniofacial morphology on pharyngeal airway space in individuals with normal sagittal skeletal pattern.

II. Materials & Method

The subjects comprised of 30 adult female patients having skeletal Class I Jaw relationship. The mean age of the group was 22 years, with a range of 18 years to 32 years. They were selected from the records of patients maintained at Department of Orthodontics, Awadh Dental College & Hospital Jamshedpur.

Criteria for selection of sample:

1. Adult female patients having skeletal Class I jaw relationship, with ANB angle more than 0° but less than 4° and Witt's appraisal showing AO coinciding with BO.
2. Subject with craniofacial anomalies including cleft lip and palate and gross facial asymmetries were excluded from the study.
3. Subjects with previous history of Orthodontic treatment or Orthognathic surgery were also excluded from the study.

III. Method of Study

Over the years pharyngeal airway space has been studied by various techniques. The most common among them being cephalometry, endoscopic examination¹⁵, computed tomographic (CT) scan¹⁶, magnetic resonance (MR) scans¹⁷ and acoustic reflection techniques.¹⁸

Each method has its own advantages and disadvantages. The cephalometric analysis of the airway permits precise measurement to be taken in the sagittal plane at anatomically well-defined homologous locations but does not provide transverse dimension of the airway. In spite of the obvious limitations of cephalometry it still remains the most popular technique in the evaluation of posterior airway space because of its easy access, low cost and minimal radiation.¹⁹

In the present study lateral cephalograms of selected cases were obtained. The following criteria's were observed when exposing the film.²⁰

1. The distance from the focus to the median plane was kept at 180cms and the median plane to film distance at 10cms. The enlargement if any was not corrected.
2. The subjects were seated with median plane parallel to the film with maximum inter-cuspatation of the teeth and lips in its natural relaxed position.
3. Bilateral ear rods were gently inserted into the external part of the auditory canal to stabilize the head posture during exposure.

The cephalograms obtained were hand traced; various soft and hard tissue points identified and linear and angular measurements were carried out to evaluate the airway changes. The reference points and lines used in the analysis are as described in previous papers by Lyberg et al (1989) and Krogstad et al (2000).²¹⁻²². The various linear and angular measurements carried out in the study are as per Tables 1&2 and the same has been illustrated in Figures 1& 2.

Method Error

To reduce the method error in defining the measuring points and reference structures, all radiographs were analysed twice by the same investigator with a two week interval between the recordings. The mean value of the two recording was used as final measuring value. Linear measurements were made to the nearest 0.5mm and the angular measurements to the nearest 0.5 degrees. The linear roentgenographic enlargement of 7% was not corrected.

Statistical Analysis

The data collected was entered into Microsoft excel spreadsheet and analysed using IBM SPSS Statistics, Version 22(Armonk, NY: IBM Corp). Descriptive data were presented in the form of mean and standard deviation. Pearsons correlation test was used to test the Correlation between craniofacial morphology and pharyngeal air way space at different levels of pharynx. P value < 0.05 was considered as statistically significant.

IV. Result

Table 3 presents the data of different variables used in this study along with their mean and standard deviation. Table 4 presents the correlation of different linear and angular variables to the pharyngeal airway space at different levels of pharynx.

Linear Variables

The lower anterior face height (LAFH) showed a mild negative correlation to pharyngeal airway space, however it was statistically non-significant. The cranial base length (Na-Se-Ba) did not show any significant correlation with pharyngeal airway space. ($p>0.05$, Table 4)

Angular Variables

The mandibular plane angle (MPA) showed a mild negative correlation with the airway space however, statistically it was non-significant. The cranial base angle (Na-Se-Ba) did not show any correlation with the airway space. SNA and SNB values showed a mild positive correlation to pharyngeal airway space however they also were statistically non-significant. ($p>0.05$, Table 4)

V. Discussion

Abnormal development of the upper airway is related to airway constriction, and the relationship between reduced respiratory function and craniofacial growth has long been of interest to orthodontists.^{5,23} Different aspects of craniofacial morphology can affect both upper as well as the lower airway and therefore in this study we have evaluated the pharyngeal airway space at four different levels.

ANB angle is not a very reliable indicator of skeletal jaw relationship, as it is affected by changes in the position of nasion point, vertical rotation of the jaws, anteroposterior position of the Nasion, and vertical distance between point A and point B. It has been suggested that the orthodontic diagnosis should be based on more than one anteroposterior parameter.²⁴ Therefore in the present study in addition to ANB angle, Witt's appraisal was also considered while selecting the sample.

In our study, the cranial base length (Na-Ba) and the cranial base angle (Na-Se-Ba) did not show any statistically significant correlation with the pharyngeal airway space which is unlike an earlier study carried out by Trenouth & Timms which showed a significant positive correlation between cranial base angle and pharyngeal airway space.²⁵ This could possibly be attributed to sample of the present study which was restricted to skeletal Class I jaw relationship.

A mild positive correlation was seen between SNA & SNB values and the pharyngeal airway space however it was statistically insignificant. This finding is in accordance with earlier studies carried out by Claudino et al¹⁴ and Hong et al.²⁶ Celikoglu et al conducted a study and found a negative correlation between the growth pattern of the individual and the pharyngeal airway dimensions.²⁷ In the present study although the lower anterior face height (LAFH) and the mandibular plane angle (MPA) both showed a mild negative correlation, it was statistically insignificant.

In this study, a very weak influence of craniofacial morphology was found on the oropharyngeal dimension as the airway did not show any statistically significant correlation with any of the craniofacial morphology parameters. This is in accordance with other studies, which have reported either a weak or insignificant correlation between craniofacial morphology and pharyngeal airway space.^{12,25,28-30}

VI. Conclusion

Craniofacial morphology has often been attributed as one of the important factors affecting pharyngeal airway space. However in the present study we did not find any significant correlation between the two. At best it can play a secondary & contributory role in airway discrepancies.

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Table 1: Linear Variables

Variables	Definitions
S-N	It is the distance between Sella point (S) and Nasion point (Na), determining the extension of anterior cranial base.
N-S-Ba	It is the distance between Nasion to Sella and from Sella to Basion. It determines the total length of cranial base.
Na-Me	It is the distance measured from Nasion to Menton perpendicular to the maxillary plane(ANS-PNS).It represents the lower anterior facial height.
Pm-UPW	The distance from Posterior Nasal Spine (PNS) to Upper Pharyngeal Wall (UPW), measured parallel to SN plane and representing the naso-pharyngeal airway space.
U-MPW	The distance from tip of uvula (U) to middle pharyngeal wall (MPW), parallel to SN plane, representing the oro-pharyngeal airway space.
V-LPW	The distance from vallecula (V) to lower pharyngeal wall (LPW), parallel to SN plane, representing the hypo-pharyngeal airway space.
PASmin	The minimal distance between the base of tongue and the posterior pharyngeal wall, representing the minimum pharyngeal airway space.

Table 2: Angular Variables

Variables	Definitions
N-S-Ba angle (cranial base angle)	Angle between nasion-sella plane and sella-basion plane, depicting the flexure of anterior and posterior cranial bases
SNA angle	Angle between nasion-sella plane and nasion – point A line, shows the relative position of maxilla to anterior cranial base
SNB angle	Angle between nasion-sella plane and nasion – point B line, shows the relative position of mandible to the anterior cranial base.
ANB angle	Angle between nasion-point A line and nasion – point B line, shows the relative positioning of mandible to maxilla
MPA (Mandibular Plane Angle)	Angle between nasion-sella line and mandibular plane(tangent to lower border of mandible), shows the growth pattern of the individual

Table 3:- Linear and angular measurement of variables with their standard deviation.

	Mean	Std. Deviation	Minimum	Maximum
MPA (degrees)	33.17	7.03	19	47
CB angle (degrees)	129.27	4.57	120	139
CB length (mm)	112.43	3.88	107	126
LAFH (mm)	64.23	6.14	52	76
PM-UPW (mm)	26.27	2.24	21	30
U-MPW (mm)	10.13	2.99	6	16
V-LPW (mm)	14.6	3.91	6	22
PASmin (mm)	6.23	2.21	3	10
SNA (degrees)	82.37	4.29	74	93
SNB (degrees)	79.40	4.03	72	90
ANB (degrees)	2.97	0.93	2	4
Age (years)	22.10	3.41	18	32

Table 4:- Correlation between craniofacial morphology and pharyngeal air way space at different levels of pharynx

		PM-UPW	U-MPW	V-LPW	PAS
MPA	r	-0.03	-0.27	-0.27	-0.23
	p-value	0.88(NS)	0.15(NS)	0.15(NS)	0.23(NS)
CB_angle	r	0.22	0.04	-0.09	-0.18
	p-value	0.25(NS)	0.85(NS)	0.63(NS)	0.34(NS)
CB_length	r	-0.19	0.10	0.01	-0.01
	p-value	0.32(NS)	0.60(NS)	0.98(NS)	0.97(NS)
LAFH	r	0.05	-0.18	-0.19	-0.07
	p-value	0.81(NS)	0.33(NS)	0.31(NS)	0.73(NS)
SNA	r	0.28	0.11	0.03	0.18
	p-value	0.14(NS)	0.56(NS)	0.87(NS)	0.35(NS)
SNB	r	0.22	0.11	0.05	0.23
	p-value	0.25(NS)	0.55(NS)	0.79(NS)	0.23(NS)

Pearson’s correlation test
 p<0.05 statistically significant, p>0.05 Non significant, NS

Legend for Figure 1:

1-SN plane, 2- Sella to Basion line, 3- FH plane, 4- PNS to UPW (upper pharyngeal wall), 5- U (tip of uvula) to middle pharyngeal wall (MPW), 6- PASmin (Minimum distance between base of tongue and post pharyngeal wall, 7- V(Vallecula) to lower pharyngeal wall (LPW), 8- Mandibular Plane, 9- Lower face height Na-Me

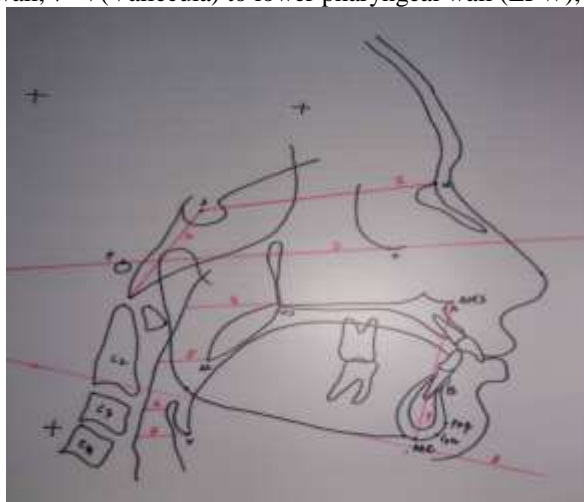


Fig.1

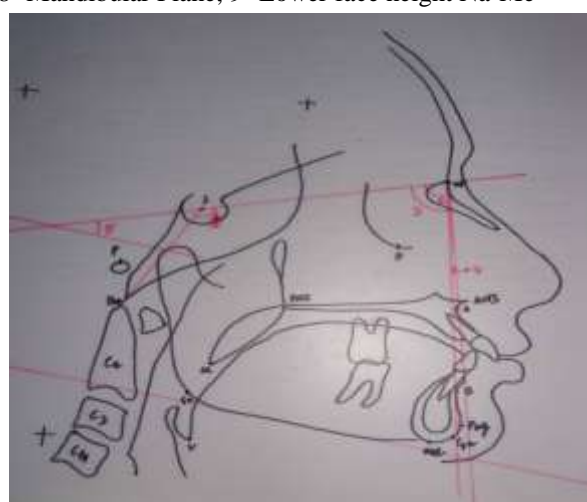


Fig.2

Legend for Figure 2:

1-Cranial Base Angle (NSBa), 2- SNA Angle, 3- SNB Angle, 4- ANB Angle, 5- Mandibular Plane Angle