Pharyngeal Airway Dimensions Related To Skeletal Malocclusion And Respiratory Function – A Radiographic Study

Reene Mary Kuruthukulam[1], Meenal Tepan[2], Pragati Hemgude[3], Amol Patil[4], Shivdas Mali[5], Rajani Komble[6], Siddharth Shinde[7]

1- Post Graduate, Department of Orthodontics and Dentofacial Orthopedics, Bharati Vidyapeeth (Deemed to be University) Dental College and hospital, Pune, Maharashtra, India
2- Assistant Professor, Department of Oral Medicine and Radiology, Bharati Vidyapeeth (Deemed to be University) Dental College and hospital, Pune, Maharashtra, India.
3- Assistant Professor, Department of Prosthodontics, Bharati Vidyapeeth (Deemed to be University) Dental College and hospital, Sangli, Maharashtra, India.
4- Professor, Department of Orthodontics and Dentofacial Orthopedics, Bharati Vidyapeeth (Deemed to be University) Dental College and hospital, Pune, Maharashtra, India.
5- Assistant Professor, Department of General Pathology and Microbiology, Bharati Vidyapeeth (Deemed to be University) Dental College and hospital, Pune, Maharashtra, India
6- Assistant Professor, Department of Public Health Dentistry, Bharati Vidyapeeth (Deemed to be University) Dental College and hospital, Sangli, Maharashtra, India.
7- Assistant Professor, Department of Orthodontics and Dentofacial Orthopedics, Bharati Vidyapeeth (Deemed to be University) Dental College and hospital, Pune, Maharashtra, India

Corresponding Author:Dr. Amol Patil, Department of Orthodontics and Dentofacial Orthopedics, Bharati Vidyapeeth (Deemed to be University) Dental College and hospital, Pune, Maharashtra, India. Contact number: +91 7774048166. E-mail address: amolp66@gmail.com

Abstract:

Aims: To study the correlation between, upper and lower pharyngeal airway dimensions in untreated Class I, Class II, Class III malocclusions
Methods and Material: Our Sample consisted of 400 patients divided into three groups according to their ANB Values, Class I: ANB 1-3, Class II: ANB >4, Class III: <0. Lateral Cephalograms were used for the study.
Statistical analysis used: In each of the groups, the means and standard deviation for the ages, and upper and lower airways, were determined. The comparisons between all the groups, were performed by using the 1-way ANOVA at P<.05
Results: There is a decrease in upper and lower airway width from Class I to Class II to Class III. However it has shown no statistical significance.
Conclusions: Upper and lower airway does not have any significant influence on the type of malocclusion.
Key Messages: Lower airway decreases from Class I to Class II to Class III malocclusion patients. Patients with Class III malocclusions have the lowest lower airway dimensions and these patients may be more prone to mouth breathing as a result of their relatively diminished pharyngeal dimensions. Small pharyngeal spaces in Class III patients are probably due to large tongue.

Key-words: Cephalometric, Orthodontic diagnosis, pharyngeal airway, respiratory function
DOINumber:10.14704/nq.2022.20.8.NQ44819 **NeuroQuantology 2022; 20(8): 7934-7939**

Introduction:

Since the time of Edward. H Angle, the effects of upper airway obstruction have been recognized in the field of craniofacial biology.The relationship of variance in breathing pattern to dentofacial form continues to be a topic of debate even after a century of discussion and intense argument.[1]

Respiratory function is very important for 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. [2-4]Pharyngeal space size is determined by the growth and size of the soft tissues surrounding the dentofacial skeleton. Craniofacial anomalies, including mandibular or maxillayretrognathism, short mandibular body, and backward and downward rotation of the mandible,can lead to reduction of the pharyngeal airway passage.[5]

Significant relationships between the pharyngeal structures and both the dentofacial and craniofacial structures have been reported [6,7] .The influence of the soft tissues in craniofacial growth has been studied for quite some time, today we know that this is highly relevant to the orthodontic diagnosis and treatment plan. [8]

Various methods have been used to evaluate the airway, including, cine-computed tomography (CT), lateral cephalogram, magnetic resonance imaging (MRI) as well as polysomnography.[9-12]Cephalometry is most commonly used, although it is a two-dimensional analysis, it has proved very reliable in diagnosing pharyngeal volumes.[13,14]Furthermore, numerous researchers reported the interaction between pharyngeal dimensions and various sagittal and vertical facial growth patterns at varying degrees.[15-17] Skeletal features such as retrusion of the maxilla and mandible and vertical maxillary excess in hypodivergent patients may lead to narrower anteroposterior dimensions of the airway.5 As there is close association between pharynx and dentofacial structures, a mutual interaction is expected to occur between pharyngeal structures and various dentofacial patterns, thus justifying orthodontic treatment.

The ultimate vector of mandibular growth is a consequence of the competition between horizontal and vertical growth[18].For correct treatment of various malocclusions, diagnosis of facial skeletal type is very crucial[19]. An interaction occurs between respiratory function and the maxillary[20] and mandibular growth pattern[21].

Various anatomical landmarks of lateral cephalogram are used for assessment of different malocclusions[22]. Pharyngeal space size is determined primarily by relative growth and size of the soft tissues surrounding the dentofacial skeleton. From adulthood to older age (20-50 years of age), the nasopharyngeal skeleton may change.[23]

Some authors associated mouth breathing and Class II malocclusions[24-27] and others [17,28-30] reported associations of vertical growth pattern with obstruction of upper and lower pharyngeal airways concurrently with mouth breathing. Chronic mouth breathing restores the normal balance in the oral and paraoral structures; however, alteration of both structures is expected.[28]

In a recent study by Kim et al., the children with skeletal Class II malocclusions and retrusive mandibles had a smaller pharyngeal airway dimensions, than the children with skeletal class I malocclusions. [22]. Another study by De Freitas et al, in 2006, demonstrated significantly narrower upper pharyngeal airways in Class I and Class II malocclusion patients with vertical growth patterns in comparison to Class I and Class II subjects with normal growth patterns. Furthermore, the growth pattern did not affect the lower pharyngeal airway.[7]

Linder-Aronson (1993) presented a hypothesis, stating that increased adenoids aggravate nose breathing, which disrupts the balance of lingual, labial, and cheek muscles. This results in the changes that are reflected in malocclusion and anomalies of dental position.[23]Nasal obstruction causes changes in muscular function, conditioning dentofacial anomalies.[28-30]

Hence the evaluation of upper and lower airway space, should be an integral part of diagnosis and treatment planning to achieve functional balance and stability of the results,thus this study is designed and planned to measure the upper and lower pharyngeal airway widths in patients with different vertical, horizontal, antero-posterior and normal skeletal patterns.

Subjects and Methods:
The sample comprised of pre-treatment lateral cephalograms of 400 patients of age group 10 to 16 years. All the subjects were informed about the research content and a consent was signed by every child's parent. No subject had a history of previous orthodontic treatment or any palatal or lip cleft syndrome. The parents were questioned about their children's medical history to exclude any child with chronic mouth breathing, permanent snoring, and tonsillectomy or adenoidectomy.

All the cephalograms were taken on the same digital radiography equipment on Carestream Digital machine, 78 kvp, 15 mA for2 seconds. They were taken in one standard method in natural head position and their teeth were in centric occlusion. All the radiographs were traced manually.
The subjects were divided into three groups according to the value of ANB.

1. Class I: ANB 1-3deg
2. Class II: ANB >4deg
3. Class III:<0 deg

The landmarks and measurements identified on the lateral cephalogram are as follows:

SNA: Inward angle towards cranium between NA line and SN plane.
SNB: Inward angle towards cranium between NB line and SN plane.
ANB: Angle between NA and NB.
Witts Analysis: Distance between AO and BO (functional occlusal plane)
Jarabaks Analysis: (Posterior facial height*100)/Anterior facial height
Sn:GoGn: Anterior angle measured formed by intersection of SN and GoGn.
Lower anterior face height (LAFH): Measured to ANS to menton.

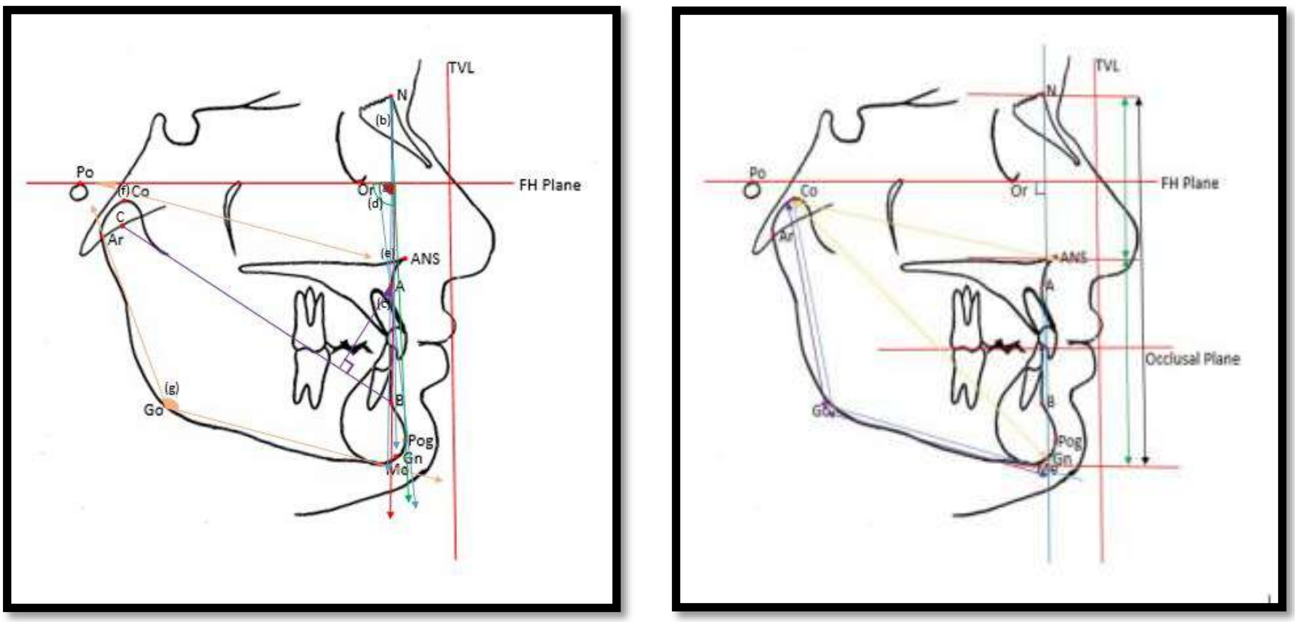

Figure A: Cephalometric measurements demonstrating Angular parameters.Figure B: Cephalometric measurements demonstrating Linear parameters

Statistical Analysis:
Keeping the level of significance at 5%, the sample size (n) was / 2 Δκcalculated using the "comparing two means" formula: n = (σ1 2 + σ2 2) (Z1-α/2+Z1-β). The sample size was calculated with the power of the study at 95%.
The research was carried out as per the Declaration of Helsinki – Ethical Principles For Medical Research Involving Human Subjects

Results:

The dimension of the upper airway decreases from Class I to Class II to Class III. This result is insignificant as the p-value is 0.56. There is a difference between the upper airway in all the groups but it is not statistically significant

The dimension of the lower airway decreases from Class I to Class II to Class III. There is a difference between the upper airway in all the groups but it is not statistically significant.This result is insignificant as the p-value is 0.166.

Descriptives								
	N	**Mean**	**Standard Deviation**	**95 % Confidence Internal for Mean**		**Minimum**	**Maximum**	**P-value**
				Lower bound	**Upper bound**			
Upper airway	Class I	202	12.35	11.91	12.80	5.00	21.00	0.56
	Class II	174	12.06	11.57	12.56	3.00	20.50	
	Class III	24	11.77	10.34	13.20	4.00	17.50	
	Total	400	12.19	11.87	12.51	3.00	21.00	
Lower airway	Class I	202	10.51	10.10	10.92	5.00	25.00	0.166
	Class II	174	10.04	9.63	10.45	4.00	17.00	
	Class III	24	9.69	8.51	10.87	4.00	15.00	
	Total	400	10.26	9.98	10.54	4.00	25.00	

Table 1. Comparison of upper and lower airway in different growth patterns

Discussion:

Pre-treated lateral cephalograms of subjects in natural head position were taken to evaluate pharyngeal airway dimensions in different skeletal malocclusions subjects. We chose lateral cephalograms for this study because posterior airway space as measured by lateral cepholometric radiography was highly correlated with measurements using three-dimensional CT scan. Malkoc et al noted that cephalometric films were significantly reliable and reproducible in determining the pharyngeal airway dimensions[27]. Cameron et al. compared computer tomography and cephalometric films in skeletal malocclusion subjects and found a significant positive correlation between nasopharyngeal airway size on cephalometric films and CBCT scan determined its true volumetric size in adolescents. Cephalograms also provide other advantages including low cost and minimal exposure to radiation.[28]

In the present study we found the mean upper airway decreases from Class I to Class II to Class III. However, we found no statistically significant relationship between upper airway dimensions when compared to Class I, Class II, and Class III skeletal malocclusions. Previous studies report that the upper pharyngeal width in the subjects with Class I and Class II malocclusions and vertical growth patterns were significantly narrower than in normal growth patterns[30].Analyzings these results, we can infer that upper airway width is influenced by the craniofacial growth pattern[17,20,26,29,30]. Several other researchers found that there is no relationship between upper airway space and the type of malocclusion. Gwynne-Evans concluded that facial growth is constant regardless the mode of breathing.

In this study we found that mean lower airway decreases from Class I to Class II to Class III. However, we found no statistically significant relationship between lower airway dimensions when compared to Class I, Class II, and Class III skeletal malocclusions[1,27]. This correlates with different studies. However, additional studies necessary to clarify this issue because Linder-Aronson and Leighton and Linder-Aronson and Backstrom[15] suggested that oropharyngeal space appears to be larger than normal when nasopharyngeal airway is smaller, although they did not evaluate this correlation directly.

As patients with Class III malocclusions had the lowest mean for airway dimensions, these patients may be more prone to mouth breathing as a result of their relatively diminished pharyngeal dimensions. Small pharyngeal spaces in Class III patients are probably due to large tongue.

In conclusion, malocclusion type does not influence upper and lower pharyngeal airway dimension.
On comparing individually, Class I, Class II, Class III there was no significant correlation found between the upper and lower airway widths.

References:

1. Handelman CS, Osborne G. Growth of nasopharynx and adenoid development from one to eighteen years. Angle Orthod 1976;46:243-59.
2. Zhong Z, Tang Z, Gao X, Zeng XL. A comparison study of upper airway among different skeletal craniofacial patterns in non-snoring Chinese children. Angle Orthod. 2010;80(2):267–74.
3. Sheng CM, Lin LH, Su Y, Tsai HH. Developmental changes in pharyngeal airway depth and hyoid bone position from childhood to young adulthood. Angle Orthod 2009;79:484-90.
4. SahinSaglam AM, UydasNE.. Relationship between head posture and hyoid position in adult females and males. J CraniomaxillofacSurg 2006;34:85-92.
5. Joseph AA, Elbaum J, Cisneros GJ, Eisig SB. A cephalometric comparative study of the soft tissue airway dimensions in persons with hyperdivergent and normodivergent facial patterns. J Oral MaxillofacSurg 1998;56:135-9.
6. Preston BC. Cephalometric evaluation and measurement of the upper airway. SeminOrthod 2004;10:3-15.
7. Freitas MR, Alcazar NMPV, Janson G. Upper and lower pharyngeal airways in subjects with Class I and Class II malocclusions and different growth patterns. Am J OrthodDentofacOrthop 2006;130:742-5.
8. Martin O, Muelas L, Vinas MJ. Nasopharyngeal cephalometric study of ideal occlusions. Am J OrthodDentofacialOrthop 2006; 130: 1-9.
9. Haponik EF, Smith PL, Bohlman ME, Allen RP, Goldman SM, Bleecker ER. Computerized tomography in obstructive sleep apnea. Correlation of airway size with physiology during sleep and wakefulness. Am Rev Respir Dis 1983;127:221-6.
10. Holmberg H, Linder-Aronson S. Cephalometric radiographs as a means of evaluating the capacity of the nasal and nasopharyngeal airway. Am J Orthod 1979;76:479-90
11. Rodenstein DO, Dooms G, Thomas Y, Liistro G, Stanescu DC, Culée C, et al. Pharyngeal shape and dimensions in healthy subjects, snorers, and patients with obstructive sleep apnoea. Thorax 1990;45:722-7.
12. Johnson PL, Edwards N, Burgess KR, Sullivan CE. Detection of increased upper airway resistance during overnight polysomnography. Sleep 2005;28:85-90.
13. deBerry-Borowiecki B, Kukwa A, Blanks RH. Cephalometric analysis for diagnosis and treatment of obstructive sleep apnea. Laryngoscope 1988;98:226-34.
14. Riley R, Guilleminault C, Herran J, Powell N. Cephalometric analyses and flow-volume loops in obstructive sleep apnea patients. Sleep 1983;6:303-11.
15. Linder-Aronson S, Backstrom A. A comparison between mouth and nose breathers with respect to occlusion and facial dimensions. Odontol Revy 1960;11:343-76.
16. Kirjavainen M, Kirjavainen T. Upper airway dimensions in class II malocclusion. Angle Orthod 2007;77:1046-53.
17. Tourne LP. Growth of the pharynx and its physiologic implications. Am J OrthodDentofacialOrthop 1991;99:129-39.
18. Chung CH, Mongiovi VD. Craniofacial growth in untreated skeletal Class I subjects with low, average, and high MP-SN angles: a longitudinal study. Am J OrthodDentofacialOrthop. 2003;124:670–678.
19. Patil AS, Kapasiawala NN, Rawal NN. Comparative analysis of size of sellaturcica with different skeletal patterns. Int J Cur Res 2016;8:42311-42315.
20. Gungor AY, Turkkahraman H. Effects of airway problems on maxillary growth: a review. Eur J Dent. 2009;3:250–254.
21. Jena AK, Singh SP, Utreja AK. Sagittal mandibular development effects on the dimensions of the awake pharyngeal airway

*e*ISSN1303-5150

passage. Angle Orthod. 2010;80:1061–1067.

22. Patil AS, Kapasiawala NN, Rawal NN. Comparitive analysis of dimension of frontal sinus with different skeletal patterns. Int J Current Res 2016;8:42947-42951.
23. Johnston CD, Richardson A. Cephalometric changes in adult pharyngeal morphology. Eur J Orthod. 1999;21: 357–362.
24. Mergen DC, Jacobs MR. The size of nasopharynx associated with normal occlusion and Class II malocclusion. Angle Orthod 1970;40(4):342-6.
25. Kerr WJ. The nasopharynx, face height and overbite. Angle Orthod 1985;55(1):31-6.
26. Paul JL, Nanda RS. Effect of mouth breathing on dental occlusion. Angle Orthod 1973;43(2):201-6.
27. Subtelny JD. Malocclusions, orthodontic correlations and orofacial muscle adaptation. Angle Orthod 1970;137(3):301-11.
28. Vig KWL. Nasal obstruction and facial growth: the strenth of evidence for clinical assumptions. Am J OrthodDentofacialOrthop 1998;113:603-11.
29. McNamara JAJr. Influence of respiratory pattern on craniofacial growth. Angle Orthod 1981;51(4):269-300.
30. Cheng MC, Enlow DH, Papidero M, Broadbent BH Jr. Oyen O, Sabat M. Development of effects of impaired breathing in the face of the growing child. Angle Orthod 1988;58:309-20.

(Acknowledgement: Bharati Vidyapeeth Dental College and Hospita, Pune and Department of Orthodontics and Dentofacial Orthopedics.)