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A Cephalometric Evaluation of Airway Space in Skeletal Class II Subjects

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Authors' contributions

This work was carried out in collaboration between all authors. Author SSI carried out the research, did the statistical analysis and wrote the first draft of the manuscript. Author BSC designed the study and wrote the protocol. Author PCRK analyzed the study. Authors VPR, CMM and BS did the corrections in the manuscript after going through the research work. Author AS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims and Objectives: To study the correlation of 1. pharyngeal airway space and skeletal class I and II malocclusions and 2. pharyngeal airway space and growth pattern using lateral cephalograms

Materials and Methods: 60 pre-treatment lateral cephalograms of untreated skeletal class I and class II patients were traced using 0.003 inch matte acetate sheets. The subjects were divided into skeletal class I (ANB 0º-4º) and class II (ANB >4º) based on ANB angles. Each group was further divided into three sub groups based on mandibular plane angle. (SN-GoGn <26º-low angle, SN-GoGn 26º-38º-normal angle and SN-GoGn >38º-high angle).

Results: Nasopharyngeal airway space decreased from low angle to normal to high angle. The upper airway was wider in Class II subjects with low, normal or vertical growth than in Class I subjects with low, normal or vertical growth. The lower pharyngeal airway did not have any correlation with the type of malocclusion or the growth pattern.

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Conclusion: Thus, it can be concluded that malocclusion type (skeletal Class I or Class II) as well as growth pattern (normal, horizontal and vertical) influence upper pharyngeal airway width, and both do not influence the lower pharyngeal airway width.

Keywords: Upper airway; lower airway; Class I; Class II; vertical growers; horizontal growers.

1. INTRODUCTION

This study evaluates the airway size and its relationship to skelatal class I and class II as well as the different vertical growth patterns. It is necessary for us to understand the extensively studied vertical growth patterns and the pharynx.

It is essential to know the vertical growth of face and various factors affecting it. Vertical malocclusions occur due to an interplay of many different etiological factors during growth. The changes in facial growth in the two extreme growth patterns are due not only to the direction of condylar growth but are also the result of differences in anterior facial height and posterior facial height development. The differences in these heights lead to rotational growth or positional changes of the mandible that influence the position of chin. The anterior facial height is determined by the amount of eruption of maxillary and mandibular posterior teeth and sutural lowering of maxilla. When the vertical condylar growth exceeds the dentoalveolar growth that is the eruption of teeth then forward rotation of jaw occurs. In contrast if dentoalveolar growth is greater then the resulting change in mandibular position is backward or posterior rotation of the mandible [1].

The pharynx is closely associated with oral structures. The pharynx anatomically as we know is a median fibromuscular tube that extends from the base of the skull. It is continuous from the sphenoid and the occipital bones to the level of the sixth cervical vertebra, where it is continuous with the oesophagus. Certain structural features of the pharynx under genotypic control are associated with skeletofacial structure [2].

Adult nasopharyngeal depth dimensions are established early in life. At the oropharyngeal level the sagittal stability is exemplified by the constant position of the hyoid bone relative to the cervical column. The ultimate capacity of the pharynx depends on the soft tissues, their growth and size. Adenoid vegetation or tongue mass may decrease the patency and induce postural adaptations at the oropharyngeal level [2].

The predisposing factors for obstruction of pharyngeal airways like allergies, irritants and infections, are amenable to adequate treatment. However, there is also the natural predisposition of narrower airway passages which needs to be studied [3]. As the pharyngeal space size is determined primarily by the relative growth and size of soft tissues surrounding the dentofacial skeleton, it is implied that the malocclusion characteristics have a predisposing anatomical factor for these airway problems [3,4].

The controversy is not only academically important; it also has considerable clinical consequences. It can influence the orthodontist's decision as to whether active allergy management or a more aggressive therapy such as adenoidectomy should be performed for solely orthodontic reasons [2]. With increasing treatment of adults optimising the airway for every patient and never doing any treatment which will diminish the airway even minutely, needs to be the centre of caring in airway centric orthodontics.

There has been numerous literature till date on the pharyngeal airway space but the subjects have not been divided based on this vertical dimension while interpreting the airway. Since the vertical growth pattern of the mandible has a significant effect on the pharyngeal airway passage it is necessary to include all of the subjects with similar vertical growth patterns of the mandible in order to eliminate any effect on pharyngeal airway passage caused by changes in the vertical plane while evaluating the pharyngeal airway dimensions among subjects with various sagittal mandibular development [5]. Thus, to overcome the lacuna, the present study was designed to evaluate the pharyngeal airway passage dimensions among class I and class II subjects who demonstrate a similar vertical growth pattern of the mandible.

2. MATERIALS AND METHODS

Sixty pre-treatment lateral cephalograms of skeletal class I and class II patients each requiring orthodontic treatment were taken. The radiographs were collected from the archives of the department of orthodontics and dentofacial orthopaedics at the college.

0.003 inch matte acetate sheets were used for tracing each of these radiographs. All cephalometric roentgenograms were taken in a natural head position by the same technician. All the radiographs were traced by the same observer twice and an average of the two was taken to avoid interobserver and intrabserver bias.

Subjects included belonged to the age group of 18-30 years. The subjects included had no history of any prior orthodontic treatment. The subjects were divided into skeletal class I and class II based on ANB values. Patients with class I skeletal relationship corroborated by ANB values of 2º ± 2º (i.e. 0º to 4º). Patients with class II skeletal relationship corroborated by ANB values of greater than 4º.

Patients with less than 24 permanent teeth or suffering from craniofacial anomalies or systemic muscle or joint disorders were excluded. Subjects with BMI > 30 were excluded from the study. Only good quality of pre-treatment cephalometric radiographs were included.

2.1 Cephalometric Measurements

Angular measurements taken were (Fig. 1):

1. SNA angle
2. SNB angle
3. ANB angle
4. Saddle/Sella angle (NSAr)
5. Articular angle (SArGo)
6. Gonial/Jaw angle (ArGoGn)
7. Mandibular plane angle (SN-GoGn)
8. Palatal-Mandibular angle (PP GoGn)
9. Y-Axis: NSGn
10. Angle of convexity: Intersection of N – point A to point A – Pog
11. FMA(FH line-GoMe line).

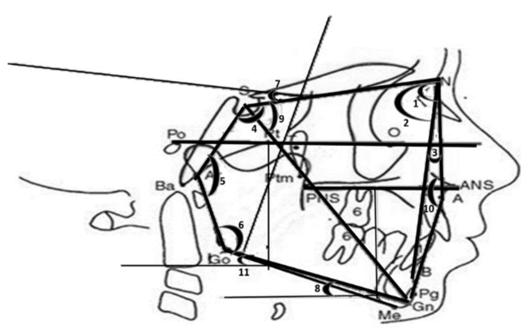

Fig. 1. Angular measurements

Linear measurements taken were (Fig. 2):

1. A point to Nasion perpendicular (A to N perp)
2. Pogonion to Nasion perpendicular (Pog to N perp)
3. Ramus Height (Ar-Go)
4. Mandibular Body Length (Go-Gn)
5. Y-Axis Length (S-Gn)
6. Posterior Facial Height (S-Go)
7. Anterior Facial Height (Na-Me)
8. Overjet: Horizontal distance between labial surfaces of upper incisors at the incisal margin and labial surfaces of lower incisors at centric occlusion.
9. Overbite: Vertical distance between upper and lower incisor margins at centric occlusion.
10. Jarabak ratio

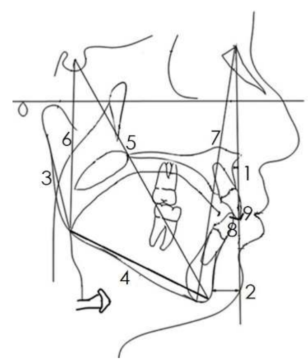

Fig. 2. Linear measurements

Airway space measurements taken were (Fig. 3):

1. Upper PAS (mm): Point of intersection of line from soft palate centre perpendicular to posterior pharyngeal wall and posterior pharyngeal wall.
2. Lower PAS (mm): Distance of mandibular plane intersection between posterior pharyngeal wall and tongue posterior wall.

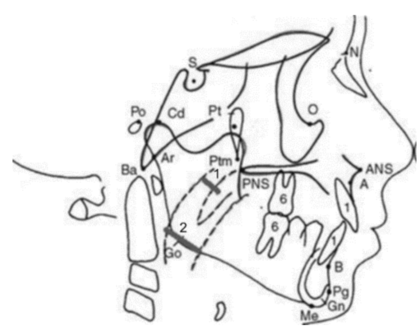

Fig. 3. Airway space measurements

The various subjects in the class I and the class II groups were later subdivided based on their growth pattern in this study. Individuals with the same growth pattern were grouped together.

Subjects with SN-MP angle of <26 were grouped under low angle.

Subjects with SN–MP angle of 26-38 were grouped under normal growth.

Subjects with SN–MP angle of >38 were grouped under high angle.

2.2 Statistical Analysis

The results were averaged (mean + standard deviation) for continuous data and number and percentage for dichotomous data are presented in Table and Figure. Normality assumption of the data was analyzed using Shapiro-Wilks test. Proportions were compared using Chi-square test of significance. One way analyses of variance were used to test the difference between groups.

3. RESULTS

According to ANOVA results, statistically significant differences were found in nasopharyngeal airway space, the upper posterior airway space (PAS). Pairwise comparisons among groups of orofacial airway measurements were also done via the Tukey HSD test. The data demonstrated a significant difference between normal angle and high angle groups at the level of the nasopharyngeal airway space i.e. upper PAS. As seen in Table 1 and Fig. 4 the nasopharyngeal airway space decreased from low angle to normal to high angle. There was statistically significant difference between normal and high angle upper pharyngeal airway (P<.011). The sagittal dimension of the superior part of the upper airway (upper PAS) decreased from low angle to normal to high angle.

The lower airway did not show any statistically significant values among different growth patterns as shown in Table 2 and Fig. 5.

The upper airway intergroup comparisons in the same growth patterns showed significant differences as shown in Table 3 and Fig. 6, with an association of upper airway space with type of malocclusion. The upper airway was wider in Class II subjects with low or normal growth than in Class I subjects with low or normal growth. (p <.05). The upper airway was wider in vertical growing Class II subjects too than in vertical growing Class 1 subjects. But this value was not statistically significant.

Table 1. Comparison of upper airway space measurements in different growth patterns by class

Class	Angle	N	Mean (mm)	SD	'F' value (ANOVA)	'p' value	Low vs normal	Low vs high	High vs normal
Class 1	Low	9	17.000	3.3541					
	Normal	39	18.576	4.1620	1.762	0.180	0.640	0.975	0.250
	High	12	16.333	3.9848					
Class 2	Low	16	20.733	3.7506					
	Normal	29	21.310	3.1180	4.605	*0.014**	0.871	0.068	*0.011**
	High	15	17.455	4.6339					

*ANOVA, analysis of variance, SD standard deviation, * P < .05; ** P < .01; *** P < .001*

Table 2. Comparison of lower airway space measurements in different growth patterns by class

Class	Angle	N	Mean (mm)	SD	'F' value (ANOVA)	'p' value	Low vs normal	Low vs high	High vs normal
Class 1	Low	9	11.000	4.3012					
	Normal	39	11.935	4.0587	0.783	0.461	0.878	0.987	0.578
	High	12	10.500	1.9306					
Class 2	Low	16	11.500	3.3327					
	Normal	29	10.241	3.3664	0.971	0.385	0.577	1.000	0.632
	High	15	11.545	3.5599					

*ANOVA analysis of variance, SD standard deviation, * P < .05; ** P < .01; *** P < .001*

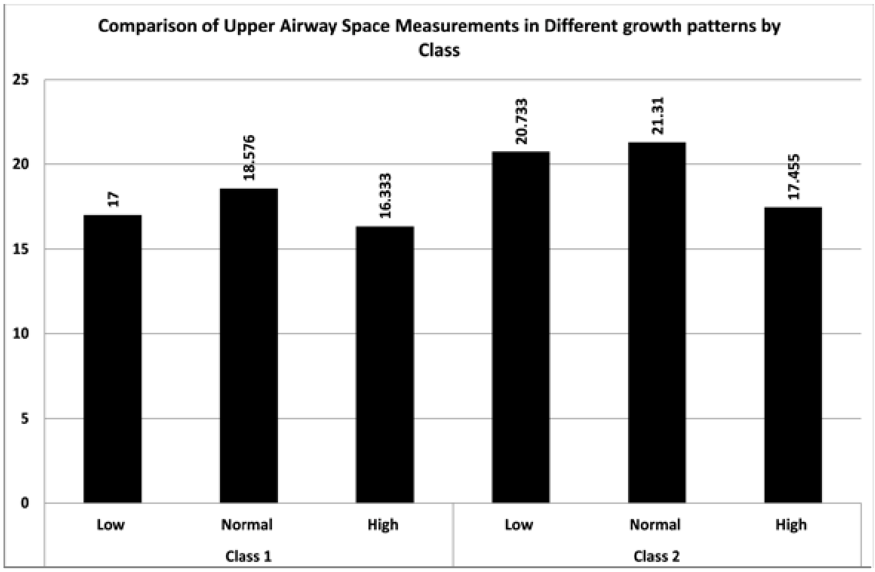

Fig. 4. Comparison of upper airway space measurements in different growth patterns by class

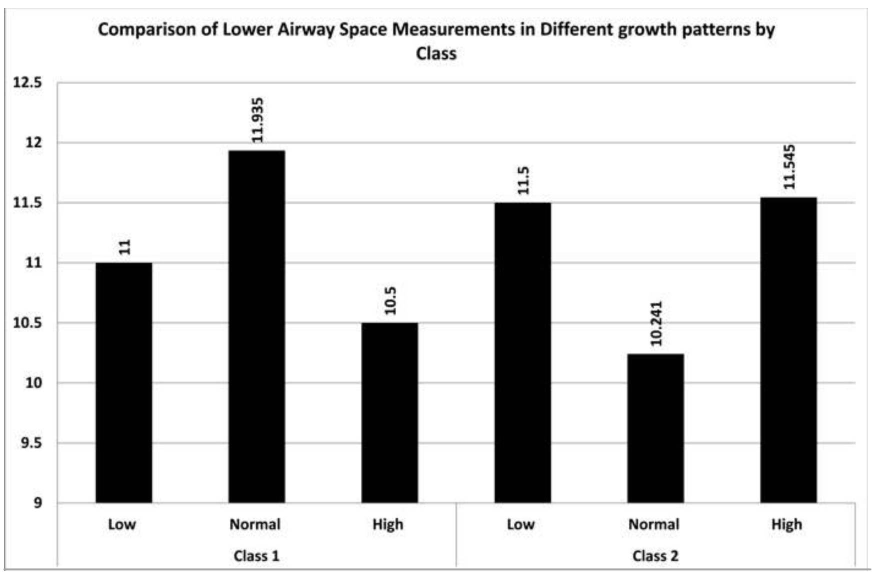

Fig. 5. Comparison of lower airway space measurements in different growth patterns by class

Table 3. Comparison of upper airway space measurements in different class by different growth patterns

Angle		N	Mean (mm)	SD	't' value (unpaired t test)	'p' value
Low angle	Class 1	9	17.000	3.3541	6.011	*0.023**
	Class 2	16	20.733	3.7506		
Normal angle	Class 1	39	18.576	4.1620	9.230	*0.003***
	Class 2	29	21.310	3.1180		
High angle	Class 1	12	16.333	3.9848	0.389	0.539
	Class 2	15	17.455	4.6339		

*SD standard deviation, * P < .05; ** P < .01; *** P < .001*

The lower airway did not show any statistically significant values among different malocclusions as shown in Table 4 and Fig. 7.

4. DISCUSSION

The etiology of malocclusions is multifactorial and the airway is assumed to play a role in dentofacial development. This study tries to correlate patients with normal nasorespiratory functions with different malocclusions and airway dimensions [6].

At present there are variety of options to study the pharynx including cineradiography [7], acoustic reflectance [8] and lateral cephalometry [9,10], forced expiratory manoeuvres and the techniques of CT scanning [11].

In the current literature, as we have seen lateral cephalometry has been used. Malkoc et al. [12] has found cephalometric films reliable and reproducible. When computed tomography (CT) and cephalometric films were compared in subjects with skeletal malocclusion, Cameron et al. [13] found a significant positive relationship between nasopharyngeal airway size on cephalometric films and its true volumetric size as determined from CBCT scan in adolescents. We used lateral head films for airway measurement, according to these findings [13]. However, we cannot necessarily determine three-dimensional volumetric measurements with lateral measurements.

In the present cross-sectional study age and sex were found to be compatible. Subjects included belonged to the age group of 18-30 years. This would limit the errors caused by the various stages of growth of pharynx. As only postpubertal subjects were selected for the current study the influence of growth and ageing on the various parameters were eliminated. The nasopharyngeal airway space would reflect only natural anatomic conditions without pathology as any population with craniofacial anomalies were excluded in the present study. Also obese individuals (BMI > 30) were excluded from the study as it is a well known cause of narrowing upper airway in children and adults.

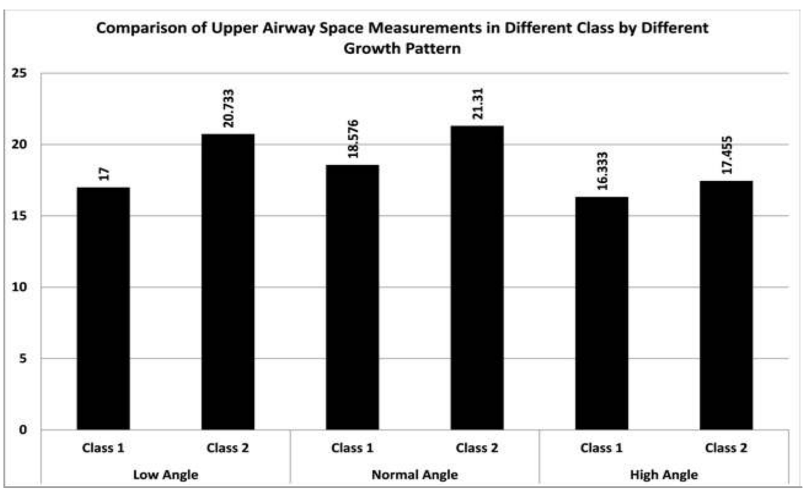

Fig. 6. Comparison of upper airway space measurements in different class by different growth patterns

Table 4. Comparison of lower airway space measurements in different class by different growth patterns

Angle		N	Mean (mm)	SD	't' value (unpaired t test)	'p' value
Low Angle	Class 1	9	11.000	4.3012	0.102	0.753
	Class 2	16	11.500	3.3327		
Normal Angle	Class 1	39	11.935	4.0587	3.517	0.065
	Class 2	29	10.241	3.3664		
High Angle	Class 1	12	10.500	1.9306	0.785	0.386
	Class 2	15	11.545	3.5599		

*SD standard deviation, * P < .05; ** P < .01; *** P < .001*

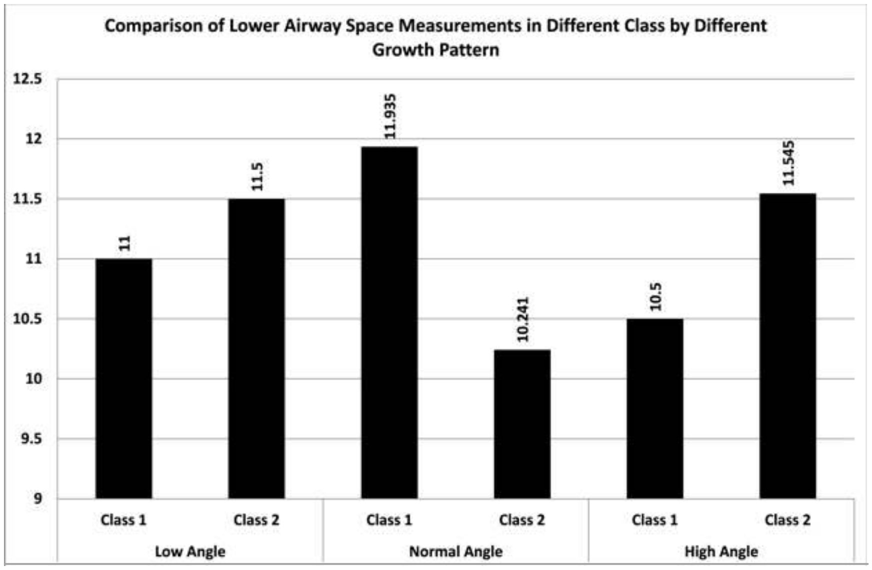

Fig. 7. Comparison of lower airway space measurements in different class by different growth patterns

It must be stressed at the outset that a cephalogram is a two dimensional representation of a three dimensional structure. Positive findings observed cephalometrically can only serve as a 'Red Flag'. Further investigations are required to conform the findings [14]. Therefore these studies do not suggest that subjects with more vertical growth have reduced airflow capacities. These need further confirmation by other medical investigations. Perhaps, vertical-growth patients are larger, transversely, than normal growers. However, the prevalence of mouth breathing in subjects with vertical growth pattern can be explained by the findings of Ricketts [15], Linder-Aronson [16] and Dunn et al. [17] They 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 [18,19]. The mouth breathing in turn leads to structural changes.

Ceylan and Oktay [20] reported that changes in the ANB angle affected nasopharyngeal airway size, and that the oropharyngeal space was reduced in subjects with an enlarged ANB angle. Akcam et al. [21] found a decrease in the upper airway dimensions of subjects who had posterior mandibular rotation. Similarly, Ucar et al. [22] reported a decrease in upper airway space with functional anterior shifting. This reveals a close relationship between the upper airway passage and positioning of the jaws. Sample selection criteria were sensitive, and samples were classified as skeletal Class I and Class II, according to the ANB angle.

In our study no statistically significant difference in the lower pharyngeal airways was noted among groups, and no association of the lower pharyngeal airway space was seen with a different vertical growth pattern. This complies with the findings of previous studies [20,23]. According to Jacobson a smaller than average value of the lower pharynx is of little consequence. An obstruction of the lower pharyngeal airway because of a posterior positioning of the tongue against the pharyngeal wall is rare. A greater than average lower pharyngeal width, on the other hand, suggests a possible anterior positioning of the tongue, either as a result of habitual posture or due to tonsillar enlargement.

Joseph et al. [24] reported that the nasopharyngeal airway in hyperdivergent individuals was significantly narrower than that in normodivergent individuals. However, they suggested that this difference occurred because of the relative bimaxillary retrusion exhibited by the hyperdivergent group. Their conclusions were similar to those of the present study, in which we found a smaller nasopharyngeal airway space in high angle subjects when compared with low angle and normal growth subjects. However, selection criteria of the experimental group in the study reported here included no restriction of the sagittal skeletal pattern; only, classification as skeletal Class I and Class II was a requirement based on ANB angle.

The relationship between the upper PAS and the vertical facial pattern might be the result of deficient development of the craniomaxillary complex [5]. In the present study, analysis of the craniofacial skeleton demonstrated that reduced SNA, SNB, and posterior facial height may explain the lack or deficiency in high angle subjects, which may be caused by a decrease in dimensions of the superior part of the upper airway in high angle subjects. Clinically, we assumed that with bialveolar retrusion, the high angle individual may lack airway dimensions.

Significant difference in the ANB angle distribution was noted in the subgroups, so the impact of a different sagittal skeletal pattern on the superior part of the upper airway was taken into consideration because sagittal development of the mandible has a significant effect on the PAS [23,5]. It is necessary to include all subjects with similar sagittal development of the mandible to eliminate any effect on PAS caused by changes in the sagittal plane, while pharyngeal airway dimensions are evaluated among subjects with different vertical growth patterns. Hence while studying the effect of growth pattern it was done within the Class I and Class II samples.

Kerr [25] reported that Class II malocclusion subjects showed narrow nasopharyngeal airway space compared with Class I and normal occlusion subjects. However, in his study, the vertical skeletal pattern was not emphasized. In our study the results do not go in accordance to the previous study. Here the upper airway is wider in Class II subjects than Class 1 however with similar growth patterns also considered in the evaluation which had not been included in the previous study. It is possible that since in the previous study growth pattern was not considered the Class II subjects included could be having a more vertical growth and hence a narrower upper airway.

In the present study, vertical pattern also affected the upper airway space, and greater upper PAS was found in low angle subjects than in high angle subjects.

Although the use of cephalometry in this study can be criticized on some fronts it is still a valid tool for a study of this sort. The faults in cephalometry are also not completely rectified by other methods. Hence the other newer methods are yet to be developed for better precision in diagnosis and lesser discrepancies. Cephalometric radiography, computed tomography (CT) and magnetic resonance imaging (MRI) have been used to study the pharyngeal airway space. Although CT and MRI can provide a three-dimensional assessment, the results of different studies are difficult to compare owing to a lack of standardized protocols defining the thickness, direction and precise location of sections. Cephalometry cannot be applied at a constant head posture, as is also the case for the above two methods, and does not provide information on the transverse dimension of the airway. Cephalometric analysis of the airway does permit precise measurements in a sagittal plane, and has the advantages of convenience, low cost and minimal exposure to radiation [26]. In this study the nasopharyngeal region was selected such that the outline was easy to identify.

5. CONCLUSION

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. Also the upper pharyngeal airway was wider in subjects with same growth pattern but having class II malocclusion than in those having class I malocclusion. The lower pharyngeal airway was not found to correlate with any change in growth patterns or with different malocclusion types. Thus upper airway varies in various growth patterns and skeletal malocclusions as well apart from being affected by the orthodontic treatments.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Nielsen L. Vertical malocclusions: Etiology, development, diagnosis and some aspects

of treatment. Angle Orthod. 1991;61(4): 247–60.

2. Tourne LMP. Growth of the pharynx and its physiologic implications. Am J Orthod Dentofac Orthop. 1991;99(2):129-39.
3. DeFreitas MR, Alcazar NMPV, Janson G, de Freitas KMS, Henriquesa JFC. Upper and lower pharyngeal airways in subjects with Class I and Class II malocclusions and different growth patterns. Am J Orthod Dentofacial Orthop. 2006;130(6):742-5.
4. Ucara FI, Uysalb T. Orofacial airway dimensions in subjects with Class I malocclusion and different growth patterns. Angle Orthod. 2011;81(3):460–8.
5. Zhong Z, Tang Z, Gaoc X, Zeng XL. A comparison study of upper airway among different skeletal craniofacial patterns in nonsnoring Chinese children. Angle Orthod. 2010;80(2):267–74.
6. Ela H, Palomob JM. Airway volume for different dentofacial skeletal patterns. Am J Orthod Dentofacial Orthop. 2011;139(6): e511-e521.
7. Borowiecki BMD, Pollak CP, Weitzman ED, Rakoff S, Imperato J. Fibro-optic study of pharyngeal airway during sleep in patients with hypersomnia obstructive sleep-apnea syndrome. The Laryngoscope 1978;88(8):1310–9.
8. Fredberg JJ, Wohl ME, Glass GM, Dorkin HL. Airway area by acoustic reflections measured at the mouth. Journal of Applied Physiology. 1980;48(5):749-58.
9. Riley R, Guilleminault C, Herran J, Powell N. Cephalometric analyses and flow-volume loops in obstructive sleep apnea patients. Journal of Sleep Research & Sleep Medicine. 1983;6(4):303-11.
10. Rivlin J, Hoffstein V, Kalbfleisch J, McNicholas W, Zamel N, Bryan AC. Upper airway morphology in patients with idiopathic obstructive sleep apnea. American Review of Respiratory Disease. 1984;129(3):355-60.
11. Suratt PM, Dee P, Atkinson RL, Armstrong P, Wilhoit SC. Fluoroscopic and computed tomographic features of the pharyngeal airway in obstructive sleep apnea. American Review of Respiratory Disease. 1983;127(4):487-92.
12. Malkoc S, Usumez S, Nur M, Donaghy CE. Reproducibility of airway dimensions and tongue and hyoid positions on lateral cephalograms. Am J Orthod Dentofacial Orthop. 2005;128:513–5.
13. Aboudara C, Nielsen IB, Huang JC, Maki K, Miller AJ, Hatcher D. Comparison of airway space with conventional lateral headfilms and 3-dimensional reconstruction from cone-beam computed tomography. Am J Orthod Dentofacial Orthop. 2009;135:468–479.
14. Jacobson A, Jacobson R. Radiographic cephalometry from basics to 3-d imaging. 2nd ed. Canada. Quintessence; 2006.
15. Ricketts RM. Respiratory obstruction syndrome. Am J Orthod. 1968;54(7):495-507.
16. Linder-Aronson S Adenoids. Their effect on mode of breathing and nasal airflow and their relationship to characteristics of the facial skeleton and the denition. A biometric, rhino-manometric and cephalometro-radiographic study on children with and without adenoids. Acta Otolaryngol. 1970;265(Suppl):1-32
17. Dunn GF, Green LJ, Cunat JJ. Relationships between variation of mandibular morphology and variation of nasopharyngeal airway size in monozygotic twins. Angle Orthod. 1973;43:129-35.
18. Cheng MC, Enlow DH, Papsidero M, Broadbent BH, Oyen O, Sabat M. Developmental effects of impaired breathing in the face of a growing child. Angle Orthod. 1988;58(4);309-19.
19. Subtenly JD. Oral respiration: Facial maldevelopment and corrective dentofacial orthopaedics. Angle Orthod. 1980;50:147-64.
20. Ceylan I, Oktay H. A study of the pharyngeal size in different skeletal patterns. Am J Orthod Dentofacial Orthop. 1995;108(1):69–75.
21. Akcam MO, Toygar TU, Wada T. Longitudinal investigation of soft palate and nasopharyngeal airway relations in different rotation types. Angle Orthod. 2002;72(6):521-6.
22. Ucar FI, Kurt G, Ekizer A, Ramoglu SI. Effects of functional anterior shifting on skeletal and airway structures. Turkish J Orthod. 2009;22:218-27.
23. Allhaijaa ESA, Al-Khateebb SN. Uvulo-glosso-pharyngeal dimensions in different anteroposterior skeletal patterns. Angle Orthod. 2005;75(6):1012–8.
24. 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 Maxillofac Surg. 1998;56(2):135-9.
25. Kerr WJ. The nasopharynx, face height, and overbite. Angle Orthod. 1985;55:31-6.
26. Muto T, Yamazaki AS. Takeda: A cephalometric evaluation of the pharyngeal airway space in patients with mandibular retrognathia and prognathia, and normal subjects. Int. J. Oral Maxillofac. Surg. 2008;37(3):228–31.

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