Original Article

Comparison between Growth Patterns and Pharyngeal Widths in Different Skeletal Malocclusions in South Indian Population

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ABSTRACT

Aim: The main aim is to determine whether growth pattern had an effect on the upper airway by comparing different craniofacial patterns with pharyngeal widths and its importance during the clinical examination.

Methodology: Sixty lateral cephalograms of patients aged between 16 and 24 years with no pharyngeal pathology or nasal obstruction were selected for the study. These were divided into skeletal Class I (n = 30) and skeletal Class II (n = 30) using ANB angle subdivided into normodivergent, hyperdivergent, and hypodivergent facial patterns based on SN-GoGn angle. McNamara's airway analysis was used to determine the upper- and lower-airway dimensions. One-way ANOVA was used to do the intergroup comparisons and the Tukey's test as the secondary statistical analysis.

Results: Statistically significant difference exists between the upper-airway dimensions in both the skeletal malocclusions with hyperdivergent growth patterns when compared to other growth patterns.

Conclusion: In both the skeletal malocclusions, vertical growers showed a significant decrease in the airway size than the horizontal and normal growers. There is no statistical significance between the lower airway and craniofacial growth pattern.

KEYWORDS: *Lower pharyngeal width, McNamara analysis, upper pharyngeal width*

INTRODUCTION

The effects of pharyngeal airway obstruction on the dentofacial patterns have its own landmark in the craniofacial biology since the time of E.H. Angle.[1] Pharynx is divided into three parts, i.e. oropharynx, nasopharynx, and laryngopharynx. Oropharynx and nasopharynx play a major role in the deglutition and respiration, respectively. From the literature, it has been proposed that the dimensions of oropharynx and nasopharynx may get varied with craniofacial growth or by functional appliance therapy.[2]

Previously, many clinicians and researchers involved in treating the dentofacial deformities tried to sort out the facial morphology determinants. The close interaction between the pharyngeal space and dentofacial pattern had a controversial debate in the literature.[3] There were two conflicting opinions – one opinion was breathing pattern as an etiological factor for vertical malocclusion and the other opinion was that the vertical malocclusions have an inherited pattern and oropharyngeal airway patency acts as an aggravating factor for vertical growth. The most accepted view can be explained by functional matrix hypothesis which states that relative size of soft tissues surrounding the skeleton determines the pharyngeal size.[3] However, there is an evidence from previous studies[4,5] that altered upper airway during the active growth may be the etiological factor for the vertical malocclusions. In contrast, various craniofacial anomalies such as short mandibular bodies in Class II, narrow and short maxillae,

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downward rotation of jaws, and high-vault palate cases were associated with reduced pharyngeal space.[6] From these studies, the important unanswered question is that which occurs first.

Previous studies[3,4] revealed that there is a significant relationship between the pharyngeal space and both dentofacial and craniofacial structures at varying degrees. A study by Mergen and Jacob[7] revealed that size of pharyngeal airway is greater in the normal occlusion patients than in the patients with distal occlusion. Kirjavainen and Kirjavainen[8] in their study on children concluded that Class II malocclusion has a narrower pharyngeal airway compared to that of the Class I participants. However, a study by Aboudara *et al*.[5] reported that there is no correlation between the dentofacial pattern and the pharyngeal airway.

Some authors have concluded that severe changes in the upper airway may lead to obstructive sleep apnea and Class II malocclusion, and others have reported that there is a strong relation between the vertical growth pattern and pharyngeal airway obstruction concurrently occurring with mouth breathing, loud snoring, excessive daytime sleepiness, and even cor pulmonale.[8,9] To maintain the patency of airway, the mandible will rotate backward and downward and the tongue will get lowered in the oral cavity which are responsible for the changes in the dentofacial skeletal patterns.[10] Many of these studies were aimed to prove that pharyngeal airway reduction affects the growth pattern. Only few studies determine the effect of growth pattern on the pharyngeal space, and the paucity of literature warrants this study.

One such recent study was by Iqbal *et al*.[3] at Peshawar, Pakistan, proved that the vertical growers have reduced pharyngeal space than the normal growers. Hence, it is important to incorporate the pharyngeal airway assessment in the diagnosis as it has its own importance in the functional, positional, and structural assessments of dentofacial patterns. Therefore, the purpose for this study is to compare different growth patterns with the upper and lower pharyngeal airway and to determine whether the growth pattern is a contributing factor for the upper-airway changes.

Methodology

Sixty pretreatment standard lateral cephalograms between 16 and 24 years' age group were collected from the department of orthodontics and dentofacial orthopedics. The radiographs for this retrospective study were randomly collected from the department between 2016 and 2017. This is a radiographic study, and already existing records were collected from the available records. Institutional review board clearance was obtained with the reference number CKST/IECC/ORT/2016 dated January 19, 2016.

The sample size in this study was determined after doing a pilot study on 18 cephalograms. Taking into consideration the statistical power of 80% and the confidence level of the 90th percentile, a minimum of 10 cephalograms was required in each subgroup to attain statistical significance. The exclusion criteria include skeletal Class III malocclusions, craniofacial syndromes, congenital deformities, and previous surgeries for pharyngeal pathologies.

A 0.3-mm lead pencil was used to trace the lateral cephalograms on 0.003-inch acetate paper and various landmarks were identified. Based on the A-Nasion-point B (ANB) angle and the Steiner's mandibular plane angle, grouping was carried out as shown in Figure 1. Based on ANB angle, participants were divided into skeletal Class I (0°–4°) and Class II (>4°). The sample is divided into hypodivergent, normodivergent, and hyperdivergent facial patterns if SN-GoGn angle is <32°, 33°–37°, and >38°, respectively.

McNamara's airway analysis was used to measure the upper and lower pharyngeal airway as shown in Figure 2. The upper pharyngeal width was measured from the point on the posterior outline of the soft palate to the closest point on the distal wall of pharynx. The width of the upper airway measures around 15 mm–20 mm, whereas reduction by 2 mm or more indicates the impairment of the upper airway. The lower airway was measured from the point of intersection of the distal portion of the tongue and the lower border of the mandible to the nearest point on the distal wall of pharynx, and it is approximately 11 mm–14 mm irrespective of the age.

Statistical analysis

The means and standard deviations were calculated for the upper and lower airways. One-way ANOVA was used to do the inter-group comparison, and there existed a statistical significance for the upper pharyngeal airway. Student *t*-test has been used to find the significance of study parameters on continuous scale within each group. *Post hoc* Tukey's test has been used to find the pairwise significance.

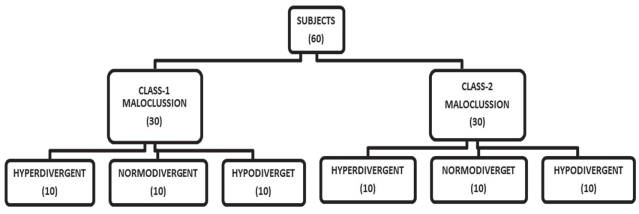

Figure 1: Classification of sample size

Results

When comparing the upper airway among different growth patterns in both the Class I and Class II groups, hyperdivergent groups exhibited lesser values compared to normodivergent and the hypodivergent subgroups. Tables 1 and 2 unveiled statistical significant reduction in the upper airway when the subgroups were compared with one-way ANOVA. In Tables 3 and 4, when *post hoc* Tukey's test was performed for pairwise comparisons among different growth patterns in skeletal Class I and II participants individually, vertical growers exhibited statistically significant narrowing of the upper airway, whereas in the normal and horizontal growers, there was no greater difference for the upper airway in either Class I or Class II participants. There was no statistical difference when the lower airway was analyzed in different growth patterns in both Class I and Class II cases.

Discussion

Normal nasal breathing patency depends on the sufficient size of the nasopharynx, and it had a key role in the craniofacial growth. Craniofacial growth is complex and multifactorial in nature. The relationship between the airway patency and craniofacial growth is highly controversial in literature, and it had its influence on orthodontist decision in the clinical diagnosis and treatment planning.[3,6]

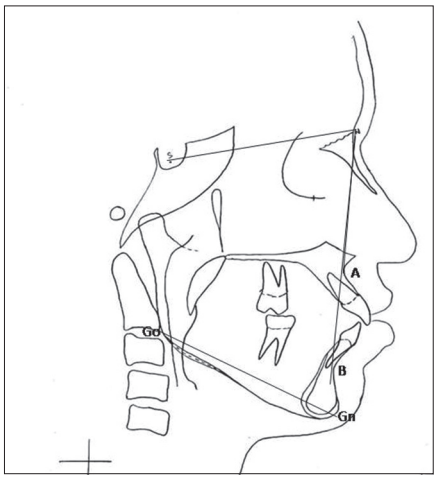

Figure 2: Cephalometric tracing

In the present study, comparison of the upper and lower airway using McNamara analysis was carried out in different growth patterns in both Class I and Class II and found that there is significant narrowing of the upper airway in hyperdivergent cases in both Class I and Class II malocclusions than in normodivergent cases which is in support with the recent study by Iqbal *et al*.[3] In this study, hypodivergent cases exhibited greater upper-airway dimensions compared to the hyperdivergent cases which is in correlation with the de Freitas *et al*.[11] study which concluded that increase in the divergence increases the narrowing of airway. Similarly, Ucar and Uysal[3] study states that statistical significance exists between the high- and normal-angle cases for the upper airway and tongue space, but no significance exists with respect to the lower airway which suggests that divergence affect the upper-airway dimensions.

However, some studies concluded that there exists a weak relationship between the growth pattern, facial morphology, and nasopharyngeal airway.[12,13] Gwynne-Evans[12] concluded that facial growth is not influenced by airway patency. Leech[13] in his study on 500 mouth breathing patients concluded that 60% of patients were Class I and commented that oral breathing had no effect on the growth pattern. This might be due to evaluating the influence of the nasopharyngeal airway on facial form and occlusion which is reversal of the present study indicating the growth pattern as the contributing factor for the pharyngeal airway changes.

Ceylan and Oktay[9] in their study reported that there exists a positive relation between the upper airway and the ANB angle which is in agreement with the

Table 1: Upper- and lower-airway comparison in Class I participants with different growth patterns

	Mean±SD			*P*
	Normodivergent (*n*=10)	Hypodivergent (*n*=10)	Hyperdivergent (*n*=10)	
Upper airway (mm)	12.1	12.5	10.62	0.02
Lower airway (mm)	8.94	9.96	8.52	0.3

Level of significance 0.05; One-way ANOVA test. SD=Standard deviation

Table 2: Upper- and lower-airway comparison in Class II participants with different growth patterns

	Mean±SD			*P*
	Normodivergent (*n*=10)	Hypodivergent (*n*=10)	Hyperdivergent (*n*=10)	
Upper airway (mm)	12.02±3.1952	12.6±4.395	10.6±3.291	0.02
Lower airway (mm)	9.8±2.8	9.3±3.8	8.62±3.81	0.6

Level of significance 0.05; One-way ANOVA test. SD=Standard deviation

Table 3: Pairwise comparison of different growth patterns in Class I participants

Pharyngeal airway	Vertical patterns	Mean difference	*P*
Upper airway	Hyperdivergent and hypodivergent	−2.2	0.045
	Hyperdivergent and normodivergent	−1.5	0.066
	Hypodivergent and normodivergent	0.7	0.91
Lower airway	Hyperdivergent and hypodivergent	−1.5	0.52
	Hyperdivergent and normodivergent	−0.4	0.92
	Hypodivergent and normodivergent	1.0	0.73

n=30; **P*<0.05; Tukey's test

Table 4: Pairwise comparison of different growth patterns in Class II participants

Pharyngeal airway	Vertical patterns	Mean difference	*P*
Upper airway	Hyperdivergent and hypodivergent	−1.4	0.062
	Hyperdivergent and normodivergent	0.4	0.096
	Hypodivergent and normodivergent	1.8	0.46
Lower airway	Hyperdivergent and hypodivergent	1.5	0.6
	Hyperdivergent and normodivergent	−0.2	0.99
	Hypodivergent and normodivergent	−1.7	0.53

n=30; **P*<0.05; Tukey's test

present study. This can be explained with the Balters philosophy[14] which states that Class II malocclusions have the following predisposing factors such as backward position of the tongue that disturbs the cervical region which in turn reduces the airway dimension, whereas Class III malocclusions are due to forward positioning of the tongue and result in greater airway dimensions. As the airway is least affected in Class III malocclusions, they were not included in the study.

Postpubertal participants were selected in the present study to eliminate the effect of growth and aging. Lymphoid tissues vary significantly during the growth, but after puberty, their size reaches near to normal and the upper airway measured here is from the posterior wall of the palate to the posterior pharyngeal wall which is below the adenoid tissue level. This eliminated the most common cause of nasal obstruction, i.e., the adenoid hypertrophy.[15]

The two possible limitations of the study include retrospective nature and the use of two-dimensional lateral cephalograms. As the study is retrospective in nature, only healthy individuals were included in the study, and the results interpreted only the natural anatomic variations that were present, but no pharyngeal pathology was considered. Although previous studies[2,16] showed that weak correlation existed between the sagittal linear measurements on the lateral cephalogram and cross-sectional area measurements in CBCT which is more appropriate for the measurement of airway patency, a recent systematic review[17] suggested that no ideal diagnostic tool exists to reliably screen the airway patency and adenoid hypertrophy. More research is required to suggest a diagnostic tool which is more reliable, low risk, and highly acceptable.

Despite the limitations, the findings in the present suggest that careful diagnosis of airway patency is required during orthodontic, orthopedic, and orthognathic treatments to prevent the reduction in the upper airway and even it should help to increase it, especially in vertical growers. Although there is a paucity of literature regarding growth pattern as a contributing factor to reduction of the upper-airway dimensions as suggested by this study, further research with a larger sample size in various anteroposterior (Class I, Class II, and Class III) and in different growth patterns will be more appropriate to support the findings of this study.

Conclusion

1. In both the skeletal malocclusions, vertical growers showed a significant decrease in the airway size than the horizontal and normal growers, indicating that growth pattern affect the upper-airway size
2. There is no statistical significance between the lower airway and craniofacial growth pattern.

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Conflicts of interest

There are no conflicts of interest.

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