ORIGINAL ARTICLE

Pediatric Obstructive Sleep Apnea vs Adult Obstructive Sleep Apnea: An Orthodontic Perspective

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Abstract

Introduction: The literature evidence currently available shows a significant shift toward orthodontics and the orthodontist for management of obstructive sleep apnea (OSA). Individuals with narrow airways and/or craniofacial anomalies may have an increased risk for OSA/hypopnea syndrome, and identification of these at an early stage quite often is done by the orthodontist. The management approach to pediatric OSA is diametrically different than that of adult OSA. This study was performed to determine the upper pharyngeal airway (UPA) space and the lower pharyngeal airway (LPA) space in children of South Indian origin and establish a correlation between airway measurements and growth patterns, if any.

Materials and methods: Lateral cephalometric radiographs of 100 medically fit children less than 12–13 years were assessed. The cephalograms were digitally analyzed using Facad and categorized into three growth patterns. McNamara airway analysis was used to measure the UPA and LPA space. Obtained results were subject to statistical analysis.

Results: Of total 100 subjects, 33 were in group I [horizontal growth pattern (HGP)], 30 in group II [average growth pattern (AGP)], and 37 in group III [vertical growth pattern (VGP)]. There was a significant reduction in both UPA and LPA dimensions in hyperdivergent or vertical growers: 9.56 ± 0.54 mm and 9.03 ± 1.67 mm, respectively. An odd's ratio of 1.18 was obtained, suggestive of good correlation between Frankfurt mandibular plane angle (FMA) and airway measurements.

Conclusion: The impact of OSA on the growth and development of a child may have detrimental effects on health, neuropsychological development, quality of life, and economic potential; therefore, OSA in children should be recognized as a public health problem as in the adult population.

Clinical significance: Results of this study clearly indicate that there is strong correlation between the pharyngeal space and type of growth pattern in children of South Indian origin.

Keywords: Growth patterns, Lower pharyngeal airway, Mandibular protraction appliance, Maxillary constriction, Pediatric obstructive sleep apnea, Rapid maxillary expansion, Upper pharyngeal airway.

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Introduction

The orthodontist has a specific role in the diagnosis and management of obstructive sleep apnea (OSA) with a plethora of diagnostic and treatment modalities available. There is a lot of debate regarding a gold standard of diagnosis for children with OSA as there are many etiological factors ranging from genetic inheritance[1] and combinations of anatomical and pathophysiology factors. Diagnosis and management of pediatric OSA should be given significant importance because of its adverse effects especially on growth and overall development of an individual.

Currently, there is substantial evidence[2] that craniofacial abnormalities occur commonly in OSA patients, and it is thought that these abnormalities predispose to OSA through an adverse effect on upper airway dimensions. The more commonly identified abnormalities include mandibular deficiency, an inferiorly placed hyoid bone relative to the mandibular plane, a narrowed posterior air space, a greater flexion of the cranial base, and elongation of the soft palate. A number of observations suggest that maxillary constriction may also play a role in the pathophysiology of OSA.[3]

Maxillary constriction is a term used by orthodontists to describe a maxilla that is narrow in the lateral dimension relative to other facial bones, particularly the mandible. It is known that subjects with maxillary constriction have increased nasal resistance, and resultant mouth breathing, features typically seen in OSA patients.[4] Maxillary constriction is also associated with low tongue posture, which could result in retroglossal airway narrowing, another feature of OSA. Marfan's syndrome patients characteristically have a high-arched palate with maxillary constriction and are known to have a high prevalence of OSA, and the degree of sleep apnea correlates with maxillary measurements. Similarly, maxillary intermolar distance is a component of a recently reported morphometric model for the prediction of OSA[5] and clinically evident maxillary constriction is common in the typical OSA patient. Because individuals with narrow airways and/or craniofacial anomalies may have increased risk for OSA/hypopnea syndrome, orthodontics can play an important role in the identification and possible treatment of such patients.

The literature available for standard airway widths in adult population is extensive; yet, there exists a lacunae in relation

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to pediatric airway dimensions. This study was performed to determine the upper and lower pharyngeal airway (UPA and LPA) space in children of South Indian origin and establish a correlation between airway measurements and growth patterns, if any.

Materials and Methods

Lateral cephalometric radiographs of 100 medically fit children less than 12–13 years were assessed. Inclusion criteria included the presence of a full complement of teeth excluding the third molars, no history of dental treatments involving arch expansion, orthodontic and orthopedic corrections, no history of respiratory ailments, and breathing difficulties and injuries. Lateral cephalograms were taken in natural head position (NHP) subjects, which is the standardized and reproducible position of the head in an upright posture, when the subject is looking at a distant point at eye level and provides the key for meaningful cephalometric analysis.[6] Lateral cephalograms taken with aberrant head position, without occlusion, missing scales, and extensive magnification errors were excluded. Patients who have already undergone a phase of interceptive orthodontic/orthopedic treatment, a BMI of greater than 24.9, and with underlying pathologies like asthma, obstructive adenoids, and habitual mouth breathers were excluded. The obtained lateral cephalograms were subject to scrutiny and only those that met the abovementioned criteria were included in the study.

The cephalograms were digitally analyzed using Facad, a software program developed by Ilexis AB, Linköping, Sweden (Fig. 1), and categorized into three growth patterns, average growers (average facial height), horizontal growers (short face), and vertical growers (long face) based on the Frankfort mandibular plane angle (FMA).[7] An FMA of 25 ± 3° is considered within normal range and categorized as average growers. An FMA angle below 22° was considered horizontal growers and above 28° was considered vertical growers. Furthermore, upper and lower airway measurements were taken. The McNamara airway analysis was used to measure the UPA and LPA.[8,9] Upper pharyngeal width was measured from a point on the posterior outline of the soft palate to the closest point on the posterior pharyngeal wall. Lower pharyngeal width was measured from the intersection of the posterior border of the tongue and the inferior border of the mandible to the closest point on the posterior pharyngeal wall. Parameters measured were the following (Fig. 2):

- Frankfurt mandibular angle (°)
- Upper airway space (mm)
- Lower airway space (mm)

The obtained results were subject to statistical analysis using the IBM SPSS software, v.20; one-way ANOVA tests were used to calculate the airway measurements among the three groups and the odd's ratio was calculated to establish a correlation between the airway dimensions and growth pattern of the individual.

Results

The cephalograms were digitally analyzed and categorized into average growers, vertical growers, and horizontal growers. The FMA values of less than 22° were grouped as horizontal growers/hypodivergent, values lying between 22° and 28° were grouped under the category of average growers/normodivergent, and values greater than 28° were assigned to the category of vertical growers/hyperdivergent. Of total 100 subjects assessed, 33 were in group I [horizontal growth pattern (HGP)], 30 in group II [average growth pattern (AGP)] and 37 in group III [vertical growth pattern (VGP)]

In each group, means and standard deviations of UPA and LPA spaces for the sample were determined. The comparison was done among various facial patterns for growing/pediatric subjects. The values obtained for UPA and LPA spaces in all three groups are

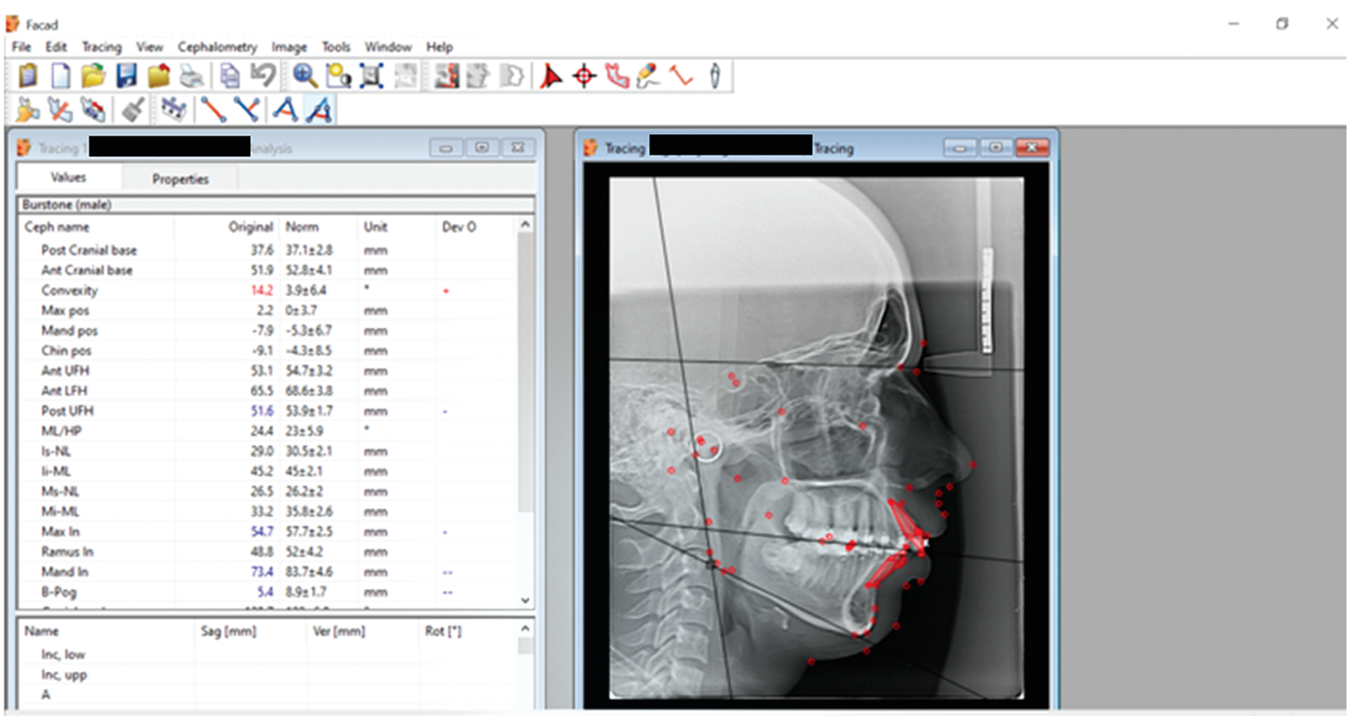

Fig. 1: Digital cephalometric analysis, Facad, Ilexis AB, Linköping, Sweden

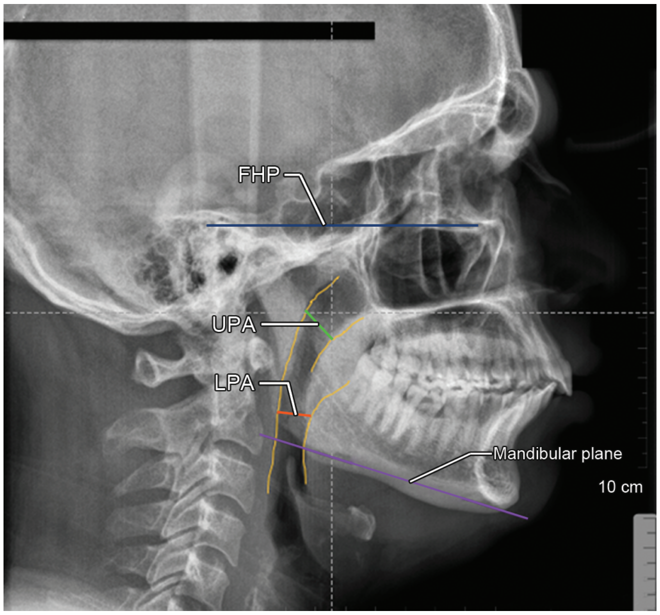

Fig. 2: Lateral cephalogram showing following landmarks: Frankfort horizontal plane (FHP), mandibular plane; upper pharyngeal airway (UPA) (linear), lower pharyngeal airway (LPA) (linear)

Table 1: Upper pharyngeal airway measurements (mm) among the three groups

Group	*Mean*	*SD*
I	11.12	2.42
II	12.21	1.78
III	9.56	0.54

I, hypodivergent; II, normodivergent; III, hyperdivergent; *p* value: 0.00; level of significance = 0.005; *F* value: 0.22; One-way ANOVA—UPA measurements

Table 2: Lower pharyngeal airway measurements (mm) among the three groups

Group	*Mean*	*SD*
I	10.12	2.45
II	11.32	2.09
III	9.03	1.67

I, hypodivergent; II, normodivergent; III, hyperdivergent; *p* value: 0.00; level of significance = 0.005; *F* value: 1.12; One-way ANOVA—LPA measurements

described in Tables 1 and 2. A one-way ANOVA revealed that there were statistically significant narrow upper and lower pharyngeal airway widths found in the hyperdivergent facial pattern subjects when compared to normodivergent and hypodivergent facial pattern, 9.56 ± 0.54 mm and 9.03 ± 1.67 mm, respectively. The UPA width between normodivergent and hypodivergent facial patterns showed no significant statistical difference. Similarly, in LPA widths, no significant intergroup difference was found between the normal and horizontal growth patterns.

The odds ratio is a measure of association between exposure and an outcome. In this study, it is the ratio of the odds of constricted airways in hyperdivergent facial patterns divided by the odds of constricted airways in normodivergent facial patterns. An odds ratio of 1.18 was obtained, which was suggestive of good correlation between FMA and airway measurements.

Discussion

The orthodontist has a major role to play in the diagnosis and treatment of OSA especially in the case of young growing children. One can very well say that the orthodontist could be the first line of defense in diagnosing a patient with OSA and to prevent the progression of the disease. Even though evaluation of the upper airway using lateral cephalogram is somewhat limited as they provide two-dimensional images of the complex three-dimensional structures of the nasopharynx, subjecting growing children to excess radiation is surely not recommended. The potential health hazards of ionizing radiation in younger subjects are higher than the elderly, and patients under 10 years have six times more risk when compared to the 30–50 years age group.[10] International guidelines have also embraced the as low as reasonably achievable (ALARA) principle while exposing a patient to radiation.

Measurements made from a lateral cephalogram are significantly reliable and reproducible in determining the pharyngeal airway dimensions and position of the tongue and hyoid bone.[11]

Therefore, this study to measure the airway patency was done on a 2D lateral cephalogram, which is taken as a routine essential diagnostic aid before the start of every orthodontic treatment.

Results of the study showed that there was a significant reduction in both UPA and LPA dimensions in hyperdivergent or vertical growers: 9.56 ± 0.54 mm and 9.03 ± 1.67 mm, respectively. This is in concordance with previous studies[12] indicating that a backward and downward rotation of the mandible restricts the airway and reduces its potency leading to development of OSA and OSA-like symptoms in pediatric patients. If not identified at an early stage, these could manifest as adult OSA as the child grows.

The key role of an orthodontist in management of pediatric OSA is often of an interceptive nature with the focus on alleviating the apnea/hypopnea index. It is imperative to remember that abnormal nasal resistance results in a lowered tongue posture and increased buccinator muscle activity resulting in maxillary arch width constriction.[13] Abnormal nasal interference will have an impact not only on the maxilla but also on the mandible. Management of a constricted maxilla in pediatric patients can be performed with an orthopedic appliance called the rapid maxillary expander (RME), which corrects the faulty tongue position. However, despite a change in tongue position with RME, the gain may not be sufficient. The width of the mandible should be considered when RME is performed, as upper and lower teeth must be in apposition. Combined treatment on the maxilla and mandible[14,15] in very young patients with signs and symptoms of OSA, palatal expanders that deliver less forces, termed as tooth-borne slow expanders, are advisable and more physiological in nature. Maxillary expansion would be very helpful for patients with septal deviation, a problem that is often congenital and perhaps genetically determined. Septal surgery is not indicated in children, but abnormal nasal resistance can lead to maxillary deficiency early in life, and both problems may be addressed with maxillary expansion.[5] Maxillary expansion and mandibular advancement are preferred modalities along with the adjunct use of fixed functional appliances or mandible protraction devices like Herbst appliance[16] and oral elastic mandibular appliances.[17] Literature evidence suggests that in RME there is an increase in oral volume directly via expansion of the maxillary dental arch[3] and also through concomitant release of the mandible, which may have been locked within the constricted maxillary arch. Likewise, in retroposition and retruded mandibles, a forwardly positioning appliance in terms of an MPA[18] has shown to reduce the pressure on the upper airway while in the supine position and improve airway patency simultaneously. The incidence of pediatric OSA patients is on the rise associated with change in lifestyle and food habits. Pediatric OSA patients should be considered as a separate and independent entity when compared to adult OSA with regard to diagnosis and treatment planning.

Conclusion

The impact of OSA on the growth and development of the child may have detrimental effects on health, neuropsychological development, and the overall quality of life. Obstructive sleep apnea in children should be recognized as a public health problem as in the adult population and methods to predict the onset of OSA in children should be of prime importance. Deriving average measurements of the pharyngeal space in children and correlating it with their growth patterns would help in the predictability of OSA.

Clinical Significance

Results of this study clearly indicate that there is strong correlation between the pharyngeal space and type of growth pattern in children of South Indian origin. There was a statistically significant narrow upper pharyngeal airway width found in the hyperdivergent facial pattern subjects when compared to normodivergent and hypodivergent facial patterns.

Limitations

The present study is of a small group of subjects and hence cannot be applied as a standard norm for entirety of population—but can be used as a guide for development of further well-designed studies with a larger sample.

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