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Pharyngeal Airway Dimensions and Its Impact on Growing Children - An Overview

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ABSTRACT

A healthy and patent airway is the foundation for ideal health at any age. Obliteration of the dimensions of nasopharyngeal and oropharyngeal airway alter individual's breathing pattern that can lead to disturbances in normal growth. This eventually leads to malocclusion by muscular and postural alteration of the tongue and mandible and also by creating imbalance of forces exerted by orofacial musculature and tongue. This also affects the normal life and cognitive development in a growing child by the different systemic and local ill effects. .The management of problems associated with airway in children need to be done by a multidisciplinary team based approach depending on the age of the patient because interception done at the earliest will give a fruitful result. Pediatric dentists should work as a team with the pediatricians and ENT to refer the patients at an early age on detection of potential problems.

Keywords: Pharyngeal airway dimensions, malocclusion, multidisciplinary approach, Early detection

INTRODUCTION

A healthy and patent airway is the foundation for ideal health at any age. For optimal airflow, sufficient anatomic dimensions of the airway are mandatory. This airway plays an important role in growth of the craniofacial structures. The dimension of the pharyngeal airway depends on many factors including ethnic variations [1-2]. Research on South Indian (Tamil Nadu) children in the age group 8-12 years showed that the mean value of UPA(Upper pharyngeal airway) in the age group of 8-10 years is 11.764 ± 3.061mm and that among the children of age group 11-12 years as 12.617 ± 3.4524 mm. The mean value of LPA (Lower pharyngeal airway) in 8-10 years children is seen as 8.248 ± 2.7309 mm and that among children of age group 11-12 years is 9.627 ± 2.5752 mm [3]. In the study among Chinese children in the age group 11-16 years the mean value of UPA was seen to be 12.6 ± 3.25 mm and the mean value of LPA being 11.7± 3.73 mm [4] . In 6-17 years children of Caucasian ethnicity the mean value of distance p (shortest distance between the soft palate and posterior pharyngeal wall) is seen to be 8.12 mm - 9.15 mm and that of distance t (shortest distance between the tongue and posterior pharyngeal wall) is 10.61- 11.19 mm [5].

Obliteration of the dimensions of nasopharyngeal and oropharyngeal airway alter individual's breathing pattern that can lead to disturbances in normal growth. This eventually leads to malocclusion by muscular and postural alteration of the tongue and mandible and also by creating imbalance of forces exerted by orofacial musculature and tongue. Obstruction of the upper airway may occur due to hypertrophy of the adenoids and tonsils, chronic and allergic rhinitis, constriction from asthma,

environmental factors, infections, nasal trauma, polyps, fat deposits or poorly toned musculatures. Sleep disordered breathing (SDB) refers to the occurrence or repetitive episodes of complete or partial obstruction of the upper airway during sleep, usually in association with loud snoring and daytime sleepiness. Risk factors associated can be upper or lower respiratory problems, obesity, race etc. SDB can present itself in a variety of symptoms that can be easily ignored, misdiagnosed, and most often left untreated [6,7]. The symptoms associated with SDB can include mouth breathing, loud snoring and fatigue can point to serious underlying health issues and the need for treatment. The central issue for many children suffering from the effects of SDB or Obstructive Sleep Apnea (OSA) is a compromised airway. When a child's airway is constricted, underdeveloped or blocked in any way, the child struggles to obtain enough oxygen during the night, wake-up or change position to breathe, causing disrupted sleep of poor quality. This viscious cycle ultimately leads to mouth breathing and an open mouth posture during the day making the situation worse [7,8].

Thus an altered dimension of the pharyngeal airway negatively impacts the child in the growing stage and also affects the society and family as a whole.

EFFECTS OF AIRWAY OBSTRUCTION

- **LOCAL EFFECTS**

Any obstacle in the respiratory system forces the patient to breathe through the mouth. Due to mouth breathing, the lips become incompetent and the mandible is lowered, tongue takes a lower position reducing the support of the palate and maxillary arch. This results in altered forces affecting the craniofacial structures and their position, specially the position of the mandible in relation to the craniofacial base. Mouth breathing, caused by an obstruction of the upper airway can result in enlarged tonsils and adenoids, bruxism causing wear and fracture of teeth, temporo-mandibular disorder of the jaw joints, myofascial pain, erosion of the teeth, malocclusion, periodontal disease, caries and impacted teeth. Craniofacial abnormalities such as mandibular deficiency, bimaxillary retrusion, steep occlusal plane, increased mandibular plane angle, open-bite, cross-bite, excessive anterior face height, incompetent lip posture, excessive appearance of maxillary anterior teeth, narrow external nares, "V" shaped maxillary arch. etc are also associated with narrowing of the pharyngeal airway passage [9-11].

- **SYSTEMIC EFFECTS**

An obstructive airway disease like asthma and allergic rhinitis affects the quality of sleep in children and frequently leads to day-time fatigue as well as sleepiness. It is also thought to be a risk factor for sleep disordered breathing. SDB, that can range from snoring to Obstructive Sleep Apnea, is a vicious cycle and leads to symptoms such as: Swollen tonsils and adenoids, frequent ear and upper respiratory infections, bed wetting , severe allergies, asthma, digestive issues ,disrupted sleep pattern, delayed growth, depression ,headache, ADHD like behavior, cognitive and learning issues, poor memory and ability to focus ,aggression and socialization issues ,type II diabetes ,Cardiovascular diseases which affects the quality of life in a growing child [8,9,12]. Allergic rhinitis results in increased school absenteeism and distraction during class hours. These children are often embarrassed in school and have decreased social interaction which significantly hampers the process of learning and school performance. All these aspects upset the family too. Several other co-morbidities like sinusitis, asthma, conjunctivitis, eczema, eustachian tube dysfunction and otitis media are generally associated with AR [13,14]. These mostly remain undiagnosed and untreated adding to the morbidity.

Considering the ill effects of decreased airway dimensions, early and prompt diagnosis of the potential problem needs to be done to provide early intervention to this grave yet neglected area.

DIFFERENT METHODS OF ASSESSMENT OF POTENTIAL AIRWAY PROBLEMS IN CHILDREN

Upper airway assessment is considered important for orthodontists, pediatric dentists, ENT specialists, speech therapists, etc., because of its close relation with the development of craniofacial structures and with associated pathologies. Thus by recording a proper history and examination of a child we can diagnose the presence of any risk factors which can further be evaluated by different modalities and referral to other specialities like Pediatricians or ENT [15].

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During the examination there should be an evaluation of facial form and symmetry, an examination of the nose, the tonsils and adenoids, the tongue, the teeth, and the soft and hard palates to diagnose any form of malocclusion and presence of mouth breathing. Bottle-feeding, weaning to soft foods, thumb sucking, pacifier use and mouth breathing are the main causes of poor facial development. Poor facial development and asymmetry are two of the most easily identified signs of airway dysfunction.

The different imaging techniques to assess the airway include: nasal endoscopy, rhinomanometry, acoustic rhinomanometry, cephalometry, computed tomography (CT), magnetic resonance imaging (MRI) and cone-beam computed tomography (CBCT). Cephalometry provides a two dimensional reconstruction of three-dimensional structures, so the information provided is often considered limited. The CBCT shows 3D structures, the construction of projections on different plane allowing us to measure the volume of different structures, hence it provides a large amount of diagnostic information. However, it is not a routine examination procedure as it involves a larger radiation dose, specially in children. In systematic reviews, lateral cephalometry has been found to be a reliable initial screening tool of upper airway obstruction to determine the need for more in-depth ENT follow-up. Its validity has been tested using three- dimensional computed tomography (CT) and magnetic resonance imaging (MRI). Cephalometry is one of the most commonly used methods in dentistry due to its low cost, convenience, minimal exposure to radiation as well as being able to simultaneously analyze head position, craniofacial morphology and the dimensions of the pharyngeal airway [15,16]. **Kirsi Pirila¨-Parkkinen el al. in 2011, Sunil Kumar et al. in 2019** conducted studies confirming the reliability of Lateral Cephalometric radiographs over different other imaging techniques in measurement of pharyngeal airway dimensions [17,18].

It is imperative that healthcare professionals use a strong team-based approach to manage all aspects of the patients with compromised airways. As pediatric dentists we must focus on the importance of a healthy airway in children, thus providing a holistic approach to dental treatment. In this aspect the role of preventive and interceptive orthodontics should be understood.

MANAGEMENT OF AIRWAY OBSTRUCTION IN CHILDREN

The management of problems associated with airway in children need to be done by a multidisciplinary team based approach depending on the age of the patient because interception done at the earliest will give a fruitful result.

Significant component of craniofacial development occurs in the first 4 years of life. Ninety percent of craniofacial development is complete by the age of 12 years; therefore, it can be concluded that features that put adults at risk of obstructive sleep apnea (OSA) or SDB are probably present as early as 12 years of age. An important factor involved in the proper development of the maxilla at a very early age is breastfeeding. Breastfeeding is an important orofacial exercise required for stimulating maxillary expansion which aids in achieving normal tongue posture and propels mandibular growth, proper swallowing pattern is seen in breastfed children and is crucial for optimum craniofacial development. Tongue thrust is likely to develop in bottle fed children. Importance of breastfeeding should also be seen in light of its effects on craniofacial development and prevention of SDB [19].

Oropharyngeal exercises are new, non-invasive, cost effective treatment modality for the treatment of mild to moderate obstructive sleep apnoea. It acts by increasing the tone of pharyngeal muscles, is more physiological, and effects are long lasting. Graded oropharyngeal exercise therapy increases the compliance and also reduces the severity of mild to moderate OSAS. The oropharyngeal exercises target soft palate elevation that recruits several upper airway muscles such as the tensor and levator veli palatini, as well as muscle fibers of the palatopharyngeal and palatoglossus muscles, tongue repositioning, and training of mandibular elevation to avoid mouth opening.

Airway focused orthodontics is a newer concept which rules over everything else in contemporary orthodontics. The philosophy mainly stresses on practice of clinical orthodontics aimed at obtaining ideal jaw relationship, establish normal oral function and performance, optimal proximal and occlusal

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contact of teeth. Ideal facial development is dependent on correct tongue posture and nasal breathing. Therefore, present day protocols, whether preventive, interceptive, or corrective orthodontics should aim to achieve upper airway improvement in addition to focusing on betterment of smile and facial esthetics [20,21].

Adenotonsillar enlargement is one of the most prevalent causes of airway obstruction in children leading to compromised breathing and altered craniofacial development. Obstruction in the nasopharyngeal airway promotes oral breathing which is a sign of impending OSA. Adenotonsillectomy often improves nasal breathing, quality of sleep, and enhancement in delta sleep which increases growth hormone secretion influencing craniofacial growth. Recently, the role of adenotonsillectomy combined with RME is considered the best sequence of treatment and was evaluated in prepubertal children who had OSA and adenotonsillar hypertrophy. In majority of such patients, both therapeutic approaches were required to resolve OSA, and the order of treatment does not appear to be significant. Another landmark study by Pirelli *et al*. in 31 children with narrow maxillae and the absence of adenotonsillar hypertrophy suggested a complete resolution of SDB with the use of RME in 6–12 months. These studies suggest an important role of RME in the treatment of OSA in children. Mandibular deficiencies in growing children are best addressed by functional orthopedic appliances such as activator, bionator, and twin blocks. The functional appliances correct mandibular deficiency by growth modification improves tongue posture and optimizes spatial maxillomandibular relationship. The effect of functional appliances on oropharyngeal airway dimensions has been assessed by Ozbek *et al*. more than a decade back. They found that these appliances significantly increase the airway space at oropharyngeal and nasopharyngeal levels. Myofunctional orthodontics help address and correct the different damaging oral habits and problems that may cause mouth breathing and other cranio facial abnormalities and help correct the poor airway development that occurs early in life [21] .

Thus it is important to acknowledge the importance of orthodontic treatment earlier in life by promoting breastfeeding, habit breaking therapy, RME, and functional jaw orthopedics. Maxillomandibular advancement surgeries are known to enhance the upper airway dimensions in addition to improving dentofacial esthetics drastically.

CONCLUSION

We can understand by this review how a healthy airway is the foundation for optimal health in children and any treatment should not only be focused on teeth but improving the general health in a child. The overall wellness of a child should be taken care of while we assess the oral health of the individual by imparting proper knowledge to the parents about the risk and benefits of early treatment. Pediatric dentists should work as a team with the pediatricians and ENT to refer the patients at an early age on detection of potential problems. As rightly said-

"Breathing affects your respiratory, cardiovascular, neurological, gastrointestinal, muscular, and psychic systems, and also has a general effect on your sleep, memory, ability to concentrate, and your energy levels."

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