Cranio-facial morphology, upper airway and orthodontics – the crucial connection

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Abstract

Narrowing and collapse of upper airway particularly in sleep has been observed in individuals with retrognathic maxilla, retrognathic mandible, narrow maxillary and mandibular arches, long face syndrome, inferiorly and posteriorly placed hyoid bone, retrogenia and increased over jet. Therefore the above observations can be summed up as risk factor for upper airway narrowing that would lead to potential health risks like obstructive sleep apnea, hypopnea syndrome, upper airway resistance syndrome, intractable snoring, mouth breathing and nasal allergies. In children it is likely to affect academic performance, memory, growth and development per se.

Extraction orthodontic treatment used as a of camouflage sometimes could be detrimental by altering the tongue posture and thus compromising the airway. Functional considerations should outweigh purely aesthetic ones. It is important when making an orthodontic surgical or combined diagnosis for a patient, to bear in mind the impact that the treatment would have on the upper airways. Good aesthetics should never be achieved at the expense of diminishing the capacity of their upper airway. The speciality of orthodontics has a crucial role to play in terms of prevention, interception and correction of the potential health risks by accurate diagnosis, dento-facial orthopedic treatment and surgical orthodontics. This presentation would be focusing on the crucial connection between the three and the urgent need to change the existing mind set among orthodontic community in the country in order to redefine and optimize our treatment goals so that we contribute significantly to the general health and well being of our patients.

Keywords : Craniofacial morphology, upper airway, orthodontics.

Introduction

The significant component of craniofacial development occurs within the first 4 years of life 90% of craniofacial development is complete by the age of 12. Therefore, it can be concluded that morphometric features that put adults at risk of OSA/

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SDB were probably present at age 12 [1]. Hence addressing and correcting these features early may significantly reduce medical problems that many children have as a result of undiagnosed OSA or UARS. The most important thing in one's life is the ability to breathe oxygen. If a child or adult can not breathe well, then their health will be affected in some way. Mandibular deficiency, retrogenia, skeletal class-II, malocclusions, high arch palate, maxillary deficiency, inferiorly and posterior placed hyoid bone have been documented as risk factors for upper air way disorders [2,3,4].

There is also mounting evidence that supports the view that environmental and neuromuscular influences

alter facial and dental structures. Harvold and coworkers concluded from non human primate studies that any factor lowering the posture/ position of mandible will promote additional tooth eruption and thereby cause an increase in lower anterior facial height [5,6,]. One such factor is an obstructed naso pharyngeal airway. This is most commonly due to adeno-tonsillitis.

Therefore, it is clear that craniofacial anatomy can influence the upper airway and environmental factors can influence the craniofacial anatomy. Orthodontists, by virtue of their training in growth and development of craniofacial region in particular, can play a crucial role in prevention, interception and correction of abnormal craniofacial anatomy, thus having a positive cascading effect on airway aesthetics and general health.

This paper will focus on the role the orthodontist should play to connect the three factors i.e craniofacial morphology, upper airway and practice of orthodontics to assure larger health benefits to our patients.

Discussion

Many growth factors and developmental issues have been recognized to be potentially involved in the risk of or the development of sleep-related breathing disorders. In the orthodontic patient airway related or breathing problems especially when sleeping, merit further investigation. It has been stated that mouth breathing as an on going breathing pattern may be a sign of impending sleep apnea [7].

The use of cephalometrics in investigating sleep related breathing disorders is well established, especially in children and when comparing snorers with non snorers [8]. Therefore it would seem prudent for any practicing orthodontist to be familiar with the cephalometric findings that might indicate the potential for upper airway compromise. Often, the findings on these images and detailed history will further confirm that such a problem exists. Factors such as mandibular length, maxillary length, skeletal position (retrusion or protrusion), steepness of the mandibular plane angle, hyoid position and various soft tissue findings may have implications for existence of upper airway compromise leading to sleep related breathing disorder. In some instances head and neck postural adaptation can be recognized in patients with a distinct possibility of sleep related problem[fig 1a,1b] [9]. The adaptations such as cranio-cervical extension and forward head posture help maintain the patency of the compromised airway.

Figure 1a: Normal Cranio Cervical posture. **Fig 1 b.** Cranio cervical extension and forward head posture is observed in patients with upper airway compromise as a mechanism of postural adaptation. This tendency is observed in children with adenoids and OSA patients.

One must also be cognizant of the effect certain therapeutic modalities may have on the airway. It has been reported that the use of headgear may affect children predisposed to sleep apnea when used in conjunction with other conditions such as mandibular retrognathia, large tonsils or history of upper airway infections [10]. It has been found that patients with compromised upper airway who had narrow maxillas and underwent palatal expansion, either with an appliance or surgically showed a significant improvement in the number of respiratory events that occurred following the expansion [11]. Therefore it is imperative to look for the intra oral signs associated with snoring and sleep apnea. The signs include high arch palate, narrow maxilla, cross bites, dental crowding, enlarged tonsils, a swollen or inflamed uvula and an apparent habitual mouth breathing pattern.

Seventy five percent of the patients in private and public orthodontic facilities are children. Contemporary orthodontists, in addition to inputs like investigations and clinical examination for a typical case of malocclusion, should also consider behavioural problems, poor school performance, medication usage, history of frequent upper respiratory infections (including ear infections) and evidence of bruxism and jaw pain. Upper airway grading using Malampatti scores must be made integral to orthodontic examination.

The upper airway compromise in children leads to snoring, sleep apnea and other respiratory related breathing issues which have more significant effect on children than adults. Children require more sleep (quantity & quality) than adults. If sleep is disturbed due to upper airway compromise the impact can be significant. Attention deficit hyperactivity disorder can also be attributed to poor quantity and quality of sleep.

Congenital syndromes that affect craniofacial morphology such as Pierre-Robin, Crouzons, Aperts and Treacher- Collins often present with OSA.

High arch palate, narrow dental arches, mandibular retrognathism, increased overjet, high body mass index and large neck circumference are considered risk factors for upper airway compromise which would lead to OSA/ SDB. If the individual does not have high BMI or large neck size, the predictive factors of OSA/SDB are high arch palate, narrow dental arches and increased overjet [12].

Breast feeding is important for the proper development of the swallowing action of the tongue, shaping of dental arches and proper alignment of teeth [Fig 2a, 2b, 2c] [13]. The tongue contributes to the developmental shaping of the palate during its motion across the palate while swallowing. Use of bottle nipple or pacifier can interfere with proper contact of tongue and its distribution of force on palate [Fig 3a]. The physical contact of the bottle-nipple can actually elevate the height of the palate [Fig 3b]. A vacuum created by strong sucking actions can also increase the height of the palate [13]. Proper swallowing pattern and maturation is seen in breast fed children and is crucial for craniofacial development. A tongue thrust is likely to develop in bottle fed children. Therefore the orthodontist should propagate the fact that bottle feeding and subsequent development of tongue thrust and narrowing/ deepening of palate are the main contributing factor of the malocclusion that put an individual at risk of OSA/ SDB. The above is also true for excessive use of pacifiers, thumb sucking, blanket sucking and arm sucking. Therefore, propagation of breast feeding should be done not only in the light of immunological benefits, nutrition, and prevention of caries but also for proper craniofacial development and airway patency.

Although monoblock was prescribed by Anderson in a case of Pierre-Robin syndrome to prevent asphyxia [14], the merit of functional appliances to improve breathing by enhancing posterior airway space is often not factored. The popular one phase – biphasic orthodontic treatment argument has not factored the influence of functional appliances particularly the mandibular advancement appliance for improving airway, its influence on quality of sleep and its cascading influence on craniofacial growth [15,16]. Therefore there is a need for revisiting functional jaw orthopedics in the light of upper airway.

Figure 2a: During breast feeding the nipple of the breast adapts to the shape of the mouth. The peristaltic motion of the tongue during breastfeeding presses the breast up against the palate. The stimulus is vital for optimizing palatal arch development

Figure 2b,2c: Demonstrates position and action of tongue during breast feeding. The action of the tongue is one of the key stimulus for mandibular growth and maxillary arch development.

Figure 3a: Demonstrates action of pacifier / bottle nipple. The mouth has to adjust to any object in the mouth other than the breast. The unnatural forces that can develop can impact the position of the teeth and shape the palate.

Figure 3b: Bottle feeding can separate the epiglottis/soft palate connection, elevate the soft palate, drive the tongue back and alter the action of the tongue.

There is mounting evidence from anthropological studies that pre-historic skull had wide palate and large posterior nasal aperture. The broad width between the pterygoid plates resulted in a wide entry to the soft tissue portion of the airway. In studies conducted after 1940s, the skull on an average had high palate and narrow arch resulting in small posterior nasal aperture [17]. This could be due to wide spread use of bottle feeding, pacifier and digit sucking which cause adverse effect on the craniofacial development.

Considering the above connection, it would be pertinent for orthodontists to envisage transverse deficiency of maxilla and deepening of palate and therefore the scope to introduce palatal expansion as a preventive measure. Cistulli has reported that OSA patients who have narrow maxillae and undergone palatal expansion either with orthodontic appliance or by surgery show significant improvement in the number of respiratory events that occur following expansion [18]. Symptoms of snoring in OSA disappear following transverse expansion of maxilla [Fig 4a, 4b, 4c, 4d, 4e], [19].

There is also mounting evidence in favour of use of oral appliance therapy (OAT) like mandibular advancement device (MAD) in intractable snoring, mild to moderate OSA and in severe cases not amenable to CPAP therapy or surgery [Fig 5] [20, 21, 22, 23]. MAD acts by elevating the base of the tongue, and increasing the tone of palatoglossus muscle and pulling the soft palate forward. It decompresses the tissue around the pharynx and allows the pharynx to expand [24]. The practice of oral appliance therapy for sleep disorders is akin to

Figure 4a: Pre treatment occlusal view of a 14 year old female with constricted maxillary arch. She also reported snoring.

Figure 4b: Pre treatment frontal view of the same patient showing sagittal and transverse discrepancy. The discrepancy may have been the reason for poor tongue posture which resulted in snoring.

Figure 4c: Expansion of maxillary arch with banded hyrax appliance.

functional appliance treatment which the orthodontists should be familiar with. So incorporation of the philosophy of oral appliance (OA) therapy with some basic training in sleep medicine would be a value addition to the practice of orthodontics and would ensure greater

Figure 4d: Post treatment occlusal view showing well expanded maxillary arch.

Figure 4e: Post treatment frontal view showing optimum overjet and well aligned arch. Snoring ceased following completion of orthodontic treatment due to improvement in tongue posture

Figure 5: Adjustable mandibular advancement appliance is the most popular oral appliance for snoring, mild to moderate OSA. The appliance shown in picture is medical dental snoring device.

health benefits for our patients as conditions like OSA are potentially life threatening disorders.

Maxillo mandibular advancement in the form of orthognathic surgery or distraction osteogenesis is considered the most definitive therapeutic procedure after tracheostomy for OSA [25, 26]. The orthodontist has to play a crucial role in diagnosis, evaluation and treatment of cases requiring maxillo mandibular advancement surgery in collaboration with maxilla-facial surgeons.

There is a tendency for removal of all the four bicuspid in camouflage orthodontic treatment especially in case of mandibular deficiency. This indeed merits revisiting. Removing four bicuspids for purely orthodontic reasons can be harmful [27]. It reduces the tongue space and alters tongue posture thus reducing the posterior airway space [fig 6]. This can be a risk factor for developing upper air way disorders like OSA. Therefore airway analysis and tongue posture inputs are key variables to be considered for fixed orthodontic treatment with bicuspid extractions. Dr William Hang one of the strongest advocates of bioblock orthotropics and who has recommended optimizing oral posture as core philosophy of dento facial orthopedics has reported cases of OSA which has been attributed to bicuspid extractions at a young age as a part of fixed orthodontic appliance therapy at a young age. The extractions spaces were reopened which resulted in improvement in tongue posture and significant improvement in OSA [28]. He also quotes in the same article, "It is time to cease bicuspid extractions, headgear, temporary anchorage devices used for retraction and retraction mechanics until their effect on decreasing tongue space and possibility of producing OSA has been completely resolved [28]. The authors also share the same concern. It is important when making an orthodontic, surgical and combined diagnosis for a patient to bear in mind the impact the treatment can have on the upper air way. Good aesthetics should never be achieved for patients undergoing orthodontic treatment at the expense of diminishing the capacity of their upper air ways [29]

Figure 6: Diagram depicting the detrimental effect of orthodontic treatment with first premolar extractions on the upper airway.

Conclusion

Upper airway has various cranio facial anomalies which are characterized by maxillo mandibular deficiencies and inferiorly placed hyoid bone. Environmental and neuromuscular influences can alter the mandibular posture and head posture affecting the phenotype and thus compromising the upper airway. Orthodontists are experts in growth and development of craniofacial region in particular and thus can play a crucial role in the correction of upper airway disorders by integrating growth modification, prevention and interception of deleterious habits, OA therapy and maxillo mandibular advancement procedures.

References

1. **Shepard JWJ**, Geffer WB, Guilleminault C et al. Evaluation of upper airway in patients in OSA/SDB. *Sleep* 1991; 14:361-371.
2. **Gulliminault C**, Riley R, Dowell N. Obstructive sleep apnea and abnormal Cephalometric measurements: implications for treatment. *Chest* 1984; 86; 793.
3. **Lowe AA**, Fleetham JA, Adachi S, et al. Cephalometric and computed tomographic predictors of obstructive sleep apnea severity. *Am J Orthod dentofac orthop.* 1995; 107: 589.
4. **Jayan B**, Prasad BNBM, Kotwal A, Kharbanda OP, Roy chowdhury SK, Gupta SH. The role of cephalometric analysis in obese and non obese urban Indian adults with obstructive sleep apnea syndrome, A pilot study. *Indian J of sleep medicine.* 2007; 2(2): 59-63.
5. **Harvold E**, Chierici G, Vargervik K. Experiments on the development of dental malocclusions. *AmJ orthod* 1972; 61: 38-44.
6. **Harvold E**, Tomer BS, Vargervik K, Chierici G. Primate experiments on oral respiration. *Am J orthod.* 1981; 79: 359-372.
7. **Caprioglio A**, Zucconi M, Calori G et al: Habitual snoring, OSA and Craniofacial modifications: Orthodontic, Clinical and diagnostic aspects in a case control study. *Minerva stomatol* 1999. 48: 125-137.
8. **Kulnis R**, Nelson S, Strobi K, et al : Cephalometric assessment of snoring and non snoring in children. *Chest* 2000; 118:1596-603.
9. **Ozbek MM**, Miyamoto K, Lowe AA, et al : Natural head posture, upper airway morphology and obstructive sleep apnea severity in adults, *Eur J orthod* 1998.20: 133-143.
10. **Pirila-Parlkinen K**, Dirlinemi P, Niemines P, et al : Cervical head gear therapy as a factor in obstructive sleep apnea syndrome. *Pediatr Dent.*1999;45: 39-45.
11. **Cistulli**, Palmisano RG, Poole MD: Treatment of obstructive sleep apnea syndrome by rapid maxillary expansion. *Sleep* 1998; 21: 831-835.
12. **Kushida CA**, Efron B, Guilleminault C. A predictive morphometric model for obstructive sleep apnea syndrome. *Am intern med* 1997; 127: 581-587.
13. **Palmer B**. The influence of breast feeding on the development of the oral cavity: a commentary *J Hum Lact.*1998; 14: 93-98.
14. **Robin P**, Glossoptosis due to atresia and hypertrophy of the mandible. *AmJ dis child.* 1934; 48: 541-47.
15. **Eveloff SE**, Rosenberg C, Carlisle CC, et al. Efficacy of Herbst mandibular advancement device in obstructive sleep apnea. *Am J Respir Crit Care med* 1994; 149: 905-09.
16. **Gozz P**, Ballanti F, Prete L. A modified monobloc for treatment of children with Obstructive sleep apnea. *J Clin orthod.*2004; 38 C: 241-47.
17. **Laurenic IB**, The origin of pharyngeal obstruction during sleep. *Sleep and Breathing* 1999; 3(i)17-22.
18. **Cistulli**, Palmisano RG, Poole MD, Treatment of obstructive sleep apnea syndrome by rapid maxillary expansion. *Sleep.* 1998.21; 831-835.
19. **Roy Choudhury SK**, Jayan B, Menon P S, Prasad BNBM, Ravishankar K. Management of obstructive sleep apnea and non apneic snoring with Maxillo-mandibular distraction osteogenesis. *Indian J sleep med.* 2007; 2(3). 101-108.
20. An American academy of sleep medicine report. Practice parameters for snoring and obstructive sleep apnea with oral appliances. An update for 2005. *Sleep* 2006; 29,240-243.
21. **Ferguson K**. Oral appliances therapy for obstructive sleep apnea. *Am J Resp Crit Care Med.*2001; 163(6): 1294-1295.
22. **Lowe AA**. Dental appliances for snoring and obstructive sleep apnea. In Kryger M, Roth T, Dement W (eds) W(eds). Principles and practice of sleep medicine,ed 3. Philadelphia, WB Saunders, 2000, 929-939.
23. **Jayan B**, Prasad BNBM, Dhiman RK. Role of oral appliances in the management of sleep disorder. *MJAFI.*2009. 65(2).123-127.
24. **Mohsenin N**, Mostofi MJ, Mohsenin V.The roleof oral appliance in treating OSA. *J Am Dent Ass.*2003;134;442-445
25. **Mc Carthy JG**, Stelnicki EJ, Meharara BJ, Longaker MT. Distraction Osteogenesis of the craniofacial skeleton. *Plast Reconstr Surg* 2001; 107(7).1812-27.
26. Distraction osteogenesis: A new frontier in correcting Dentofacial deformities. In news letter-orthodontic dialogue, *American Association of orthodontists.*2000; 12(2)
27. www.brianpalmerdds.com.
28. **Hang WA**.Obstructive sleep apnea : Dentistry's unique role in longetivity enhancement.*Journal of American orthodontic society.Spring*2007. 28-32.
29. **Cobo PJ**, de Carlos UF, Macias EE. Orthodontics and upper airway. *Orthod Fr* .2004,75(1):31-37.