REVIEW ARTICLE

Upper Airway Sleep Disorders in Children: Orthodontist's Role

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Abstract

Significant component of craniofacial development occurs within the first four years of life. A total of 90% of the craniofacial development is complete by the age of 12 years. Therefore, it can be concluded that morphometric features that puts an adult at risk of obstructive sleep apnoea(OSA)or sleep disordered breathing (SDB) were probably present at the age of 12 years. Class II malocclusions, narrow maxilla, mandibular deficiency, retrognathia, long face problems, inferiorly and posteriorly placed hyoid bone are all considered as craniofacial anomalies that predisposes a child to SDB.

Craniofacial anatomy can influence the upper airway and environmental factors, like adeno-tonsillitis, nasal allergy, pernicious oral habits (prolonged pacifier use, thumb sucking, tongue thrusting and mouth breathing), and can also influence the growth and development of the craniofacial complex. It has been stated that mouth breathing as an ongoing pattern may be a sign of impending sleep apnoea. So it is of paramount importance for the healthcare professionals to keep a close eye on the risk factors and make appropriate referrals for requisite preventive, interceptive and corrective treatment. Promotion and propagation of breast feeding in infants, adeno-tonsillectomy, maxillary expansion and functional appliances aimed at posturing the mandible in forward position/optimal position, habit breaking appliances and maxilla-mandibular distraction osteogenesiss are the preventive, interceptive and corrective treatment options at our disposal. This communication is aimed at providing an overview of orthodontist's role in the management of upper airway sleep disorders in children in the back drop of craniofacial risk factors, environmental influences and appropriate orthodontic and dentofacial orthopaedic intervention strategies.

Introduction

Obstructive sleep apnoea and other upper airway sleep disorders, like snoring and upper airway resistance syndrome, not only affect adults but are also seen in children. OSA is estimated to occur in 1%–3% of children and snoring is believed to occur in 3%–12% of the population[1,2]. Management of SDB in children is by an interdisciplinary approach involving paediatrician, oto-rhino-laryngologist, pulmonologist, orthodontist, maxillofacial surgeon and speech therapist.

SDB, particularly OSA, affects memory, school performance, growth and development, cardio-respiratory health in children[3–6]. Craniofacial development is almost 90% complete by the age of 12 years. Hence, all those craniofacial risk factors that are

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responsible for SDB are present at a very young age[7,8], hence, there is a very strong case in hand to recognise these craniofacial risk factors and institute the appropriate preventive, interceptive and corrective treatment strategies so that breathing at night during sleep is optimised. Orthodontists are specialists who deal with the growth and development of the face and jaws in particular and prevention, interception and correction of malaligned teeth and jaws. So there is a need for the orthodontic profession to integrate management of upper airway sleep disorders into their practice, so that their expertise is leveraged optimally for the prevention and comprehensive management of SDB in children. The other specialties also need to have a basic understanding of the orthodontist's competence and role for better interactions and appropriate referrals.

This paper aimed at providing an overview of the orthodontist's role in the management of SDB with special emphasis on craniofacial risk factors, their recognition and appropriate intervention.

Discussion

Upper airway is like a collapsible tube supported by the craniofacial skeletal bones, which include maxilla, mandible, cervical vertebrae and hyoid bone. The patency of this passage is maintained by various muscle groups whose tonicity is crucial to overcome the collapsibility. Human beings being bipedal have a unique airway/air passage compared to other quadripedal mammals. Unlike the other quadripedal mammals where the larynx is approximating the soft palate to facilitate simultaneous eating and breathing, in humans the larynx descends inferiorly to facilitate phonation and speech. Unlike other mammals where the tongue is more forwardly placed, in human the tongue is posterior and contained within the oral cavity and is integral to maintenance of upper airway patency. This unique phenomenon necessitate human to possess an erect head posture and craniocervical extension to facilitate breathing. So the craniofacial risk factors can have severe cascading effects on various entities, predominantly airway.

Significant component of craniofacial growth is complete by the age of 4 years and is 90% complete by the age of 12 years. So all those recognised craniofacial risk factors that are associated with SDB are present since very young age. Some of the recognised risk factors are retrognathic maxilla and mandible, lower and inferiorly placed hyoid bone, narrow maxillary arch, deep palatal vault, macroglossia, excessive lower face height and long face problems[7,8]. These features may be seen in both syndromic and non-syndromic cases. Some of the common syndromes include Treacher Collin syndrome, Crouzons syndrome, Apert's syndrome, Pfeiffer's syndrome, Pierre Robin syndrome and cleft lip and palate[9].

Post-natal craniofacial growth is supported by various theories and the most accepted as per contemporary literature is functional matrix theory proposed by Dr. Melvin Moss in early 1970s, which summarises that growth of the face occurs as a response to functional needs and is mediated through soft tissue in which jaws are embedded. The facial pattern is genetically programmed, however, the epigenetic and functional factors ultimately determines the craniofacial architecture[10].

The initial influence of environmental factors can be associated with use of pacifiers and dummies. Breast fed children have been reported to have better developed jaws as compared to bottle/pacifier fed children[11]. The breast feeding facilitates suckling unlike sucking facilitated by pacifier use. The muscular thrust produced by tongue on the palate helps in the expansion of the palatal vault and also impacts the craniofacial sutures, which respond by sutural growth[12]. This initial impetus is crucial for optimising tongue posture, which later influences the maturing to adult swallowing pattern and maintaining the balance of orofacial musculature. On the contrary, a pacifier does not create adequate posterior oral seal and the impetus for maxillary arch development is not adequate. So the first step therefore would be to promote breast feeding, hence, breast feeding needs not only to be highlighted in the wake of immunological and nutritional benefits but also for balanced craniofacial development and it is cascading benefits with respect to optimising the patency of upper airway[11,12]. There is mounting evidence from anthropological studies that pre-historic skulls 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 the studies conducted on skulls after 1940s, skulls on an average had high palate and narrow arch resulting in smaller posterior nasal aperture[13]. This can be attributed to widespread use of bottle feeding, pacifier and digit sucking, which cause adverse effects on the craniofacial development.

Many environmental factors influence the craniofacial growth, which in turn has an impact on the airway. Most common environmental influences concerned with craniofacial growth are oral breathing and nasal blockage. This is attributed to enlarged adenoids, tonsils, deviated nasal septum, nasal allergies and chronic upper respiratory infections. These environmental factors, particularly adeno-tonsillitis, result in increased craniocervical extension and forward head posture, which in fact is a compensatory mechanism to facilitate breathing[8,14]. This compensatory mechanism seizes to exist in sleep resulting in the upper respiratory collapsibility, a commonest feature of SDB. These environmental factors also impact the orofacial balance resulting in the oral breathing, lowered posture of tongue, narrowing of upper arch due to aberrant buccinator mechanism and clockwise growth rotation of mandible. This often leads to classical Class II malocclusion and anterior open bite. The first interventional step would be recognising these environmental predisposing factors and eliminating them.

Adeno-tosillectomy would be the first step[15,16]. Gulleminault (16) and colleagues in their seminal study compared the therapeutic efficacy of adeno-tonsilectomy alone and combination of adeno-tonsillectomy and rapid maxillary expansion (RME). They reported almost 100% cure in the groups those underwent both adeno-tonsillectomy and RME. The benefits of RME also been ratified in other reported studies[17,18]. Change in the head and tongue posture and accelerated growth and closure of mandibular plane angle has been observed post adeno-tonsilletomy. This has been attributed to normalisation of secretion of growth hormone and mediators attributed to quality delta sleep[14]. Appropriate referral of children suffering from SDB undergoing adeno-tonsillectomy to orthodontist by paediatrician and oto-rhino-laryngologist for RME merits serious consideration.

RME is a procedure commonly prescribed by orthodontist for expansion of maxillary arch. Different sizes of jackscrews are secured to the teeth by soldering on bands on teeth or by bonding acrylic plate (Figure 1).

In growing children, the jackscrew is opened at a rate of 1 mm per day, which aids in opening/distracting midpalatal suture and expansion of palatal arch, thus increasing the oral volume. Literature reports the procedure enlarges the posterior nasal aperture, decreases nasal resistance and thus improves nasal breathing[17,18]. The procedure is also positively associated with management of nocturnal enuresis and conductive hearing loss in children[19].

Pernicious oral habits like digit sucking habits, abnormal tongue thrusting and mouth breathing are impending risk for abnormal craniofacial growth and SDB like the pacifier habits. Digit sucking in particular after the age of 5 years is to be viewed much more seriously by treating physicians, paediatricians and dentists. Thumb sucking during the late deciduous and mixed dentition stage result in protrusion of upper anterior teeth, deepening of palatal vault and deficient growth of mandible due to counter pressure on mandibular condyles. Orthodontic intervention for these habits includes counselling and prescription of removal and fixed habit breaking appliances (Figure 2). These appliances basically encompass palatal cribs, made up of wire framework that would defer the patient to indulge in the habit. If the habit is corrected at appropriate age, the growth and development can get normalised. Similarly, tongue thrusting and mouth breathing can also be treated with orthodontic appliances, like tongue guard or oral screen. These appliances will help not only discontinuing the habit but also improve the orofacial muscular balance.

Mandibular deficiency is one of the most common risk factor associated with SDB[20]. As early as in 1902, monoblock was prescribed in a child with Pierre Robin syndrome to prevent asphyxia[21]. Various mandibular advancement appliances were designed and developed during the last century by orthodontists to promote and redirect mandibular growth (Figure 3). These appliances help in holding or posturing the mandible forward by harnessing myotonic and myodynamic properties of facial muscles. These are together labelled as functional appliances. Although orthodontist historically has been prescribing these appliances to harness growth, the merits of improving breathing during sleep have not been highlighted adequately and are under reported. The commonly prescribed appliances for this purpose are activator, bionator, twin block and frankel's functional regulators. Clark[22] designed a simple removable twin block appliance for correction of Class II malocclusion due to mandibular deficiency. He has highlighted the merits of these appliances in the light of improvement of airway[22].

David Page, Mohony, Dave Singh and Willam Hang are strong advocates of use of functional jaw orthopaedics for improvement of airway[23,24]. They have aptly interrelated airway, mode of breathing and craniofacial formation during growth and development and have pointed out the philosophy of form following function and function following form. According to them it is imperative to normalise form and function as early as possible, so that function is optimised for life.

The facial features that indicate the risk for SDB in children are summarised vide Table 1.

Table 1: Facial features that indicate the risk for SDB in children

Sr No	Clinical feature	Presentation
1	Adenoid facies	This is a condition with long face. The face is rounded and offers a blank stare.
2	Allergic shiners	These are dark circles that are often found under the eyes. They are related to reduced or absent nasal breathing with increased amount of mouth breathing.
3	Poor or inadequate lip seal	The lips are found to be apart with difficulty to maintain lip seal.
4	Small nares	The opening of nasal airway is small and appears constricted.
5	Nasal crease	Horizontal line that goes across the nose above the tip of the nose. Clinical feature may be associated with allergy.
6	Intra-oral features	Bruxism or worned teeth cross bite, high arched palate, scalloped tongue, enlarged or swollen uvula, enlarged tonsil, deep or collapsed bite.
7	Facial profile	Convex facial profile retruded chin

Maxillary deficiency is often associated with decreased velo-pharyngeal airway space because of posteriorly placed velum. Maxillary deficiency is most commonly observed in operated cleft lip and palate CLP cases. SDB is reported higher in CLP cases due to severe maxillary growth disturbance[25,26]. The anterio-posterior discrepancy is often associated with narrowing of maxillary arch or transverse discrepancy, which also impacts the tongue posture. So early intervention by expansion of maxillary arch and protraction with the maxillary face mask will not only facilitate growth but also improve the velo-pharyngeal airway space.

Cephalometrics is the most common investigation resorted by orthodontist for diagnosis and treatment planning. Although a two-dimensional image it gives adequate information regarding jaw relationship, soft tissue relationship and airway (Figure 4). It is economical and easily available. Orthodontist should leverage this modality not only for routine treatment planning procedure but also to screen patients for airway compromise. Most of the common airway measurements that can be easily done on lateral cephalogram are naso-pharyngeal airway space, posterior airway space, velo-pharyngeal airway space and hyoid distance.

Various craniofacial syndromes with severe mandibular deficiency can be life threatening. Mandibular advancement by distraction osteogenesis can be a life saving measure in these cases. The technique involves incremental traction to regenerate to harness elongation of mandibular corpus. The procedure often carried out by maxillofacial surgeons in collaboration with the orthodontists using various paediatric intra-oral distraction devices. Large amount of mandibular advancement is possible by this technique. Significant improvement in airway parameters and breathing has been reported in literature[27,28,29]. Similarly, severe maxillary deficiency particularly as in case of operated CLP can be addressed at very early age by mid-face distraction. This is done by Lefort I osteotomy of maxilla using RED or modular internal distracter. Literature recommends maxilla-mandibular distraction as most successful approach in management of severe OSA other than tracheostomy in craniofacial syndromes and success rate approaches 100%[27,28].

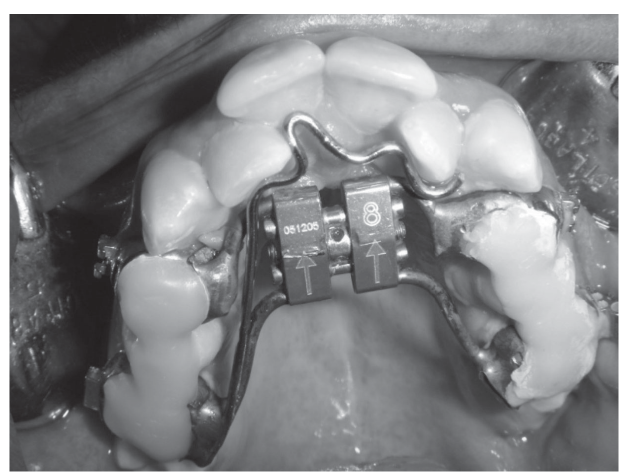

Figure 1: Rapid maxillary expansion with HYREX appliance

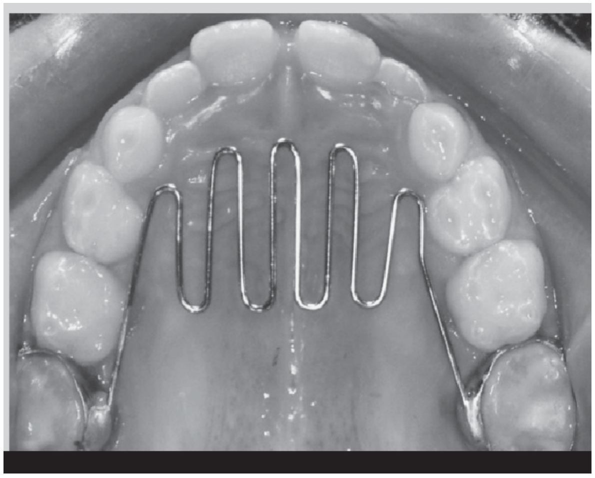

Figure 2: Habit breaking appliance for digit sucking habit

Figure 3: Photo sequence depicting various functional orthodontic appliances used commonly to facilitate mandibular growth

Dentofacial esthetics should never be achieved at the cost of compromising the airway. Airway parameters must therefore be made integral to orthodontic practice[30,31]. There are reports of bicuspid extraction at younger age, which have attributed to development of OSA in adult life. Reasons cited are reduced airway volume and tongue space. So extraction orthodontics must be weighed against airway compromise and long-term health benefits[30,31].

Conclusion

Orthodontist needs to be more involved in airway management and craniofacial development in growing children. Current literature shows that early orthodontic and orthopaedic intervention impact the airway and breathing. Orthodontic and orthopaedic intervention can lead to normal and healthier life. Orthodontic specialist has the competence to recognise craniofacial risk factors for SDB and practice appropriate prevention, interception and corrective treatment. As interdisciplinary approach is the only way forward in management of SDB in children. Regular interaction and understanding of the role of various specialities is the need of the hour for evidence based practice of sleep medicine.

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