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Review Article

Obstructive Sleep Apnea in Children and the Role that Dentists Play: A Review

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Abstract

Obstructive Sleep Apnea found more common in children than previously. OSA (Obstructive Sleep Apnea) consists of a constellation of symptoms which can vary with age. Adenotonsillar hypertrophy remains the most common cause of the condition in children. There has been a surge in our understanding of the condition due to advance in diagnostic methods such as nocturnal polysomnography and pulse oximetry. This paper provides an insight into the underlying mechanisms of Obstructive Sleep Apnea in children, current diagnostic methods and the treatment options with a brief on the dentist's role in its identification and management.

Keywords: *Obstructive Sleep Apnea; Polysomnography; Adenotonsillar Hypertrophy*

Introduction

Children with sleep-disordered can demonstrate a continuum with simple snoring and upper airways block, hypoxemia and on the other hand it found difficult to ventilate. These are the reasons which cause Obstructive Sleep Apnea. OSA is identified by airway unconstructive which is a sustained episodes for more than 10 seconds during sleep, this sleep Apnea.

Sleep apneas was firstly described in 1975 in related to rapid infant death syndrome and since then in children are observed that the sleep disorder has been significantly increasing. The most common cause of pediatric OSA is adenotonsillar hypertrophy. Other risk factors that can also be considered may include asthma, exposed to tobacco smoke and low socioeconomic status, whereas macroglossia, mandibular or midface hypoplasia, obesity and other craniofacial anomalies, these are the additional craniofacial risk factors in children [1-3].

Owing to increased recognition of the condition among children, health care providers must be aware of the ways to detect OSA and aid in early referral. This review is an attempt to provide a basic understanding of OSA, its diagnosis and treatment alternatives in children.

The search methods were used citations to potentially relevant trials published in various journals and dissertations through several databases (PubMed, and Cochrane Central Register of Controlled Trials), along with hand-search of the trial that were conducted as well as Google Scholar searches were also done. Contact with experts in the area were undertaken to identify potentially relevant published and unpublished studies.

Definition

OSAS is defined as a disorder of breathing during sleep characterized by *prolonged* partial upper airway obstruction and/or *intermittent* complete obstruction (obstructive apnea) that disrupts normal ventilation during sleep and normal sleep patterns [4]. An apnoea-hypopnoea index value greater than 1 is considered abnormal in a child. According to the International Classification of Sleep Disorders (ICSD 2), apnoea is a condition which is associated with a cessation of airflow over two or more respiratory cycles. Due to the variation in respiration cycle in newborn where it is around 60 breaths per minute and it is reduced to 12 breaths per minute in an adolescent so, a

specific time in seconds is not applicable to children. Atleast 30% reduction in airflow along with or without an arousal and with oxygen desaturation of 3 - 4 per cent is more appropriate description of hypopnea [5].

Prevalence

Due to the differences in the various definition of SDB, it was difficult to ascertain the prevalence value and this condition has been recognized recently in children. Snoring has been useful marker of SDB and on this basis a meta-analysis has been conducted and reported a global prevalence of 7.45% in children, a parental report of apnoea varied from 0.2 to 4.0 per cent. Thus, the prevalence has been estimated between 1 and 4% [6].

Etiology

The etiology of OSA is multifactorial. There are certain features that predispose children to sleep apnea. a significant factor in children is Adenotonsillar hypertrophy, and its largest in the first few years of life and then involutes by adolescence and into adulthood [5]. Among the craniofacial characteristics predisposing to OSA, nasomaxillary midface deficiency can occur in various craniofacial deformities as in Apert syndrome, Crouzon syndrome, Pfeiffer syndrome and repaired cleft palate whereas in Pierre Robin sequence, severe juvenile rheumatoid arthritis, Treacher Collins syndrome, Nager syndrome, Stickler syndrome presented with Marked mandibular hypoplasia among the predisposing factors. Combination of the factors may be seen in Down syndrome, Achondroplasia, Prader-Willi syndrome and Mucopolysaccharidoses [7].

Pathophysiology of obstructive sleep apnea

Sleep stages are the intervals of non- Rapid Eye Movement (REM) and REM sleep. Non-REM sleep is divided into stages 1 to 4 with stage 1 being the lightest level and stage 4 very deep sleep. After progression through all 4 stages in about 90 minutes, stage REM begins. It is during this stage that dreams most often occur and more importantly the muscle tone decreases. The cycle repeats during the night with the length of stage REM increasing until this stage predominates by early morning.

Active sleep reduces the intercostal muscle tone resulting in a reduction in lung volume compared to wakefulness which further leads to a reduced functional residual capacity and decrease in oxygen reserves. These events ultimately increase the likelihood of hypoxia.

A deeper understanding into the process reveals that there are two important groups of muscles that are responsible for inspiration while we are asleep. The *diaphragm and the intercostal muscles* are responsible for creating a negative airway pressure which is necessary for the process of inspiration to begin. Conversely the upper airway patency is maintained by the *oropharyngeal muscles*. Nevertheless, when the negative pressure exceeds the force produced by these muscles, the pharynx will collapse thus, occluding the airway. The negative pressure creates a vacuum that sucks not just the air but also the flaccid tongue. The resultant narrowed airway accelerates the airflow which causes audible vibrations of the soft palate and uvula leading to what is commonly called "Snoring". The falling back of the tongue along with the collapse of the pharynx seals the airway such that the oral and nasal air can no longer reach the lungs. The diaphragm intensifies its efforts to suck in the air but instead makes the seal tighter. With the resultant cessation of breathing, the blood carbon dioxide levels raise high enough to awaken the patient. This usually occurs with a loud snort and then within seconds, the patient is asleep [9].

Clinical features

Patient-specific factors such as neuromotor tone and duration of disease may differ rendering to the severity of the disease. Chronic snoring, increased work load due at breathing, daytime tiredness and sleepiness, nocturnal enuresis, irritability and other associated behavioral and neurocognitive changes, thus they manifest as poor academic performance and with social adjustment problems. Successful treatment of OSAS has been associated with reversible improvement with reported recurrence of OSAS. Failure to thrive, cor pulmonale, pulmonary hypertension are the most serious complication in poorly or uncontrolled OSAS [3].

Children with SDB differ from the adults, as it is often difficult to diagnose in the children due to its much varied presentation. In children, nonspecific symptoms often lead to an alternate diagnostic pathways. The excessive daytime sleepiness is not a significant symptom in children, they tend to become a hyperactive and it has been seen that the symptoms changes with age [5].

Habitual snoring is an indicator of increased upper airway resistance, is a frequent episodes during childhood, with a median incidence of about 10% among preschool and school-aged children, with subsequent declines in frequency after 9 years of age many children with habitual snoring, approximately 2 - 3% will have clinically relevant disease [10].

Dental implications

To understand the etiological factors and the various strategies for treatment for a constricted upper respiratory tract in children, which can be facilitated by the interrelationships between craniofacial deformities and along with the physiological function. Difficulties present with nasal breathing are most often seen due to adenoids in children which may lead to chronic mouth breathing and subsequent anatomical changes in facial growth. Juliano and colleagues compare between children nasal breathers and mouth breathers, they have reported that mouth-breathing in OSAS individuals showed an increase in the anterior facial height, greater inclination of the occlusal plane, decreased mandible length and steep mandibular plane, open bite tendency and lip incompetence and reduced pharyngeal airway spaces [11].

Pirilä-Parkkinen and colleagues studied the cephalometric features of children with SDB with mean age of 7.3 years. Children with SDB were found to be characterized by an increased antero-posterior jaw relationship, increased mandibular inclination in relation to the palatal plane, increased total and lower anterior face heights, a longer and thicker soft palate, smaller airway diameters, lower hyoid bone position, and larger craniocervical angles when compared with the non-obstructed controls [12].

Diagnosis

Various diagnostic methods include history and physical examination, audiotaping or videotaping, pulse oximetry and polysomnography.

History and physical examination

Screening of patient with snoring should be a part of regular follow up [4]. In children, the occurrence of OSAS is very unlikely, as habitual snoring is not associated. If it is present, a more detailed history regarding labored breathing during sleep, observed apnea, restless sleep, diaphoresis and behavior or learning problems etc. should be obtained to establish a diagnosis.

An assessment of sleepiness severity can be done using the Epworth Sleepiness Scale (ESS). The ESS helps in differentiating between average sleepiness and excessive daytime sleepiness. A total score 10 or more from the overall eight individual scores, it reflects excessive daytime sleepiness and requires further detailed evaluation [13] however these questionnaires do not clearly differentiate from the children with or without SDB.

On examination, a nonspecific findings of adenotonsillar hypertrophy as mouth breathing, nasal obstruction, adenoid facies [4]. Obesity and clinical features of upper airway constriction that can increase the chances for the development and its related consequences. The blood pressure with hypotension, particularly orthostatic, are the sign of Upper Airway Resistance Syndrome. The risk of SDB increases if the neck circumferences more than 40 cm [15].

Mallampati staging is very useful in decisive of a small airway, and it is based on visualization of an airway with tongue in protruded position [16].

A relatively large tongue i.e. Macroglossia indicate deficient mandible, as seen in Down syndrome along with other features like narrow airway, high arched palate or torus palatinus. Indentation on the buccal mucosa is due to the overlapped teeth, particularly lower jaw, these could be relative risk factors.

Although examination are useful in screening the patients, there is controversy in patients requiring treatment. It is attributable to a combination of adenotonsillar hypertrophy with the neuromuscular tone during sleep. Thus, the presence of large adenoids alone does not necessarily specify [17].

Audiotaping and videotaping

In the literature there are two studies where they have examined the application of audiotaping [18,19] and in one study [20] the videotaping has been used, alone or in combination with the other clinical findings, with the sensitivity ranged from 71% to 94%, and specificity ranged from 29% to 80% in instituting the diagnosis. The discrepancies in outcomes from various centers direct that further research is required in search of better alternatives.

Polysomnography

A noninvasive test which involves the extent of a physiological functions over a night, together with EEG, oronasal airflow, abdominal as well as chest wall movements, carbon dioxide partial pressure etc. along with video recording as well is considered as a gold standard for diagnosing SDB. Specific scoring criteria should be used for measuring the severity of the condition.[4] the sleep architecture, breathing events during sleep as well as change in autonomic functions and respiratory work can be evaluate by using these criteria. Polysomnography for over a night is usually sufficient to make a diagnosis especially in children [21]. Since PSG is expensive, alternatives for diagnosis such as nocturnal video recording, nocturnal oximetry etc. have been sorted after. In some centers overnight pulse oximetry is used, which is an alternative to polysomnography and may be used as first line investigations as it is considered to be a sensitive test, if the test is positive [4].

Treatment options

General treatment

Several measures can be employed along with the other specific treatment options available for OSA by changing the sleep position, evading alcohol and sedative drugs before sleep, get rid of nasal congestion. These treatment modalities are more applicable to adults than children.

Specific treatment

The main focus of the various treatment modalities is to uphold the upper-airway patency specially during sleep. To achieve this the various surgical procedures have been attempted for improving the anatomy of the upper airway, CPAP or the other devices that helps in maintain the patency of an upper airway mechanically during sleep [23].

Adenotonsillectomy it is the most common treatment modality for OSAS in children. In the literature, tonsillectomy and adenoidectomy have been reported to give superior results with a success rate of 80% to performing either procedure alone [2]. according to the few studies it was recommended that the cure attained in less than 50% of the cases with SDB it could be due to the presence of other structural deformities such as retrognathia, engorged nasal turbinates and a deviated nasal septum [17]. All these children must have a follow up polysomnography after adenotonsillectomy usually 2 - 3 months interval to allow for oedema resolution on a regular basis. Haemorrhage risk during anesthetic procedures or the contamination are the main complications but the most common being poor oral intake post operatively and pain.

In those with residual sleep disordered breathing, other factors should also be as it was mentioned above and RME has been revealed to improve AHI [4,25]. Pirelli., *et al*. evaluated the effectiveness of RME in children of average age 8.68 years. The active expansion was based on the constriction of the maxilla thus, indicating that RME is one of the promising treatment options in children *without* adenoids. Children's treatment should be carried out under parent supervision, by maintaining good oral hygiene during the distraction [25].

Mandibular distraction Osteogenesis is another treatment alternative for the grownup children in whom fused cartilage has been seen and also in those patient who do not require maxillomandibular advancement [4].

Noninvasive mask ventilation

Sullivan in 1981 first described Positive airway pressure, helps in pneumatic splinting of the upper respiratory tract and it is effective in the reduction of AHI score, helps in delivering continuous CPAP and it could also be either bilevel (BPAP) or autotitrating (APAP) modes. In children and infants with unresolved OSAS, it is considered as a 2nd line of treatment. CPAP is indicated in cases of moderate to severe OSA. PAP may be applied through nasal, oral or oronasal interface during sleep. In the literature most of the authors have supported CPAP therapy and BPAP is an optional therapy in the cases where high pressure is required and in those patient who have experiences difficulty at the time of exhaling against a fixed pressure or central hypoventilation is also coexist [26].

Different sizes of Pediatric masks are increasingly available for conditions such as craniofacial syndromes. Even custom made pediatric masks can also be ordered to allow the perfect fit to the facial contours to avoid inevitably leak, and also to reduce the efforts to seal such leaks and also prevent from developing pressure sores, especially on the nasal bridge. Velcro or elastic straps or a tissue cap are the other means which are used to secure the mask. The acceptance and tolerance to these devices can be improved by the adequate parental training and by the use of other behavioural techniques and this will help in getting more compliant by the child and their family as well [27].

Desensitization of a child is recommended before starting CPAP, this can be done by positive reinforcement at every steps, parental education and gradual exposure to the CPAP, similar approach was also reported in the literature before staring CPAP for increased time duration and then attached to headgear to apply the pressure. One of the main problems of CPAP use is nasal congestion and xerostomia i.e. dry mouth [4].

Oral appliance therapy

In childhood this condition is most commonly treated by adenotonsillectomy, but surgical risks and in some patients the recurrence also have been reported, they are the limitation of this approach. A narrower respiratory airway space, along with poorly developed maxilla as well as retruded mandible is seen in the children who do not get improved even after adenotonsillectomy. Functional orthopaedic appliances are one of the dynamic appliances which are usually loose, removable intraoral appliance to alter the muscle forces and neuromuscular action to effect the resultant growth and development of bone and occlusion as well [6]. These intra oral appliances were in used for the management of such disorders in children since early 1900s. Tongue repositioning devices or TRDs and mandibular repositioning appliances, or MRAs are the two different types of intra oral appliances [23]. TRD's hold the tongue in a forward position in contrast to the rest position without mandibular repositioning [26]. The MRAs are more commonly used in most studies. These functional orthopaedic appliances brings the mandible forwards and potentially enlarge the upper airway space thus improving the function. Several designs of MRAs made up of different materials are available. Most commonly used material is clear acrylic and which are closely adapted onto the teeth, the various acrylic component are connected with adjustable screws and rods in varying lengths. Most of the intra oral appliances used facilitate the mouth opening and also side-to-side mandibular movement, just to enhance the patient cooperation. The appliance are usually fabricated at the 75% of the maximum mandibular range, fine adjustments may be required for the advancement of mandible and to minimize discomfort to the patient, thus creating a more space and stabilizing the pharyngeal airway during sleep, and are more effective in patient with mild-to-moderate sleep apnea. In those patient who cannot tolerate CPAP or in those where surgical intervention has been failed, oral appliances can be used effectively [23]. Intolerance and improper use of the device are the main potential problems for patients using OAs, they may aggravate TMJ disease and malocclusion.

During the initial checkup, maximal opening of an oral cavity, and the auscultation of TMJ for joint spaces sounds and palpation of the right and left sides of muscle of mastication particularly masseter and temporalis for tenderness should be performed, and also the presence or lack of inter-cuspation. However, it should be illustrious that in the literature most of the follow-up studies have been reported being of relatively short duration; therefore, the long-term complications associated with these appliances should be examined further [23]. Whenever an oral appliance is indicated in the child with OSA, prior to the insertion of an appliance, it is necessary to establish a treatment objective and it could be either palliative or immediate care, to reduce the apnoea index, by bringing the mandible in a forward position leading to increase in the upper airway space. The effect of intra oral appliance in the management of OSA patient can be assessed by Polysomnography. However, if the treatment objective is to treat and cure, it will change the mandibular position forwards and enlarge the upper airway but also promote dento-alveolar and skeletal growth.

After reviewing the literature, it was found that there was no strong evidence relating to the efficacy of treatment with intra oral appliance. These intra oral appliances may be considered in specified cases as an auxiliary in the treatment of children with craniofacial anomalies which are at risk for apnoea [6].

Complications of untreated SDB

In untreated cases of SDB, the patient present with complications as neurocognitive, cardiovascular and disturbances of growth as well as mood disorder, resulting in daytime sleepiness. However, children without such complications are more likely to be hyperactive or inattentive. On the basis of the presence of these features, child often being diagnosed as ADHD and has a negative impact on school performance and intellectual function like short term memory and lack of concentration are affected.

There are only few studies in the literature where they have been evaluated cardiovascular complications in children whereas it was well established in adults. Hypertension most commonly seen in children with SDB in contrast to one without SDB. The increased work load on the heart with airway obstruction requires energy, results in utilization of energy used for growth will lead to diminish gain in weight as well as height [4].

A summary of the role of the dentist in obstructive sleep apnea

Early identification of OSA in children is essential so that, the provision of appropriate treatment may be rendered, to avoid the development of various complications and to prevent long term serious complications in adulthood.

Thus, the role of the dentist begins with the identification of patients with sleep disordered breathing which further depends on appropriate history taking, general and physical examination. Patients with OSA may exhibit certain characteristics extra oral features like adenoid facies, others may exhibit intra- oral findings such as high arched palate or unilateral or bilateral crossbites.

Dentists play a vital role today in the management of patients with sleeping related breathing disorders. It is important that for the dentists to look prior to treating malocclusion for any respiratory problems because they treat the respiratory problems without knowing the patient existing respiratory disorders, or they may diminish the oral cavity space so that the increased chances of tongue to fall into the oropharynx and cause obstructive sleep apnoea due to the limited space for tongue, or they can face difficulties when treating because of an existing respiratory problems. Dental management of patients with oral appliances should be overseen by practitioners who were trained in sleep medicine or sleep related breathing disorders with thorough knowledge of the protocol for diagnosis, treatment and follow up of OSA. Thus, best treatment plan can be made only after consulting a team of different specialties.

Conclusion

Sleep medicine is constantly evolving as an advanced specialty and dentists have been identified as having an important role to play both in the early identification of Obstructive Sleep Apnea as well in its management. Thus, a greater understanding and awareness among dentists on OSA, particularly in children cannot be over emphasized.

Why this paper is important to pediatric dentists

- Obstructive sleep apnea is increasingly more common today among children, thus increasing the likelihood of pediatric dentists encountering them in their day to day practice.
- Pediatric dentists play an important role in the early identification of children with OSA since such children may have characteristic facial features and jaw configurations. Hence dentists can help prevent complications of OSA by early referral for treatment.
- Furthermore, dentists are now being recognized as an important treatment providers due to the advantages of oral appliance therapy in OSA.

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