Pediatric Sleep Apnea: Ticking time Bomb, ensure diffusion before explosion.

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Abstract

During sleep, several physiological processes occur, and occasionally pathological disorders are also encountered. Obstructive Sleep Apnea (OSA), the severest one is characterized by the partial/complete collapse of an upper airway, causing decrease in saturation level of oxygen and arousal from sleep, affecting the functioning of different organs and systems. The first mention in the literature about the OSA in children dates back to 1836. Since then, it is a significant public health problem, having the prevalence of 1-5% globally at present. The most common etiology is adeno-tonsillar hypertrophy, though the other risk factors like cranio-facial abnormalities and obesity are also associated. In children the commonest sign & symptoms include mouth breathing, snoring, nocturnal enuresis and learning disabilities. Without treatment pediatric OSA results in serious morbidity in cardiovascular, neuro-behavioral, somatic growth & development of the child. Therefore, early diagnosis and treatment of the cause is of paramount importance. The gold standard considered for the diagnosis is nocturnal Polysomnography (PSG). The other tests include overnight continuous

pulse oximetry and questionnaire, implemented after thorough history taking and clinical evaluation. The treatment modalities include lifestyle modifications, surgical, non-surgical therapies and selected based upon reasonable consideration of subjective symptoms, disease severity, risks of morbidity and mortality. The pediatric dentist inspects the oro-facial region of a children from a young age on a regular basis and without difficulty can detect any signs & symptoms of Pediatric OSA and he can contribute to the treatment as well with oral appliance therapy, if recommended.

Keywords Pediatric Obstructive Sleep Apnea, Pediatric dentistry, Sleep-disordered breathing

Introduction

"Laugh and the world laughs with you, snore and you sleep alone."
— Anthony Burgess.

In the world of literature and cinema, a snoring sleep is considered as a metaphor of sound sleep. But in terms of medicine snoring and good sleep are considered the opposite of each other. Sleep is a universal phenomenon, characterized by a reversible state of partial un-responsiveness and major physiological drive. It is vital for child's growth & development, health, and daily functioning (1). Several physiological processes occur during sleep and occasionally pathological disorder like sleep disorder breathing are also encountered (2). Sleep related breathing disorders (SRBD) in an ascending order of severity, includes: (i) simple snoring, (ii) syndrome of increased respiratory resistance (Upper Airways Resistance Syndrome - UARS), (iii) obstructive hypoventilation, and (iv) Obstructive Sleep Apnea (OSA) (3). OSA is characterized by the partial/complete collapse of an airway, resulting in decreased saturation levels of oxygen and arousal from sleep. This disturbance leads to fragmented & non-restorative sleep affecting the functioning of different systems and organs most importantly the cardiovascular system, brain, and alteration in metabolic balance of the body (4). In children, OSA is a severe condition and unlike in the adults it differs in physiology, clinical features, polysomnographic readings and outcomes (5). As per study done by HypnoLaus, OSA is found in 49.7% of the men and 23% of the women, worldwide (6). In the children, primary snoring prevalence rate is estimated at 8-27% and that of OSA 1-5% (7). The important risk factor is the enlargement of the adenoids & lingual tonsils (adeno-tonsillor hypertrophy). The other risk factors include obesity, craniofacial abnormalities, obstructive nasal diseases (asthma/allergic rhinitis), age, family history, syndromic diseases and premature or multiple pregnancies (8). Without, treatment pediatric OSA, results in serious morbidity in cardiovascular, neurobehavioral, somatic growth & development of the child (9). Mostly, it remains undiagnosed, and patients report only when significant problem arises. Lack of community awareness about the negative sleep-related effects on the day-to-day functioning of children, together with the parents miscounting the condition, are factors that also contribute to this under estimation (10). Since the pediatric OSA impacts overall growth &development of a child adversely, an early diagnosis and treatment of the cause is of paramount importance. Clinical evaluation consists of careful history taking, clinical examination, and finally endoscopic & instrumental assessment (3). The gold standard

considered for diagnosing OSA is full night-time sleep-laboratory based polysomnography (PSG) (11). PSG has many limitations such as it is quite stressful to both children & parents; requires child hospitalization quite expensive; and not easily accessible. Due to these shortcomings, in the recent past many questionnaires have been developed for its diagnosing. The Pediatric OSA should be treated by a multidisciplinary team comprising of a Pediatrician, ENT specialist, Speech therapist and Pediatric dentist (12). The management options include surgical and non-surgical methods. The method employed is as per the severity and cause of the condition. The Dentist can recognize the sign & symptoms of Pediatric OSA, an underestimated fact. It is pertinent that dentists should understand SRBDs and upon suspecting the condition be able to evaluate their patients, for the well -timed referral, or provision of treatment as deemed appropriate. The pediatric dentist inspects the oro-facial region of children from a young age on a regular basis and without difficulty can detect any signs & symptoms of Pediatric OSA (13). In addition, he observes the behaviour and mood of the child as well which can sometimes be a sign of sleep disorder. It has proven to be beneficial in teaching pediatric dentists to be sensitive in the identification of the symptoms, risk factors, diagnosis and treatment of this condition and an appropriate referral of Pediatric OSA patients for further study. Thus, an elaborate review of signs and symptoms, risk factors, diagnostic aids and treatment options have been made through this article.

History

Obstructive sleep apnea, gradually becoming more prevalent and a significant public health problem was initially reported in 1970s. The first mention in the literature dates back to 1836, as Charles Dickens describes a child suffering from OSA (SRBD) in his book "*The Pickwick Papers* a boy, called Joe" and for this reason the OSA was also earlier called as "Pickwickian syndrome" (Figure 1) (14). But the usage of the Pickwickian syndrome term is discouraged as it describes individuals with obesity hypoventilation syndrome also. Dr. John Cheyne was the first one to explain SRBD associated with an irregular breathing during sleep & heart failure in the medical literature (15). Until the mid-twentieth century, cases were slowly reported over time, then the problem became widely recognized, and its effects extended to every domain of medicine. Obesity was considered to be the primary factor in the development of sleep apnea, until the 1970s, when Dr. Guilleminault and Dr. Dement presented, that thin individuals can suffer from sleep apnea as well(16). In 1889 Hill carried out a study on "some causes of backwardness and stupidity in children" (17). Quite a lot of astounding revelations emerged in this work as in, he identified obstructive sleep apnoea symptoms: "children who were suffering from nasal and pharyngeal obstructions, often had headaches especially while studying, and were unable to focus on their lessons or work for any length of time" (17). In 1960s and 1970s tonsillectomy, was the almost usual treatment in the children for a range of apparent clinical features, including frequent upper respiratory tract infections and blocked noses. Many children amongst these might had unrecognized sleep disordered breathing. The first case series of obstructive sleep apnoea in children was published in 1976 by Dr. Guilleminault and Dr. Dement (16). A position paper, published by ENT-UK (the British Association of Otorhinolaryngology—Head and Neck Surgery) has

appraised that approximately quarter of 27400 tonsillectomies in the children were performed for obstructive conditions in 2008-09 in the UK (18). Since then, this field has grown enormously to become a medicine's sub specialized field, entrenched in numerous disciplines, including neurology, psychiatry, respirology, psychology, pediatrics, anesthesia, otolaryngology, internal medicine, cardiology, and dentistry.

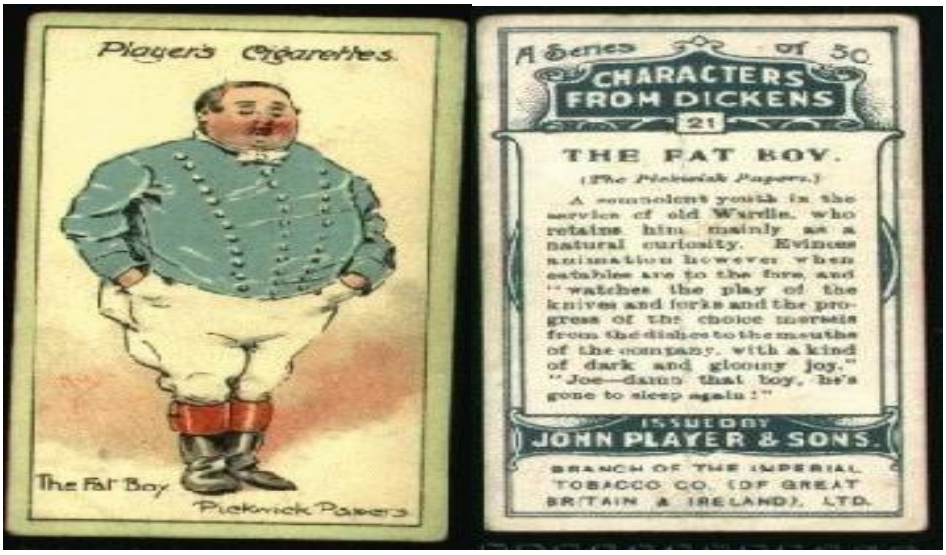

Figure 1: Joe the Fat Boy, Posthumous Papers of the Pickwick Club

Etiology

It is highly essential to identify children at risk for this condition in the early stages by determining the factors associated with high risk for OSA.

1. Physical factors:

a) Age. Children aged between 3 to 7 years are generally affected, but it can range from 4 months to 14 years (19).

b) Obesity. Excess fatty tissues lead to restrictions in airflow as pathway is narrowed during sleep (Figure 2). Redline *et al*. found that obesity (BMI > 28 kg/m^2) increased a child's risk of having OSA with and apnea-hypopnea index (AHI) ≥ 10 events/h by at least 4.5 fold (20).

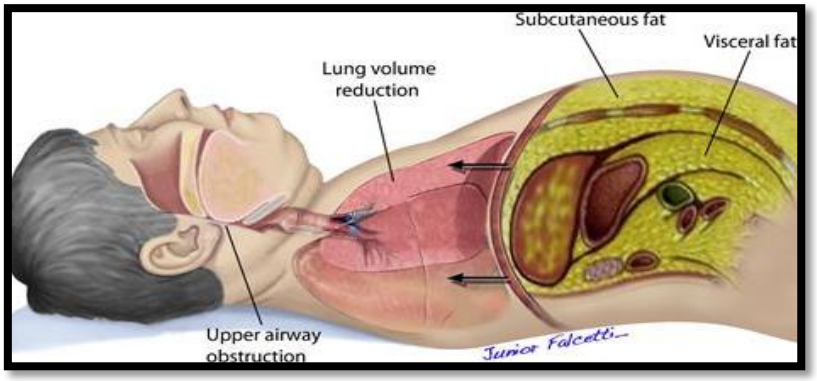

Figure 2: Upper airway obstruction due to excessive weight

c) Ethnicity. In Asians narrower cranial base angle is found; a feature which increases their risk of OSA. Asians has higher Mallampati score, smaller thyro-mental distance, and steeper thyro-mental plane than western population (21).

2. Structural factors:

a) Enlarged adenoids or tonsils. The main risk-factors for OSA in preschool children are adeno-tonsillar hypertrophy and recurrent upper respiratory tract infection, leading to hypertrophic epithelium thus limiting the airway potency (22).

b) Large neck circumference. Circumference of neck to Height Ratio of 0.25 and higher is considered as a predictor of OSA (23).

c) Size of tongue. As the size of tongue increases the chances of the tongue to fall back and block the upper airway also increases leading to apneic episodes. Tongue volume/Mandibular volume ratio can be used as an appropriate variable to evaluate the risk of OSA in children (24).

d) Upper Airway size and shape. The lateral pharyngeal wall is found significantly thicker in children having OSA (25). As per Ivanhoe - J Prosth Dent 1999, the Anatomic alterations like Steep Posteriorly placed pharyngeal walls, Retrognathic mandible, Large anteroposterior discrepancies between maxilla and mandible, Anterior open bite associated with large tongue, Cranio-facial syndromes (Treacher-Collins, Crouzon syndrome, Apert syndrome, mid-facial hypoplasia, Pierre Robin sequence, etc.) reduces airway.

e) Craniofacial abnormalities. In children, cranial index and facial index were different with obstructive sleep apnea (AHI $\geq$15) vis a vis those who did not have obstructive sleep apnea (AHI<5). Cranial Index is probably a better anthropometric variable than Facial Index as a risk factor for OSA (26).

f) Hyoid position. Apneic children have longer Hyoid-Mandibular Plane (H-MP) distance. In children with OSA, the hyoid bone lies in a significantly inferior and posterior position at an early age (27).

3. Environmental factors

Environmental exposures like irritants or allergens, tobacco smoke exposure, alcohol and hypnotic-sedative medications are the risk factors for snoring in preschool children (28).

4. Systemic factors

Systemic hypertension, Hypothyroidism and acromegaly are found to have an association with an increased risk of OSA (29).

5. Genetic factors

Familial factors also play a role. The epsilon- 4 allele of the APOE gene has been found to be related with an increased risk of OSA (30).

Signs & Symptoms

From subtle intrusion into daily life that may be recognized as intense sleepiness, snoring witnessed apnoea and other more classic recognizable OSA symptoms in children manifests in a number of ways. As any other disease, even in this the severity of the symptoms often gradually increases over years, ensuing to delay in diagnosis and granting time for the disease to affect adversely the health of the child.

The symptoms manifested based on the time of manifestations and based on age of the child are as per Table 1 & 2 respectively (31, 32).

Table 1: Symptoms based on time of manifestation

Diurnal symptoms	**Nocturnal symptoms**
Morning confusion and headaches	Snoring
Dry mouth in morning	Choking or gasping at night
Excessive sleepiness	Night sweats, Nocturia
Decreased vigilance	Insomnia
Personality and mood changes, including depression and anxiety	Patient report of "Trouble Sleeping"
Cognitive deficits; memory and intellectual impairment (short-term memory, concentration)	Non-restorative sleep (i.e., "waking up as tired as when they went to bed")
Sexual dysfunction, decreased libido	-

Table 2: Symptoms based on age of the children

Infants	**Toddlers**	**Preschool-aged children**	**School-aged children**
• Disturbed nocturnal sleep with repetitive crying • Noisy breathing or snoring • Poor sucking • Failure to thrive • Delayed Development • Apparent life threatening event	• Noisy breathing or snoring • Restless nocturnal sleep • Abnormal sleeping positions • Nocturnal sweating • Mouth breathing • Night terrors • Poor eating & growth	• Regular, heavy snoring • Mouth breathing • Restless nocturnal sleep • Sleepwalking • Night terrors • Enuresis • ADHD-like symptoms • Increased need for napping • Poor eating • Growth problems	• Regular, heavy snoring • Restless nocturnal sleep • Sleep walking • Sleep talking • Excessive Bruxism • Difficulty to wake up in the morning • Morning Headache • Poor apatite • Emotional instability • Learning difficulties • Excessive daytime sleepiness aggressiveness

Signs include (33):-

a) Increased neck circumference, body mass index

b) Airway obstruction with mallampatti score greater than III and IV

c) Enlarged tonsils occupying more than 40% of oropharyngeal width

d) Enlarged nasal turbinates.

Oral manifestations include (34):-

a) Forward tongue posture

b) Anterior Open-Bite and large Over-Jet

c) Steep mandibular plane

d) Increased gonial angle

e) Steep Occlusal Plane

f) Increased height of lower and upper face

g) Bulky or long uvula that fails to elevate from the base of the tongue during phonation

h) Large tonsils compromising pharyngeal orifice

j) General appearance of the pharynx as being narrow and small

k) Airway space grading.

Screening and Diagnosis

According to the American Academy of Pediatrics (AAPD) recommendations, screening of OSA is to be carried out by caregivers of children by asking about snoring during their routine health care visits. Any child who snores habitually (eg, ≥3 nights per week), has loud snoring, or pauses while breathing needs to go through a full diagnostic evaluation for OSA (35). Diagnostic evaluation may also be warranted by other children, if they have risk factors or symptoms associated with OSA, including sleepiness, hyperactivity, learning problems or behavioural problems (35). The following steps for complete diagnostic evaluation are:

- **Clinical History**. The history should specifically evaluate the risk factors for OSA, daytime & nocturnal symptoms, with special attention to snoring, particularly when frequent or loud, Daytime inattention, behaviour problems and learning difficulties (eg, attention deficit hyperactivity disorder [ADHD] or problems with performance in school).
- **Physical Examination**. In children with OSA, several abnormalities may be observed providing evidence of increased upper airway resistance particularly enlarged tonsils and adenoids.
- **Growth**. Another sign of chronic severe OSA, especially in infants and young children is poor growth (36).

- **Head and Nose**. Craniofacial anomalies suggest abnormal upper airway anatomy. Mouth breathing, adenoidal (long) face, diminished nasal airflow and hypo-nasal speech are found consistent with adenoidal hypertrophy. Mucosal or turbinate swelling & obstructive septal deformity or intranasal mass may also be evaluated.
- **Mouth**. A clinician should look for high-arched & narrow hard palate, crossbites, overlapping incisors, and large overbite suggest a small jaw, which may be due to an abnormal maxillomandibular development (37). Macroglossia should also be looked for as it reduces the air flow through the upper airway. The examiner should note tonsil size as per Mallampati classification or Friedman score, to define the degree of oropharyngeal crowding.

Once the OSA is suspected based upon history & clinical evaluation the child is refereed for Polysomnography (PSG). The bench-mark diagnostic test considered for OSA is Attended in-laboratory nocturnal PSG (38). It can definitively identify obstructive events, including gas exchange abnormalities and sleep disruption quantifying the severity of OSA. The advice for PSG is guided by several factors like, child's age, medical comorbidities, tolerance for PSG sensors, accessibility & availability of testing, etc. (39). PSG has many limitations and also may not be easily available, in such conditions referral to an otolaryngologist for further evaluation or alternate diagnostic tests may be considered. These alternate tests include **Overnight continuous pulse oximetry** and Questionnaires (PSQ-SRBD, I'm Sleepy, etc.) (40, 41, 42).

Treatment

After the final diagnosis is made, treatment should be selected considering disease severity, site(s) of obstruction, risks of morbidity & mortality, subjective symptoms and patients' choice. The treatment must be evaluated from time to time and should be modified according to the results for good patient outcome. The various modalities for treatment of PSA is shown in Figure 3 (33).

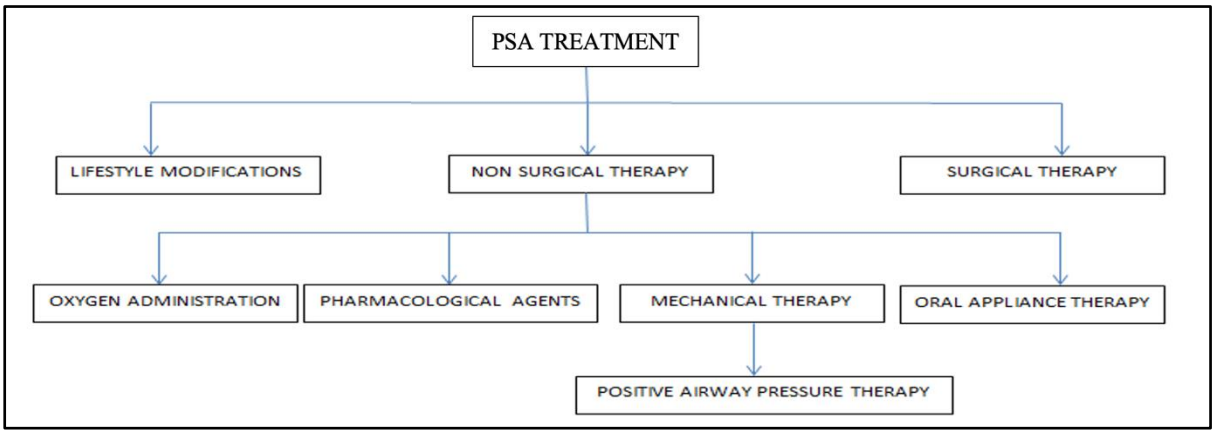

Figure 3: Various Modalities for Treatment

1. **Lifestyle modifications.** These should be included in the treatment of OSA but should be used exclusively in patients whose main complaint is snoring and having very mild apnea. These include weight loss and positional therapy (position change from supine to the lateral while sleeping).
2. **Non-Surgical Therapy.** The specific therapy for PSA should be tailored for an individual child based upon medical history, physical examination, and the findings of PSG.
   a) **Oxygen administration**. It's a temporary measure till the definitive treatment is not implemented and is reserved for those children who are unable to tolerate Continuous Positive Airway Pressure (CPAP) (43).
   b) **Pharmacological agents.** Leukotriene antagonists &Corticosteroids can be used to improve airway patency in those children suspecting of seasonal allergies (44).
   c) **Mechanical Therapy**. Positive airway pressure or CPAP therapy prevents and reduce airway collapse (Figure 4) (45, 46).

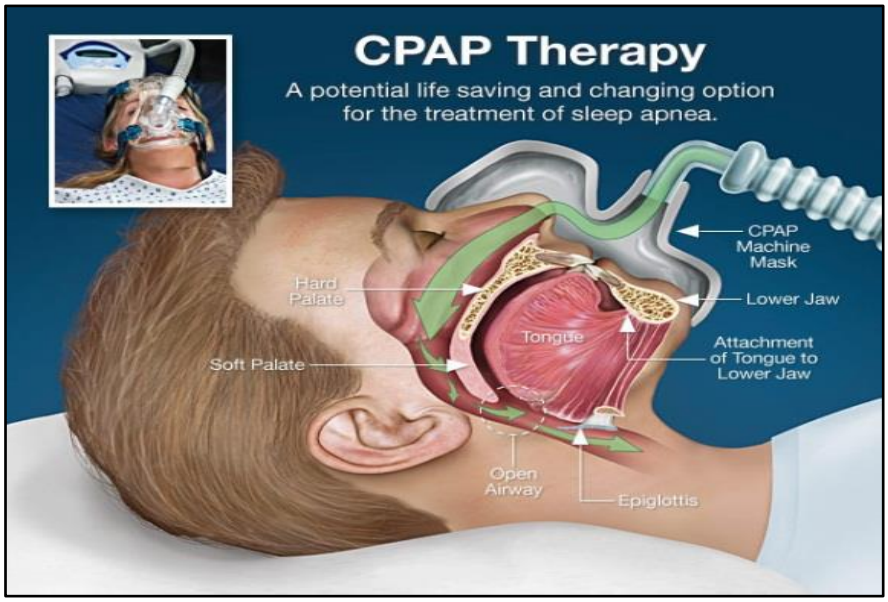

Figure 4: CPAP Therapy

   d) **Oral appliances (OA)**. Dental appliances may modify the position of the upper airway structures enlarging and/or reducing collapsibility of the airway (47). The examples are Rapid Maxillary Expansion appliances, Mandibular repositioning devices (Figure 5), Tongue retention devices (Figure 6).

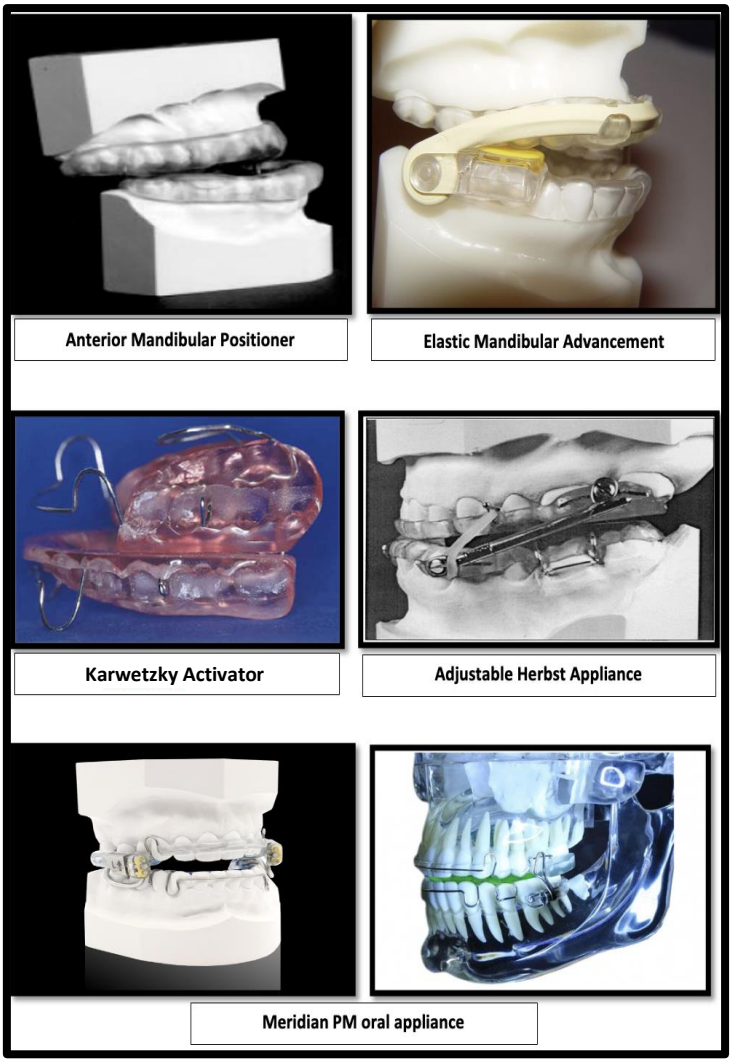

Figure 5: Mandibular Repositioning Devices

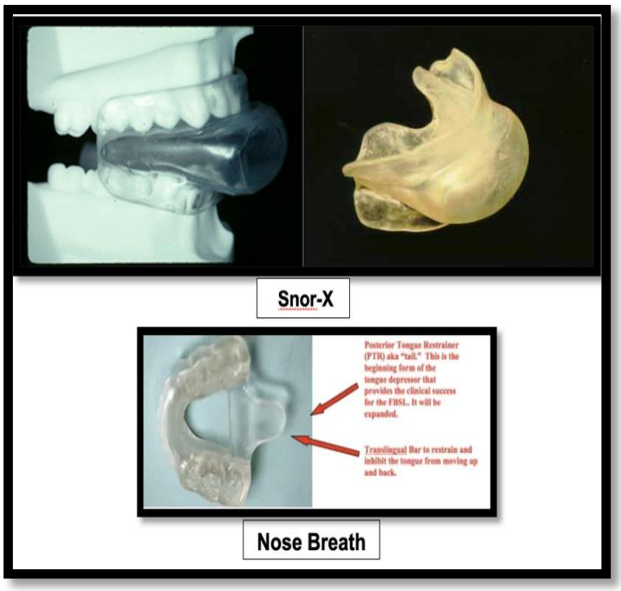

Figure 6: Tongue Retention Devices

3. **Surgical therapy** Surgery may be advised if non-surgical therapy, CPAP, or OA fail to successfully treat OSA, AHI of >20 events/hour of sleep supplemented by excessive daytime fatigue and sleepiness (33). Various types of surgeries performed are Adenotonsillectomy, Tongue surgeries, Hypoglossal nerve stimulation, Mandibular distraction osteogenesis & Uvulopalatopharyngoplasty (48, 49, 50, 51).

Role of dentist

"Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem" a report published in 2006 by the Institute of Medicine (presently the National Academy of Sciences), illuminated an importance of dentists in consolidated care of children with SRBDs (52). In delivering concerted patient-centred care in children suffering with OSA, dentists are advised to follow an established guidelines promulgated by the American Dental Association (ADA), American Academy of Pediatric Dentistry (AAPD), American Academy of Pediatrics (AAP) and jointly by the American Academy of Dental Sleep Medicine (AADSM) &the American Academy of Sleep Medicine (AASM) (53). As per the AAP guidelines, dentists treating children, should screen all children/adolescents for snoring and subsequently referred to a qualified medical professional (53). The dentist is positioned in an important place for both screening and monitoring their patients for signs and/or symptoms of OSA, as per AAPD's recommendations on the timing of the first dental visit. As mentioned earlier, the most common etiology for children with OSA is adenotonsillar hypertrophy, therefore, dentists are most likely to assess tonsillar hypertrophy as well as tongue position to rule out airway obstruction during an oral examination. The dentist should also be prepared to treat or refer the child for providing oral appliance therapy (OAT) that may be recommended by the physician heading the care team for the child diagnosed with PSA. Current ADA policy delineates the responsibilities of the dentist for screening and then referring patients, and also lay down his role in providing treatment with oral appliance therapy (54).

Conclusion

Even with increasing awareness of the serious adverse consequences of untreated sleep apnea in children, epidemiologic studies suggest that PSA is under-diagnosed. In children, even a single apneic event ought to be considered pathological. Early diagnosis and management of pediatric OSA is encouraged as it will improve a child's long-term cognitive skills, social potential and school performances. Because of its clinical features' complexity, its management demands a multidisciplinary approach involving pluri-specialists particular to mention the pediatric dentist. Dental examination can identify irregular maxillary growth, dental crowding, crossbite, increased overjet, and overbite. Considering the high prevalence rate of OSA in children, it is advised for the dentists should become aware & accustomed with screening tools, diagnosis, and treatment of this disorder. Since pediatric dentist can play an important role not only in early diagnosis but also in managing & treating PSA, additional specialist training would be desirable by better collaboration between specialists, especially between pediatric dentist and an otolaryngologists. The pediatric dentist, as a sentinel for OSA in children, could differentiate the clinical evaluation according to standard parameters

of this disorder, gaining the chance to start target therapies specifically for every patient with OSA and instilling a beneficial effect on the health as well as quality of life of their pediatric patients.

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Conflict of Interest: None

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