

Management of obstructive sleep apnea using oral appliances: A Review (Part I)

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Abstract

Sleep-Disordered breathing (SDB) describes a group of disorders characterized by abnormalities of respiratory pattern (pauses in breathing) or the quantity of ventilation during sleep. Obstructive sleep apnea (OSA) is one of the commonest types of SDB, it is a condition characterized by the repetitive total or partial collapse of the pharyngeal airway during sleep leading to oxygen desaturation or arousals.

The first part of our review tries to give an explanation of etiology, signs and symptoms, pathophysiology, diagnosis and management of OSA. The second part focuses on the role of a dentist in treating OSA using various oral appliances (OAs) and the dental changes brought about, side effects of appliances and patient compliance.

Key words: Sleep-disordered breathing (SDB), Obstructive sleep apnea (OSA),

Introduction

Obstructive sleep apnea (OSA) is a common upper airway disorder characterized by repetitive, complete or partial closure of the upper airway during sleep, resulting in sleep fragmentation and oxygen desaturation, the condition is also associated with loud snoring^{1,2}. When there is a cessation of airflow at the mouth and nose for 10 seconds or more, then such a condition is termed apnea (Greek word 'apnea' means-without breath)³. During this time, the individual's oxygen levels will drop. If a person experiences 30 or more apneic episodes during a seven-hour sleep period, that person is believed to be suffering from sleep apnea syndrome. These episodes can last from 10 to 120 seconds. These apnea events terminate with a partial awakening or an arousal. It is important to understand that these arousals are necessary for the person to begin breathing again⁴, as these arousals increase the activity of tongue and throat muscles that enlarge the airway⁵. OSA is a relatively common condition occurring in 2 to 4% of males and 1 to 2 % of females in middle age⁶. Though it can occur in any age, the prevalence increases with the age. The problem is even more common among obese people, with 40% of men and 3% of women having the disorder⁶.

Pathophysiology

The underlying pathophysiology of OSA is complex and not fully understood. The causes are multifactorial and may vary considerably between individuals. Important risk factors include obesity, male sex, and aging. However, it is generally accepted that stability and patency of the upper airway plays an important role^{3,7}.

An obstruction in the upper airway can occur in three areas. They are the nasopharyngeal, oropharyngeal, and hypopharyngeal regions. The nasopharynx is the part of the pharynx that lies above the level of the soft palate. The oropharynx is the division of the pharynx that lies between the soft palate and the upper edge of the epiglottis. The hypopharynx is the division of the pharynx that lies below the upper edge of the epiglottis and opens into the larynx and esophagus^{4,8,9}.

The upper airway obstruction during sleep may occur as a result of narrowing of the respiratory passages. Partial obstruction results in loud, irregular snoring sounds caused by air rushing through the narrow passage and stimulating the soft palate, uvula, throat walls and tongue to vibrate. The narrower the airway passage,

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the greater the negative pressure. When the negative pressure increases to a certain point, the airway may completely collapse. This is what is known as an apneic episode, during which breathing ceases^{7,8,10,11}. The apneic episode terminates in an arousal, which results in increased muscle tone of the airway, opening up the pharynx so breathing is re-established⁹.

Also it has been hypothesized that individuals with OSA have impaired genioglossal function, allowing the prolapse of tongue against the posterior pharyngeal wall with inspiration effort during sleep³.

Etiology

The commonest cause of a narrow upper airway is obesity^{7,12}. One possible explanation for the relationship between obesity and OSA is that the upper airway is narrowed in obese patients as a result of increased fat deposition in the pharyngeal walls^{7,12}. In nonobese individuals, craniofacial anomalies like micrognathia and retrognathia resulting in insufficient room for the tongue thus predisposing to OSA^{13,14}. Other craniofacial features predisposing to OSA include enlarged palatine tonsils, enlarged uvula, high arched palate, deviated nasal septum, long anterior facial height, inferiorly displaced hyoid bone, macroglossia and decreased posterior airway space^{13,14}. In addition ethnic background, genetics, habits such as alcohol consumption, smoking and sedatives can aggravate the chances of OSA^{7,13}.

The causes of Obstructive Sleep Apnea (OSA) are discerned as follows¹⁵:

- (a) Anatomic anomalies: such as hypertrophic tonsils and adenoids, choanal atresia or stenosis, anomalies of the nasal septum and soft tissue thickening of the upper respiratory system.
- (b) Neuromuscular diseases: such as cerebral palsy, myotonic dystrophy, congenital myopathies. These diseases may coexist with decreased muscle tone of the upper respiratory muscles and defective breathing control by the central nervous system.
- (c) Craniofacial anomalies: such as midfacial hypoplasia, micrognathia, hypotony, and sometimes mental retardation.

Signs and Symptoms

OSA is associated with a series of daytime and nocturnal signs and symptoms. The daytime symptoms include excessive sleepiness and abnormal behavior ranging from aggressiveness, hyperactivity and social withdrawal. Morning headaches, poor job performance, loss of alertness, clouded memory, intellectual deterioration and occupational accidents are also some presenting symptoms^{4,13,15,16,17}.

Nocturnal symptoms include difficult breathing whilst asleep, heavy snoring, gasping and choking, restless sleep, heavy sweating, nightmares, frequent arousals during sleep (fragmented sleep), kicking and leg movements and bed wetting in children^{4,13,15,16,17}.

Diagnosis

Medical diagnosis

Diagnosis can be made on history, examination, polysomnography, split night testing and oximetry.¹³ The most reliable method to identify OSA is a nocturnal polysomnograph. The necessary parameters recorded are: mobility of thoracic and abdominal muscles, cardiac rate, ECG, air flow through nasal and oral cavities, hemoglobin saturation in oxygen and exhaled carbon dioxide^{4,10,13,15,19}. A number of imaging modalities like nasopharyngoscopy, fluoroscopy, MRI and computed tomography have also been used to assess the airway¹⁵.

Apnea severity is usually categorized by the frequency of apnea events that occur per hour. The apnea-hypopnea index, or AHI—also known as the respiratory disturbance index—is used by many clinicians to confirm the diagnosis and quantify the illness severity. The categories are as follows: ⁴

- **Mild** -- 5 to 20 episodes per hour;
- **Moderate** -- 20 to 40 episodes per hour; and
- **Severe** -- 40 or more episodes per hour.

Dental diagnosis

A dentist may be the first health care provider to identify a person with OSA because its salient signs and symptoms often are recognizable in the dental office¹⁰. Dental assessment includes history and oral examination focusing on occlusion, periodontal status, tooth mobility, parafunctional habits, TMJ evaluation, wear facets, DMFT, recording sensitivity of teeth, tori, and amount of over jet and overbite present.¹³ The lateral cephalometric radiographs of people with OSA usually show an elongated soft palate, a large tongue, a repositioned maxilla and mandible, an inferiorly positioned hyoid bone, a narrowed posterior airway space or calcified carotid artery atheromas.¹⁰

Treatment modalities

Treatment of OSA is aimed at the reduction or eliminating the collapse of pharyngeal tissues. Treatment for OSA must be based on the assessment of severity of the sleep disorder, patient's preference and general health. The treatment options must be less invasive whenever possible. Simplest options are lifestyle modification and oral appliance therapy for mild to moderate cases. Continuous positive airway pressure and surgical options are for moderate to severe cases.^{11, 13}

The treatment options can be non-surgical or surgical based on the preference of the patient.

Non-surgical options

- Lifestyle modification
1. **Loose weight.** People with severe sleep apnea are often overweight. Loss of weight will result in reduced adipose tissue volume in the upper airway, decrease the load on the chest wall and abdomen, and improve respiratory muscular efficiency^{4, 12}.
 2. **Sleep on one side.** The patients who sleep on their backs have a significantly higher level of sleep disturbance as the supine position causes a gravitational pull on the tongue forcing it to come in contact with the posterior pharyngeal wall. Therefore, any technique that allows one to sleep on a side could be beneficial.⁴
 3. **Avoid alcohol within two to three hours of bedtime.** Alcohol is a central nervous system depressant and changes motor activity in the muscles that control normal inspiration. These changes include relaxation of the walls of the upper airway causing it to collapse.⁴
 4. **Avoid certain pharmacological agents.** Benzodiazepines, narcotics, barbiturates, and testosterone have all been reported to affect the occurrence of apneic episodes⁴.

Other life style modifications are designed to improve 'sleep hygiene'. These include measures to improve the sleep environment like to keep the bed comfortable and the bedroom warm, quiet and dark, avoiding caffeinated drinks in the evenings and avoiding daytime napping.¹²

Medical treatment

1. Nasal Continuous Positive Airway Pressure

The gold standard treatment for OSA is nasal continuous positive airway pressure (nCPAP) delivered via a nasal mask. This technique involves wearing a mask tightly over the nose during sleep. A high flow blower delivers a continuous stream of air into a sealed nasal mask. This forced air creates a pneumatic splint, keeping the airway open and allowing the person to sleep normally. This is a highly effective therapy and is the most common approach for moderate and severe apnea patients^{4,8,10,21}. Unfortunately, compliance with nCPAP has been very poor. nCPAP has its own side effects such as claustrophobia, air leaks, pressure sores, nasal stuffiness, dry mouth, and mask discomfort^{8,10,20}.

2. Drug therapy

Drug therapy has been proposed in some patients with mild to moderate sleep apnea and could be of value in patients intolerant to nCPAP. A number of mechanisms

have been proposed by which drugs could reduce the severity of OSA. These include an increase in tone in the upper airway dilator muscles, an increase in ventilatory drive, a reduction in the proportion of REM sleep, a reduction in airway resistance and a reduction in surface tension in the upper airway. Physostigmines, nasal lubricant, topical nasal steroid, acetazolamide are some of the drugs which are used.²¹

Surgical treatment

Surgery aims to alleviate anatomic sites of obstruction in the naso-, oro-, and hypopharynx.²² Surgical treatment increases the upper airway cross-sectional area, removes obstructive tissues, such as enlarged tonsils, or bypass the pharyngeal airway.^{23,24}

The principal interventions can be considered as:²³

1. Tracheostomy (which bypasses the pharyngeal airway)
2. Uvulopalatopharyngoplasty (UPPP) which increases the area of the retro palatal airway by resection of the free edge of the uvula and soft palate, and may be combined with tonsillectomy- a modification is laser-assisted uvulopalatoplasty (LAUP)
3. Tonsillectomy and adenoidectomy - accepted treatment of OSA in children
4. Inferior sagittal mandibular osteotomy and genioglossal advancement with hyoid myotomy and suspension (GAHM) aims to create an enlarged retrolingual airway.
5. Laser midline glossectomy and lingualplasty also create an enlarged retrolingual airway.
6. Maxillo-mandibular osteotomy and advancement enlarges both retrolingual and retropalatal airway.
7. Epiglottoplasty for selected cases of laryngomalacia.
8. Removal of local specific obstructing pathological lesions.

Surgical success depends on appropriate patient selection, the type of procedure performed, and the experience of the surgeon. Surgery is considered appropriate on a case-by-case basis in patients with usually moderate to severe OSA with associated symptoms of excessive daytime sleepiness or with significant medical morbidities²².

Untreated OSA can result in serious morbidity.⁸ Cardiovascular disease is common in patients with OSA. The prevalence of angina, cardiac arrhythmias and myocardial infarction is increased in patients with apnea^{8,18}. Cerebrovascular diseases may also be more prevalent in these patients^{8,18}. There are metabolic and other systemic complications that also may occur as a result of untreated sleep apneas¹⁸.

Conclusion

Obstructive sleep apnea (OSA) is a common upper airway disorder characterized by repetitive, complete or partial closure of the upper airway during sleep, resulting in sleep fragmentation and oxygen desaturation, the condition is also associated with loud snoring. In this first part the authors have reviewed the etiology, signs and symptoms, diagnosis and treatment modalities in offer and the following second part reviews on the role of a dentist in the treatment perspective of OSA.

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