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Can Sleep Apnea be Prosthodontically Managed? –A Review

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Abstract:
Sleep apnea is a condition in which breathing stops involuntarily for brief periods of time during sleep. Normally, air flows smoothly from the mouth and nose into the lungs at all times. Periods when breathing stops are called apnea or apneic episodes which can be potentially life-threatening. In obstructive sleep apnea, the normal flow of air is repeatedly stopped because the airway space in the area of throat is too narrow. This result in snoring, a characteristic feature of obstructive sleep apnea as well as frequent arousal from sleep causing excessive daytime sleepiness, affecting one's quality of life.

Keywords: *Sleep apnea, Oral appliance, Obstructive sleep apnea, Mandibular advancement device*

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I. Introduction

Sleep apnea syndrome is a relatively common and potentially life-threatening disorder. Increased public awareness, more frequent recognition by health care providers, and improvements in diagnostic procedures, have led to a dramatic increase in the number of diagnosed patients. The increasing demand for noninvasive treatment modalities, which includes intraoral prosthesis, should motivate dentists to become more aware of this syndrome.[1]

The sleep apnea syndrome was first described by Gastaut, as a disorder associated with repeated cessation of breathing during sleep.[2] Sleep apnea is defined as 30 or more apneic episodes (the cessation of airflow at the mouth and nose for more than 10 seconds) occurring during 7 hours of nocturnal sleep.[1] In the symptomatic patient, these episodes lasts on average of 20 to 60 seconds and may occur as frequently as 200 to 600 times a night.

There are 3 types of sleep apnea namely obstructive, central, and mixed patterns.

The most common form is obstructive sleep apnea, also known as occlusive apnea, where cessation of airflow occurs because of upper airway obstruction with the presence of simultaneous respiratory effort. This respiratory effort continues despite obstruction until the individual's sleep is disturbed.[1]

In central sleep apnea, simultaneous cessation of both airflow and respiratory effort is observed.

In mixed apnea, episodes are accompanied by no respiratory effort initially, followed by respiratory muscle movement, and finally, by airflow.[1]

This article is focused mainly on the obstructive type because it is more common and tends to be more responsive to conservative treatment modalities using oral appliances.[1]

II. Etiology

Obesity is an important risk factor for obstructive sleep apnea (OSA). The prevalence of OSA is high and correlates with increasing body mass index (BMI) among obese individuals.

Craniofacial anomalies like micrognathia and retrognathia, enlarged palatine tonsils and uvula, high-arched palate, deviated nasal septum, longer anterior facial height, steeper and shorter anterior cranial base, inferiorly displaced hyoid bone, enlarged tongue, and decreased posterior airway space also predispose to obstructive sleep apnea.

OSA is more prevalent in males than females, and it increases with the age. In a cross-sectional prevalence study, it shows a 4-fold higher prevalence of at least moderate OSA in postmenopausal women as compared with premenopausal women. Interestingly, in postmenopausal women taking hormonal replacement therapy, the prevalence of OSA was found to be similar to that of premenopausal women.[1, 3]In addition,

ethnicity, genetic predisposition, habits like consumption of alcohol, smoking, and sedatives may aggravate existing OSA.[3, 4]

III. Pathophysiology

Pathophysiologic mechanism of snoring and OSA is not yet fully understood. During inspiration a negative intrapharyngeal pressure is developed, but the airway collapse is prevented by the action of the pharyngeal abductor and dilator muscles (Figure 1). These muscles are activated rhythmically during daytime breathing but, they become hypotonic during sleep, and airway stability becomes dependent upon pharyngeal size and its tissue compliance. Apnea occurs when the throat muscles and tongue relax during sleep, partially blocking the opening of the airway. As yet, little is known about the compliance of the pharyngeal tissues. However, conditions that reduce airway dimensions result in OSA.

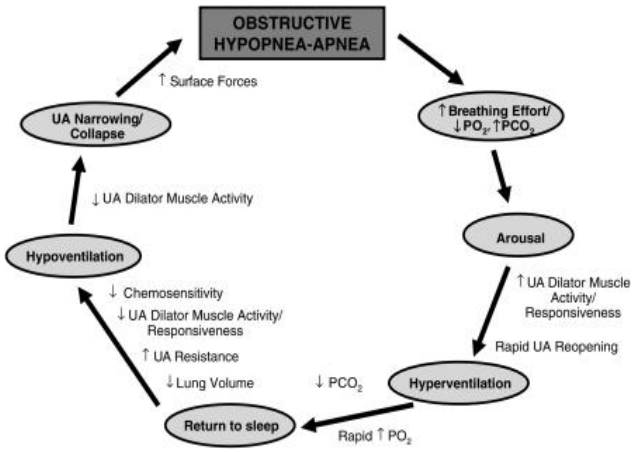

Figure 1: Schematic representation of the typical pathophysiological sequence that occurs in obstructive sleep apnea (OSA) (shown in gray) and the associated physiological processes that occur throughout the cycle that are either protective/restorative (outside the circle) or perpetuating (inside the circle). UA = upper airway.

Adopted from:Proc Am Thorac Soc. 2008 Feb 15; 5(2): 144–153.

IV. Signs and symptoms

Simple snoring is a common complaint and also is a sign of upper airway obstruction.

The most common complaints of patients suffering from OSA are hypersomnolence which is excessive daytime sleepiness and disturbed sleep characterized by heavy snoring and frequent arousal from sleep. After a night of restless sleep, patients often complaints of morning headache and nausea.

Other complaints include poor concentration, temperamental behavior, depression, severe anxiety irritability, xerostomia, poor work performance, occupational accidents and a reduction in social interactions and other aspects of quality of life.[5]Impotence and nocturnal bed-wetting were also reported in some patients.[1]

Recent evidences indicate that OSA is also associated with hypertension, ischemic heart disease, heart failure, cerebral ischemia, and cardiac arrhythmias. Consequently, in view of its high prevalence and its emerging association with cardiovascular morbidity, OSA is considered to be an important public health problem needing intervention.[6]

V. Diagnosis

History: A proper information is gained from the patient regarding the common complaints, onset duration etc.

Physical examination: Reveals an overweight individual, tending to have a short neck and strong masticatory musculature.

Structural abnormalities, includes enlarged tonsils and uvula, macroglossia, nasal deformities, retrognathia and micrognathia, temporomandibular joint derangements and hyperactive gag reflex.

VI. Investigations

Lab tests: Arterial blood gases, electrocardiograms, and pulmonary function tests are often within normal limits. A complete blood count may show an elevated hematocrit level, which may be the result of oxygen desaturation during sleep.[1]

Pulse oximetry has been one of the most popular monitoring techniques used in attempts at screening for sleep apnea at home. Oxyhemoglobin indices from pulse oximetry have been used to screen and predict the severity of hypopnea.

Polysomnogram (PSG) is considered as the gold standard test for diagnosis of OSA. The test involves overnight recording of sleep, oxygenation and breathing pattern. The study records, analysis of apnea, oxygen saturation, changes in heart rate, body position, snoring, desaturation relations, and staging of sleep. The recordings include electroencephalography, electrooculography, electromyography, and electrocardiography.

Lateral cephalograms, CT, MRI, Spirometry and Acoustic reflection tests are also used for the diagnosis of OSA.

VII. Treatment

The treatment of OSA involves lifestyle modifications, medical, dental, and surgical interventions.

Behavioral changes and customized oral appliances are chosen for patients with mild-to-moderate OSA. Behavioral therapies include weight loss sleep position training for improving the airway patency, cessation of alcohol consumption, sedative agents etc.[7, 8]

Continuous positive airway pressure (CPAP) and surgical options are opted for patients with moderate to severe apnea. Continuous positive airway pressure (CPAP) is a type of positive airway pressure, where the air flow is introduced into the airways to maintain a continuous pressure to constantly stent the airways open, in spontaneously breathing people. Benefits of starting CPAP treatment includes reduction or elimination of snoring, better sleep quality, and less daytime sleepiness.[9]

Surgical treatment options include tracheostomy, mandibular osteotomy with genioglossus or inferior border advancement, uvulopalatopharyngoplasty (UPPP), laser-assisted uvuloplasty (LAUP), reduction glossectomy, tonsillectomy and adenoidectomy, internal and external nasal reconstruction, and advancement of the upper and lower jaws. [10]

VIII. Oral appliance therapy

Oral appliances are basically thermoplastic materials with retainers and are usually custom made.Oral appliances are suggested as an alternative treatment option in patients with mild to moderate OSA and for those who cannot tolerate CPAP.

The oral appliances used for OSA are broadly categorized into 3 types:

1. Tongue repositioning devices (TRD), such as the tongue retaining device
2. Mandibular advancement devices (MAD)
3. Soft palate lifters or Palatal lift appliances (PLA)

The tongue retaining device (Figure 2) is a bubble shaped device custom made from casts using of soft polyvinyl material. It consists of a mouthpiece that covers the entire upper and lower dental arches, with a defined mandibular protrusion. The patient's rests his teeth in the custom fitted grooves which are extended to form a bubble that sticks out from between the lips. The patient positions his teeth in the grooves, sticks his tongue forward into the bubble which pulls the tongue slightly forward due to the negative pressure created by the displacement of air from the lingual compartment of the device. Positioning the tongue forward may eliminate any obstruction caused by the base of the tongue. The initial mandibular protrusion is 50% to 75% that of the maximal protrusion. This protrusion distance can be reduced if the patient complains of pain and increased if snoring remains unchanged even after a few weeks. Lateral holes facilitates in mouth breathing.[11, 12] e.g., SnorEx.

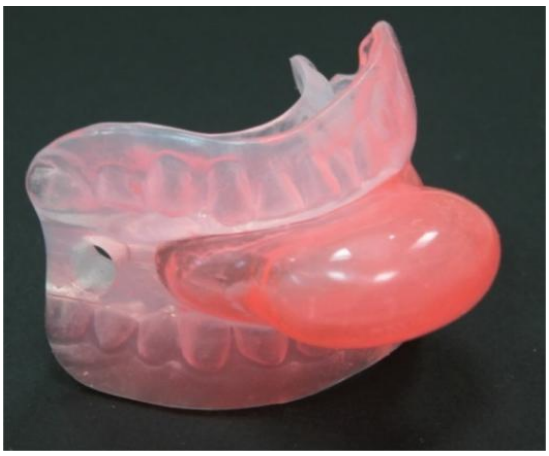

Figure 2: The tongue-retaining device. Tongue protraction is achieved due to the design of the device, which results in a slight negative pressure in the lingual compartment of the device, following the displacement of air once the tongue is placed in this compartment.

Adopted from : J Clin Sleep Med. 2009 Oct 15; 5(5): 431–438.

A palatal lifter appliance (PLA) (Figure 3), as the name suggests, displaces the soft palate superiorly as well as posteriorly in order to assist the soft palate to affect closure with the peripheral pharyngeal tissues and helps to improve the airway passage by increasing the upper pharyngeal dimensions. It is also useful in cases of cleft palate with palatal insufficiency and a submucous cleft, myasthenia gravis, cerebral palsy, bulbar poliomyelitis, and injuries to the soft palate that can occur during surgeries like tonsillectomy and maxillary resection.[13] There are certain advantages of PLAs, such as gag responses are minimized due to its superior positioning and sustained pressure of the lift portion of the prosthesis against the soft palate, the tongue

physiology is not compromised due to superior position of palatal extension, the lift portion can be developed sequentially to aid patient adaptation to the prostheses and it can be used for diverse groups of patients. There are a few limitations where this prosthesis cannot be used, such as in uncooperative patients, cases where there is inadequate retention for the basic prosthesis or in cases where the soft palate is difficult to displace.[14]

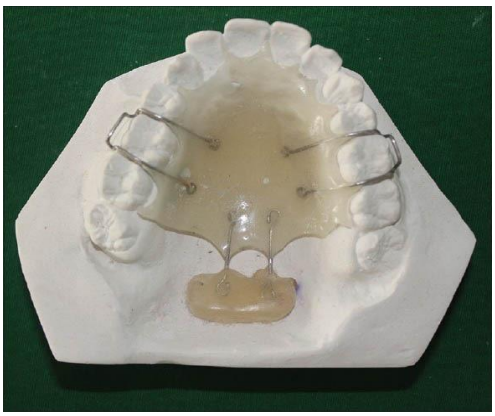

Figure 3: Soft palate lifting appliance

Adopted from: Ann Med Health Sci Res. 2014 Jul-Aug; 4(4): 481–486.

The oral appliance most commonly in use today is the Mandibular Advancement Device (MAD) (Figure 4). It represents the main non-continuous positive airway pressure (non-CPAP) alternative for patients with OSA. As the name implies it protrudes the mandible forward. Mandibular Advancement Device essentially consists of a plastic mould of the teeth which is relatively simple, reversible and cost effective.[15] These devices aims to increase the size of upper airway, reducing the risk of sleep apneas and snoring in patients with OSA. There is a widening of the upper airway in a lateral dimension. The tongue base muscles move anteriorly and the pharyngeal fat pads relocate laterally from the airway which reduces the pharyngeal collapsibility.[15, 16]

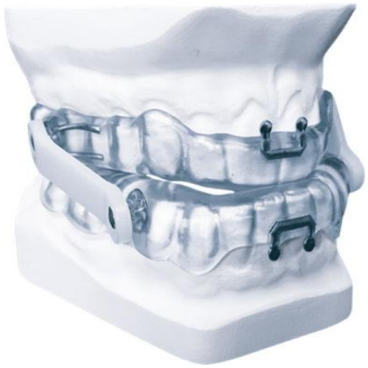

Figure 4: Mandibular advancement device

The degree of mandibular advancement is an important modulator of the treatment outcome, since there is a dose dependent effect on pharyngeal collapsibility and nocturnal oxygenation. Mandibular titration is, therefore, a key procedure when it comes to obtaining optimal effects on OSA using this device. A titration procedure millimeter by millimeter and concomitant measurement of respiratory events during sleep is recommended in order to achieve optimal results. [16]

Mandibular protrusion devices should only be used in patients who has at least 8 teeth in each arch and is able to demonstrate a protrusion of at least 5 mm and a bite opening greater than 25 mm.[17] It is possible that the exact degree of mandibular advancement is of less importance for patients with mild to moderate disease compared with patients with more severe sleep apnea.[16]

Patients preferred devices with a smaller opening, but a mouth opening of 4–14 mm has not been found to influence the treatment outcome in terms of sleep apnea.[18]

Appliances can also be used in combination with partial dentures that replaces no more than 4 teeth. Patients with edentulous maxillary arches and at least 8 teeth in the mandibular arch may be able to wear some mandibular protrusion devices, especially those that are fabricated with heat-softening acrylics. Totally edentulous patients, patients who present with severe TMJ pain, patients with significant bruxism who can frequently damage mandibular protrusion devices probably are not good candidates for treatment with these devices. [17]

MADs exist in various designs and with various types of adjustment mechanism. With adjustable devices, it is easy for the patient as well as the dentist to change the mandibular positioning in order to achieve the desired effects.[16]

The silencer system in MAD incorporates Halstrom Hinge titanium precision attachments at the incisor level, allowing sequential advancement of 2 mm up to 8 mm, lateral movement of 6 mm, (3 mm bilaterally) and vertical pin height replacements. A flat posterior bite plane is also provided for biting. It is the only appliance that allows adjustment in not only in an antero-posterior direction, but also in an 'open and closed' position as it includes a very expensive titanium metal hinge device.[5]

The Klearway oral appliance utilizes a maxillary orthodontic expander to consecutively move the mandible forward. Klearway is a fully adjustable oral appliance used for the treatment of mild to moderate OSA and snoring. Mandibular advancement is initiated by the patient in small increments and this prevents rapid jaw movements that cause significant patient discomfort. Lateral and vertical jaw movements are also permitted which enables more comfort to the patient.[5]

The PM positioner is a material made of thermoplastic material which links the upper and lower splints with bilateral orthodontic expanders. This appliance must be heated in hot tap water every night before it is placed in the mouth. The adjustment hardware is positioned on the buccal aspect of the molar teeth and does not permit any mandibular movement while the appliance is worn.[5]

The Thornton adjustable positioner (TAP) allows for progressive ¼ mm advancements of the jaw via an anterior screw mechanism present on the labial aspect of the upper splint. This appliance has a separate section for the mandible and maxilla. Each portion of the appliance is placed separately into the mouth.[5]

Modified Herbst Appliance design connects upper and lower splints with a piston-post and sleeve adjustable telescopic mechanism on each side of the mouth. It prevents lateral (side to side) motion, but since the mandible is held with small orthodontic rubber bands, opening the jaws is very much easy for the patient.[5]

The elastic mandibular advancement (EMA) is the thinnest and least bulky of all the appliances. It is similar to clear acrylic orthodontic retainers, and uses specially designed patented elastic bands. It moves the jaw forward in fairly significant steps, which might be difficult to tolerate.[5]

DUOBLOC is a custom-made adjustable type mandibular advancement device which has attachments in the front teeth area that allows for progressive advancement of the mandible for the treatment of OSA.[5]

Before placing an appliance to treat OSA clinicians should explain the possible side effects of treatment including the possibility that the appliance may become loose or break dental restorations. Excess salivation, xerostomia, TMJ pain, soreness of the muscles of mastication (masseter muscle), and tooth discomfort are some of the major side effects. These symptoms tend to occur at the beginning of the treatment and their intensity usually increases with time. Patients that are treated with a mandibular protruding device for OSA may find that when they wear the appliance their occlusion feels different for a short while after the appliance is removed. More permanent, but usually relatively minor, occlusal changes have also been reported.[17]

IX. Recent advances

Some patients who appear to have OSA during the diagnostic test develop central sleep apnea on initiation of CPAP. The incidence of this form of atypical apnea, known as Complex Sleep Apnea Syndrome (CompSAS). Patients with CompSAS tolerate CPAP very poorly because of increased sleep disruptions resulting from central sleep apnea events. Although some of those with CompSAS can eventually be treated with CPAP, up to 50% will require the use of a new device known as the adaptive servo-ventilator.[15]

Recently, a new treatment device has undergone a multicenter trial to assess efficacy. Rather than using a machine to generate positive airway pressure (PAP), Provent uses a 1-way valve and maintains a constant pressure in the posterior pharyngeal region. It is a tape-like device worn over the nostrils at night.[15]

Newer oral appliances allow greater lateral movements of the mandible, cover the entire dentition, and provide better retention. Adjustable appliances allow the clinician to calculate the correct amount of mandibular protrusion in order to obtain an adequate treatment response. Patients report high levels of compliance with oral appliance therapy, which can be objectively confirmed with an intraoral compliance monitor. Several studies are currently underway to study the effects of adjustable oral appliances vs. CPAP in the treatment of OSA.[17]

There should be continued exploration of the problems in compliance and the long-term side effects of these appliances to assist in predicting an appropriate treatment response. Late recurrences of snoring and other symptoms, in the absence of weight gain or any other obvious cause, do occur and require monitoring of therapy.[19]

X. Conclusion

Oral appliances play a major role in the non-surgical management of sleep apnea syndromes and have become the first line of treatment in almost all patients suffering from OSA. Compliance with oral appliances depends mainly on the balance between the perception of benefit and the side effects. Many patients experience

a complete or partial resolution of their symptoms, while for some others it may not improve or may even become worse. It is therefore crucial that physicians conduct progress evaluations while the respective dental care provider continues to make adjustments to optimize the effectiveness of the appliance chosen for the treatment. As dental professionals, we have a significant role to play in the early diagnosis, management and care of patients suffering from sleep apnea. There is a vast space that's left unexplored in OSA research. Hope future research will help to explore further and generate evidences and identify the types of patients who are suitable for a specific kind of OSA treatment.

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