Dental Considerations in Obstructive Sleep Apnea Patients: A review

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Abstract
Upper airway sleep disorders are becoming recognized common medical concerns. The management and treatment of obstructive sleep apnea patients have long since been addressed by medical personals. Recently, dental participation in management of the patients through oral devices has been accepted as a recommended treatment modality by the American Sleep Disorders Association. As dental professionals, we have significant role to play in the early diagnosis, management and care of patients suffering from sleep apnea. This article reviews the etiology, clinical features, management and dental perspective of obstructive sleep apnea.

Keywords
Obstructive sleep apnea; Sleep disorders; Snoring; Oral devices

Introduction
Approximately 3% of the middle aged population suffers from excessive day time sleepiness that may be the result of frequent night time sleep interruptions caused by upper airway disorders (Smith et al., 1985). Excessive sleep interruptions may interfere with the health and lifestyle of persons, causing them to be less productive in their work, to suffer an increased number of automobile and work related accidents and sometimes be associated with potentially life threatening medical conditions like pulmonary hypertension, acute pulmonary edema and systemic hypertension etc.

Sleep disordered breathing (SDB) is a term which includes simple snoring, upper airway resistance syndrome (UARS) and sleep apnea (Brown, 1994). Simple snoring is a common complaint affecting 45% of adults occasionally and 25% adults habitually and is a sign of upper airway obstruction. Snoring has also been identified as a possible risk factor for hypertension, ischemic heart disease and stroke (Waller et al., 1989; Palomaki et al., 1991).

The role of dentistry in sleep disorders is becoming more significant, especially in co-managing patients with simple snoring and mild to moderate obstructive sleep apnea (OSA). The practicing dental professional has the opportunity to assist patients at a variety of levels, starting with the recognition of a sleep related disorder, referring them to a physician for evaluation and assisting in the management of sleep disorders especially during fabrication of oral devices. Almost every discipline in dentistry needs to be aware of sleep disorders and their potential impact.

Sleep apnea syndrome is a sleep interference disorder characterized by apneic and possibly hypopneic events, resulting in low oxygen levels to the lungs (hypoxia), blood oxygen de-saturation and a sleep arousal or awakening (Strohl et al., 1996; Caples et al., 2005).

Types of Apnea
Sleep apnea is probably the most prevalent of all the sleep disorders and is classified as central, obstructive, or mixed; it may be mild, moderate or severe. Apnea is defined as cessation of airflow that lasts for at least 10 seconds (Lowe et al., 1997; Peker et al., 2000).

Central sleep apnea (CSA) occurs when the brain fails to send appropriate signals to the breathing muscles to initiate respiration. It is often secondary to central nervous system diseases such as infarction and...
infection involving the brain stem or due to neuromuscular diseases involving respiratory muscle.

**Obstructive sleep apnea (OSA)** occurs due to obstruction caused by collapse of soft tissue structures in the oropharynx or hypopharynx. OSA when combined with the excessive day time sleepiness is termed obstructive apnea syndrome.

A patient with a combination of CSA and OSA is said to have mixed sleep apnea. Mixed apnea occurs more often than central but less often than obstructive apnea.

The American Academy of Sleep Medicine (AASM) rates the average number of obstructive sleep apnea events per hour as respiratory distress index (RDI). An RDI of 0 to 5 is normal; 5 to 20 is mild; 20 to 40 is moderate and over 40 is considered severe (Young et al., 1993; He et al., 1988).

**Etiology** (Swedish Medical Research Council, 1994; Gula et al., 2004)

- **Obesity**: Fatty cells are known to narrow the airway.
- **Alcohol or any other substance abuse**: They influence the brain, which stimulates respiration. This may cause relaxed breathing muscles and blockage of the airways.
- **Mouth breathing**: It may lead to certain structural abnormalities in the facial area which may contribute to sleep apnea.
- **Medication**: Certain medication used for emotional purposes are known to relax breathing muscles.
- **Asthma**: Asthma cramps the airway, which may result in a blockage of the throat.
- **Acid reflux**: It can cause heavy scar tissue in the throat which may cause obstructions in the airways.
- **Smoking**
- **Bad body posture**

Studies have indicated that the genioglossus and tensor veli muscles may have increased activity in the awake OSA patients and thus help maintain the shape of the upper airway. However, when the patient assumes a supine position and goes to sleep there is a decrease in the activity of these muscles that results in a decreased airway space which may result in an increase in the velocity of the air passing through the airway increasing the degree of sub atmospheric pressure. The combination of increased negative pressure and decrease in muscle activity allows the tongue and soft palate to move toward and often contact the posterior wall of the oropharynx, resulting in a decreased airway space ultimately causing snoring and/or OSA (Schwab et al., 1995; Tangugsorn et al., 1995).

The other possible causes of obstruction are deviated nasal septum, polyps, enlarged adenoids, enlarged tonsils and uvula, enlarged base of tongue, tongue base falling into pharyngeal airway, submucosal fat or redundant mucosa. Davies et al found that men and women were at greater risk for OSA if they had neck circumferences of 17 and 16 inch or greater, respectively (Davies et al., 1990). Pae et al also showed that the thickness of the soft palate increases and the oropharyngeal cross section area decreases when a patient changes form an upright to supine position (Pae et al., 1994).

**Clinical Features**

- **Snoring**
- **Sleepiness during the daytime and even falling asleep during normal activities such as eating or driving.**
- **Lowered concentration and learning difficulties**
- **Excessive fatigue**
- **Having headaches for a longer period of time.**
- **Heart burn**
- **Need to urinate and excessive sweating during sleep**
- **Cramped feeling in the chest area**
- **Choking sounds during sleep**
- **Gasping for air**
- **Restlessness**
- **Increased blood pressure**
- **Depression**

Many patients who suffer from severe obstructive sleep apnea are at a high risk of

- **Obesity**
- **Heart failure**
- **Strokes**
- **Fatty liver (fat in the liver cells)** (Tsai et al., 2007).
Diagnosis
It is difficult to recognize this disorder. Partner is the first one to notice the symptoms. For patients who are under the impression that they suffer from this disorder, it is considered wise to keep a sleeping diary which is done by either tapping the sounds patient make while sleeping or writing down patient’s sleeping habits.

When visiting the doctor, ask the patient to bring the sleeping diary with him, this helps the doctor to determine the condition of the patient.

Patient assessment
1. **BMI**
   Patients who snore are commonly overweight, and one of the first lines of management is to encourage patients to attain the ideal weight for their height which is determined by calculating the Body Mass Index (BMI), done by dividing weight in Kg by height in meter squared. A BMI greater than 25 is considered overweight.

2. **Epworth**
   Patients with significant obstructive sleep apnoea usually fall asleep easily during normal activities and this is assessed by a *simple questionnaire* which gives a result known as the Epworth score. Scores of 16 and above are suggestive of significant OSA (Johns, 1991).

3. **Sleeping position**
   It is well known that many snorers only make a noise when sleeping flat on their back. Patients are to encourage sleeping on their side.

4. **Alcohol**
   Alcohol causes relaxation of the pharyngeal muscles and therefore they tend to collapse and narrow the pharyngeal lumen cross-sectional area. This is particularly enhanced during deep sleep and increases the tendency to snore. It is suggested that snorers should avoid alcohol after 7pm.

5. **Drugs**
   Sedative drugs have the same effect as alcohol in that they precipitate relaxation of the pharyngeal muscles. Sedative drugs such as ‘sleeping tablets’ or antidepressants should be used at the minimum effective dose under the supervision of the patient's General Practitioner.

6. **Nasal airway**
   The first point of narrowing of the upper airway is the nasal airway. If the nose is blocked then the patient makes increased effort to breathe in. Eventually the patient may breathe with the mouth partly open and this increases the chance of snoring. Also the increased effort of inspiration results in negative pressure in the pharynx which leads to inwards collapse of the loose membranes at the back of the throat and precipitates snoring.

7. **Pharynx**
   Examination of the throat may show a persistent narrowing of the airway at the back of the mouth (oropharynx). This is commonly due to enlarged tonsils or enlargement (hypertrophy) of the lymphoid tissue at the back of the tongue. Sometimes there is a broad flap of mucosal membrane hanging down from the edge of the soft palate which need to be corrected in order to maximize the upper airway during sleep and reduce snoring.

8. **Mallampati scale**
   It is the grade of upper airway obstruction: 4 grades are present. Higher the grade, smaller the airway:-indication of sleep disordered breathing.

9. **Oximetry**
   The only alternative to polysomnography at present is a procedure called overnight oximetry which measures a patient's oxygen saturations throughout the night. Oximetry is not valid in those receiving oxygen therapy (Chiner et al., 1999).

10. **Multiple Sleep Latency Test (MSLT)**
    MSLT measures the speed of falling asleep and the level of daytime sleepiness. The average adult requires 10 or more minutes to fall asleep during the day. A mean sleep latency of less than five minutes is considered abnormal (Chervin et al., 2000).

**Polysomnography**
Patient is recommended an overnight sleep study in a sleep lab under the observation of a trained health care provider known as polysomnography (Chervin et al., 1999). A polysomnograph shows a patient’s brain
activity, heart rate, eye movement and respiratory activity during sleep. This test will help to determine if the patient does or does not suffer from sleep apnea. Electrodes on the chest, scalp and eyelids will send off messages to the health care provider. These electrodes will measure the time it takes for the patient to fall asleep and the time it takes to fall in REM (Rapid Eye Movement) sleep. Also, a video camera will monitor the patient’s movements. All these components will determine if and how often the patient stops breathing during the night. It is important to avoid any alcohol or caffeine before the test as this may cloud the test results. After the polysomnography the right diagnosis will be determined and the patient will be informed on possible treatments.

Treatment

Nonsurgical Treatment

1. CPAP Machine

Sufferers of sleep apnea are often prescribed a CPAP, also sometimes referred to as “the sleep apnea machine”. CPAP stands for Continuous Positive Airway Pressure (Bohadana et al., 2002, Raphaelson et al., 1998; Sleep, 2002). This machine over-rides the apnea sufferer’s tendency to not breathe by “forcing the issue” a bit, by constantly presenting a certain level of air pressure, breathing is reinforced and the airway is prevented from collapsing, resulting in a nice, continuous flow of oxygen to the lungs and by extension, to the blood and brain. In recent years, they have become smaller and quieter (which, along with providing a solution to the apnea sufferers breathing difficulties, helps enhance the sleep environment).

CPAP machines use filters which help protect the user from breathing in certain particulates. These filters should be replaced on a regular basis (this is somewhat dependent on the environment where the machine is used).

The CPAP mask comes in a variety of shapes and sizes.

a) Some provide only a small connection to the nostrils
b) Some cover the entire nose
c) Some “full-face” masks cover the nose and mouth.

Getting used to a mask can take some effort and a lot of patience

- BiPAP machines (or bilevel PAPs)
  It adds another feature to breathing enhancement, by lowering the pressure during exhalation. This makes the breathing process easier for some apnea sufferers (Reeves-Hochi et al., 1995; Engleman et al., 1996; Martinez-Garcia et al., 2006).

- AutoPAP
  Employs an internal regulator which adjusts the pressure as needed, rather than remaining at a fixed level.

2. Nasal Sprays

a) Topical nasal steroid sprays eg: Beconase or Rhinolast
b) Nasal decongestant sprays eg. Otrivine or Ephedrine.

The decongestant sprays must be used sparingly for periods of maximum one week in order to reduce risk of damage to the nasal lining.

3. Palate Sprays

Sprays are available which are applied to the soft palate before bedtime. They act as a mild irritant to the palate and can help reduce snoring noise. Generally the effect is not long-lasting

4. Drugs

Snoring is usually most marked during REM sleep. This is when the pharyngeal muscles are maximally relaxed. Drugs such as protoptryline are used to reduce the REM phase of sleep and consequently shorten the period of snoring.

5. Oral Appliances

Most effective treatment for mild to moderate obstructive sleep apnea.

Oral appliance therapy involves selection and fitting of a custom made appliance, worn at night and designed to maintain an open unobstructed airway during sleep.

A custom oral appliance worn while sleeping, they hold the lower jaw forward and open, preventing the tongue and throat tissues from collapsing the critical airway. There is a 96%
success rate (snoring) for people treated with these appliances.

Types of Oral Appliances

A. Mandibular advancement devices (MAD)
B. Tongue repositioners (TR)

The dentist chooses whether an MAD or TR is appropriate based on:
- The number of healthy teeth
- Status of the TMJ
- Patient preference

A Mandibular Advancement Devices

The mandibular advancement devices work by positioning the lower jaw and tongue downward and forward. The airway passage is increased not only by the forward positioning of these structures, but also by increasing the tension of the airway muscles. The result is an increase in the size of the airway as well as less relaxation of the muscles associated with the maintenance of the airway during sleep (Meyer et al., 1990; Knudson et al., 1992; Sadan et al., 1998; Kurtulmus et al., 2009).

Various mandibular advancement devices available in market are:

1. Thornton Adjustable Positioner (TAP)
   It is a mandibular advancement device composed of two separate arches (maxillary and mandibular) containing an advancing mechanism which permits unlimited advancement of the lower jaw.
   
   The arches are custom fit to a patient's models.
   
   The advancing mechanism is engaged and the screw mechanism in the upper tray is then turned to advance the mandible until the patient begins to feel any discomfort in the temporo-mandibular joint or in the facial muscles (maximum mechanical protrusion which is an average of 2.5mm beyond maximum protrusion).
   
   The advancing screw is then turned back until patient is comfortable.

2. SomnoMed MAS
   It is a Mandibular Advancement Splint (MAS) that treats both snoring and obstructive sleep apnea (OSA), by advancing the lower jaw forward. It is a custom-made device consisting of upper and lower dental plates with a unique patented fin-coupling mechanism. If required, a component can be added to make the device adjustable. This feature provides incremental and adjustable levels of jaw advancement, which improves the effectiveness and comfort-level of treatment as the jaw is moved only as far as is required to alleviate snoring and reduce OSA.

3. OASYS
   Oral/Nasal Airway System It is the first dental device to be reviewed by both the dental and ENT divisions of the FDA and to be approved as a dental device for treatment of snoring and sleep apnea through mandibular repositioning and also as a nasal dilator for reduction of nasal resistance and improved nasal breathing. To understand the way the dilator works, close your lips and hold your teeth together while breathing slowly through your nose for several breaths. Now allow air to fill your upper lip and try the breathing again. Notice how much easier it is to inhale? This is why the OASYS is designed this way.

4. Silent Nite
   This device does not interfere with breathing through the mouth, and is one of the more comfortable designs. It is not made for severe grinders, but it is a comparatively small device with tiny connectors attached to transparent flexible upper and lower forms.

5. Silencer Professional
   A laboratory fabricated fully adjustable oral appliance. The appliance features a titanium precision attachment, which controls the anatomical settings of the appliance. It is capable of anteroposterior adjustment as well as vertical adjustment through a range of 10mm, in both dimensions. The design of the precision attachment also allows lateral movement of the mandible which protects the TMJ.

B Tongue Repositioning Devices

Tongue repositioners work by pulling only the tongue forward and not the entire lower jaw.

Advantage
The teeth, jaw muscles and joints are less affected.

Disadvantage
Less chance of success due to inadequate retention during sleep.
Tongue Repositioners

1. Tongue Retaining Device. The "TRD" is constructed of a flexible polyvinyl material adapted to the general contours of the teeth and dental arches. It does not depend on teeth for retention. The tongue is held forward by the negative pressure created in the vacuum bulb on the front of the appliance.

2. AveoTSD, or "Tongue Stabilizing Device" The aveoTSD is made from a soft medical silicone for comfort and works by holding the tongue forward by gentle suction preventing it from falling back against the back of the throat, keeping the airway open during sleep (George et al., 1987; Schmidt-Nowara et al., 1991; Meyer-Ewert et al., 2002; Wade, 2003; Chen et al., 2012).

Adverse Effects of Oral Appliances (Ferguson et al., 2006; Chan et al., 2007; Ogawa et al., 2015; Ballanti et al., 2015).

Short-term adverse effects
- Excessive salivation
- Mouth dryness
- Tooth pain
- Gum irritation
- Headaches
- Temporomandibular joint discomfort
- Myofascial pain
- TM joint sounds
- Morning-after occlusal changes

Long-term adverse effects
- Reduction in overjet
- Increase in facial height
- Increase in mandibular plane angle
- Increase in degree of mouth opening
- Changes in inclination of incisors
- Gagging (soft palate lifter mostly)

Compliance (Hoffstein, 2007)
Compliance with oral appliances depends strictly on the balance between the perception of benefit and side effects. Most patients treated with oral appliances have relatively mild sleep apnea and relatively few daytime symptoms; the main reason for treatment was snoring. Consequently, the perception of benefit is generally that of the bed partner, whereas the side effects are experienced by the wearer of the appliance.

This is why the assessment of compliance is a complex issue. In some cases, although the appliance is quite comfortable, the patient may stop wearing it if the bed partner is no longer present or no longer complains of snoring.

Surgical Treatment

1. Septal surgery
The nasal airway is separated into right and left by a vertical plate of cartilage and bone known as the septum. A common reason for permanent nasal blockage is a deviated (twisted) septum. This can be improved by 'septoplasty'. An incision is made inside the nostril and the twisted piece of cartilage is removed or reshaped.

2. Turbinate surgery
Often septal surgery is combined with an operation to reduce the size of the fleshy internal nasal swellings called turbinates.

3. Tonsillectomy
Some patients whose main problem is that of narrowed pharyngeal airway due to big tonsils, may be completely cured of snoring by simply removing the enlarged tonsils.

4. Reduction of uvula
The piece of fleshy tissue that dangles down from the centre of the palate at the back of the throat is called the uvula. Sometimes it seems excessively long and broad and obstructs breathing when the patient is lying down and asleep. Uvula may be shortened to reduce snoring.

5. Uvulopalatoplasty (UVP)
The uvula, edge of soft palate and tonsils are all removed together.

6. Tracheotomy
A hole in the trachea or windpipe allows air to travel through the airways. This is a treatment for patients who suffer from severe cases of sleep apnea and have tried other treatments without results (Fujita et al., 1981; Tiner, 1996; Mehra et al., 2000; Payen et al., 2010).

Conclusion
Obstructive Sleep apnea is a damaging condition that can disturb the sleep of both the sufferer and his/her partner. It’s actually very serious problem and can
have a long list of negative effects on patient’s health. So definitive care should be taken to get rid of this problem and avoid risks to health. Dental treatment has been showed to be a successful and conservative method to treat mild to moderate OSA. It should be considered by the medical profession over more invasive treatment modalities or in patients who do not respond to behavioral modifications.

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