OSAS (Obstructive Sleep Apnea Syndrome): evaluations and main therapeutic solutions in dentistry

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OSAS (Obstructive Sleep Apnea Syndrome): evaluations and main therapeutic solutions in dentistry

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Abstract

Obstructive sleep apnea syndrome (OSAS) is a common chronic disorder (with a prevalence of about 2-4%) characterized by repetitive episodes of breathing cessation due to complete or partial collapse of the upper airway therefore affecting ventilation. If untreated, OSAS can lead to significant neurological problems (such as stroke, cognitive decline, depression, headaches, peripheral neuropathy, and nonarteritic ischemic optic neuropathy), but treatment reverses some of these neurological problems. The treatment for OSAS depends on the factors causing the obstruction: there are several possible treatments, that range from a change in behavior to facial surgery. Treatment includes weight loss, continuous positive airway pressure (CPAP), oral appliances and upper airway surgery. Oral appliance is an effective treatment option for people with mild to moderate OSAS who either prefer it to CPAP or are unable to successfully comply with CPAP therapy. They increase the size of the upper airway (by either advancing the mandible or the tongue) and offer an alternative that may be attractive for OSAS patients dissatisfied with other therapies or unwilling to accept more complex interventions.

This article provides an update to previous recent reviews. It provides an overview of the effectiveness of treatment, the predictors of treatment success, adherence and the potential adverse effects associated with this treatment. This chapter only focuses on the use of oral appliances in the adult population.

Introduction

Obstructive sleep apnea syndrome (OSAS) is a sleep-related breathing disorder that involves a decrease or complete halt in airflow despite an ongoing effort to breathe. It is a disorder characterized by intermittent narrowing (hypopnea) and/or total closure (apnea) of the upper airway during sleep. It occurs when the muscles relax during sleep, causing soft tissue in the back of the throat to collapse and block the upper airway. This leads to partial reductions (hypopneas) and complete pauses (apneas) in breathing that last at least 10 seconds during sleep. Most pauses last between 10 and 30 seconds, but some may persist for one minute or longer. This can lead to abrupt reductions in blood oxygen saturation, with oxygen levels falling as much as 40 percent or more in severe cases. The intermittent lack of air flow during these events leads to episodic oxyhemoglobin desaturations (intermittent hypoxemia).

The brain responds to the lack of oxygen by alerting the body, causing a brief arousal from deep sleep that restores normal breathing. This pattern can occur hundreds of times in one night. The result is a sympathetic activation, sleep fragmentation that often produces an excessive level of daytime sleepiness (increased risk of car crashes). Due to intermittent hypoxemia and sympathetic activation, patients with severe OSAS are exposed to long term cardiovascular consequences (resistant arterial hypertension, stroke, myocardial infarction, cardiac arrhythmias).

Discussion

Most people with OSAS snore loudly and frequently, with periods of silence when airflow is reduced or blocked. They then make choking, snorting or gasping sounds when their airway reopens. Furthermore, OSAS has a strong genetic component, and creates a proinflammatory state with elevated TNFα and other cytokines.

A common measurement of sleep apnea is the apnea-hypopnea index (AHI) that is an average that represents the combined number of apneas and hypopneas that occur per hour of sleep.

OSAS can occur in any age group, but prevalence increases between middle and older age. It is more common in men than in women: OSAS with resulting daytime sleepiness occurs in at least four percent of men and two percent of women.

It is also more likely to develop in African-Americans, Hispanics, and Pacific Islanders than in Caucasians. The likelihood of developing the condition increases
With age. For women, the condition is more likely after menopause. OSAS occurs in about two percent of children and is most common at preschool ages.

The prevalence of OSAS in the general population is approximately 20% if it is defined by an apnea-hypopnea index (AHI) of more than five events per hour; it decreases to 2-9% if OSAS is defined by an AHI of more than five events per hour and daytime sleepiness. About 80-90% of adults with OSAS remain undiagnosed.

OSAS can be classified into three types:
- Mild OSAS (AHI of 5-15): involuntary sleepiness during activities that require little attention, such as watching TV or reading;
- Moderate OSAS (AHI of 15-30): involuntary sleepiness during activities that require some attention, such as meetings or presentations;
- Severe OSAS (AHI of more than 30): involuntary sleepiness during activities that require more active attention, such as talking or driving.

Sleep apnea is more common among people with thick or large necks. The condition is also more common among people who have smaller airways in their noses, throats, or mouths. The small airway could be related to the actual size and shape of the airway, or to obstructions or other medical conditions that are causing obstructions.

Risk groups include:
- People who are overweight (Body Mass Index of 25 to 29.9) and obese (Body Mass Index of 30 and above);
- Large neck sizes (17 inches or more for men, 16 inches or more for women);
- Middle-aged and older men, and post-menopausal women;
- Ethnic minorities;
- People with abnormalities of the bony and soft tissue structure of the head and neck;
- Down Syndrome;
- Children with large tonsils and adenoids;
- Family predisposition;
- People with endocrine disorders (acromegaly and hypothyroidism);
- Smokers;
- Those suffering from nocturnal nasal congestion due to abnormal morphology, rhinitis or both.

This common chronic disorder may have several effects:
- Fluctuating oxygen levels;
- Increased heart rate;
- Chronic elevation in daytime blood pressure;
- Increased risk of stroke;
- Higher rate of death due to heart disease;
- Impaired glucose tolerance and insulin resistance;
- Impaired concentration;
- Mood changes;
- Increased risk of being involved in a deadly motor vehicle accident;
- Disturbed sleep of the bed partner.

The most common obstructive sleep apnea symptoms are shown in Table I.

Table I. The most common obstructive sleep apnea symptoms. Symptoms of OSAS in children may not be as obvious.

It is therefore important to recognize, adequately diagnose and subsequently treat this medical condition.

The diagnostic approach includes: patient history (snoring, witnessed apneas, daytime somnolence), clinical examination (obesity, large neck size, systemic hypertension), screening (overnight continuous pulse-oximetry) and diagnostic confirmation by cardio-respiratory polygraphy and/or polysomnography (determination of Apnea-hypopnea Index, that is the number of apneas and hypopneas per hour of recording or sleep time).

Sleep apnea must first be diagnosed at a sleep center or lab during an overnight sleep study, or "polysomnogram." The sleep study charts vital signs such as brain waves, heart beat and breathing. Nocturnal pulse-oximetry is a screening method used in the diagnostic approach of OSAS: it is not recommended for the definitive diagnosis of this chronic disorder (or to esclude its presence), but it may be used as a screening method for patients with high clinical pre-test suspicion. In fact, in OSAS the qualitative analysis of nocturnal pulse-oximetry curve has a distinct "sawtooth" pattern (intermittent hypoxemia). The gold standard is the polysomnography: it establishes the definitive diagnosis.

The Desaturation Index (DI) is the number of independent desaturations starting from the baseline per hour of recording and it is used to estimate the existence and severity of OSAS. By calculating it we could refer the patient for diagnostic confirmation. The Desaturation Index evaluated by overnight pulse-oximetry in patients with morbid obesity (BMI > 40 Kg/m²) may not reflect the severity of OSAS as accurately for non obese patients (BMI < 30 Kg/m²), as the pattern of nocturnal pulse-oximetry is different in patients with morbid obesity. In morbidly obese patients with OSAS the pulse-oximetry curve is often characterized by a combination between "continuous hypoxemia" and "intermittent hypoxemia": in fact, in
these patients the hypoventilation in supine position during sleep produces a decreased basal nocturnal saturation. However, assessment of the Desaturation Index by nocturnal pulse-oximetry maintains its utility as a screening method for OSAS in both obese and non obese patients with clinical pre-test suspicion (despite the fact that the basal nocturnal saturation is lower in the morbidly obese patients).

The cardiorespiratory polysomnography (PSG) is performed in a sleep laboratory or sleep center and it is the reference standard for many sleep disorders, where manifestations of events can be observed during the night. Cardiorespiratory PSG requires the recording of several physiological signals during the night under standardized conditions with the attendance of trained sleep medicine personnel. After the recording of the physiological parameters the signals are scored by a sleep technician and thereafter validated by a sleep physician. Altogether this validated and approved approach is a time consuming process.

The treatment for obstructive sleep apnea syndrome depends on the factors causing the obstruction. There are several possible treatments that range from a change in behavior to facial surgery. The aim of treatment is to open the airway and restore normal breathing during sleep and to alleviate the bothersome symptoms, such as daytime fatigue and snoring. Treatment may also help lower blood pressure and decrease risks for stroke, diabetes, and heart disease.

Based on a sufficient diagnosis in the sleep centre the appropriate treatment can be initiated. If untreated, OSAS can lead to significant neurological problems that include stroke, cognitive decline, depression, headaches, peripheral neuropathy, and nonarteritic ischemic optic neuropathy (NAION). Treatment reverses some of these neurological problems. Usually the treatment is chronic due to the chronic nature of the OSAS. In the case of sleep-disordered breathing (SDB) the therapy is often a home ventilation system, that is more of a physical support than a causative cure. The chronic therapy should be monitored over time with intervals of several months, at least once per year. As a consequence, diagnostic strategies are again needed for the treatment follow-up studies in these patients.

**Table II.** The treatment for OSAS depends on the factors causing the obstruction. There are several possible treatments for obstructive sleep apnea, that range from a change in behavior to facial surgery.

**Behavioral changes:**

Weight loss benefits many people with sleep apnea, and changing from back-sleeping to side-sleeping may help those with mild cases of OSAS.

- **Over-the-counter remedies:** although some external nasal dilator strips, internal nasal dilators, and lubricant sprays may reduce snoring, there is no evidence that they help treat OSAS. They may even mask the problem by muting the loud snoring that is a warning sign for sleep apnea.

- **Position Therapy:** a treatment used for patients suffering from mild OSAS. Patients are advised to stay off of the back while sleeping and raise the head of the bed to reduce symptoms.

**Continuous positive airway pressure (CPAP):**

Currently, it is the preferred initial treatment for most people with obstructive sleep apnea. In fact, CPAP is the standard treatment option for moderate to severe cases of OSAS and a good option for mild sleep apnea. First introduced for the treatment of sleep apnea in 1981, CPAP provides a steady stream of pressurized air to patients through a mask that they wear during sleep. With CPAP, patients wear a mask over their nose and/or mouth. An air blower forces air through the nose and/or mouth. The air pressure is adjusted so that it is just enough to prevent the upper airway tissues from collapsing during sleep. The pressure is constant and continuous. CPAP prevents airway closure while it is being used, but apnea episodes return when CPAP is stopped or it is used improperly. This airflow keeps the airway open, preventing pauses in breathing and restoring normal oxygen levels. Newer CPAP models are small, light and virtually silent. Patients can choose from numerous mask sizes and styles to achieve a good fit. Heated humidifiers that connect to CPAP units contribute to patient comfort. However, some patients are unable to tolerate and comply with CPAP on a long-term basis. Other styles and types of positive airway pressure devices are available for people who have difficulty tolerating CPAP.

**Oral appliances:**

Oral appliances are used by dentists for many purposes, including correction of varuous types of occlusal disorders. They are now widely used for the treatment of snoring and mild-to-moderate OSAS, both as primary therapy and as an alternative for patients who are unwilling or unable to tolerate CPAP. It is a simple, reversible, quite and cost-effective therapy for selected patients with OSAS. Oral appliances look much like sports mouth guards, and they help maintain an open and unobstructed airway by repositioning or stabilizing the lower jaw, tongue, soft palate or uvula. Some are designed specifically for snoring, and others
are intended to treat both snoring and sleep apnea. They should always be fitted by dentists who should be knowledgeable in sleep medicine and have skills and experience in oral appliance therapy, with a written referral and a copy of the sleep diagnostic report.

However, oral appliances as therapy for OSAS remain underutilised. The techniques often modify the position of the mandible within the restricted mobility defined by the temporo-mandibular joint (ATM) and the pterygoid muscles. For all appliances, proper fitting and allignment is important. A large number of different oral appliances are currently available for the treatment of OSAS and they can be divided into two groups:

- those that reposition the mandible and the attached tongue, the mandibular advancement splint (MAS) or mandibular advancement device (MAD);
- those that hold the tongue forward, the tongue retaining device (TRD).

Oral appliances improve OSAS because of an increase in upper airway size, the provision of a stable anterior position of the mandible, advancement of the tongue or soft palate, and possibly by a change in genioglossus muscle activity. In fact, the goal of therapy with an oral appliance is to modify the position of upper airway structures so as to enlarge the airway or otherwise reduce its collapsibility. Moreover, these devices have important effects on muscle function or airway compliance. The appliances must be comfortable for the patient, because this is a long-term commitment for them: they can be used in cooperative patients who are motivated to wear the oral appliances during sleep.

The mandibular advancement splints (MAS) are most widely used and utilise traditional dental techniques to attach the appliance to both dental arches and maintain the mandible in a forward position. Some MAS are available in a prefabricated form and are sometimes referred to as “boil and bite”, but have limited efficacy. These can either be fitted by the patient, themselves, or moulded to the patient’s teeth in an office setting. Determining the optimal degree of mandibular advancement is the most important step when using MAS therapy successfully. MAS have been developed with an adjustable hinge that allows progressive advancement of the mandible, after initial construction, until the optimal mandibular position is achieved. MAS sometimes include anterior tubes or openings that allow for oral breathing or pressure relief. MAS have been further developed to allow lateral jaw movement, as well as some degree of vertical jaw opening. MAS can made of thermosensitive acrylic resin materials (which the patient can heat in hot water prior to insertion and that cool and harden intraorally) or traditionally designed cold-cure acrylic MAS: the first type provide considerably more retention than the traditional MAS.

The other major type of oral appliance available is the tongue stabiliser device (TSD), which keeps the tongue in an anterior position during sleep by means of negative pressure in a softplastic bulb. It fits over both the mandibular and maxillary arches and has a flange that is placed between the lips and teeth, keeping the appliance stable in the mouth. This appliance was one of the first to be developed and is available in both a fabricated and prefabricated form. It has recently been evaluated for dentate patients. It is mainly used in edentulous patients and is the oral appliance of choice for patients with no teeth, limited anterior-posterior mandibular movement or a very large tongue.

Mandibular advancement device (MAD): its construction requires dental impressions, bite registration and fabrication by a dental labo. However, some appliances are available in a prefabricated form with a thermolabile material that can be molded to the patient’s teeth in the clinician’s office. Several appliances allow readjustment of the mandibular position after initial construction, but for other this requires refabrication of the entire devices.

There are other minor design differences in currently available oral appliances that may also impact on their success and treatment adherence.

The tongue retaining device (TRD): this second class of oral appliances is designed to keep the tongue in an anterior position during sleep. The TRD was first described in 1982. It consists of a mouthpiece that covers the entire upper and lower dental arches, with a defined mandibular protrusion. The tongue retaining device (TRD) is a customized monobloc oral appliance that associates moderate mandibular protrusion with the maintenance of the tongue in an anterior position. This device secures the tongue by means of negative pressure in a soft plastic bulb; a flange (between lips and teeth) holds the device and tongue anteriorly. So, it pulls the tongue slightly forward due to the negative pressure created by the displacement of air from the lingual compartment of the device. Moreover, it modifies mandibular posture, at least by downward rotation.

The TRD is custom made from casts of the tongue and teeth using a soft copolymer. The initial mandibular protrusion is 50% to 75% of maximal protrusion. This protrusion distance is reduced if the
patient complains of pain and is increased if snoring. The main reasons for discontinuing TRD use are discomfort or sensation of a foreign body, pain, excessive salivation, excessive mouth dryness and esthetic reasons. The presence of a nasal obstruction (anatomic or secondary to allergic rhinitis) is a negative predictor of good compliance. This device is fabricated by a dental impression, but a prefabricated version is available too. Its tolerance has appeared to be lower than that of MAD.

Table III. Side effects of oral appliances.

Compliance is very important and patients need instructions regarding the proper use of all oral appliances. In fact, some patients do not initially use these devices for the whole night (adaptation is fundamental).

Surgery:

Surgical procedures are a treatment option for OSAS when noninvasive treatments such as CPAP or oral appliances have been unsuccessful. There are many types of surgical procedures, often performed on an outpatient basis. Surgery is reserved for people who have excessive or malformed tissue that is obstructing airflow through the nose or throat. In fact, it is most effective when there is an obvious anatomic deformity that can be corrected to alleviate the breathing problem (deviated nasal septum, markedly enlarged tonsils, or small lower jaw and a large tongue that causes the throat to be abnormally narrow). These procedures are typically performed after sleep apnea has failed to respond to conservative measures and a trial of CPAP. Otherwise, surgical options most often address the problem by reducing or removing tissue from the soft palate, uvula, tonsils, adenoids or tongue. More complex surgery may be performed to adjust craniofacial bone structures. Surgical options may require multiple operations, and positive results may not be permanent. One of the most common surgical methods is uvulopalatopharyngoplasty (UPPP), which trims the size of the soft palate and may involve the removal of the tonsils and uvula. Adenotonsillectomy is the most common treatment option for children with OSAS.

Other children with sleep apnea may benefit from CPAP.

Types of surgery include:

- Somnoplasty: it is a minimally invasive procedure that uses radiofrequency energy to tighten the soft palate at the back of the throat.
- UPPP, or UP3, which stands for uvulopalatopharyngoplasty: it is a procedure that removes soft tissue in the back of the throat and palate, increasing the width of the airway at the throat opening.
- Mandibular/maxillary advancement surgery: surgically moving the jaw bone and face bones forward to make more room in the back of the throat (it is an intricate procedure that is reserved for patients with severe sleep apnea and head-face abnormalities).
- Nasal surgery: correction of nasal obstructions, such as a deviated septum.

Results and conclusions

During sleep, muscle activity is decreased and the resistance of the upper airways increased. The result is that the reduction of muscle tone can lead to OSAS in children with hypertrophic lymphatic tissue or another abnormality of the upper airways. It has furthermore been reported that sleep disturbances have an influence on the endocrine system, especially on the secretion of growth hormones. Children with OSAS and hypertrophy of the lymphatic tissue showed disturbed somatic growth because of abnormal nocturnal secretion of growth hormone (GH). After the adenotonsillectomy may occur a significant increase in the serum levels of GH mediators, such as insulin-like growth factor I (IGF I) and its binding protein. Thereafter somatic growth returned to normal or even caught up.

Furthermore, children with OSAS have similar craniofacial characteristics to children with "adenoid facies". The OSAS children have a significantly enlarged overjet, a reduced overbite with a higher incidence of an open bite and a narrower upper and shorter lower dental arch. Both the OSAS children and the children with nocturnal snoring often have distoclusion. The number of children with mandibular crowding and an anterior open bite rise with the increasing obstructive apnea-hypopnea index. The effects of the increased resistance of the upper airways on jaw morphology are due to the long-term repercussions of the altered head, mandibular and tongue posture adopted in order to ensure an adequate airway during sleep.

The 1996 Canadian Thoracic Society (CTS) guidelines on the diagnosis and treatment of sleep disordered breathing in adults included six recommendations concerning oral appliances for OSAS. Two recommendations specifically addressed the dental community. First, it was recommended that these devices should be fitted by qualified dental practitioners who have undertaken special training in sleep disordered breathing. Second, it was recommended that patients initiated on treatment with
an oral appliance should be seen in follow-up by a qualified dental practitioner regularly during the first year and then every year thereafter to monitor treatment adherence, oral appliance deterioration and oral health.

Oral appliances, in particular the mandibular advancement device, are used to enlarge the upper airway and prevent its collapse by displacing the mandible forwards. The minimum pharyngeal distance behind the soft palate and tongue improved by 1 mm and 0.8 mm respectively.

OSAS patients have narrower airways, reduced oropharyngeal areas and larger tongues. Furthermore, the cephalometric analyses reveal shorter and more retrognathic mandibles.

Compared with CPAP treatment, oral appliances (MAD) are less effective in reducing the apnea-hypopnea index; however, the MADs are superior to corrective surgery on the upper airway. Thus, oral appliance therapy should be considered as a viable treatment alternative to continuous positive airway pressure (CPAP) in patients with mild to moderate obstructive sleep apnea syndrome (OSAS). In patients with severe OSAS, CPAP remains the treatment of first choice.

References


## Illustrations

### Illustration 1

Table 1: The most common obstructive sleep apnea symptoms. Symptoms of OSAS in children may not be as obvious

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Symptoms of OSA in children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daytime sleepiness or fatigue</td>
<td>Bedwetting</td>
</tr>
<tr>
<td>Sudden awakenings with a sensation of gasping or choking</td>
<td>Poor school performance</td>
</tr>
<tr>
<td>Snoring</td>
<td>Learning and behavioral disorders</td>
</tr>
<tr>
<td>Night sweats</td>
<td>Choking or drooling</td>
</tr>
<tr>
<td>Sexual dysfunction</td>
<td>Snoring</td>
</tr>
<tr>
<td>Restlessness during sleep</td>
<td>Pauses or absence of breathing</td>
</tr>
<tr>
<td>Difficulty getting up in the mornings</td>
<td>Restlessness in bed</td>
</tr>
<tr>
<td>Dry mouth or sore throat upon awakening</td>
<td>Inward movement of the ribcage when inhaling</td>
</tr>
<tr>
<td>Headaches in the morning</td>
<td>Sluggishness or sleepiness (often misinterpreted as laziness in the classroom)</td>
</tr>
<tr>
<td>Trouble concentrating, forgetfulness, depression, or irritability</td>
<td>Unusual sleeping positions, such as sleeping on the hands and knees, or with the neck hyperextended</td>
</tr>
</tbody>
</table>
### Illustration 2

Table 2: The treatment for OSAS depend on the factors causing the obstruction. There are several possible treatments for obstructive sleep apnea, that range from a change in behavior to facial surgery.

<table>
<thead>
<tr>
<th>Conservative treatments</th>
<th>Weight loss (even a 10%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avoid the use of alcohol and sleeping pills (which make the airway more likely to collapse during sleep and prolong the apneic periods)</td>
</tr>
<tr>
<td></td>
<td>Avoiding sleep deprivation</td>
</tr>
<tr>
<td></td>
<td>Nasal sprays to reduce snoring and improve airflow for more comfortable nighttime breathing (in people with sinus problems or nasal congestion, who are more likely to experience sleep apnea)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral appliances</td>
</tr>
<tr>
<td>Surgery</td>
</tr>
<tr>
<td>Use of pillows and other devices that help patients who have mild sleep apnea sleep in a side position may be helpful (in these patients breathing pauses occur only when they sleep on their backs)</td>
</tr>
<tr>
<td>Continuous positive airway pressure (CPAP)</td>
</tr>
<tr>
<td>These devices help keep the airway open during sleep. For patients with mild sleep apnea, dental appliances or oral mandibular advancement devices that prevent the tongue from blocking the throat and/or advance the lower jaw forward can be made.</td>
</tr>
<tr>
<td>Somnoplasty</td>
</tr>
<tr>
<td>UPPP, or UP3, which stands for uvulopalatopharyngoplasty</td>
</tr>
<tr>
<td>Mandibular/maxillary advancement surgery</td>
</tr>
<tr>
<td>Nasal surgery</td>
</tr>
</tbody>
</table>
Illustration 3

Table 3: Side effects of oral appliances

<table>
<thead>
<tr>
<th>Side effects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive salivation</td>
<td>Excessive salivation and discomfort (for a brief time after awakening): very common with initial use; may prevent early acceptance of oral appliances.</td>
</tr>
<tr>
<td>Mouth dryness</td>
<td></td>
</tr>
<tr>
<td>TMJ pain</td>
<td></td>
</tr>
<tr>
<td>Occlusal changes</td>
<td></td>
</tr>
<tr>
<td>Parodonthopathy</td>
<td></td>
</tr>
<tr>
<td>TMJ dullness</td>
<td></td>
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</table>