Obstructive Sleep Apnea And It’s Management: A Prosthodontic Perspective
Ann Sales*, Akshar Bajaj*, Kushan Kishore Dhawan*, Umesh Pai*, Shobha Rodrigues**

Abstract
Obstructive sleep apnea (OSA) is repetitive cessation of breathing during sleep. It is characterized by loss of airway patency accompanied by simultaneous respiratory effort. Patients with undiagnosed sleep apnea represent a major public health problem. Prosthodontists have a unique role in recognizing the sleep disorder and co-managing the patients along with a physician or a sleep specialist. Oral appliance therapy is an important adjunct for treatment of sleep apnea patients. This review paper aims to explain the etiology, clinical features and management of Obstructive Sleep Apnea with special reference to a prosthodontic treatment approach.

Keywords: obstructive sleep apnea, polysomnography, mandibular repositioning appliance, tongue retaining devices, soft palate lifters.

Introduction
The vast increase in sleep related research over the past two decades has led to sleep medicine being recognized as a separate specialty.1 Dental sleep medicine is a subset of sleep medicine where the dentist plays an important role in screening for patients who present with sleep-disordered breathing (SDB) and works with a variety of specialists to provide the best treatment possible. Some studies have found a correlation between SDB, parafunction, movement disorders related to sleep orofacial pain sleep interactions.2 A better understanding of these can help the formulation of a holistic treatment plan for each patient.

Sleep Disordered Breathing
Sleep disordered breathing (SDB) is a common medical disorder associated with important morbidities. It can be divided into obstructive and non-obstructive breathing disorders. (Fig 1)3

Obstructive Sleep Apnea
Obstructive sleep apnea (OSA) is a sleep disordered breathing disease involving repeated obstruction of the upper airway during sleep.

Etiology and Pathogenesis Of OSA
The main feature of OSA is the collapse of the tongue backwards on the pharynx during sleep. Due to this, breathing gets restricted leading to a decreased O2 and increased CO2 levels in the blood which alerts the receptors in the carotid sinus, thereby causing the patient to wake up in order to breathe normally. Alcohol is a
common co-factor because of its depressant influence on respiratory muscles. Due to a structurally compromised airway, these patients are predisposed to malocclusion. In a few patients, abnormal pharynx, adeno-tonsillar hypertrophy, retrognathia and macroglossia could be the reason for the structural compromise. This structural defect is a subtle reduction in airway size that can be identified in most patients as pharyngeal crowding which can be confirmed with imaging techniques. Obesity often leads to reduced size of upper airway by increased fat deposition or a compressed pharynx due to superficial fat in the tongue.

Role of edentulism in pathogenesis of OSA
Edentulism has a significant effect on the prosthodontic implications of sleep medicine and is associated with the treatment outcome of OSA. Loss of teeth can lead to the following anatomical changes:
- Decrease in vertical dimension of occlusion
- Change in position of mandible
- Change in position of hyoid bone
- Impaired function of oropharyngeal musculature such as loss of tone in soft palate and pharynx, macroglossia etc.

Diagnosis
For an OSA syndrome to be diagnosed, a comprehensive sleep history, presence of specific clinical features and an objective demonstration of SDB is required. High-risk patients for OSA can be identified based on:
- Obesity (body mass index [BMI] >35)
- Type 2 diabetes
- Treatment refractory hypertension
- Pulmonary hypertension
- Nocturnal dysrhythmias
- Congestive heart failure
- Stroke
- High-risk driving populations

Systemic health evaluation can include questionnaires which are to be filled by patients at their regular appointments. The most widely used questionnaires are the Berlin Questionnaire and the Epworth Sleepiness Score. The STOP-Bang questionnaire is shown to have a greater clinical utility for identifying the pretest probability of apnea. If three or more items are positive, the patient is considered to be at high risk for OSA and further questions can be asked.

STOP-Bang questionnaire items
1. Snoring
2. Tiredness
3. Observed apneas
4. Elevated Blood Pressure
5. BMI >35
6. Age >50 years old
7. Neck >40 cm
8. Male Gender

Characteristic symptoms and clinical features
Nocturnal symptoms:
- Snoring
- Insomnia
- Witnessed apneas by bed partner
- Nocturnal reflux
- Nocturnal choking, snorting, or gasping
- Bruxism
• Other nocturnal symptoms: enuresis, nocturia, frequent arousals, diaphoresis, impotence

Daytime symptoms:
• Excessive daytime sleepiness
• Other daytime symptoms: fatigue, memory impairment, personality changes, morning nausea, morning headaches, depression

• Physical characteristics/examination:
  Obesity: neck size >17 inches (men), >16 inches (women); BMI >35
  Craniofacial anatomy: retrognathia, micrognathia, tonsillar hypertrophy, macroglossia, inferior displacement of the hyoid bone, narrowing of oropharyngeal airway

• Hypertension: especially drug-resistant hypertension

Along with medical history, self-questionnaires, and presence of clinical features, the diagnosis of OSA syndrome also requires demonstration of abnormal respiratory events with polysomnography (PSG) or home apnea testing.

**Objective Testing**
Before a dentist starts treatment, overnight sleep studies need to be conducted and interpreted by a qualified sleep physician. Polysomnography (PSG) is the “gold standard” for diagnosis of OSA. The following physiologic signals are monitored and recorded by a trained professional:

• Electroencephalogram
• Electromyogram
• Nasal pressure
• Electrocardiogram
• Respiratory effort
• Electrooculogram
• Oxygen saturation
• Oral or oronasal thermistor
• Audio, video

AHI (apnea-hypopnea index) is the total number of apnea and hypopnea events divided by total sleep time in hours observed on an electroencephalogram. Respiratory disturbance index (RDI) is the sum total of apnea, hypopnea and RERA (respiratory effort related arousal) events divided by total sleep time in hours. Insomnia, hypersomnia, fatigue and other neurocognitive problems are comorbidities that can reduce the threshold for treatment.

**Grading of OSA based on AHI**
Mild OSA - AHI 5 and <15 per hour of sleep with symptoms or comorbidity factors
Moderate OSA - AHI 15 and <30 events per hour of sleep
Severe OSA - AHI 30 events per hour of sleep

**Mallampati Classification**
Screening for sleep apnea should include the modified Mallampati score according to the American Academy of Sleep Medicine (AASM). With the patient in the upright position, the base of the uvula and the appearance of the soft palates are observed and scored accordingly. A high score (class 3 or 4) is indicative of sleep apnea.
Treatment Options for OSA

A long-term, multidisciplinary management is needed for a chronic disease like OSA. Treatment includes medical, dental, behavioral and surgical options. Adjunctive treatment modalities can be used along with a primary treatment therapy to manage the condition. The patient needs to be educated regarding the severity, risk factors, modes of treatment of the disease and their role in the treatment process.6

Options for Treatment:
1. Positive airway pressure (PAP)
2. Upper airway surgical procedures
3. Pharmacologic treatment
4. Oral appliances
5. Behavioral modification: weight loss, alcohol avoidance, alteration of sleeping position

Initially reported in 1981, PAP provides pneumatic splinting of the upper airway and remains the standard treatment for OSA.15,16 Various forms of PAP include Continuous PAP (CPAP), bilevel PAP, or auto titrating PAP modes. Nasal masks are often used but the effectiveness can be hampered by mouth leaks.17 Full face masks (oronasal masks) facilitate nasal and oral breathing but if the mandible gets displaced when the interface is tightened, the tongue can be pushed posteriorly thereby worsening the apnea. Effects of PAP include alleviation of symptoms, reduced risk of traffic and workplace accidents, decreased cardiovascular comorbidities. CPAP is an effective modality for reduction of AHI. However, it has a few drawbacks such as expense, side effects with regard to the nose or face, or mask discomfort.18 Adjunctive treatment modalities include lifestyle modification, prevention of supine sleep position, exhalation pressure valves applied nasally, oral appliances, and upper airway surgery.19

For patients with mild to moderate OSA who are not comfortable with a CPAP device, or those with a snoring problem oral appliance therapy is a good alternative. According to studies20-24, even though CPAP is more effective than mandibular repositioning appliances (MRAs), patients usually prefer oral appliances over CPAP in cases where both are effective.

AASM Practice Parameters25

Mechanism of Action of Oral Appliances
In oral appliance therapy, the tongue and the mandible are repositioned anteriorly and inferiorly which prevents the airway from collapsing. This reduces snoring and OSA by enhancing the patency of the airway by widening the lateral aspects of the upper airway.26 The upper airway has three parts: the velo-pharynx (hard palate to tip of uvula), oro-pharynx (tip of uvula
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to tip of epiglottis), and hypo-pharynx (tip of epiglottis to vocal cords). The most common site of primary pharyngeal collapse in OSA is the velo-pharynx.\(^{27,28}\)

**Types of Oral Appliances**

<table>
<thead>
<tr>
<th>Examples of oral appliances</th>
<th>Somnora</th>
<th>Aveo-TSD</th>
<th>Adjustable Soft Palate Lifter</th>
</tr>
</thead>
<tbody>
<tr>
<td>The silencer</td>
<td>Tongue-locking appliance</td>
<td>Silent night</td>
<td></td>
</tr>
<tr>
<td>Klismway</td>
<td>Snore guard</td>
<td>Snore EX</td>
<td></td>
</tr>
<tr>
<td>NAPA</td>
<td>Silent night</td>
<td>TPE</td>
<td></td>
</tr>
<tr>
<td>TAP</td>
<td>Therabite</td>
<td>Enmark</td>
<td></td>
</tr>
<tr>
<td>Herbst</td>
<td>Snore-no-more</td>
<td>HAP</td>
<td></td>
</tr>
<tr>
<td>SNIAK</td>
<td>PM-positioner</td>
<td>Test</td>
<td></td>
</tr>
<tr>
<td>SNOAD</td>
<td>Therabite</td>
<td>Respire</td>
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</tbody>
</table>

Tongue retaining devices (TRD), MRAs and soft palate lifters are the three main categories of oral appliances used. Out of these, MRA is the most commonly used. The MRA covers the upper and lower teeth and positions the mandible anterior to the mandibular resting position. TRD incorporates an anterior bulb that creates a suction effect on the tongue which advances the tongue increasing the upper airway space. TRDs are preferred in cases of hypodontia, edentulism, and significant periodontal disease since these devices do not require support from teeth.

MRAs are classified as into titratable (2-piece appliance) and non-titratable (1-piece appliance) or custom-made appliances and prefabricated appliances. Studies evaluating the efficiency of various types of MRAs reveal that all custom-made devices have a comparable outcome. However, the treatment response with custom-made designs are significantly better when compared with prefabricated designs.

MRAs are usually designed like a conventional orthodontic appliance, either a 1- or 2-piece type that is retained by one or both dental arches.\(^{23}\)

**Advantages of oral appliances**

1. Nonintrusive
2. Simplicity
3. Lack of noise
4. Smaller and more portable than CPAP devices
5. Comfortable: fits inside the mouth
6. Potentially lower cost of treatment
7. Reversible treatment modality
8. No need for power source

**Patient Selection Criteria for MRA**

Prior to treatment with MRA, the degree of sleep-related respiratory problems should be confirmed with a PSG and the dentist should be referred. Incorrect diagnosis and subsequent treatment can make the patients’ condition worse. Effectiveness of MRA in children is yet to be studied conclusively, thereby limiting use of MRAs to adults only. It is not possible to tell if a patient will respond positively to oral appliance therapy.\(^{29}\) Success in MRAs is associated with variables such as mild OSA, supine dependent OSA, females, and non-obesity patients.\(^{30}\) Selecting ideal patients for oral appliance therapy will require further research.

![Flow chart for evaluation and treatment of patients suspected of having OSA patient](image-url)

**Fig. Flow chart for evaluation and treatment of patients suspected of having OSA patient**
### Contraindications and Side Effects of Oral Appliance Therapy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Concern</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodontal disease</td>
<td>Status: active or stable</td>
<td>Reducing anchorage potential with appliance</td>
</tr>
<tr>
<td></td>
<td>Concern: mobility of teeth</td>
<td>Increasing degree of mobility and bite change with MRA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Optional use of TRD</td>
</tr>
<tr>
<td>Temporomandibular dysfunction</td>
<td>Need to assess degree of TMD</td>
<td>Concern with potential approximation of TMD and limitation of advancement potential with MRA</td>
</tr>
<tr>
<td>Number of remaining teeth</td>
<td>If c=10 teeth per arch, or uneven distribution</td>
<td>Reduced archangrore</td>
</tr>
<tr>
<td>Protrusive capacity of the mandible</td>
<td>If c&lt; mm</td>
<td>Potential contraindication due to limitation of efficacy of MRA</td>
</tr>
<tr>
<td>Bruism</td>
<td>Patterns of wear</td>
<td>Early damage to appliance from overload or increase in pain with rigid appliance holding them in a fixed position</td>
</tr>
<tr>
<td>Occlusion</td>
<td>Number of tooth-to-tooth contacts, horizontal and vertical overlap</td>
<td>Reduced initial contacts will decrease patient awareness of bite change with MRA</td>
</tr>
<tr>
<td>Maximum vertical opening</td>
<td>If &lt;25 mm</td>
<td>Inability to seat MRA</td>
</tr>
<tr>
<td>Exaggerated gag reflex</td>
<td>Poor adaptation potential</td>
<td>Inability to wear MRA</td>
</tr>
</tbody>
</table>

Side effects can be grouped into 2 broad categories:

1. Minor in severity and temporary: they are either tolerable or tend to resolve with a short adaptive period of 6 to 8 weeks.
   - TMJ pain
   - Gingival irritation
   - Morning after occlusal changes
   - Salivation
   - Tooth pain
   - Loss of crown or restorations
   - Myofascial pain
   - TMJ sounds
   - Dry Mouth
   - Bad taste or odour

2. Moderate to severe and continuous: these occur at any stage during treatment and may cause intolerance and discontinuation of the appliance.
   - TMJ pain
   - Dry mouth
   - Tooth movement: decrease in overbite and overjet, mobility of teeth, intrusion, retraction effects
   - Gingival pain
   - Myofascial pain
   - Tongue pain (with TRDs)
   - Tooth pain
   - Gagging (mostly with soft palate lifters)
   - Salivation
   - Skeletal changes: change in vertical condylar position, change in arch width

### Conclusion
Dentistry has a vital role to play in the identification and management of obstructive sleep apnea. It is important that when indicated, the patients be evaluated for snoring, daytime sleepiness and other signs and symptoms of OSA. American Sleep Disorders Association recommends oral appliance therapy as a treatment option for selected patients. Together with a physician and a sleep specialist, the dentist forms part of the treatment team which can effectively manage a patient with OSA.

### References
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