

Obstructive sleep apnea: oral appliances and materials

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INFORMATION ABSTRACT

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For the dental profession in general and in prosthodontists speciality, the subject of sleep medicine continues to offer great challenges and opportunities in diagnosis, treatment planning, and treatment based on qualitative evidence. Though the role contends by the prosthodontists is still in its infancy, there is a lot to find out and understand in the rapidly evolving field of sleep medicine because the recognition of co-managing patients with sleep disorders by the prosthodontists is quick changing into a reality. This article discusses the prosthodontic perspectives, particularly on obstructive sleep apnea.

1. Introduction

Obstructive sleep apnea has become more common nowadays. It is the most common respiratory disease associated with chronic insomnia. OSA causes a partial or complete narrowing of the upper airway during sleep by stopping/reducing airflow, leading to regular sleep disturbances [1]. The different varieties of sleep apnea are obstructive, central and mixed. Obstructive is the most common of all three [2]. The role of prosthodontics is becoming more significant in treating sleep disorders especially in patients with mild to moderate obstructive sleep apnea (OSA). This article describes the epidemiology, etiology, pathophysiology, clinical features, and types of oral appliances used to treat obstructive sleep apnea.

2. Epidemiology

It has been reported that 10% and 5% of men and women, respectively, in the 30–40-year age group are common snorers, reaching at least 20% for males and 15% for females in the 50–60 year age group. It has been reported that 5% of the world population is affected by OSA, with the prevalence of 4% for men and 2% for women in the aged of 30–60 years [1,3–5].

3. Predisposing factors

Obesity is an important risk factor with prevalence ranging from 55 to 100% [6]. Cranio-facial abnormalities like micrognathia, retrognathia, enlarged palatine tonsils, enlarged uvula, high arched palate, nasal deviation, longer anterior facial height, enlarged tongue, long soft palate, decreased posterior airway space. In addition to age, genetic, ethnic and gender predilection and various habits such as alcohol consumption, smoking and drugs use, the existing OSA is aggravated [7].

4. Pathophysiology

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The upper airway is a soft tissue tube, the patency of which is maintained, in part, by muscles such as tensor veli and genioglossus. The base of the tongue obstructs the upper airway resulting in snoring. The upper airway is composed of the nasopharynx, oropharynx, and hypopharynx. When the patient falls asleep in the supine position, muscle relaxation causes the base of the tongue to approach the posterior wall of the pharynx. With the consequent reduction of airflow, the patient must increase the airflow speed to maintain the required oxygen supply to the lungs. This increase in airflow velocity causes the vibration of soft tissues that produces snoring.

The total volume of fat has been shown to be greater in OSA patients. Increase in thickness of the lateral pharyngeal wall predisposed to OSA development [7,8]. The various clinical symptoms observed in patients with OSA presented in Table 1 [9-14].

5. Diagnosis

Diagnosis of OSA can be made on history, examination, polysomnography [15], lateral cephalograms, computed tomography scanning, acoustic reflection test, limited channel testing and oximetry [16,17].

The severity of OSA is classified based on the patient's AHI (APNEA-HYPOPNEA INDEX) index. It is the average number of disordered breathing events per hour [5,18,19]. They include mild OSA (5 to 15 events per hour), moderate OSA (15 to 30 events per hour), and Severe OSA (more than 30 events per hour).

6. Treatment

OSA therapies include behavioural modification, positive air pressure (continuous positive airway pressure), oral and surgical procedures [20]. Oral appliances are widely used in patients with mild to moderate apnea.

7. Rationale behind using oral appliances

Oral appliances are worn solely during sleep and work to enlarge the airway by moving the tongue anteriorly or the mandible to enlarge the airway. Oral appliances help in preventing the tongue from blocking the throat, and/or pushing the mandible forward is often done. These devices help to keep the airway open during sleep. Proposed mechanisms for the action of

oral appliances include increased upper airway size, decreased upper airway collapsibility, activation of upper airway dilator muscles, and stabilization of mandibular posture [21,22].

8. Materials used for fabricating oral appliances

Two different materials used for the fabrication of oral appliances, such as hard acrylics and thermal acrylics.

8.1 Hard acrylics

Hard acrylics are either chemically or heat processed, resulting in hard and rigid tooth-borne and occlusal surfaces. These are the common materials for fabricating oral appliances. They can be adjusted or repaired chair side easily without the need for an entirely new appliance and are easy to insert and remove. Hard acrylic appliances are more retentive when the shape of the clinical crown has good undercuts. Clasps can be used for additional retention.

Acrylic resins are known as PMMA which can be packed or injected into moulds and solidifies through a chemical reaction of polymerization. The disadvantages of heat-cured acrylic resins connected to increased porosity, high water retention, volume variations, and irritating effect of the residual monomer have led to alternative materials such as polycarbonate resins and polyamides, acetal resins and epoxy resins [23,24].

8.2 Thermal acrylics

They are soft and pliable at a warm temperature. Thermal acrylics allow comfort and easy seating, minimize the occlusal derangement. The major drawback of this

Table 1. Clinical features of obstructive sleep apnea [9-14]

- Memory problems
- Excessive day time sleepiness
- Difficulty in concentrating
- Night drooling of saliva
- Depression
- Irritability
- Xerostomia
- Gasping for breath at night and witnessed apneas.
- Poor work performance
- Occupational accidents

materials is it requires more frequent replacement than hard acrylics, especially for bruxers. They are manufactured through the thermoforming procedure from Essix type-A co-polyester or polypropylene copolymer [24].

9. Oral appliances

Oral appliances were first referred to in 1923 in books by the French paediatrician Pierre Robin [25], who described the fall of the tongue base as a cause of nasopharyngeal impairment and suggested a prosthesis to correct “dysmorphic atresia of the mandible”.

However, these devices were not used in the treatment of sleep apnea until the early 1980s. They were started using after describing a tongue retaining device to treat snoring and apnea by Cartwright and Samelson [26]. A renewed interest followed this device in mandibular development devices (MADs) that re-positioned the mandible in the protrusive position to help maintain the patency of the upper airway during sleep.

There are currently more than 55 oral appliances on the market. The appliances can be broadly classified into the following 4 types.

- a. Tongue re-positioning devices, such as the tongue retaining device.
- b. Mandibular advancement devices (MAD) work by holding the lower jaw and the tongue forward during sleep.
- c. Devices designed to lift the soft palate.
- d. Uvula lifters, which are not in use now due to discomfort.

9.1 Soft palate lifting

The soft palate lifting prosthesis lifts and/or stabilizes the soft palate, preventing vibration during sleep. The palatal lift prosthesis significantly improved the upper airway passage and eliminated snoring and airway obstruction, and improved the patient’s overall quality of life [27].

9.2 Mandibular repositioning devices

It advances the mandible, brings forward the tongue and other muscles of the pharynx and elevates the palato-glossus muscle; thus, airway patency is enhanced. It also holds the mandible and other structures in a stable position to prevent the mouth opening. This is usually the most widely used respiratory device for

apnea and has a higher evidence base. The devices cover the upper and lower arch and have metal hinges. The mandibular advancement device requires good retention, sufficient protrusion to maintain airway, minimal vertical opening, and full occlusal coverage.

9.2.1 Disadvantages

Reduced effectiveness in patients with: TMJ, myofascial pain, tooth tenderness, excessive salivation, gum irritation and bleeding, dry mouth and edentulous patients. Long-term MAD use may lead to dental and skeletal side effects that include [28]:

- Decrease in overjet and overbite
- Retroclination of maxillary incisors
- Proclination of mandibular incisors
- Increase in the mandibular plane angle
- Increases in anterior facial height
- Decrease in the number of occlusal contact points
- Anteroposterior change in occlusion.

When MAD is used, the teeth should be free from caries and periodically healthy and sound teeth to withstand the displacement forces.

9.3 Klearway oral appliance

The Klearway oral appliance uses a maxillary orthodontic expander to move the mandible forward sequentially. Klearway is a fully adjustable oral appliance used for snoring and mild to moderate OSA. A Small increase in mandibular advancement is initiated by the patient, preventing rapid jaw movements that cause significant patient discomfort (Figure 1) [29].

9.4 PM positioner

This appliance links the upper and lower splints with bilateral orthodontic expanders. This appliance is made of thermoplastic material (Figure 2) that must be heated in hot tap water every night before it is placed in the mouth [30].

9.5 The Thornton adjustable positioner (TAP)

This enables the progressive 0 mm advancements of the jaw through the anterior screw mechanism at the labial aspect of the upper splint. This appliance has a separate section for both the mandible and maxillary (Figure 3) [31].

9.6 Modified Herbst Appliance

This design links the upper and lower splints with a piston-post and the adjustable telescopic mechanism on both sides. It prevents side-to-side motion, but



Figure 1. Klearway appliance



Figure 2. PM positioner

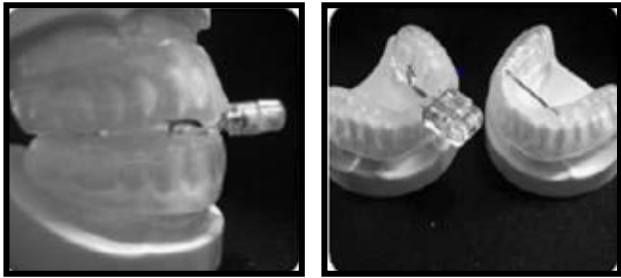


Figure 3. Thornton adjustable positioner

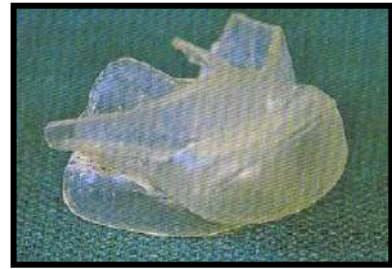


Figure 4. Tongue retaining device

since the mandible is kept close with small orthodontic rubber bands, opening the jaws is relatively easy [32,33].

9.7 The silencer system

This incorporates titanium precision attachments at the incisor level, allowing sequential 2 mm advancement of up to 8 mm, lateral movement of 6 mm, (3 mm bilaterally) and vertical pin height replacements. It is the only appliance that enables anteroposteriorly adjustment and an open and closed position since it includes a very expensive titanium metal hinge device [34,35].

9.8 Tongue retaining device (TRD)

It was first developed in 1979. It is a bubble-shaped device. TRD operates by holding the tongue in a forward position utilizing a suction bulb, which keeps the tongue from collapsing during sleep and obstructing the airway inside the throat. TRD is an excellent tool for patients or those suffering from TMJ sensitivity. This is usually a single piece of non-vinyl material without thermoplastic material to adapt to the teeth. Retention to the teeth or residual ridges is not a requirement with this device, and thus the rigidity of the device is unnecessary (Figure 4) [25]. These devices are indicated for edentulous patients, and patients with potential temporomandibular joint problems. TRDs do not require retention from dentition, Minimal adjustments are required, Cause minimal sensitivity to

teeth and TMJ.

9.9 Side effects and complications

Dental malocclusion (21%), TMJ pain (15%), and TMJ dislocation (<5%), excessive salivation, tooth pain, posterior open bite are side effects of MRD. The overall incidence of side effects with MRDs is 25-60% which can be resolved with device adjustment.

Tongue abrasion, excessive salivation, and gagging are some of the TRD's reactions. The overall incidence of side effects for TRD was 25-75%. Recalls are necessary at a minimum of two weeks, one month, and after that every six months. These appliances are retained tightly by the remaining dentition and place almost orthodontic like forces on the teeth. They may also become loose or distort, or break, and hence maintenance is mandatory [36,37].

10. Conclusion

The oral appliances used to date form a group of heterogeneous devices used in the treatment of sleep apnea. Current evidence suggests that oral appliances "cure" mild to moderate sleep apnea in 40-50% of patients and significantly improved by 10-20%. A prosthodontist should have a vital role in the initial diagnosis, management, and care of patients with sleep apnea. Oral appliances play a crucial role in managing non-surgical OSA and have become the first line of treatment for almost all patients with OSA.

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