

Management of obstructive sleep apnea using oral appliances: A Review (Part II)

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Abstract

There are various treatment options for obstructive sleep apnea (OSA) ranging from simple lifestyle modifications to surgical options. Some treatments are cumbersome in nature which makes tolerance and compliance less than optimal. This gives rise to the need for other alternatives that are equally effective and more tolerable. Dentists play a vital role in the treatment of OSA. There is growing interest in the use of oral appliances (OAs) to treat OSA. Wide ranges of appliances are available and are well tolerated by the patients. This second part of our review article focuses on various appliances their mechanism of action and effects on oral cavity.

Key words: Oral appliances (OAs), Dental appliances, Mandibular advancement appliances (MADs), Obstructive sleep apnea (OSA)

Introduction

Dentists have recently begun to play a role in the management of obstructive sleep apnea (OSA) with the use of various oral appliances (OAs) or dental appliances. These appliances can reposition the tissues by lifting up the soft palate, bringing the tongue forward, or lifting the hyoid bone. As they reposition, some appliances also stabilize these tissues, preventing airway collapse. Appliances can also increase muscle tone. Specifically, there is an increase in pharyngeal and genioglossus muscle activity¹.

These appliances are usually inexpensive, well tolerated by the patients and the side effects if any are thought to be reversible². There are a large and diverse designs that have been used in clinical practice and research studies. It is important to consider these design features when choosing a device, as they may influence the retention of the oral appliance within the oral cavity during sleep, the degree of advancement of the mandible, and the range of movement of the mandible that is permitted. As a result, variations in design may affect clinical efficacy, adverse effects, and patient compliance^{3,4}.

Historical aspects of oral appliances

George Cattlin was probably the first person who seriously thought that the route of breathing may influence sleep quality and daytime function⁵. He pointed out that breathing through the nose promotes more restful and better quality sleep, which translates into better daytime function and better general health. However, modern published clinical work began in 1903, when Pierre Robin first described a device, called the "monoblock", for the treatment of glossoptosis. It took almost another 50 years to start using oral appliances for the treatment of snoring and sleep apnea when Cartwright and Samelson described the tongue retaining device in 1982. This work stimulated further investigations⁵.

Types of oral appliances

There are abundant variety of appliances available and all these oral appliances may be divided into three general groups: soft palate lifters (SPLs), tongue retaining devices (TRDs), and mandibular advancement devices (MADs) also known as mandibular advancement appliances (MAA) or mandibular advancement splints²⁶.

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The first category is virtually no longer in use today most likely because of gag, discomfort, and the success of laser and radio frequency soft-palate procedures. The second category is used very seldom, mainly if there are dental reasons precluding the fabrication of MAD. The last category (MAD) is by far the most common type of dental appliance in use today. It protrudes the mandible forward, thus preventing or minimizing upper airway collapse during sleep^{5,6}.

Design and mechanism of action

There are various designs of oral appliances that have been used in clinical practice and research studies. Fabrication of appliance requires dental impressions, bite registration and fabrication by dental laboratory. However, they can be prefabricated too. The mandibular advancers may be made of elastomeric material or hard acrylic, or thermoplastic. Their retention on the teeth can be provided by friction fit of plastic in undercuts, which is most common, or by clasps⁷.

Mandibular advancement appliances are either one-piece (monobloc) or two-piece (duobloc) configuration³. The former may be a simple vacuum formed splints with upper and lower fused together or clasped acrylic appliances, for example snore-guard, SNOAR etc. Two piece splints, where upper and lower elements are connected by rigid or plastic lateral connectors, allow some freedom of mandibular movement, for example Silencer, Herbst, Restore^{4,8}.

The primary mechanism of action of MADs is to cause mechanical advancement of the mandible and thereby increase the anteroposterior dimensions of the oropharynx. Mandibular advancement appliances are constructed so that the mandible is positioned 2 to 5 millimeters anteriorly. The amount of forward repositioning and vertical opening varies with the appliance, the clinician and also the comfort on part of the patient. The tongue is also advanced passively because of its attachment to the genial tubercles. These devices simultaneously move the soft palate anteriorly because of its attachment to the tongue via the palatoglossus muscle. These movements enlarge the hypopharyngeal airway and reduce the likelihood that the tongue or soft palate collapse against the posterior pharyngeal wall when the patient inspires during sleep.⁹ The precise reason for this effect on hypopharyngeal patency is unclear. However, soft tissue connections exist between the mandible, tongue, lateral pharyngeal walls, and soft palate, within the palatoglossal and palatopharyngeal arches. It has been proposed that such soft tissue connections may be stretched by mandibular advancement^{3,5,10}.

Tongue retaining devices (TRDs) is a custom made soft acrylic appliance that has an anterior plastic bulb. It uses negative suction pressure to hold the tongue in forward position inside the bulb. By holding the tongue in forward direction through its attachment to genial tubercle, it stabilizes the mandible and hyoid bone, thus preventing the retrolapse of tongue¹⁰.

Effects of oral appliances

The goals of treatment with oral appliances are to prevent obstructive apneas and hypopneas during sleep, to improve the symptoms of OSA (such as snoring, excessive daytime sleepiness, and neurocognitive impairment), and to decrease the cardiovascular risk associated with OSA³.

Approximately 65% of patients achieve a 50% or greater reduction in apnea-hypopnea index (AHI) with MAD. Treatment with an MAD also improves oxyhemoglobin saturation. Improvements in sleep architecture and reduction of arousal indices have also been shown. There is significant reduction in the intensity and frequency of snoring. MAD may have a positive impact on cardiovascular disease, with improvement of intermediate end points such as oxidative stress and endothelial function³.

It is clear that not all patients are able to achieve a successful treatment outcome with oral appliances. There are anthropomorphic, physiological, and polysomnographic parameters that have been associated with a better treatment outcome, these parameters include female sex, lower age, lower body mass index, the amount of mandibular protrusion, smaller neck circumference, lower baseline AHI, supine-dependent OSA, and primary oropharyngeal collapse of the upper airway during sleep^{3,6}.

Factors affecting the success of oral appliances (OAs)^{8,11}

1. Retentive factor - OAs must fit accurately, comfortably, and remain in position all night.
2. OAs should be able to variably adjust mandibular position. Appliance should provide lateral movement for the mandible.
3. The appliance must be of low bulk. The absence of bulk makes an appliance more comfortable and therefore more likely to be worn.
4. Appliances that allow the lips to close are more likely to be accepted by patients and are easier to get used to.
5. Appliances that pinch the lips or have protuberances into or beyond the lips and appliances made at excessive vertical opening, the compliance will be poor.

6. Appliances should be non-interfering with sleep. Many appliances may cause awakening either owing to its being bulky or as a result of violation of lip seal or tongue space.
7. Must be economical.

Indications and contraindications

OAs are indicated for patients with the following¹¹:

- Simple snoring problems.
- Mild to moderate OSA

OAs are contraindicated for patients with the following¹¹

- Active dental disease
- Minimal protrusive range
- Children
- Acute temporomandibular joint dysfunction (TMJD) symptoms.
- TMJ arthritis
- Obvious psychological aversion to structures in the oral cavity
- Moderately limited dexterity

Disadvantages of oral appliances^{6,11}

The advancement of the mandible or tongue, being the principal mechanism of action of oral appliances, has the potential to cause adverse effects too. Mandibular advancement splints generate reciprocal forces on the teeth and jaw that can result in acute symptoms, as well as long-term dental and skeletal changes.

Short-term adverse effects^{6,11}

- Excessive salivation
- Mouth dryness
- Tooth pain
- Gingival and oral mucosal irritation
- Headaches
- Temporomandibular joint discomfort
- Mouth sores
- Periodontal complications
- Ingestion of broken appliance

Long-term adverse effects^{6,11}

- Reduction in overjet
- Increase in facial height
- Increase in degree of mouth opening
- Changes in inclination of incisors
- Increase in mandibular plane angle
- Root resorption

Discussion

Various factors, ranging from upper airway anatomy to central respiratory control mechanisms, interact to

produce the clinical syndrome of OSA. Different factors will predominate in individual patients, but it is likely that all patients with clinically significant OSA have a multifactorial aetiology, rather than any single causative factor. However, these factors, such as defects in ventilatory control and protective upper airway reflexes, are less easily defined and further research is needed to elucidate their precise role in maintaining upper airway patency during sleep^{4,7}.

A better understanding of the interacting factors that lead to the development of clinically significant OSA will, hopefully, lead to the development of simpler modalities of therapy¹⁰.

Oral appliances have proved to be vital as a treatment modality for OSA, future studies are needed to evaluate the effect of different appliance designs upon the success rate for reducing the AHI and improving sleep and symptoms⁶. Standard AHI criteria for success should be established as well as standard protocols for follow-up and documenting adverse effects.⁷ Future comparisons of OAs to nCPAP therapy may provide different results from studies done several years ago because of improvements in both modalities of therapy. Objective measurements of snoring and treatment adherence should also be obtained.⁹ Ongoing refinements of appliance design may eventually lead to improved outcomes with fewer complications. Head to head comparisons of different appliances and different design features may provide more information as to the key design elements that are related to treatment efficacy, adherence and complications. The role of these appliances, particularly MAD, in adolescents and children has yet to be evaluated in a comprehensive or systematic way. Studies addressing these issues will advance the field of OAs therapy and improve the care being delivered to patients with OSA⁸.

Conclusion

Major advances in the field of oral appliances have provided evidence for the use of oral appliances in the clinical management of OSA. These developments have been reflected in the updated practice parameters which now recommend the use of oral appliances for mild-to-moderate OSA, or for patients with severe OSA who are unable to tolerate nCPAP or refuse treatment with nCPAP.

As a simpler alternative to nCPAP, oral appliances are often regarded by patients as a more acceptable treatment option for OSA. This has the potential to translate to better treatment adherence and equivalent health benefits, despite the lower efficacy of oral appliances compared to nCPAP. Future research should focus on determining the influence of the design of

oral appliances on clinical outcome, the development of a clinically reliable method for identifying those patients who are most likely to achieve a favorable treatment response, and the characterization of factors predisposing to long-term adverse effects of oral appliance treatment.

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