Oral appliance therapy for sleep-related breathing disorders

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Oral appliances that advance the mandible in relationship to the maxilla offer a relatively simple and viable option in the treatment of sleep-related breathing disorders. Oral appliances are indicated for the treatment of snoring and mild to moderate sleep apnea or for those who prefer this type of therapy to positive airway pressure therapies. This article will describe the different appliance types, the proposed mechanisms of action, fabrication, and management of adverse events that may occasionally occur with oral appliance therapy.

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KEYWORDS
Oral appliance; Obstructive sleep apnea; Continuous positive air pressure; Mandibular advancement appliance; Sleep-related breathing disorders

Oral appliance (OA) therapy for sleep-related breathing disorders represents a relatively simple alternative for the more traditional positive pressure treatments.1 The practice parameters of the American Academy of Sleep Medicine (AASM) recommend OA therapy for the treatment of snoring and mild-to-moderate obstructive sleep apnea as well as for patients who prefer this type of therapy over continuous positive airway pressure (CPAP) equipment, who do not respond therapeutically to CPAP, who are not suitable for treatment with CPAP, or for whom treatment attempts with CPAP are unsuccessful.2 Several investigations also have shown OAs to be effective in cases of severe apnea.3-7 Although the use of CPAP is still considered the most efficacious treatment modality,8 many patients, especially younger ones, find the use of CPAP awkward and have difficulty complying with this treatment modality. Patients who have had the opportunity to use both treatment modalities often tend to prefer the OA over CPAP.9 OA therapy may also be used in conjunction with CPAP in patients who are otherwise recalcitrant to CPAP therapy alone.10 The use of OAs in the care of patients who experience sleep breathing disorders provides an excellent opportunity for the dentist and sleep physician to work together in providing the most comprehensive and effective treatment for these suffering patients.

Appliance types

There are 2 main types of OAs used for sleep-related breathing disorders, ie, those that advance the mandible (MAA) in relation to the maxilla and those that hold the tongue via suction in the protruded position (tongue-retaining device [TRD]; Figures 1A-B and 2). The TRD appliances lack the ability to adjust for titration, can dislodge because of a lack of suction, and ultimately have low compliance because of comfort issues. Unless dental issues prohibit their use, MAAs are the most commonly used devices. There are 2 basic types of MAAs: those that are custom-made for the patient and those that are noncustom. The noncustom appliance, sometimes referred to as “boil and bite,” will usually require heating to mold it to the patient’s dentition. These appliances have been shown to be less effective than custom-fitted appliances and are not recommended for long-term use.11 The noncustom appliance is also difficult to fit comfortably and is nonadjustable further, limiting its use in clinical practice.12
The custom fabricated appliances can be further divided to those that are nonadjustable, often called monoblock devices, and those that are 2 separate pieces fitting on the upper and lower dental arches (Figures 3 and 4). There are further classifications of MAAs based on the mechanism of which they attach the upper and lower segments together as well as titration mechanisms. MAAs depend on an adequate number of teeth in each dental arch for retention. The recommended number varies from 6 to 8 teeth per arch. However, there are several reports of oral implants being used to gain retention in edentulous arches.¹³,¹⁴ There are many custom OAs available that can make selection quite difficult. Currently, the Centers for Medicare and Medicaid Services requirements for a custom appliance are as follows:¹⁵

- have a mechanism that is hinged or jointed at the sides, front or palate;
- have a mechanism that allows the mandible to be advanced;
- are able to protrude the mandible beyond the front teeth at maximum protrusion; and
- are adjustable by the beneficiary in increments of one mm or less; and
- retain their adjustment setting when removed.

**Mechanism of action**

The precise mechanism in which OAs facilitate a reduction in sleep disorder breathing events is yet to be fully elucidated. The accepted premise is that by various mechanisms, there is a decrease in collapsibility and an increase in the dimensions of the upper airway.¹⁶,¹⁷ For most OAs, it is thought that by mechanically holding the mandible forward in relation to the maxilla, the tongue is prevented from collapsing into the airway during sleep. Ryan et al.¹⁶ reported the effect to be a maintenance of the patency of the velopharynx, particularly, the lateral dimension. Lee et al.¹⁸

![Figure 1](image1.png)

**Figure 1** (A) Mandibular advancement device; neutral. (B) Mandibular advancement device; lower jaw protruded.

![Figure 2](image2.png)

**Figure 2** Tongue retaining device.

![Figure 3](image3.png)

**Figure 3** (SomnoDent® appliance).
demonstrated increased space in the retropalatal and retrolingual spaces as well as a decreased length of the soft palate using OAs. OAs have also been shown to increase genioglossus neuromuscular activity while in use.19 Eveloff et al20 demonstrated a potential change in tongue shape via a reduction in the mandibular plane-to-hyoid distance. Kawauchi et al21 reported that advancing the mandible with OA therapy facilitated spontaneous nasal breathing via a decrease in nasal resistance. Hiyama et al22 demonstrated an increase in nasal airway patency during mandibular advancement in healthy awake subjects.

Facilitation of nasal breathing may be important as upper airway resistance and obstruction are significantly less prevalent while breathing nasally rather than orally.23 Ferguson et al24 reported that active tongue protrusion produced a marked increase in upper airway space from the soft palate area to the hypopharynx. It is generally thought that a greater degree of mandibular advancement equates to a more robust therapeutic benefit of OAs.25-29 An increase of vertical opening of OAs beyond that which is necessary to fabricate the devices component’s appears to have little effect on efficacy yet seems to have a negative consequence on compliance.30 In cases of macroglossia, a more robust opening may be necessary to increase comfort and compliance. Marklund et al31 also demonstrated that advancement of the mandible is more important than the degree of vertical opening for treatment success. One caveat to the findings mentioned is that to date, all were demonstrated in subjects who were awake. It is not known if these findings are also demonstrated during sleep stages, or if other mechanisms may be involved.

Appliance fabrication

The OA fabrication process by the dentist should begin with a comprehensive history and evaluation. Components of the examination may include study casts of the dentition, appropriate radiographs, and a careful evaluation of the head and neck. The oral evaluation should include a thorough assessment of the oral soft and hard tissue health. Tooth wear may indicate sleep bruxism. In addition, the presence of scalloping on the oral tongue lateral borders and ridging of the buccal mucosa is suggestive of sleep bruxism.32-34 The presence of torus mandibularis or palatinus has also been reported as comorbid with oral parafunctional activity.35,36 The condition of the dentition and supporting periodontal structures needs to be optimum to prevent unwanted morbidity. Any pathology should be immediately addressed before appliance fabrication.

An assessment of the occlusal classification and maxillomandibular relationship should be documented in the patient’s record before treatment. This will help assess any potential changes that may occur during therapy. A thorough evaluation of the temporomandibular joints (TMJs) and associated structures should be included in the pretreatment assessment. Palpation of the masseter, temporalis, suprahypoid, and cervical muscle groups by use of the method previously described by Fischer37 will provide diagnostic information important in the assessment of the stomatognathic musculature (Figure 5).

Masseter and temporalis muscle hypertrophy is often seen in association with bruxism and TMJ disorders.38-40 The TMJs should be palpated at both the lateral and retrodiscal aspects. The retro discal area can be palpated by having the patient open widely and pressing the preauricular area with light pressure (no more than 5 kg/cm²). Because limited range of mouth opening is often seen in patients
with impaired TMJs, the range of motion should be assessed in opening, lateral, and protrusive movements. Normal mandibular opening is thought to be between 40 and 55 mm. Normal lateral and protrusive movements measure approximately 7 mm (Figures 6, 7, and 8). The presence and quality of jaw joint noises should also be documented as they may indicate joint pathology. In some cases, intra-articular disorders may postpone or interfere with OA therapy. In other individuals, the OA may serve to decrease oromandibular dysfunction during sleep.

According to the AASM practice parameters, the fitting and delivery of an OA should be performed by a well-trained and qualified dentist after prescription by the sleep physician. The dentist should possess expertise in dental sleep medicine and temporomandibular disorders. The treating dentist should always provide for a very exhaustive informed consent before initiating therapy (Figure 9). An accurate impression of the upper and lower dental arches, as well as a recording of the relationship between the 2 arches is required for the fabrication of the custom OA (Figures 10 and 11). The impressions are poured in dental stone and sent to an approved dental laboratory for fabrication. It is helpful to maintain a second set of the dental cast to monitor dental occlusal changes that may occur with appliance usage.

The appliance is then placed in the patient’s mouth to ensure comfortable fit and adequate retention on the teeth. A great deal of care should be given this step to facilitate optimum patient compliance. It should be confirmed that the patient can form and maintain an adequate lip seal to facilitate nasal breathing as well as reduce potential drooling and/or dry mouth. The advancement mechanism should be titrated to the most comfortable protrusive position with instructions given to the patient for continued home titration. Effectiveness of the OA at the titrated position can be first accessed by the use of portable studies such as home pulse oximetry. Once portable studies indicate success, follow-up polysomnogram should be used to confirm the result. Parker et al demonstrated a 92% success rate using portable monitoring combined with polysomnogram confirmation. Follow-up appointments need to be scheduled with the dentist to assure adequate fit, compliance, and overall comfort of the appliance. Any potential morbidity should be immediately addressed at the follow-up appointments.
Adverse events

Increased salivation, dry mouth, teeth discomfort, bite changes, as well as jaw joint pain are the most common side effects reported by patients using OAs to treat their sleep-related breathing disorders. The reporting of adverse events will depend on the survey questions, the number of patients studied, and other such variables unique to the study itself. Most side effects dissipate over time and are rarely a concern for the patient. It is of benefit to include the potential adverse events in the consent form to dispel any concerns that may occur if they do happen. In most cases, adjustments can be made by the dentist to the appliance that will solve the perceived problem.

In one investigation, authors theorized about temporomandibular joint degeneration yet long-term changes to the joint complex have not been well studied to date. The most significant factor for non-compliance of OAs is usually because of lack of efficacy rather than appliance discomfort. However, in 2 studies investigators have demonstrated that 40%-50% of patients did, in fact, discontinue appliance usage because of adverse events. For the dentist, the most significant concern is changes to the occlusion or biting relationship that may occur with OAs. Martinez-Gomis et al demonstrated permanent occlusal changes after 5 years of continuous appliance usage in most of the 40 patients studied. De Almeida et al showed clinically relevant changes in the dental occlusion after a mean of 7.4 years of appliance use. Ueda et al also demonstrated what was termed “dramatic” changes in dental occlusion when the appliance was used for 5 years or longer. Not all patients will experience bite changes with OA use, but attention to the possibility by careful monitoring should be a part of the treatment protocol. Retainers or positioners can be fabricated for wear after the sleep period. These devices are fitted to the patient’s teeth and replicate the bite relationship prior to the initiation of therapy. In most cases, the patient will be able to bite comfortably into the device after approximately 30 minutes of wear.

Future directions

With the growing popularity and evidence of efficacy of OAs, studies in which the different appliance types are...
compared are needed to help guide practitioners through the maze of information now provided by the mostly by the appliance manufacturers. Design features favorable to specific patient parameters would also help the clinician in appliance selection. Criteria for patient selection, predictors of success and compliance monitoring will ensure that OAs are prescribed in the most appropriate manner and that good patient compliance is ultimately achieved. Using new imaging technology, we soon may realize a better understanding of the mechanisms of action of OAs. Future endeavors need to focus on achieving an understanding of the effect of OAs in the sleeping individual to improve outcomes of therapy. Advocacy efforts to help patients receive favorable reimbursement are also needed to ensure access to care and remove financial barriers for individuals in need of therapy.

Conclusions

OAs provide the clinician and patient a relatively easy and moderate cost alternative to the more traditional pneumatic splinting of the airway. Recent research has demonstrated evidentiary support for their use in obstructive sleep apnea. The recently updated practice parameters of the AASM recommends OAs for use in patients with mild-to-moderate sleep apnea or for patients with severe sleep apnea who are not able to tolerate CPAP or prefer an OA. This review summarized the currently proposed mechanisms of action, the fabrication and potential adverse effects of OAs for sleep-related breathing disorders. As discussed, most potential adverse events can be managed by the treating dentist if regular monitoring is maintained.

With OA therapy, as is true with all treatment modalities, a comprehensive informed consent is imperative. It is also important that doctors who are well trained and experienced in sleep disorders and TMJ function and dysfunction, lead the team in the assessment, fitting and monitoring of the patient who is a candidate OA therapy. Ultimately, the collaboration of the well-trained dentist and sleep physician will provide a cost-effective and therapeutically sound treatment alternative for the ever-increasing population of patients who suffer with sleep related breathing disorders.

References


