Revista
ESTOMATOLÓGICA
Herediana
E-ISSN 2225-7616

REVIEW ARTICLE

DOI: https://doi.org/10.20453/reh.v35i3.5989

Mandibular advancement devices as a treatment for obstructive sleep apnea: a literature review

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Received: December 02, 2024
Accepted: May 23, 2025
Online: September 30, 2025

ABSTRACT

Obstructive sleep apnea (OSA) is a sleep disorder resulting from the narrowing and collapse of the upper airway. It has been associated with an increased risk of motor vehicle accidents, diabetes, and cardiovascular diseases, making it a major public health issue. In recent years, intraoral mandibular advancement devices have gained popularity as an option for the treatment of snoring and OSA. These devices are well tolerated by most patients, and their therapeutic efficacy has been widely demonstrated. Against this background, it is important to know the advantages of their use, the treatment protocol, and their possible side effects.

Keywords: sleep apnea; obstructive sleep apnea; apnea; mandibular advancement device.

Cite as:
Laquihuanaco GM, Tay Chu Jon LY. Mandibular advancement devices as a treatment for obstructive sleep apnea: a literature review. Rev Estomatol Herediana. 2025; 35(3): 227-232. DOI: 10.20453/reh.v35i3.5989

INTRODUCTION

Obstructive sleep apnea (OSA) affects approximately 5.9% of women and 12.5% of men over the age of 40 (1). It is third most common respiratory disorder, after asthma and chronic obstructive pulmonary disease (COPD). Its prevalence is higher among individuals with obesity and in males (1-4). OSA is characterized by recurrent collapse or narrowing of the pharyngeal upper airway, which increases respiratory effort (2-4). Consequently, arterial oxygenation decreases and microarousals occur, most of which are not consciously perceived (3-5). Arousal-related surges in upper-airway muscle activity and abrupt airway reopening cause vibration of soft tissues, manifesting as loud snoring when normal breathing resumes (4, 6).

OSA is associated with multiple adverse health outcomes, including hypertension, stroke, coronary artery disease, atrial fibrillation, heart failure, and daytime sleepiness (3, 4, 7). Daytime sleepiness and related symptoms are linked to reduced vigilance while driving, learning difficulties, and memory impairment (2, 3, 5). Overall, OSA substantially impairs quality of life and daily functioning (2, 7), and its high prevalence and broad consequences make it a public health priority (4, 5).

Both conservative and surgical therapies are used to treat OSA. Continuous positive airway pressure (CPAP) remains the first line therapy for moderate to severe cases; however, suboptimal long-term adherence has prompted evaluation of alternatives. Mandibular advancement devices (MADs) have robust evidence supporting their use in mild to moderate OSA and in patients intolerant of CPAP.

Therefore, this review summarizes current evidence on the diagnosis and treatment of OSA, with emphasis on the benefits and potential adverse effects of mandibular advancement devices. Although this is not a systematic review, it aims to contribute to current knowledge by providing a detailed overview of therapeutic approaches and associated risks.

MATERIALS AND METHODS

An electronic search of PubMed, Embase, Medline, Web of Science, Scopus, Cochrane Library, and LILACS, up to August 2022, included systematic reviews, randomized clinical trials, as other relevant articles on MAD efficacy, with no language restrictions. The inclusion criteria were studies that described the treatment protocol and incorporated polysomnography. Book chapters, letters to the editor, and personal opinions were excluded. This manuscript forms part of a comprehensive review on the efficacy of mandibular advancement devices in the treatment of OSA.

DIAGNOSIS

In patients with suspected OSA, a thorough medical history is essential to guide the diagnosis. Risk factors include age, obesity (particularly in men), menopause in women, and the use of sedatives contribute to upper airway instability, thereby promoting the onset of the disease and its symptoms (8).

Family history of OSA and snoring suggests a genetic contribution (8, 9). The prevalence increases with age, approximately threefold higher in older adults than in middle-aged individuals; male-to-female ratios of ~2-3:1 are reported in middle-aged populations. Additional contributors include smoking, alcohol, sedatives/hypnotics/barbiturates, and supine sleep (9). In addition, conditions that reduce upper-airway caliber should be evaluated, such as obesity, nasal obstruction (e.g., allergic rhinitis), congenital malformations, tonsillar hypertrophy, and certain comorbidities. The latter include arterial hypertension, heart failure, arrhythmias, diabetes mellitus, stroke, pulmonary hypertension, asthma, and thyroid disorders (8, 9). Polysomnography is the gold standard for diagnosing OSA, as it enables measurement of the apnea–hypopnea index (AHI), an objective, sensitive, and specific indicator that reflects the severity of the disorder and allows for its clinical classification. AHI is calculated by dividing the total number of apneas and hypopneas by the total hours of sleep, thus obtaining the number of respiratory events per hour (8).

According to the American Academy of Sleep Medicine (AASM), OSA is classified based on AHI values as follows: Mild: 5-15 events per hour, Moderate: 15-30 events per hour, and Severe: >30 events per hour (9, 10). As established by the standardized criteria of the AASM Manual, apnea is defined as a ≥90% reduction in airflow amplitude lasting at least 10 seconds, while hypopnea is defined as a 30-89% reduction in airflow amplitude lasting at least 10 seconds, accompanied by an oxygen desaturation of ≥4% (10).

TREATMENT

There are both conservative and surgical approaches for the treatment of OSA. CPAP is the first-line conservative treatment for moderate to severe cases (5). This device delivers air at a constant pressure through a mask, helping to keep the airways open during sleep. Although it is a relatively safe method, long-term use may be associated with certain complications and poses challenges in patient adherence over time (3, 11).

As an alternative, other methods aim to increase the diameter of the upper airway, such as MADs. These intraoral appliances are worn during sleep and advance the mandible, anteriorly displacing the tongue via the genioglossus and altering hyoid position; this enlarges the upper airway and reduces collapsibility (3, 5, 7).

CONTINUOUS POSITIVE AIRWAY PRESSURE

The first-line conservative treatment for OSA consists of the administration of continuous positive airway pressure through the airways using a device known as CPAP (3). This equipment prevents airway collapse by generating positive pressure in the pharynx, creating a sort of pneumatic chamber that eliminates snoring, hypopneas, and episodes of respiratory obstruction (2, 3, 9). The pressure is delivered to the patient through a nasal mask, which helps correct snoring, obstruction, oxygen desaturation, and arousals related to respiratory events. Moreover, the use of CPAP improves concentration, sleep architecture, and various cognitive functions, reduces the risk of traffic accidents, and contributes to the regulation of blood pressure (9).

Although CPAP is considered a relatively safe method, long-term use can lead to several complications. Among

the most common are local nasal mucosal lesions—such as necrosis, irritation, edema, or nasal septum deviation—as well as upper airway discomforts like nasal drip, sneezing, and mucosal dryness, which affect approximately 40% of patients. Aerophagia-related gastric distension is also frequent. In some cases, treatment may prove ineffective, potentially leading to atelectasis. Complications associated with improper equipment fitting include skin abrasions, ulcerations, nasal and conjunctival irritation, and air leaks due to poor mask positioning. Rarely, more serious complications have been reported, such as intracranial embolism, bacterial meningitis, severe nasal hemorrhage, edema, or cardiac arrhythmias (3).

MANDIBULAR ADVANCEMENT DEVICES

Oral appliances designed to maintain airway patency during sleep have existed for almost a century. In 1934, Pierre Robin described one of the earliest versions to manage retrognathia (12). Currently, MADs are a modern and effective alternative for the management of OSA. They are a simple, reversible, and cost-effective option. Various models have been developed in recent years by different manufacturers, with approximately 50% of patients achieving an AHI < 10 or 20 events per hour (13).

Most of these devices are worn intraorally between the dental arches and gradually advance the mandible, which helps maintain upper-airway patency during sleep (12). Current evidence shows that MADs significantly reduce AHI in adults with OSA across severity categories (2, 7).

A wide range of commercially available intraoral devices differs in design, size, materials, type of dental adaptation, occlusal coverage, and whether they permit vertical/lateral movements; they may be prefabricated or custom-made, self-adjusted by the patient or adjusted by a professional. Some allow for progressive mandibular advancement, either through a stepwise or gradual adjustment system, while others are individually fabricated for each patient (2, 3, 5, 7).

These devices can be single-piece (monoblock), where the upper and lower components are fused, or two-piece (duoblock), consisting of separate arches connected by adjustable mechanisms. Non-adjustable monoblocks fix the mandible in a position determined by the dentist. In contrast, dual-block appliances allow the degree of mandibular protrusion to be modified using adjustment screws (anterior or lateral), elastic bands, and telescopic systems (5) (Table 1).

Table 1. Types of mandibular advancement devices (MADs) for treatment of obstructive sleep apnea.

Type of device	Description
Custom-made MADs	Personalized devices adjusted by screws, hinges, and elastic bands. They may be monoblock (single-unit) or duoblock (upper and lower parts separated but interconnected).
Prefabricated MADs	Standard devices are bulkier and often uncomfortable. They may have difficulty maintaining a stable mandibular protrusion position during sleep.
Titratable MADs	They allow precise and gradual adjustment of mandibular advancement. The upper and lower parts are separated but dynamically connected, enabling individualized adjustment according to patient needs.

There are multiple options available on the market for the management of snoring and OSA, and device selection should be based on the patient's phenotype and anatomical characteristics. It is recommended that a qualified dentist design a custom-made, adjustable MAD and perform periodic follow-up to minimize adverse effects such as occlusal changes. Furthermore, collaboration with sleep medicine specialists is essential, as they are responsible for conducting clinical evaluations to assess the treatment's efficacy and its impact on sleep quality (14).

Before initiating treatment with a MAD, the clinical examination should include an evaluation of the number and quality of remaining teeth, as well as the periodontal status and temporomandibular joint (TMJ) function. The minimum criteria include having at least eight stable teeth in both the maxilla and mandible, and the ability to achieve a centric occlusion with the mandible positioned between 50% and 75% of its maximum protrusion, maintaining an interincisal space of 3–5 mm to allow for oral breathing. Although greater mandibular protrusion is associated with higher therapeutic efficacy, it may also reduce device tolerance (3).

Moreover, the use of MAD is contraindicated in patients with temporomandibular dysfunction, masticatory muscle pain, insufficient or poor-quality dentition, or active periodontal disease (3, 5).

SIDE EFFECTS ASSOCIATED WITH MANDIBULAR ADVANCEMENT DEVICES

Continuous use of MADs may lead to both short- and long-term side effects in the orofacial region. Among the most frequently reported side effects are excessive salivation, xerostomia, allergic reactions to the materials used, masticatory muscle fatigue, and TMJ pain. Additionally, occlusal changes may occur, including incisor positional changes and vertical or horizontal occlusal alterations, such as variations in overjet and overbite, which may be related to splint thickness (3, 5).

These changes in overbite appear to depend on several factors, including the initial position of the incisors (both vertical and horizontal), duration of treatment, degree of mandibular protrusion, and amount of bite opening. The reduction in overjet, for instance, is often attributed to the retroclination of the maxillary incisors and the proclination of the mandibular incisors, due to forces exerted by the device (3, 5). Concerns about contraindications and adverse effects associated with MAD therapy underscore the importance of a comprehensive dental evaluation and the active involvement of dental specialists in the design, adjustment, and follow-up of these devices (5).

DEVICE ADJUSTMENTS

There is considerable variability in the literature regarding the degree of mandibular protrusion used in treatment with MAD, with reported ranges between 50% and 100% of maximum protrusion (5). For duoblock devices, a progressive adaptation period is required, gradually increasing advancement to achieve an optimal therapeutic. This process may take up to eight weeks, beginning with an initial adaptation phase of approximately four weeks.

Regarding the vertical dimension of occlusion, it is generally recommended to keep it at a minimal level. Excessive mandibular opening can cause an inferior and posterior displacement of the tongue, thereby reducing upper airway patency (15).

By contrast, monoblock devices require specific adjustments to optimize both comfort and therapeutic efficacy. These adjustments help establish the initial bite position and allow for individualized treatment according to the patient's clinical response. In a systematic review, Sakamoto et al. (16) evaluated the most effective mandibular protrusion for treating OSA and concluded that, in cases of severe OSA, a protrusion of 75% was most effective, while in moderate cases, a protrusion of 50% was effective.

DISCUSSION

Over the past decade, research output regarding OSA has increased substantially, particularly in relation to clinical outcomes. MADs are an effective therapeutic option for OSA. The efficacy of these devices has been extensively documented through numerous randomized clinical trials conducted in recent years. Several studies have compared different mandibular device designs, evaluating their impact on the reduction of AHI (2, 17-19). Although CPAP remains the most effective treatment for OSA, evidence suggests that intraoral appliances are a suitable alternative, particularly due to higher patient compliance, ease of use, and the fact that they do not require electricity (2, 3). Nevertheless, in cases of severe OSA, CPAP continues to be the treatment of choice (3).

Multiple studies agree that, in patients intolerant to CPAP therapy, the use of MAD is preferable to receiving no treatment at all and may be equally effective in cases of mild OSA (7, 9, 19). The joint clinical practice guidelines of the AASM and the American Academy of Dental Sleep Medicine (AADSM) recommend the use of intraoral appliances in patients with primary snoring without OSA, mild OSA, and moderate to severe OSA who do not tolerate CPAP therapy, refuse its use, or are not candidates for surgical intervention (9).

Long-term studies demonstrate that both CPAP and MAD therapy can significantly reduce the AHI after ten years of continuous use, suggesting that both modalities provide sustained therapeutic benefits (5). However, proper patient selection for MAD therapy remains a challenge due to the wide range of factors influencing treatment efficacy. Some of the factors associated with a better response include milder OSA severity, younger age, lower body mass index, reduced neck circumference, and female sex. Additionally, facial morphology and upper airway physiology play a significant role (3, 5).

Regarding the comparison between monoblock and duoblock devices, evidence remains controversial. Bloch et al. (18) evaluated the efficacy and adverse effects of a monoblock MAD and a duoblock device with a Herbst mechanism (OSA-Herbst), and concluded that both were effective, although the monoblock provided greater symptomatic relief and was preferred by patients due to its simplicity of use. Conversely, Ghazal et al. (17), in a two-year observational study, found no significant differences in long-term efficacy between the types of devices. In a 2020 meta-analysis, Bartolucci et al. (2) reported a success rate of 0.821 for monoblock MADs and 0.547 for duoblock devices, concluding—albeit with low-quality evidence—that monoblock devices may be more effective in reducing AHI and improving minimum oxygen saturation.

In addition, Durán-Cantolla et al. (19) reported that MADs are effective in reducing AHI and improving perceived snoring, supporting their use as a valid therapeutic option for mild to moderate OSA as well as for chronic primary snoring.

It is important to emphasize, as highlighted by AADSM, that dental surgeons play a crucial public health role in identifying undiagnosed OSA cases. Dentists play a key role within the multidisciplinary management of OSA, as they may suspect the disorder during routine dental examinations and refer patients to specialized sleep units for definitive diagnosis (20). Furthermore, they must be familiar with the various diagnostic and therapeutic tools available to offer the most appropriate individualized treatment.

This review aims to summarize the main scientific contributions regarding OSA, with particular emphasis on the use of mandibular devices for its treatment. However, due to its narrative design, systematic review and meta-analyses provide provide a higher level of evidence. Consequently, potential biases or gaps in the reviewed literature may exist. Further research and rigorous systematic reviews are needed to establish more robust conclusions based on the best available evidence.

CONCLUSIONS

MADs are safe, generally well-tolerated, and should be offered to patients with mild to moderate OSA and to those intolerant of CPAP. These devices reduce AHI, although the magnitude of reduction varies across patients. Polysomnography remains the gold standard for diagnosis and for assessing treatment response.

In summary, given the high prevalence of sleep disorders, there is a growing need to train more dentists in dental sleep medicine to ensure safe, effective, and high-quality care for patients undergoing MAD therapy.

Conflict of interest:
The authors declare no conflict of interest.

Funding:
Self-funded.

Authorship contribution:
GMLC: conceptualization, methodology, writing of original draft.
LYTCJ: visualization, writing – review & editing.

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