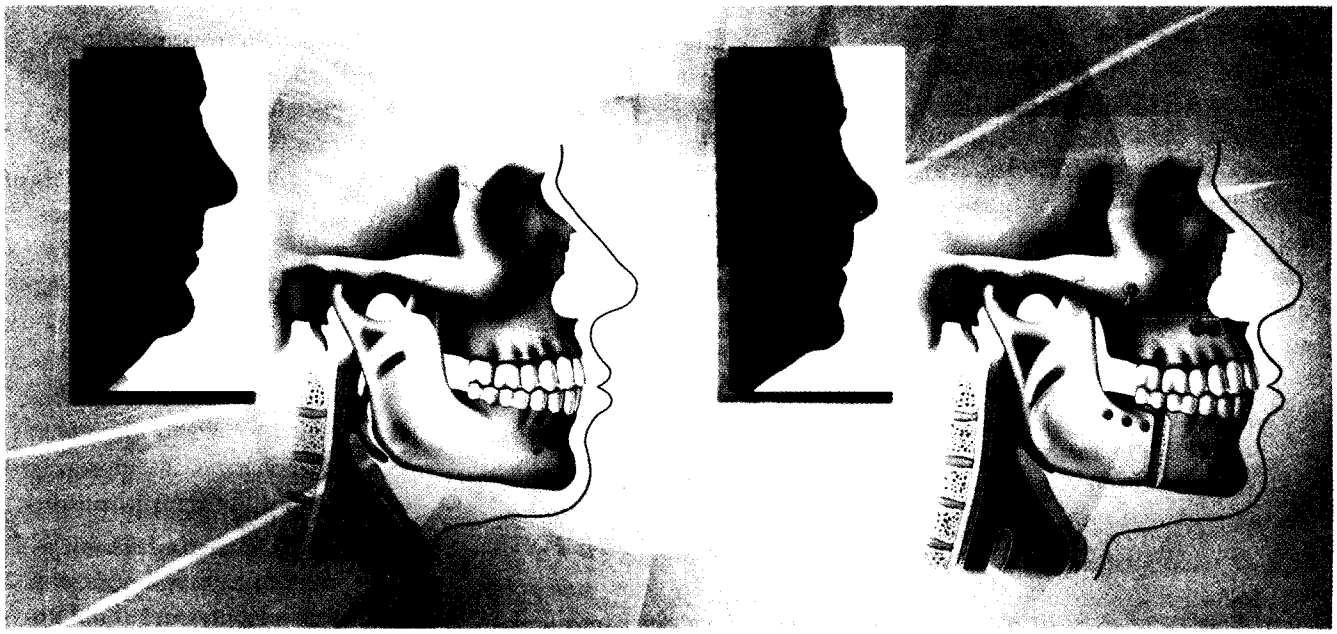
American Association of Oral and Maxillofacial Surgeons

Surgical Update



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Obstructive Sleep Apnea

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Obstructive Sleep Apnea

Summary

According to the National Sleep Foundation, some form of snoring or obstructive sleep apnea (OSA) occurs in 90 million Americans. Approximately 40% of patients over the age of 40 snore, and half of them snore every night. Among habitually loud snorers, the incidence of OSA is at least 17% in men and 15% in women.

An estimated 18 million Americans have OSA, and 16 million remain undiagnosed. OSA is associated with higher risks for hypertension, coronary heart disease, stroke, congestive heart failure, atrial fibrillation, impotence, mortality, and behavior and cognitive problems. Sleep apnea leading to excessive daytime hypersomnolence may be responsible for many job-related injuries and it is estimated that people with sleep apnea are 10 times more likely to die in a car accident than someone without sleep apnea.

Oral and maxillofacial surgeons play a key role in the surgical management of OSA. Both oral appliance therapy and jaw advancement surgery offer significant potential benefits to patients affected by this disorder.

Airway Physics

Snoring is a sign of airway narrowing. As we age and/or gain weight, the ability of the airway and tongue-base musculature to expand the upper airway during normal respiration often declines. Increased body mass index further adds to airway narrowing.

Narrowed airways result in 2 long-term consequences: *1*) an increase in air velocity via the Venturi effect, which imparts kinetic energy to the soft tissues of the upper airway; and *2*) narrowed airways via the Bernoulli principal, in which less negative airway pressure is required to collapse, and larger negative and positive pressures are needed to ventilate through the smaller tube. The combined effects of rapid airflow and increased negative inspiratory pressure gradually stretch the soft tissues of the upper airway; primarily the soft palate.

The Continuum of Airway Narrowing

The continuum of airway narrowing begins in patients with primary snoring (ie, just enough narrowing to cause rapid airflow). The airway narrows, increasing upper airway resistance, and ends when OSA results. Importantly, all of the patients along this continuum snore; however, in order to discern where along the continuum a given individual patient lies, a sleep study is indicated.

Dental Treatment for Obstructive Sleep Apnea

Over the past 15 years, oral appliances have developed into a viable and scientifically sound method for eliminating upper airway obstruction in a large percentage of patients. While individual patient selection criteria are yet to be determined, it is critical that the treating dentist maintains a basic knowledge of oral appliance therapy.

The American Academy of Sleep Medicine has recently published a newly revised practice parameter paper that lends substantial importance and credibility to the use of oral appliances in the treatment of OSA.[1] The term "oral appliance" refers mainly to the subset of mandibular repositioning appliances (MRAs). Following is a summary of the revised parameters:

1. The presence or absence of OSA, including its severity, must be determined prior to initiating treatment with oral appliances.
2. Oral appliances should be fitted by dentists who have appropriate training and experience in dental sleep medicine.
3. Cephalometric evaluation is recommended.
4. The goal of treatment in patients with primary snoring or upper airway resistance syndrome (UARS) is to reduce snoring to a subjectively acceptable level. The goal of treatment in patients with OSA includes resolution of the signs and symptoms of OSA, and normalization of the apnea-hypopnea index (AHI) and oxygen saturation.
5. Oral appliances are appropriate treatment for primary snoring.
6. Oral appliances, while not as efficacious as continuous positive airway pressure (CPAP), are indicated as a first-line treatment option for patients with mild-moderate OSA (ie, for those who prefer oral appliances to CPAP, who do not respond to or cannot tolerate CPAP, or who fail treatment attempts with CPAP or other behavioral measures).
7. Oral appliances are not indicated as a first-line treatment for severe OSA, because greater effectiveness has been shown with the CPAP than with oral appliances. Some upper airway surgical procedures, including uvulopalatopharyngoplasty (or UPPP), tonsillectomy and adenoidectomy, tracheostomy, or orthognathic surgery, may also supersede the use of oral appli-

ances in patients for whom these procedures are predicted to be highly effective.

8. OSA patients treated with oral appliances should undergo a post-titration polysomnogram (PSG) or attended cardiorespiratory sleep study (Type 3).
9. Follow-up dental visits are necessary every 6 months during the first year and annually thereafter. Oral appliances may worsen temporomandibular joint (TMJ) disease and may contribute to occlusal and orthodontic malalignment. The appliance itself needs to be continuously monitored for signs of deterioration, maladjustment, and ineffectiveness.
10. Patients treated with oral appliances should be followed periodically by the referring physician. Objective re-evaluation during sleep is indicated if signs or symptoms of OSA worsen.[2]

Those involved in the treatment of patients with OSA must be cognizant of the standards of care, the importance of proper patient education, and the ability to work with their medical colleagues.

Types of Oral Appliances

While several classes of oral appliances have been developed, MRAs have received significant legitimate scientific study and are the class of appliances most commonly prescribed at this time. MRAs can be divided into non-custom ("off the shelf" or "boil and bite") appliances, and custom-made ("monoblock" or "adjustable") appliances. Currently, the custom-made, adjustable MRA has seemed to find the most merit.

How Oral Appliances Work

While the precise mechanism of action of oral appliances in the treatment of snoring and OSA is yet to be defined, multiple studies suggest complex changes during mandibular protrusion improve airflow dynamics. MRAs have been shown to increase both lateral and anteroposterior dimensions of the upper airway at the hypopharyngeal, oropharyngeal and velopharyngeal airway segments, and genioglossus neuromuscular activity has been shown to be activated during use of these appliances.[3]

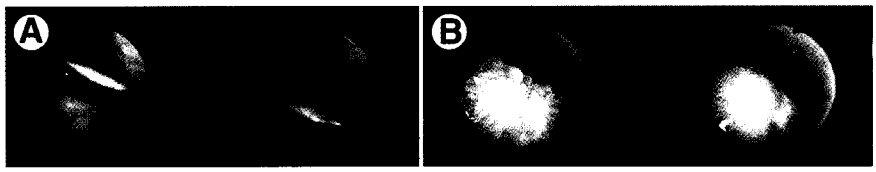

Figure 1. Endoscopic views of upper airway. Assuming both patients present with a mild-moderate level of OSA, a potentially favorable response with oral appliance therapy would be expected in the patient on the left (A), while an unfavorable response would be expected from the patient on the right (B).

The airway of the patient on the left (Fig 1A) as opposed to that of the patient on the right (Fig 1B) is seen to expand dramatically with anterior mandibular positioning. Assuming both patients present with a mild-moderate level of OSA, a potentially favorable response with oral appliance therapy would be expected in the patient on the left, while an unfavorable response would be expected from the patient on the right.

Oral Appliance Efficacy

Overall, those with mild to severe OSA have a 52% chance of controlling their OSA using oral appliances (Fig 2). Oral appliances are less effective than CPAP, but may be better accepted by patients than nasal CPAP.[1] Oral appliances are not recommended as a first line treatment in patients with severe OSA (AHI >30), but are considered a legitimate second-tiered therapy for patients with severe OSA who fail treatment with CPAP, are surgical failures, or who do not wish to undergo treatment with CPAP. The results of oral appliances in severe OSA are unpredictable.[2]

Supine-dependent OSA patients typically have less severe disease and more normal upper airway physiology, and respond better to oral appliance therapy than patients who obstruct in the lateral position.[4] Also, as supine rapid eye movement sleep is typically considered the most vulnerable body position and stage of sleep, obstruction is commonly seen to worsen in this position and stage of sleep. In these patients, cervical extension can be utilized to augment hypopharyngeal airway size using special pillows. Oral appliance therapy can also be used to determine the necessary amount of surgical advancement of the jaws (maxillomandibular complex).

Oral Appliance Therapy: Primary Versus Rescue

Oral appliances are most commonly used as a primary treatment for OSA; however, use of these appliances is commonly adopted by both sleep physicians and surgeons in cases of failed CPAP, UPPP, tongue-base or nasal surgery. The use of an oral appliance to reposition the mandible forward has been associated with lower CPAP airway pressures required to ventilate the patient. Oral appliance therapy focuses primarily on tongue-base obstruction, often making this combination an effective form of therapy.

Patient Selection

Clinical experience with MRAs in the treatment of snoring and OSA

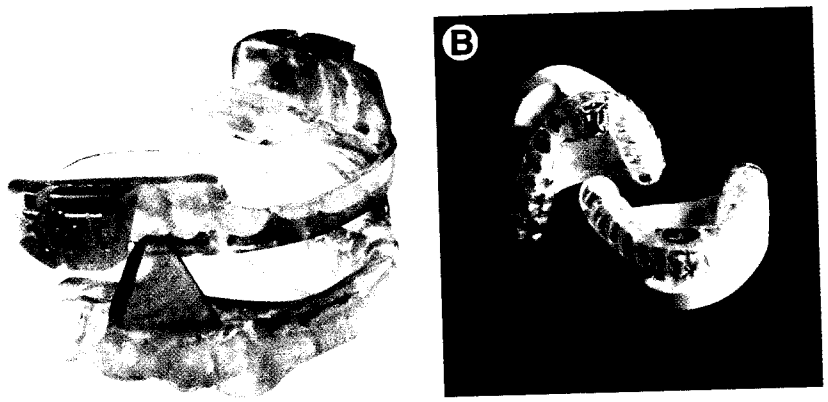

Figure 2. Two commonly used oral appliances for treatment of OSA. A, SomnoMed appliance and B, TAP appliance.

is largely restricted to adults, although 1 randomized controlled trial in children has reported effective control of OSA and airway-related symptoms.[5]

Non-apneic snorers represent a significant group for which oral appliances should be considered. The new practice parameters support the first-line application of oral appliances to patients with mild-moderately severe OSA, or those who fail other forms of therapy. Young, thin patients with lower body mass indices and respiratory disturbance indices, and with mandibular protrusive ranges of 8 mm or more are the classic responders to MRA therapy, but response is seen along a wide continuum of patients. TMJ dysfunction may or may not be a relative contraindication to the use of oral appliances. While tongue-retaining appliances are a possibility, extensive dental work or poor dentition may prevent traditional MRA therapy. Women are overall more successfully treated with MRAs than men, when controlled for disease severity, supine-dependent OSA, BMI, and below age 50.[4]

Oral Appliance Design, Fabrication and Titration

MRAs are also approved by the US Food and Drug Administration (FDA) for primary snoring versus OSA. Those FDA-approved for OSA tend to be heavier, more retentive, and more durable than those approved for primary snoring. Medicolegally, a device approved for snoring should not be used in a patient being treated for OSA, but the reverse is not true. Boil and bite appliances cannot be recommended at this time either as a screening tool to find good candidates for mandibular advancement surgery, or for treatment of OSA.[6]

While little is known about the influence of appliance design on treatment outcome, most custom-made MRAs possess good retention and adequate protrusive capability, while minimizing vertical changes. The actual appliance that is chosen is often determined by the interaction of the patient and dentist. Custom MRAs that permit some degree of lateral and vertical jaw movement may potentially minimize TMJ problems and improve patient acceptance.

The correlate also exists: in some patients, if an adequate therapeutic response is not achieved when the mandible has been fully repositioned, or the patient is unable to tolerate the mandible in a fully protruded position, then an alternative treatment option (CPAP or surgery) must be sought.

Compliance With Oral Appliance Therapy

Although most compliance studies are subjective, one objective compliance study showed patients averaged 6.8 hours of use per night with a range of 5.6 to 7.5 hours.[5] The objective data for hours of nightly use of an oral appliance is in the same range as the subjectively reported data.

Side Effects/Medicolegal Implications

Complications commonly associated with oral appliances are minor (ie, self-limited, such as tooth pain, excess salivation, dry mouth, TMJ discomfort, and muscle pain).

Tooth movement is noted in a significant number of studies, the most common of which is lingual tipping of the maxillary incisors, proclination of the mandibular incisors, and anterior shifting of the lower first molar teeth. While these changes tended to occur with increasing length of treatment, the most significant dental changes were observed at 30 months. Fourteen percent of 106 patients had evidence of occlusal changes. Eight patients were not aware of these changes. Conversely, 9 of 16 patients reported bite changes but had no clinical evidence of the changes.[7]

Informed consent, careful documentation of response to therapy, careful monitoring of the occlusal changes over time via cephalometrics, dental models, and serial records are critical.

Conclusion—Oral Appliances

Oral appliances are now a recognized first-line treatment for snoring and mild to moderate OSA. They can be a legitimate alternative or rescue therapy for some severe OSA patients who fail first-line therapies (CPAP or UPPP). Short-term side effects to MRAs are common, but typically transient,

and long-term side effects, although common, are typically mild. While airway response varies between individuals, 52% of all patients (mild-severe) respond to therapy when custom oral appliances are used.

Since dental sleep medicine and OSA are not included in the curriculum of most dental schools and residencies, additional training is required before initiating treatment. The American Academy of Dental Sleep Medicine (www.aadsm.org), an international professional organization of dentists, surgical subspecialists, and physicians advocating use and research of oral appliances, is a valuable resource for those seeking noncommercial-based education in this field. The American Board of Dental Sleep Medicine (www.abdsm.org) has been established as the credentialing body for certification.

Surgical Therapy for Obstructive Sleep Apnea

A surgical solution to OSA, if successful, eliminates any question of compliance.

The surgical approach to sleep-disordered breathing (SDB) continues to evolve. Many surgical approaches have emerged, including tracheostomy, UPPP, LAUP, septoplasty, orthognathic surgery, and radiofrequency volumetric tissue reduction ("Somnoplasty" or "Coblation"). Most recently, palatal implants have been developed and marketed as treatments for sleep apnea. The effects of bariatric surgery on adult sleep apnea have also been investigated. However, outside of tracheostomy, jaw advancement, or telegnathic, surgery remains the most accepted successful surgical therapy for OSA at this time.

In an extensive search for relevant studies of randomized trials of UPPP treatment for sleep apnea,

Figure 3. Preoperative front (A) and lateral (B) views of apneic patient.

the Cochrane investigators found 8 studies, totaling 412 participants. Surgical treatment of SDB has been so poorly evaluated in the literature that it cannot be recommended to patients as a first line treatment option. A common problem is that the surgical literature continues to define "success" on the basis of reduction in RDI by 50%—and not on a more strict definition.

UPPP and LAUP

UPPP is the most commonly performed and best studied of the surgical procedures used to treat sleep apnea. In this procedure, redundant soft palate and pharyngeal tissues, the uvula, and the tonsils are removed. Potential complications include velopharyngeal insufficiency, stenosis, and dysphagia. Because of problems with UPPP, several variations on this theme have emerged, including the uvulopalatal flap and LAUP. Unfortunately, there simply is not sufficient evidence that these procedures are beneficial for patients with sleep apnea.[8,9]

Radiofrequency Volumetric Tissue Reduction

Radiofrequency volumetric tissue reduction (RFVTR) applied to the palate ("Somnoplasty") was originally investigated as a less-painful treatment option for SDB than UPPP. This procedure has largely been abandoned as treatment for sleep apnea, though it is occasionally used primarily for snoring.

Oral and Maxillofacial Surgery (Telegnathic Surgery)

When applying the basic orthognathic surgical technique for the purpose of effecting airway expansion in patients with OSA, the correct terminology is "telegnathic surgery." This term differentiates this procedure from that performed for correction of dentofacial deformities, as the purpose of this surgery is instead focused on airway expansion.

In a recent review of oral and maxillofacial surgery, Prinsell et al concluded,

> "MMA (maxillomandibular advancement surgery for obstructive sleep apnea syndrome) is a highly successful and potentially definitive primary single-staged surgery that may result in a significant reduction in OSAS-related health risks, as well as financial savings for the health care system."[10]

Li reaches the same conclusion: **"Maxillomandibular advancement surgery is the most effective procedure for OSA."**[11] In 4

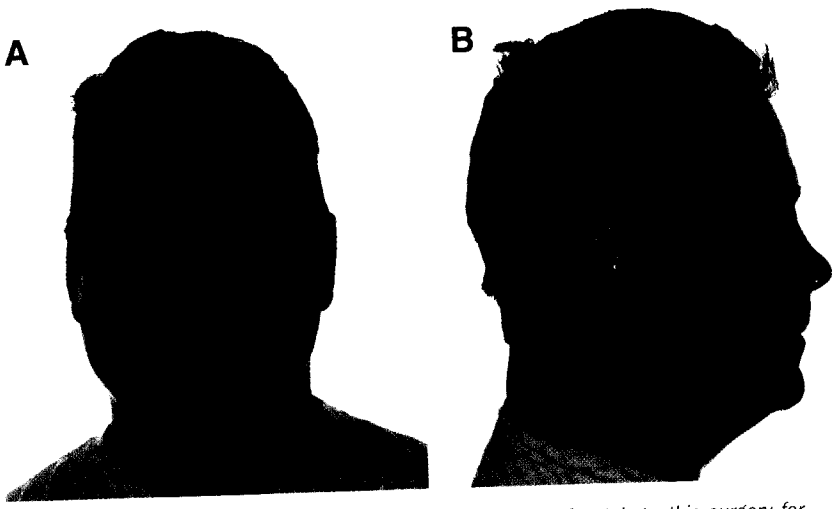

Figure 4. Front (A) and lateral (B) views of the same patient after telegnathic surgery for treatment of severe obstructive sleep apnea.

studies including a total of 214 patients who had MMA the (surgically defined) success rate was 96 to 100%.[12-15] MMA results in enlargement of the entire upper airway. When applied to the sleep apnea population, this technique is called "telegnathic" surgery; as opposed to "orthognathic" surgery performed to correct dentofacial deformities (Figs 3, 4).

Jaw advancement surgery is better tolerated and has a far more significant and beneficial effect than most airway soft tissue surgical procedures, and may produce beneficial effects on nocturnal breathing. Excellent long-term (5-year) results have been noted in patients who do not gain weight postoperatively, and favorable effects on quality of life following telegnathic surgery have been documented.

Application of this procedure to the pediatric population using distraction osteogenesis techniques continues to advance, as new and modified distraction devices continue to evolve. Distraction osteogenesis offers the treating surgeon the ability to "titrate" the degree of advancement with the amount of airway expansion needed to resolve the airway problem. Rapid maxillary expansion has been shown to have very favorable effects in the growing child on improvement (and often elimination) of OSA.

Telegnathic surgery is appropriate when there are ill effects from the use of MRAs on the temporomandibular joints; occlusion; lack of compliance to an oral appliance; failure of previous soft tissue surgical procedures, and when other structural anomalies are present, such as in the hypoplastic or constricted maxilla.

Miscellaneous Surgical Procedures

There are a variety of surgical procedures, typically including some combination of genioglossal advancement, hyoid myotomy and suspension, UPPP, and RVTR. Studies evaluating these procedures typically include very few patients, employ loose definitions of "success," employ more than one surgical technique within the same patient, thereby confounding results, and offer no meaningful follow-up data.[9,11] Various tongue-based inventions have been devised to assist in affecting expansion of this portion of the airway, including: the Repose procedure, the Advance procedure, and the SMILE (submucosal intralingual excision) procedure. Each of these procedures is considered proprietary, lacking in meaningful clinical data, and considered experimental at this time. Hypoglossal nerve stimulation has been proposed and tested clinically previously (with mixed clinical results); newer versions of this technology may soon be forthcoming.

Palatal Implants

In September 2004, palatal implants (the Pillar Procedure) received FDA approval for snoring and sleep apnea on the basis of a small number of patients with minimal follow-up. The results were less than promising and showed a significant increase in ODI (oxygen desaturation index) in a small test group.

Tracheostomy

Tracheostomy remains the "gold standard" surgical approach to severe sleep apnea in those who are CPAP intolerant and are at immediate risk. Sher notes that early resolution of sleep apnea occurs promptly in 83%, and central apneas slowly resolve in the remainder. Sleepiness resolves in 82%, hypertension resolves in 40% of those who undergo tracheostomy.[9] In a mean of 8 years of follow-up, 79 patients who had tracheostomy for severe OSA, tracheostomy was uniformly successful.[16] Sixteen of those patients had decannulation, but 5 needed CPAP, 3 had UPPP, 2 weight loss, and 3 were lost. Immediate complications of tracheostomy included 1 perioperative myocardial infarction and 1 tracheal innominate fistula.

Bariatric Surgery

Gastric bypass surgery appears to be effective in the treatment of sleep apnea,[17,18] though there are reports that SDB can recur without weight gain in the long run.[19]

In summary, tracheostomy, bariatric surgery, and maxillomandibular advancement (ie: telegnathic) sur-

gery are probably the most effective surgical approaches for SDB. Other types of surgical treatment of sleep apnea cannot be supported as a first-line treatment on the basis of the currently available literature.

Summary

CPAP is clearly first-line treatment for sleep apnea, but CPAP compliance is less than optimal. Behavioral change, the use of oral appliances, and surgery in carefully selected patients may benefit some. Oral appliances have emerged as a legitimate, effective and safe first-tier therapy in patients with mild-moderate OSA, and as a legitimate second-line treatment for severe OSA.

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