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Surgical Treatment of Sleep-Disordered Breathing

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INTRODUCTION

Sleep-disordered breathing (SDB) is a spectrum of disorders that range from benign snoring to obstructive apnea with cor pulmonale. Patients with SDB can be managed either medically or surgically. Most clinicians begin with lifestyle modifications and behavioral therapy, which can be especially useful in geriatric patients, as many of these patients may not be good surgical candidates. Patients with SDB who are obese are advised to lose weight, pursue an exercise program and a strict diet regime, and are referred to a nutritionist. They are also advised to stop smoking and to avoid sedatives and alcohol. In patients who have increased events in the supine position, positional therapy may be useful. Martin (1) proposed the following regimen of sleep hygiene for older adults:

1. Limit naps to one nap of <30 minutes per day;
2. Take a walk outdoors to increase both exercise and light exposure, particularly in the afternoon;
3. Check the effect of medications on sleep;
4. Avoid caffeine, alcohol, and tobacco, especially after lunch;
5. Limit liquids in the evenings;
6. Keep a regular sleep schedule.

Many geriatric patients with SDB may manifest complications of the disease. These include ischemic heart disease, hypertension, strokes, and cardiac arrhythmias.

The presence of these comorbidities may limit the appropriateness of surgical intervention. Nasal continuous positive airway pressure (CPAP) has a major role in the treatment of SDB. Pressurized air is delivered according to the patient's degree of upper airway obstruction and acts as a pneumatic splint to keep the upper airway patent.

NASAL CPAP

Appropriate CPAP levels can be determined in two ways. The gold standard is attended overnight polysomnography with CPAP titration. During an attended polysomnographic titration, the CPAP pressure is started first at 3–5 cm H_2O, then titrated upward by increments of 1–2 cm H_2O every 15 to 30 minutes until all apneas, hypopneas, snoring, and oxygen desaturations are eliminated. A less-costly alternative is autotitrating CPAP with pulse oximetry. The auto-PAP adjusts and delivers variable levels of CPAP at the initiation of each respiratory cycle by automatically responding to changes that are detected in the airflow resistance, pressure, or intensity of snoring (2). With the availability of the airway pressure data from the auto-PAP, the clinician can obtain the patient's mean pressure, effective 95th percentile required pressure, and the mean treatment AHI. Based on the effective 95th percentile pressure, the clinician may also prescribe a constant CPAP pressure.

The main drawback to the use of nasal CPAP is compliance. With compliance being defined as usage for at least four hours per night, on 70% of the nights, most clinical series quote compliance rates at about 46% to 70% (3). Stradling and Davies (4) found that patients who use nasal CPAP more than five hours per night are more likely to normalize their sleepiness scores than those who use it less.

Common reasons for poor compliance with nasal CPAP include:

1. Nasal problems—nasal stuffiness, irritation, discharge, pain;
2. Mask problems—poor fit, air leak, dry eyes, skin breakdown;
3. Equipment problems—noisy, cumbersome, high air pressure, pressure-related arousals;
4. Concept problems—failure to understand medical benefit.

Aloia et al. (5) found that in geriatric patients, cognitive-behavioral intervention, in the form of support group counseling and supportive phone calls, improved compliance with nasal CPAP. Regular physician follow-up is necessary to document clinical improvement or the need for alternative therapy.

ORAL APPLIANCES

Oral appliances are designed to bring the mandible and the base of tongue forward, either by stabilizing the mandibular position during sleep or by attempting to increase the baseline genioglossus muscle activity, in an effort to increase the posterior airway space (PAS) (6,7). Oral appliances are especially useful in the geriatric age group when the patient is not a candidate for surgical intervention or is unable to tolerate nasal CPAP.

Oral devices can be divided into three basic types:

1. Mandibular repositioning device—these are removable devices worn only at night. They are affixed to the upper and lower teeth and are gradually adjusted to advance the mandible by 5–8 mm.

2. Tongue-retaining device—these come in the form of a soft suction cup that is placed in the mouth, creating a negative pressure to hold the tongue in a forward position during sleep.
3. Soft palate lift—this appliance is fitted onto the upper teeth and extends posteriorly to lift up the soft palate.

The American Sleep Disorders Association supports the use of oral appliances as acceptable alternatives to nasal CPAP for patients with primary snoring and mild obstructive sleep apnea (OSA) (8).

SURGICAL TREATMENT

The American Academy of Otolaryngology Head and Neck Surgery, Sleep Disorders Committee 1997 position statement affirmed that surgery for OSA is not "experimental nor investigational, and is considered as part of a comprehensive approach in the medical and surgical management of adults with OSA." These surgical interventions are meant to address either excessive soft tissue obstruction or inadequate facial skeletal framework, and include tracheotomy, nasal airway surgery, uvulopalatoplasty, genioglossus advancement, tongue suspension, hyoid repositioning, midline glossectomy, lingualplasty, and maxillary and mandibular advancement. Patients who cannot tolerate or refuse nasal CPAP should be offered a surgical alternative.

Laser-Assisted Uvulopalatoplasty

The laser-assisted uvulopalatoplasty technique was introduced by Yves-Victor Kamami in 1986 (Fig. 1). A number of other surgeons have popularized and modified the procedure. Kamami's (9) original description of the technique included bilateral vertical transpalatal incisions and partial vaporization of the uvula with the CO_2 laser. Kamami (9) studied 417 snorers who underwent laser-assisted uvulopalatoplasty and found an improvement in 95% of the patients, with 1-year follow-up. Most authors report modest results for patients with mild OSA, although a success rate as high as 75% was reported by Walker et al. (10).

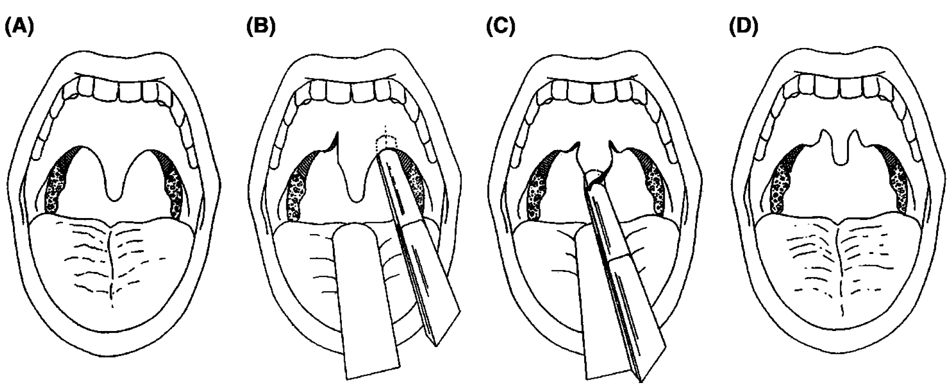

Figure 1 The laser-assisted uvulopalatoplasty was introduced as a technique for shortening and tightening the uvula and palate in an office setting using a carbon dioxide laser.

Uvulopalatopharyngoplasty

Ikematsu (11) developed uvulopalatopharyngoplasty (UPPP) to treat habitual snorers in the 1950s. Ikematsu (11) achieved this by shortening the soft palate and uvula and removing redundant tissue to tighten the pharynx. The author reported an 80% improvement in a series of over 4000 snorers. Fujita (1979) adapted the UPPP technique for the treatment of patients with OSA. The basic technique involves a palatopharyngeal incision, from the base of tongue bilaterally, across the soft palate horizontally, with removal of the uvula. Redundant soft palatal tissues are resected. The tonsils are removed if present, and the anterior and posterior mucosal edges are apposed with absorbable sutures. Many variations to the original UPPP technique have been described, but the results are similar.

Sher et al. (12) performed a meta-analysis of 37 papers, which included a total of 992 patients who had undergone UPPP for OSA. They found that UPPP was more effective (83% success rate) if used for: (i) OSA patients with Fujita type I retropalatal obstruction and (ii) patients with mild or moderate OSA. The overall response rate in unselected patients, though, was 40.7%. Friedman et al. (13) described a clinical staging for SDB in order to predict the success rate of UPPP (Fig. 2). They described three stages based on Friedman palate position, tonsil size, and BMI:

Stage I: Friedman palate position 1 and 2. Tonsil size 3 and 4. BMI <40.
Stage II: Friedman palate oosition 1, 2, 3, and 4. Tonsil size 1, 2, 3, and 4. BMI <40.
Stage III: Friedman palate position 3 and 4. Tonsil size 1 and 2. BMI (any).

Friedman reported an overall success rate of 80.6% for stage I, 37.9% for stage II, and 8.1% for stage III. Generally, UPPP should be done for patients with retropalatal obstruction, and it can be combined with procedures that address other sites of obstruction.

Genioglossus Advancement and Tongue Suspension

The genioglossus advancement (GA) was conceived as a procedure to address obstruction at the level of the base of tongue (Fig. 3). Other surgical procedures that increase the retrolingual airway space include laser midline glossectomy, lingualplasty, tongue base coblation, hyoid repositioning, tongue suspension (repose), and maxillomandibular advancement (MMA). In Powell and Riley's 306 OSA patients who underwent surgery, 239 patients had GA with or without UPPP. They achieved a success rate of 64% across all severities of OSA. They reported even better success with mild (77%) and moderate (78%) OSA (14). Riley et al. (15) also reported a success rate of 86% for OSA patients who underwent GA and UPPP.

Tongue suspension (repose) was introduced by Woodson et al. (14,16) in 2000 for OSA patients with base of tongue obstruction. The mechanism of action is similar to that for GA in that support for the base of tongue is provided to prevent prolapse during sleep. They reported some benefit for patients with OSA, with low morbidity. This experience was confirmed by Terris et al. (17), and a prospective randomized trial comparing tongue suspension with GA in patients who also underwent UPPP revealed comparable results (18).

Hyoid Repositioning Surgery

Due to the attachment of the muscles of the tongue, muscles of the floor of the mouth, and pharyngeal muscles to the hyoid bone, repositioning the hyoid bone helps increase

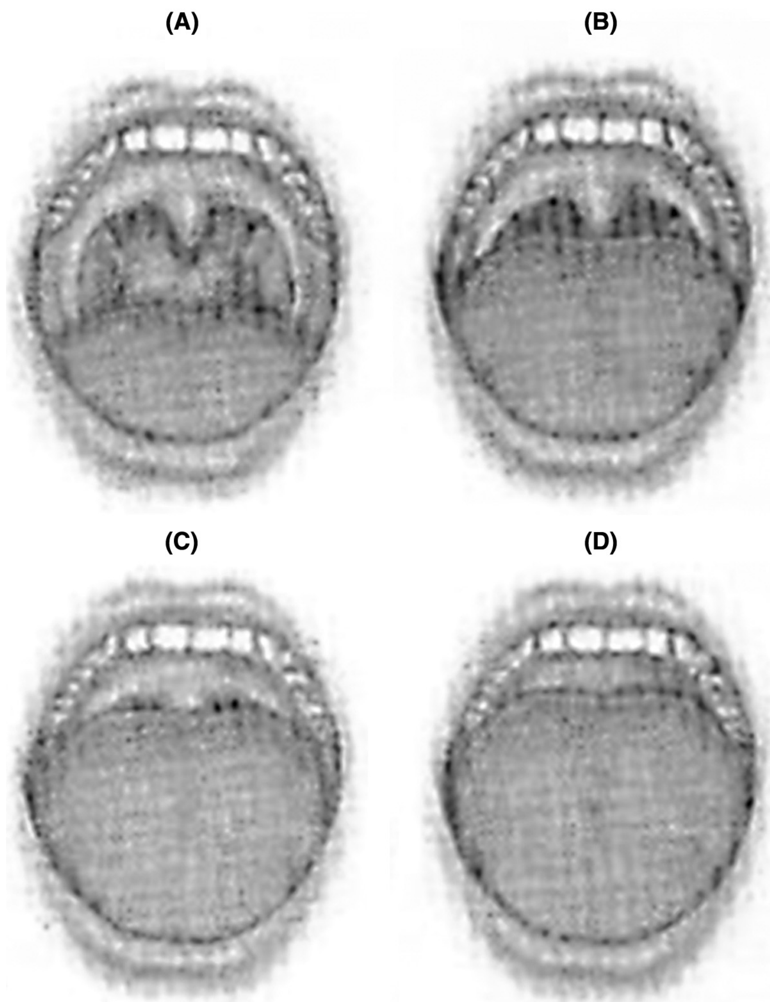

Figure 2 The Friedman classification, which is drawn from the Mallampati classification, is a general way of describing the upper airway configuration.

the PAS and hypopharyngeal area. The hyoid bone may be repositioned either anterosuperiorly to the mandible or anteroinferiorly to the thyroid cartilage. Riley et al. (15,19) have found this procedure useful in a select group of patients with BMI less than 30 and mild to moderate OSA, and also in combination with other procedures such as GA.

Tongue Reduction Surgery

Reduction of the base of tongue is an intuitive approach to diminishing obstruction at that level, and there are a number of ways to accomplish this. Fujita (20) reported a series of 22 patients with OSA undergoing laser midline glossectomy and lingualplasty, in which they achieved an overall success rate of 77%. Chabolle et al. (21) in 1999 described a combination of tongue base reduction and hyoepiglottoplasty in 10 patients with severe OSA. They reported a success rate of 80%, but temporary tracheotomies were required for all of their patients.

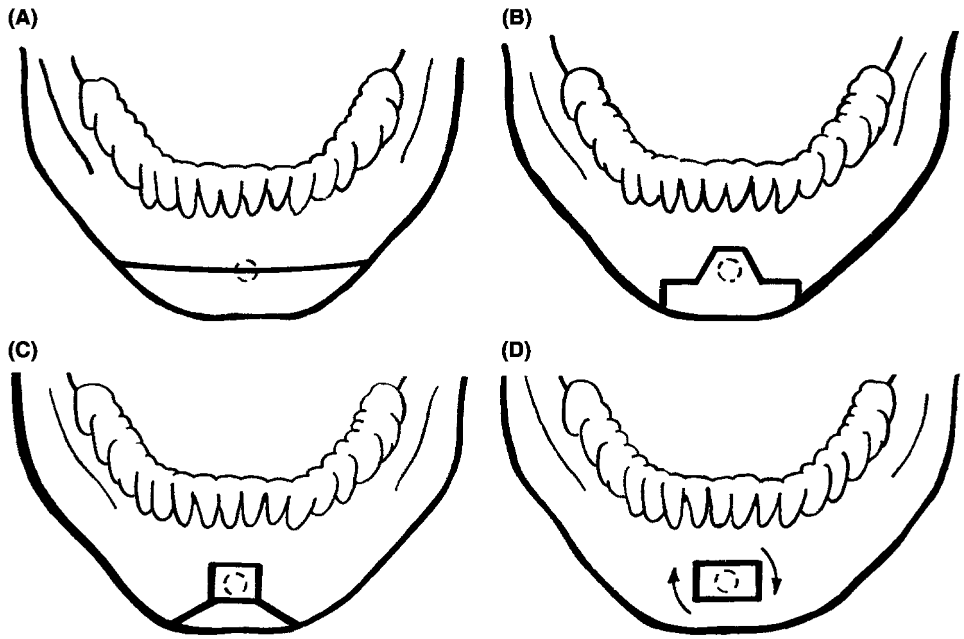

Figure 3 The genioglossus advancement is a procedure designed to enlarge the posterior airway space; a number of techniques have been described to achieve this surgical objective, with the rectangular geniotubricle osteotomy the most widely adopted.

Transpalatal Advancement Pharyngoplasty

Woodson and Toohill (22) reported transpalatal advancement pharyngoplasty in a series of 11 patients with severe OSA who failed UPPP. They underwent advancement of the soft palate to increase the retropalatal space. Woodson and Toohill (22) achieved a success rate of 67% in patients with severe OSA, a BMI >35, predominantly retropalatal obstruction, and failed UPPP. This is a promising technique, but has so far failed to gain widespread acceptance.

Maxillomandibular Advancement

Patients with cephalometrically proven severe mandibular deficiency will benefit from advancement of the maxilla and mandible (Fig. 4). In Riley and Powell's (15) group of 91 OSA patients who underwent MMA after a failed GA ± UPPP, a 97% success rate was achieved. They reported an 81% success rate with MMA even in patients with morbid obesity (BMI >45) (82). They also found that patients with severe mandibular deficiency (SNB <72°) consistently faired poorly with UPPP ± GA and required MMA at a later stage. Therefore, the authors suggested considering MMA as the first surgical option in patients with severe mandibular deficiency. Maxillomandibular advancement may also be combined with other procedures, like GA, to maximize the increase in PAS.

In an analysis of surgical outcomes, Conradt et al. (23) found that MMA compared favorably with nasal CPAP in reducing the severity of OSA in a high percentage of patients selected by cephalometric and polysomnographic studies.

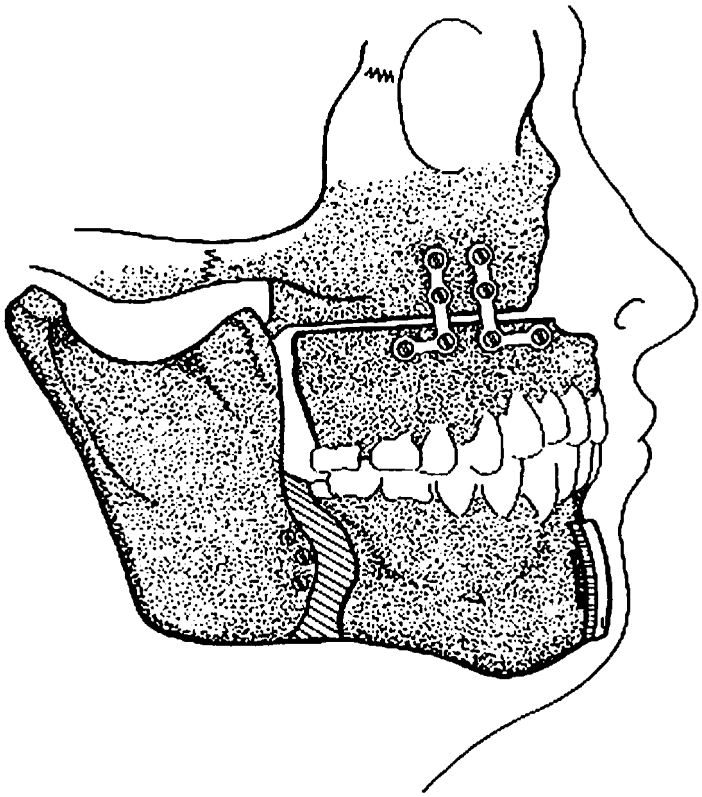

Figure 4 The maxillomandibular advancement involves a sagittal split mandibular osteotomy and a Lefort I maxillary osteotomy to achieve bimaxillary advancement. This approach may be combined with other procedures, including a genioglossus advancement and hyoid myotomy.

Radiofrequency Ablation Technique

Powell et al. (24) first described the use of radiofrequency ablation technique (RFA) in the upper airway. They introduced it as a way of tightening the soft palate to treat primary snoring. It is the use of temperature-controlled radiofrequency volumetric tissue reduction in order to stiffen and scar the soft palate (Fig. 5). The advantages of RFA are that it is minimally invasive, causes little pain, and can be done under local anesthesia as an office procedure. The radiofrequency probe can also be applied to the inferior turbinates for relief of nasal obstruction and to the base of tongue for treatment of OSA.

Subjective results for RFA of the palate based on improvement in snoring have been encouraging, with reports ranging from 67% to 86.6% improvement (25,26). Stuck et al. (27) have the largest series, with 322 snoring patients, and an 84% improvement rate. Caution should be exercised in RFA of the soft palate for mild OSA, as the results are unpredictable and so far disappointing.

Tracheostomy

The most definitive treatment for OSA is a tracheostomy, which completely bypasses any existing upper airway obstruction (28). However, this is not an attractive option

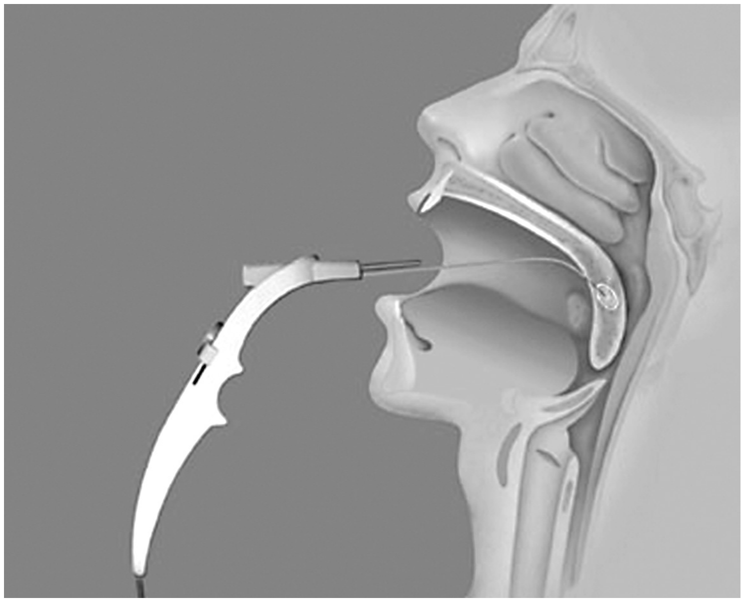

Figure 5 Radiofrequency ablation involves the delivery of radiofrequency energy in a submucosal fashion to the tissues of the palate. This is performed under local anesthesia in the office.

for most patients as it retains a social stigma and obviates the possibility of participating in water sports.

Powell and Riley suggested that patients with OSA be offered surgery based on the level of obstruction as proposed by Fujita:

Type I (*retropalatal*): palatal procedure (e.g., UPPP).
Type II (*both retropalatal and retrolingual*): palatal procedure and a procedure designed to address base of tongue obstruction (e.g., genioglossus advancement, hyoid repositioning procedure, or tongue suspension).
Type III (*retrolingual*): a base of tongue procedure alone.

Patients failing initial reconstructive surgery may be eligible for more aggressive techniques, such as maxillomandibular advancement.

CONCLUSIONS

The geriatric population is prone to sleep disorders. Altered sleeping habits and difficulty in initiating and maintaining sleep, coupled with increased tendency for SDB, predispose geriatric patients to depression. Management of these elderly individuals should therefore be comprehensive, focusing not only on the sleep disorder but also on the psychosocial aspects of the patient's health. Treatment should be customized. Surgical therapy will be appropriate for some patients, but nasal CPAP remains an important first line of treatment in most patients.

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