

Surgical Management of Snoring and Obstructive Sleep Apnea

Tanya K. Meyer, MD; B. Tucker Woodson, MD, FACS, ABSM

INTRODUCTION

Primary snoring and obstructive sleep apnea (OSA) lie at separate extremes of a continuum of sleep-related breathing disorders. In the 30-year-old population, 20% of men and 5% of women will snore. These numbers rise to 60% and 40% respectively by age 60. It is estimated that 4% of adult males and 2% of adult females have OSA, which makes the disease as common as asthma.¹ Although snoring without any features of obstruction may not have detectable health consequences² per se (aside from sleep interruption of bed partners), individuals suffering from OSA have substantially increased risks for high blood pressure (2x normal),³ heart attack (23x normal),⁴ stroke (1.5 x normal),⁵ headaches, sexual impotence, impaired intellectual function, and depression.⁶ These individuals also pose further risk to themselves and society as their excessive sleepiness may cause them to fall asleep in the work environment, with a 15 times increased incidence in motor vehicle accidents as compared to normal drivers.⁷

The fundamental abnormality of both snoring and OSA is a structurally small and unusually collapsible upper airway.⁸ These abnormalities may be skeletal or soft tissue, and interact with body mass index, ventilatory control mechanisms, or other undefined variables to determine apnea severity. The goal of surgery is to enlarge and reconstruct the upper airway to prevent collapse and obstruction. Multiple techniques are evolving to achieve this goal and to reduce both disease and surgical morbidity.

There are at least 8 different sites at which obstruction can occur: nasal (deviated septum, enlarged turbinates, enlarged adenoids, nasal polyps), soft palate and uvula (retropalatal), tonsils (palatine and lingual), tongue base (retrolingual), mandible (retrognathism), lateral pharyngeal walls (pharyngeal muscle hypertro-

phy or laxity, mucosal redundancy), hyoid and epiglottis. In addition to anatomic obstruction from the above areas, decreased dilating forces of the pharyngeal musculature during sleep and negative inspiratory pressure generated by the diaphragm can contribute to the development of obstruction. Treatment and surgical procedures must keep all these factors in mind, and often therapy must be targeted to multiple anatomic sites to result in appreciable relief.

There are multiple treatments for OSA (see Table 1). For individuals with severe OSA (Respiratory Disturbance Index [RDI] >40), continuous positive airway pressure (CPAP), maxillo-mandibular advancement (MMA), and tracheotomy are the only modalities shown to provide significant cure. The convenience and efficacy of CPAP make it the first line treatment for OSA.^{9,10} Many of the other surgical modalities used for OSA should be viewed as adjunct to CPAP or as a measure to improve tolerance to CPAP. When consistently used, CPAP can provide significant improvement in sleepiness, impaired intellectual function, and normalize increased cardiovascular risk. Unfortunately, compliance is the greatest hurdle. Up to 30% of patients will refuse CPAP at initial trial, and even when agreeing to use the device, only 50% of users will be compliant.^{11,12}

POSSIBLE SURGICAL PROCEDURES IN OBSTRUCTIVE SLEEP APNEA

Tracheotomy provides 100% cure for OSA by bypassing the nasopharyngeal airway completely, however most patients are reluctant to accept this modality for obvious reasons. For extreme cases, noncompliant patients, or mentally challenged individuals it may be the most appropriate option.

Maxillo-Mandibular Advancement (MMA) is the second most successful surgical procedure for OSA. It consists of a Le Fort I maxillary osteotomy and bilateral mandibular osteotomies with subsequent advancement of the maxilla and mandible anteriorly 1 centimeter,

Authors are with the Medical College of Wisconsin. Doctor Meyer is a resident in Otolaryngology and Communication Sciences; Dr. Woodson is Associate Professor Otolaryngology and Communication Sciences.

thus enlarging the pharyngeal airway by expanding the skeletal framework. Defining cure as a reduction in RDI to a level below 20 events per hour and a 50% reduction in RDI from baseline, Li et al reports a cure rate of 95% from MMA. In their study, mean preoperative RDI of 72.3 events per hour decreased to an RDI of 7.2 events per hour postoperatively.¹³ However, the intensive nature of the operation and its consequences, which include change in facial esthetics, dental occlusion, and potential compromise to temporo-mandibular joints, preclude many individuals without severe disease from undergoing MMA.

As an alternative to tracheotomy or major maxillofacial surgery, there are multiple procedures dedicated to the nasal septum, palate, and tongue that can help to reduce snoring and improve mild apnea. These are site specific and are directed at reconstructing specific areas of the upper airway to correct obstructive pathology.

Septoplasty can straighten a deviated nasal septum and improve the nasal airway, thus allowing patients to breathe through the nose rather than the mouth at night and alleviate snoring. Although not specifically a treatment for OSA, it can greatly improve tolerance to CPAP.

Reduction of the inferior turbinates also can improve the nasal airway, and in children and some adults an adenoidectomy may be indicated.

Adenotonsillectomy can be used to effectively treat tonsillar hypertrophy, the predominant cause of “heroic” snoring and apnea in children. Quite paradoxically, children with sleep apnea often manifest hyperactivity, irritability, and decreased concentration instead of the expected somnolence. However, the cardiovascular risk from persistent, untreated OSA remains the same in children as in adults. These symptoms rapidly improve after surgery.

Uvulopalatopharyngoplasty (UPPP)—Adults with snoring and mild apnea also benefit from tonsillectomy if they have tonsillar hypertrophy, but may also be candidates for additional palatal surgery. The most common of these is the UPPP in which redundant uvula, soft palate, and lateral pharyngeal tissues are resected with the goal of increasing the diameter of the retropalatal airway. UPPP is generally recommended for young to middle-aged non-obese (or mildly obese) snorers with mild to moderate obstructive sleep apnea and correctable palatal obstruction (large tonsils, drooping palate, long uvula) by exam. Choosing the appropriate patient is paramount in this procedure, and success is

Table 1. Surgical treatments for snoring and OSA

Radiofrequency – turbinate reduction, palatoplasty, glossectomy
Septoplasty
Tonsillectomy (palatine or lingual) and adenoidectomy
Uvulopalatoplasty
Palatal advancement
Glossectomy
Skeletal tongue advancement/Genioglossus muscle advancement
Suture tongue suspension
Hyoid suspension
Maxillo-mandibular advancement
Tracheotomy

keenly dependent on having favorable anatomy. Meta analysis has shown a 40% success rate in unselected patients.¹⁴ To improve upon this, a staging system based on routine physical findings (Malampatti score [Figure 1B], tonsil size, and morbid obesity) has been developed (Figure 1A). UPPP success approaches 80% for Stage 1 patients. Stages 2 and 3 success rates drop to 40% and 8%, respectively.¹⁵ UPPP has a moderately painful post-operative course that requires 1 to 2 weeks of narcotic medication. Although rare, complications include hemorrhage, velopharyngeal incompetence, and nasopharyngeal stenosis.

Laser-assisted uvulopalatoplasty—There are multiple variations on the UPPP. One of the most well known is the laser-assisted uvulopalatoplasty (LAUP). This is an outpatient procedure in which palatal trenches are created with a laser. They are then allowed to heal by second intention, scar, and subsequently contract. The procedure is as painful as traditional UPPP and requires multiple sessions. Objective evaluation of LAUP is lacking but most studies report marked improvement in snoring. However, the success rate for OSA is probably poor.

Transpalatal advancement is a novel approach to increase retropalatal size. The soft and hard palate are divided and the distal palatine bone is drilled away. The soft palate is then mobilized and advanced into the defect with excision of redundancy. Compared to UPPP, this procedure can yield a significant increase in the retropalatal airway and reduce lateral pharyngeal wall collapse. Significant improvement in OSA has been documented in preliminary studies.¹⁶ The major complication is transient oral nasal fistula requiring use of a palatal obturator.

Figure 1A. Malampatti classification

Malampatti I = visualization of free margin of the soft palate, tonsillar pillars, and uvula

Malampatti II = visualization of palate and uvula only with phonation



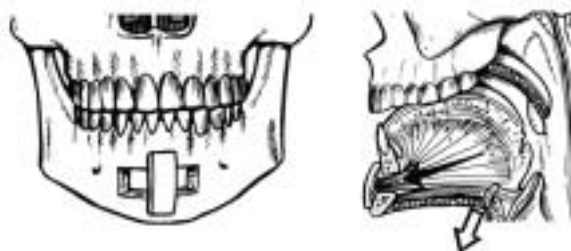
Malampatti III = visualization soft palate only

Malampatti IV = visualization of hard palate only

Figure 1B. Friedman Staging System is based on the Malampatti classification, tonsil size, and absence of morbid obesity. Tonsils are graded on the traditional 4-point scale (1+, 2+, 3+, 4+). Morbid obesity is defined as a body mass index of greater than 40 kg/m². Stage 1 is associated with excellent UPPP outcomes. Conversely, Stage 3 has poor UPPP results using this procedure alone.

	Malampatti class	Tonsil size	Morbid obesity	Success
Stage 1	I, II	3,4	BMI >40	80%
Stage 2	I, II III, IV	1,2 any	BMI >40	40%
Stage 3	any	any	BMI >40	8%

Figure 2. Schematic of the Skeletal tongue advancement (black arrow), and hyoid suspension (hollow arrow).



Radiofrequency thermal ablation is a minimally invasive method of volumetrically reducing tissue in the nose, palate, and tongue base. Radiofrequency causes frictional heating of the tissue around a handheld needle electrode by ionic agitation, thus causing a discrete and predictable submucosal lesion. The tissue within the lesion is irreversibly damaged, thus causing scar formation and contraction. This procedure has been used to treat nasal obstruction by ablation of turbinate tissue, and to treat snoring and apnea by ablation of tissues in the soft palate and tongue base. This is an outpatient procedure in selected patients with minimal post-procedure discomfort. (Patients rarely require narcotics and can often return to work the same day.) Serial procedures are routinely required to achieve desired results allowing 6 to 8 weeks healing time between treatments. Complications are rare but include mucosal erosion, airway obstruction from edema, and infection.

Glossectomy, which is more traditional, can be performed transorally using a laser or electrocautery. In this procedure, a midline strip of posterior tongue is removed and then the surgical defect is sutured. Although a 70% success rate has been demonstrated, patients may require a perioperative tracheotomy, with a 25% incidence of other complications including bleeding, edema, and persistent dysphagia.¹⁷

To circumvent these issues, other procedures have been developed to address retrolingual obstruction. A proline suture can be placed as a “sling” through the tongue base to prevent passive collapse. The literature on this procedure is difficult to interpret, and long-term efficacy is unknown. The genioglossus muscle advancement pulls the tongue anteriorly by advancement of the geniotubercle of the mandible, the insertion of the major tongue muscle. A circumferential osteotomy is created around the geniotubercle, which is then pulled forward and secured anteriorly by plates and screws (Figure 2). This procedure has shown a 70% success rate when used in combination with other procedures.¹⁸ Major complications include anterior chin numbness, tooth injury, and mandible fracture.

For patients with retro-epiglottic airway obstruction, the hyoid bone can be advanced and secured to the mandible or to the laryngeal cartilage, a procedure called hyoid suspension. This procedure is used in conjunction with other measures and has been shown to provide significant improvement in RDI in selected patients.¹⁹

CONCLUSION

Nasal CPAP is the preferred initial treatment for most patients suffering from snoring or sleep apnea. When CPAP or other conservative modalities fail, there are multiple surgical options available. For significant sleep apnea, only tracheotomy or MMA have been shown to offer significant cure, although patients are often reluctant to accept these treatments. Other surgical modalities can cure mild disease, improve moderate disease, and improve patient tolerance of CPAP. As patients often have more than one level of obstruction, it may be necessary to perform multiple procedures to address each area of disease.

REFERENCES

1. Sher AE. An overview of sleep disordered breathing for the otolaryngologist. *Ear Nose Throat J.* 1999;78(9):694-5,698-700, 703-6 passim.
2. Hoffstein V. Is snoring dangerous to your health? *Sleep.* 1996;19(6):506-516.
3. Hla KM, Young TB, Bidwell T, et al. Sleep apnea and hypertension. A population-based study. *Ann Intern Med.* 1994;120(5):382-388.
4. Hung J, Whitford EG, Parsons RW, Hillman DR. Association of sleep apnoea with myocardial infarction in men. *Lancet.* 1990;336(8710):261-264.
5. Shahar E, Whitney CW, Redline S, et al. Sleep-disordered breathing and cardiovascular disease: cross-sectional results of the Sleep Heart Health Study. *Am J Respir Crit Care Med.* 2001;163(1):19-25.
6. Decary A, Rouleau I, Montplaisir J. Cognitive deficits associated with sleep apnea syndrome: a proposed neuropsychological test battery. *Sleep.* 2000;23(3):369-381.
7. Teran-Santos J, Jimenez-Gomez A, Cordero-Guevara J. The association between sleep apnea and the risk of traffic accidents. Cooperative Group Burgos-Santander. *N Engl J Med.* 1999;340(11):847-851.
8. Isono S, Remmers JE, Tanaka A, et al. Anatomy of pharynx in patients with obstructive sleep apnea and in normal subjects. *J Appl Physiol.* 1997; 82(4):1319-1326.
9. Sullivan CE, Issa FG, Berthon-Jones M, Eves L. Reversal of obstructive sleep apnoea by continuous positive airway pressure applied through the nares. *Lancet.* 1981;1(8225): 862-865.
10. Kryger MH. Diagnosis and management of sleep apnea syndrome. *Clin Cornerstone.* 2000;2(5):39-47.
11. Popescu G, Latham M, Allgar V, Elliott MW. Continuous positive airway pressure for sleep apnoea/hypopnoea syndrome: usefulness of a 2 week trial to identify factors associated with long term use. *Thorax.* 2001;56(9):727-733.
12. Kribbs NB, Pack AI, Kline LR, et al. Objective measurement of patterns of nasal CPAP use by patients with obstructive sleep apnea. *Am Rev Respir Dis.* 1993;147(4):887-895.
13. Li KK, Riley RW, Powell NB, et al. Overview of phase II surgery for obstructive sleep apnea syndrome. *Ear Nose Throat J.* 1999;78(11):851,854-857.
14. Sher AE, Schechtman KB, Piccirillo JF. The efficacy of surgical modifications of the upper airway in adults with obstructive sleep apnea syndrome. *Sleep.* 1996;19(2):156-177.
15. Friedman M, Tanyeri H, La Rosa M, et al. Clinical predictors of obstructive sleep apnea. *Laryngoscope.* 1999;109(12): 1901-1907.
16. Woodson BT. Retropalatal airway characteristics in uvulopalatopharyngoplasty compared with transpalatal advancement pharyngoplasty. *Laryngoscope.* 1997;107(6):735-740.
17. Woodson BT, Fujita S. Clinical experience with lingualplasty as part of the treatment of severe obstructive sleep apnea. *Otolaryngol Head Neck Surg.* 1992;107(1):40-48.
18. Lee NR, Givens CD, Jr, Wilson J, Robins RB. Staged surgical treatment of obstructive sleep apnea syndrome: a review of 35 patients. *J Oral Maxillofac Surg.* 1999;57(4):382-385.
19. Riley RW, Powell NB, Guilleminault C. Obstructive sleep apnea and the hyoid: a revised surgical procedure. *Otolaryngol Head Neck Surg.* 1994;111(6):717-721.



The mission of the *Wisconsin Medical Journal* is to provide a vehicle for professional communication and continuing education of Wisconsin physicians.

The *WMJ* (ISSN 1098-1861) is the official publication of the Wisconsin Medical Society and is devoted to the interests of the medical profession and health care in Wisconsin. The managing editor is responsible for overseeing the production, business operation and contents of *WMJ*. The editorial board, chaired by the medical editor, solicits and peer reviews all scientific articles; it does not screen public health, socioeconomic or organizational articles. Although letters to the editor are reviewed by the medical editor, all signed expressions of opinion belong to the author(s) for which neither the *WMJ* nor the Society take responsibility. The *WMJ* is indexed in Index Medicus, Hospital Literature Index and Cambridge Scientific Abstracts.

For reprints of this article contact the *WMJ* Managing Editor at 866.442.3800 or e-mail wmj@wismed.org.

© 2003 Wisconsin Medical Society