Multilevel Upper Airway Surgery for OSA

By Regina Patrick, RPSGT, RST

Obstructive sleep apnea (OSA) is the intermittent obstruction of the upper airway during sleep. OSA can result from a nasal obstruction, oropharyngeal obstruction, hypopharyngeal obstruction, or obstruction in a combination of these areas. The most common treatment for OSA is continuous positive airway pressure (CPAP) in which lightly pressurized air is blown through the airway through a mask that covers the nose or nose and mouth. The force of the air pressure pushes against upper airway tissues to maintain an open airway.

Many people with OSA are unwilling to undergo CPAP treatment or are unable to tolerate CPAP treatment and may seek surgical alternatives. The most common surgical treatment for OSA is uvulopalatopharyngoplasty (UPPP), which involves the removal of a person's tonsils, adenoids, uvula, and excess tissues in the oropharynx (i.e., the area from the soft palate to the upper edge of the epiglottis). The removal of these tissues increases airflow through the oropharynx. However, if an obstruction occurs elsewhere in the upper airway (e.g., the hypopharynx [i.e., the area between the upper edge of the epiglottis and the opening of the larynx and esophagus]), UPPP may not fully relieve OSA episodes. Some research indicates that multilevel surgery is more effective than single level surgery in relieving the severity of OSA.[1-10]

Upper airway obstruction in OSA may result from upper airway muscles relaxing excessively during sleep, which allows tissues supported by these muscles such as the tonsils and adenoids to collapse into the airway and block airflow fully or partially. Surgeries for OSA involve modifying the nasal passage (e.g., septoplasty, turbinate reduction), the oropharynx (e.g., UPPP, adenotonsillectomy), and/or hypopharynx (e.g. tongue base reduction, hyoid suspension).

Septoplasty

In septoplasty, the nasal septum (i.e., the wall of tissue that divides the nose in left and right halves) is straightened or repaired. A deviated septum can reduce or block airflow through the nasal passages.

Turbinate reduction

The turbinates consist of three thin, curled, bony mucous membrane-covered plates (i.e., superior, middle, and inferior) that extend from the lateral walls of the nasal cavity. They normally slow the speed of incoming air so that it becomes heated, humidified, and filtered. In some people, the turbinates are enlarged, which narrows the amount of space within the nasal cavity, thereby reducing airflow. Turbinate reduction surgery reduces the size of turbinates to allow air to flow more readily through the nasal passage.

UPPP

As mentioned earlier, in UPPP, the uvula, soft palate (i.e., the soft portion of the roof of the mouth), tonsils, adenoids, and excess throat tissues (e.g., fatty tissue) are removed to widen the oropharynx.

Adenotonsillectomy

Adenotonsillectomy is the surgical removal of the adenoids and tonsils. A tonsil is located on each side of the pharynx between the palatal arches at the back of the throat (i.e., palatine tonsils) and at the base of the tongue (i.e., lingual tonsils). The adenoids (also called "pharyngeal tonsils") are located on the back of the pharynx behind the soft palate. Enlarged tonsils and adenoids can narrow the oropharyngeal space.

Tongue base reduction surgery

In tongue base reduction surgery, a portion of the tongue base is removed so that the tongue can not fall into the hypopharynx and block airflow. The reduction in the tongue base can be accomplished by using laser or radiofrequency waves to destroy distinct areas of the tongue base. These lesions ultimately are resorbed and shrink. The shrunken tissue decreases the volume of the tongue base.

Hyoid suspension

Hyoid suspension surgery involves moving the hyoid bone upward and forward. In this surgery, sutures are wrapped around the hyoid bone body and then attached to screws on the lower border of the chin bone. The tension exerted by the sutures pulls the hyoid bone up and forward. With the hyoid bone more forward, muscles attached to it are also pulled forward, and the base of the tongue is pulled forward, which opens the hypopharynx.

The hyoid bone is a small horseshoe-shaped bone that lies at the base of the tongue and just above the thyroid cartilage. Many muscles at the floor of the mouth and the larynx are attached to the hyoid bone such as the middle pharyngeal constrictor muscles (which constrict the pharynx and are involved in collapsibility of the airway); genioglossus muscles (which protrude and depress the tongue); mylohyoid muscles (which elevate the hyoid bone); stylohyoid muscles (which draws the hyoid bone backwards while elevating the tongue); geniohyoid, hyoglossus, and digastric muscles (all of which elevate the larynx) and the thyrohyoid, omohyoid, and sternohyoid muscles (all of which lower the hyoid bone). The hyoid bone is positioned lower and more posteriorly in people with OSA than in people without OSA.[3,11,12]

In recent years, scientists have investigated the efficacy and safety of using multilevel surgery versus a single level surgery to treat OSA. Some findings have been encouraging.

Tantawy and colleagues[8] used hyoid suspension surgery in combination with palatal surgery (i.e., suspension palatoplasty [a surgery in which the palatopharyngeus muscle is modified so that it pulls the soft palate forward]) and nasal surgery (i.e., tonsillectomy) in their multilevel surgery for OSA. The patients in their study had collapse of the oropharynx and lateral wall of the hypopharynx. After surgery, the mean apnea-hypopnea index (AHI) dropped significantly by 63%, and no complications occurred. Tantawy proposed that hyoid suspension could safely be combined with other palatal procedures in multilevel surgery for OSA.

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Madkikar and colleagues[6] used rhinoplasty (i.e., nose surgery), followed by barbed relocation palatoplasty, to treat OSA. Rhinoplasty included septoplasty and turbinate reduction. In barbed relocation palatoplasty, sutures are strategically placed to pull the soft palate forward and pull the palatoglossus and palatopharyngeal muscles (which are on the lateral walls of the oropharynx) forward and laterally. The tonsils are also removed in this procedure. After this multilevel surgery, the AHI was reduced by approximately 75%, only two patients had complications from the barbed reposition pharyngoplasty (e.g., suture failure), and no patient had complications from the rhinoplasty. The researchers concluded that this combined approach was safe and effective.

Eric Berg and colleagues[1] examined the effectiveness of using pharyngeal suspension procedures in conjunction with UPPP as a multilevel treatment for OSA. Their study involved 30 middle-aged obese adults, all of whom had moderate or severe OSA and had failed CPAP treatment. Twenty patients underwent tongue base suspension surgery (in which sutures are used to pull the tongue base forward so that it cannot fall into the airway; the sutures are anchored to a screw on the bottom edge of the chin bone) and hyoid suspension surgery (13 of these patients had previously undergone UPPP) and the remaining 10 patients underwent tongue base suspension only (these 10 patients had previously undergone UPPP). Approximately 4 months after the surgery, a polysomnographic (PSG) study revealed an overall surgical success rate of 63% (based on the criteria of a decrease of 50% or greater in respiratory disturbance index [RDI] and an RDI <20 events/hour). In the surgical success group, the mean RDI fell by approximately 78.9%. In the surgical failure group, the mean RDI increased by 15.5%. However, among the surgical failure group, just over one-half (55%) of patients actually experienced an improvement in the RDI postoperatively but did not meet the criteria for surgical success (e.g., one patient's OSA severity improved from moderate to mild OSA, but the reduction in RDI was not >50%). Therefore, Berg and colleagues concluded that pharyngeal suspension surgery could be part of the multilevel treatment for moderate and severe OSA and has a better outcome than conventional surgical treatments.

Antonio Minni and colleagues[7] compared the functional outcomes of UPPP and barbed reposition pharyngoplasty (BRP) with hyoid suspension (i.e., multilevel treatment) and without hyoid suspension (i.e., single level treatment). Postoperative PSG studies revealed the AHI was more greatly reduced in the BRP group than in the UPPP group. The

postoperative AHI was more reduced in the hyoid suspension + BRP group than in the hyoid suspension + UPPP group. The difference between BRP with and without hypoid suspension was not substantial as that between UPPP with and without hyoid suspension. Minni believes this finding is because hyoid suspension reduces the collapse of the lateral walls of the hypopharynx, thereby enhancing the effects of UPPP.

Scientists continue to investigate the efficacy and safety of multilevel surgery for OSA.

The most frequent site of collapse is the soft palate, followed by the pharyngeal walls, base of the tongue, and palatine tonsils. To a lesser extent, the larynx (e.g., a lax epiglottis) can contribute to OSA. Of these areas, the hypopharynx is the most difficult area to approach surgically.

In recent years, the advent of transoral robotic surgery (TORS) has made performing surgery in the hypopharynx less difficult. In TORS, robotic arms are inserted through a patient's mouth and passed downward to the hypopharynx. This approach gives a better view of the hypopharynx, compared to other transoral techniques (e.g., accessing the hypopharynx through the base of the tongue in the mouth). The end of the robotic arms contains a camera and other surgical tools. The arms of the robot are guided by a surgeon, who sits at a console and uses joysticks to control the actions of the arms. However, a drawback of TORS is that its success rate decreases with increasing body mass index (BMI).[2] For example, the success rate of TORS is >50% in obese patients (i.e., a BMI of 30–35 kg/m2) and 75% in nonobese patients.[2]

The use of TORS for apnea was only first reported in 2010,[13] and its use is not very widespread. Therefore, more research of this technique in OSA surgery is needed. In the future, improvements in using TORS for OSA could potentially improve the outcomes of surgery and allow more patients to undergo successful OSA surgery. For now, scientists continue to investigate the efficacy and safety of multilevel surgery for OSA, which combinations of surgery work best and for which patients, and whether multilevel surgeries are best performed in one step (i.e., two or more procedures during the same surgery) or in separate steps.

References

1. Berg EE, Bunge F, Delgaudio JM. Multilevel treatment of moderate and severe obstructive sleep apnea with bone-anchored pharyngeal suspension sutures. *Ear, Nose, and Throat Journal*. 2013;92:E1-E5.
2. Garas G, Kythreotou A, Georgalas C, et al. Is transoral robotic surgery a safe and effective multilevel treatment for obstructive sleep apnoea in obese patients following failure of conventional treatment(s)? *Annals of Medicine and Surgery (Lond)*. 2017;19:55-61.
3. Ha JG, Min HJ, Ahn SH, et al. The dimension of hyoid bone is independently associated with the severity of obstructive sleep apnea. PLoS One. 2013;8:e81590.
4. Lin HC, Friedman M, Chang, H. W, et al. The efficacy of multilevel surgery of the upper airway in adults with obstructive sleep apnea/hypopnea syndrome. *Laryngoscope*. 2008;118:902-908.
5. MacKay S, Carney AS, Catcheside PG, et al. Effect of multilevel upper airway surgery vs medical management on the apnea-hypopnea index and patient-reported daytime sleepiness among patients with moderate or severe obstructive sleep apnea: the SAMS randomized clinical trial. *JAMA*. 2020;324:1168-1179.
6. Madkikar N, Pandey S, Ghaisas V. Multi level single stage: barbed reposition pharyngoplasty and nasal surgery in treatment of OSA—our experience. *Indian Journal of Otolaryngology–Head and Neck Surgery*. 2019;71:309-314.
7. Minni A, Cialente F, Ralli, M, et al. Uvulopalatopharyngoplasty and barbed reposition pharyngoplasty with and without hyoid suspension for obstructive sleep apnea hypopnea syndrome: A comparison of long-term functional results. Bosnian Journal of Basic Medical Sciences Web site. http://bjbms.org/ojs/index.php/bjbms/article/view/4724. Published 2020. Accessed 10-28-2020.
8. Tantawy AA, Askar SM, Amer HS, et al. Hyoid bone suspension as a part of multilevel surgery for obstructive sleep apnea syndrome. *International Archives of Otorhinolaryngology*. 2018;22:266-270.
9. Lin HC, Weaver EM, Lin HS, et al. Multilevel obstructive sleep apnea surgery. *Advances in Otorhinolaryngology*. 2017;80:109-115.
10. Verse T, Hormann K. The surgical treatment of sleep-related upper airway obstruction. *Deutsches Arzteblatt International*. 2011;108:216-221.
11. Kikuchi M, Higurashi N, Miyazaki S, et al. Facial patterns of obstructive sleep apnea patients using Ricketts' method. *Psychiatry and Clinical Neurosciences*. 2000;54:336-337.
12. Gungor AY, Turkkahraman H, Yilmaz HH, et al. Cephalometric comparison of obstructive sleep apnea patients and healthy controls. *European Journal of Dentistry*. 2013;7:48-54.
13. Vicini C, Dallan I, Canzi P, et al. Transoral robotic tongue base resection in obstructive sleep apnoea-hypopnoea syndrome: a preliminary report. *ORL Journal for Otorhinolaryngology and Its Related Specialties*. 2010;72:22-27.

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