

TITLE: Surgical Management of Obstructive Sleep Apnea in Adults
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Background Information

Sleep apnea exists among a spectrum of disorders known as sleep disordered breathing. These range from primary snoring to obesity hypoventilation syndrome. Primary snoring is characterized by a snoring with a lack of nighttime awakenings and daytime sleepiness. This is followed by upper airway resistance syndrome (UARS), which has frequent nighttime awakenings and daytime sleepiness, but an absence of apneic episodes. Obstructive sleep apnea syndrome (OSAS) has nocturnal episodes of apnea and oxygen desaturation that cause frequent nighttime awakenings and daytime sleepiness. Finally, patients with obesity hypoventilation syndrome, also known as Pickwickian syndrome, are obese, have daytime hypercapnea, and have some form of sleep disordered breathing.

Some facts about OSA are that it affects approximately 18 million Americans, with up to 70% of the cases associated with obesity. There is an increased incidence with age, and patients have an increased overall mortality compared to the general population. It is estimated that 38,000 deaths attributed to cardiovascular disease in the United States per year are related to OSA. Additionally, patients with OSA have a risk for motor vehicle accidents up to seven times the general population.

History

Important points of the history when interviewing a patient with suspected OSA include: the presence of daytime sleepiness and restless sleep, the use of alcohol and sedatives, mouth breathing during sleep and throughout the day, and morning headaches (especially in females). It is helpful to ask the patient about their bedtimes, awakening times, body position during sleep, caffeine intake, and menopausal status in females (postmenopausal is a risk factor for OSA). It is crucial to obtain input from the patient's bed partner or a family member, as these patients often unaware of their symptoms. This is in part due to a lack of awareness during sleep, but can also be attributed to the gradual onset of symptoms.

Physical Exam

On physical exam, it is first necessary to note the patient's general body habitus, describing if they are obese and whether their weight distribution is central or peripheral. The physician should look for signs of chest wall deformity and note if the patient has a systemic disorder such as achondroplasia or Marfan syndrome (both have a high prevalence of OSA). Additionally, the presence of retrognathia or micrognathia should be noted, along with a quantitative measurement of the patient's neck size. Next, signs of nasal obstruction should be sought out, looking for a deviated septum, polyps, turbinate hypertrophy, or nasal valve collapse. On oropharyngeal exam, the size of the palate, tongue, uvula, and tonsils should be described. In OSA, patients often have an elongated palate and uvula with mucosal folding. Finally, the posterior pharyngeal wall should be examined for the presence of banding. Following the oropharyngeal exam, a thorough examination for enlarged lymph nodes, as well as an enlarged or irregular thyroid is important. Often tumors of the head and neck can present with new onset OSA.

In addition to the head and neck exam, a cardiovascular exam is important, as many OSA patients have comorbidities involving this organ system. A final important part of the physical exam is examination via flexible nasopharyngeal scope. This can further evaluate the nasal cavity for polyps and tumors, as well as for the presence of enlarged adenoids. Flexible scope will allow the physician to better examine the base of tongue and epiglottis. A thickened, omega shaped epiglottis can sometimes be found in patients with OSA.

Finally, the physician should have the patient perform the Müller maneuver. This is accomplished by asking the patient to close their mouth, hold their nose shut, and inspire with maximal effort. The physician should look for signs of airway collapse at the palate, base of tongue, and lateral pharyngeal walls. The collapsibility of each structure can be quantified on a scale of 0 to 4, with 0 indicating minimal collapse, and 4 indicating complete collapse.

Diagnostic Modalities

After history and physical exam, there are three main methods of diagnosis for OSA. These include **questionnaires**, **cephalometric analysis**, and **polysomnography**.

A variety of **questionnaires** exist to aid in the diagnosis of OSA. The first type measures the degree of sleepiness throughout the day. This type includes the Epworth and Stanford sleepiness scales. The Epworth sleepiness scale is probably the most widely used questionnaire, and asks the patient to rate their sleepiness during various everyday activities such as reading, watching TV, and driving. The Stanford sleepiness scale is similar, but asks the patient to rate their sleepiness at each hour of the day. Other types of questionnaires involve quality of life measures that are specific to OSA. Downsides of these questionnaires are that they are not highly specific to OSA, with diseases such as narcolepsy and restless leg syndrome often having positive questionnaires.

The next type of diagnostic modality available is called **cephalometric analysis**. This involves take lateral plain radiographs of the face and skull base. Several points are plotted in order to evaluate the position of the mandible in reference to the skull. Using these points,

several linear and angular measurements are taken. Important for the diagnosis of OSA is the size of the posterior airway space, the length of the soft palate, and the distance from the mandible to the hyoid bone. These measurements are especially beneficial for decisions concerning surgical management.

The gold standard for the diagnosis of OSA is the **sleep study**, or **polysomnography**. Although alternatives exist, the ideal sleep study takes place overnight at a sleep lab. A variety of measurements are taken during the study, including: pulse oximetry, electroencephalogram (EEG), electrooculogram (EOG), electrocardiogram (ECG) electromyogram (EMG), degree of respiratory effort, amount of oral and nasal airflow, and limb and body movements. Terms that are important for the diagnosis of sleep apnea are apnea, hypopnea, and apnea/hypopnea index (AHI). Apnea is defined as a lack of ventilation for greater than or equal to 10 seconds with signs of arousal. Hypopnea is defined as a decrease in respiratory movement with a drop in oxygen saturation or with signs of arousal. Finally, the AHI, which is also known as the respiratory disturbance index (RDI) is defined as the number of apneas plus the number of hypopneas divided by the number of hours of total sleep. While there is a large amount of data generated during sleep studies, often the diagnosis of OSA is made only by the RDI. However, other important parameters for diagnosis and determination of severity are: lowest oxygen saturation, number of desaturation episodes below 90%, and the total amount of time below 90% oxygen saturation.

Going back to the spectrum of sleep disordered breathing, there are more technical terms based on polysomnography for each of the disorders. Primary snoring has an RDI below 5. UARS has an RDI below 5, but an arousal index above 5 (number of arousals per hour as determined by EEG). OSA must have an RDI above 5 and oxygen desaturation episodes below 90%. For Pickwickian syndrome, the patient must have a BMI greater than 30 kg/m², daytime hypercapnea with a PaCO₂ of at least 45 mmHg, and some type of sleep disordered breathing.

Surgical Indications

Surgical indications for the management of OSA include an RDI above 15, an RDI above 5 with daytime sleepiness, oxygen desaturation episodes below 90%, or the presence of cardiac arrhythmias. Underlying all of these criteria is that there must have been an unsuccessful trial of medical therapy, or CPAP. When patients are completely compliant with CPAP, it is nearly a universal cure. However, 100% compliance is difficult to maintain, and patients often seek surgical alternatives with the goal of becoming free of the CPAP machine or to help them better tolerate the machine. Finally, as these patients often have many medical comorbidities, they must be considered medically stable for surgery.

Surgical Management

Surgical management of OSA includes a wide variety of procedures that vary in their invasiveness and success rates. Most of the studies that have examined the success rates are retrospective chart reviews and vary greatly in their reported numbers. Generally, success is defined as a drop in the RDI by either 50% or 20 total points.

The first types of procedures done for OSA are rhinological. Increased nasal resistance may increase negative pressure in the airway during inspiration, causing airway collapse. The main procedures used to correct nasal obstruction are septoplasty, turbinate reduction, and functional endoscopic sinus surgery. These serve to correct problems such as a deviated septum, allergic rhinitis, nasal polyposis, and chronic rhinosinusitis. These are usually considered adjuncts to other procedures or treatments, with the goal often being improvement of nasal CPAP compliance. The clinical usefulness of these procedures for OSA is considered controversial, as some studies have shown that septoplasty can increase the severity of OSA.

The next type of procedure involves palatal reduction. This is typically an uvulopharyngopalatoplasty (UPPP), which is the most common procedure performed for OSA. The UPPP trims excess palatal length along with the uvula, and is often combined with a tonsillectomy. Success rates are reported to be between 40 and 50%. However, these figures drop to 6% if macroglossia is present. This procedure, like many of the other procedures for OSA, has a low complication rate, with most problems arising from airway compromise.

More aggressive and less commonly performed procedures involve the tongue base. The first type is the **tongue base suspension**, where a permanent suture is run through the base of tongue and attached to a screw placed on the inner aspect of the anterior mandible. This serves to prevent the tongue from collapsing posteriorly during sleep. An advantage of the procedure is that it is quick, with operation times reported as only 20 minutes. This procedure is considered to have a variable success rate of between 20 and 82%. A newer type of tongue base procedure is the **tongue base reduction**. This is usually an office based procedure performed with the Coblator. It can be done multiple times to achieve the desired result. The success rates reported in the literature are more promising at between 60 and 85%.

The next procedure is the **genioglossus advancement**. This is accomplished by performing an osteotomy of the anterior mandible with advancement of the bone segment one width of the mandible. The segment is then rotated to prevent retraction, and secured in place with a titanium plate or screw. The procedure serves to reduce tongue collapse in a similar manner to the tongue suspension. The success rate has been reported to be anywhere from 23 to 77%. Associated complications are injury to the genioglossus muscle and mental nerve.

A more aggressive procedure for OSA is the **hyoid suspension**. In this procedure an external incision is made on the neck, and the hyoid is dissected inferiorly and advanced over the thyroid cartilage. The hyoid is held in place by placing a permanent suture. This procedure is typically performed in conjunction with a genioglossus advancement or UPPP. As with many of the other procedures, it has a variable success rate of between 17 and 65%. In addition to the high failure rate, another disadvantage of the hyoid suspension is that it often causes dysphagia.

The next procedure is the **maxillomandibular advancement**. For this procedure, a Lefort I osteotomy is created in the maxilla, along with bilateral ramus osteotomies and an anterior inferior mandibular osteotomy. Each segment is advanced 10-14 mm while ensuring that proper dental occlusion is maintained. This serves to enlarge the posterior airway and is the only procedure mentioned thus far with a reproducible high success rate (75-100%). One downside of the procedure is that it significantly alters the patient's facial appearance. However, reports have stated that patients are usually happy with the change.

The final procedure is the **tracheotomy**. This is only indicated for the presence of severe, life-threatening OSA. It is the only procedure that has consistently shown 100% success rates for severe OSA. However, even this procedure is not completely curative for patients that already have cardiopulmonary decompensation. Many patients with Pickwickian syndrome fall into this category and have to go on the ventilator during sleep. Due to obvious quality of life and social stigma issues, the tracheotomy is rarely done for treatment of OSA.

Surgical Planning

With several different procedures available to help patients with OSA, it can be difficult to decide which is best suited for each individual patient. To make this decision, determination of the site or sites of obstruction, as well as the severity of OSA must be made. The usual levels of obstruction are: the nasal cavity/nasopharynx, the palate/oropharynx, and the base of tongue/hypopharynx. This information can be obtained via physical exam, with the Müller maneuver being particularly helpful, and cephalometric analysis.

Next, the severity of the patient's OSA should be determined by polysomnography. Patients with mild OSA have an RDI of less than 20 and a lowest saturation of oxygen greater than 85%. Patients with moderate OSA have an RDI between 20 and 40 and a lowest saturation of oxygen of greater than 80%. Patients with moderate/severe OSA have an RDI between 40 and 60 and a lowest saturation of oxygen of greater than 70%.

Finally, patients with severe OSA have an RDI less than 60 and a lowest saturation of oxygen less than 70. Generally, as the severity of OSA increases, so should the invasiveness or aggressiveness of the procedure. The surgical planning should also keep in mind the patient's overall desires, preferences, and goals. Finally, the patient's health status and ability to tolerate each type of procedure should be considered. Overall, the goal is to minimize the surgical intervention and avoid unnecessary surgery, while helping the patient achieve their goal for the treatment.

Protocol for Surgical Management

A specific protocol was developed at the Stanford Sleep Center for the surgical planning of OSA. The protocol involves having a presurgical evaluation with physical exam including flexible scope examination, cephalometric analysis, and a sleep study. Then, the patient undergoes a procedure or combination of procedures based on the site of obstruction and severity of disease. A sleep study is completed 6 months postoperatively. If the surgery is not found to be a success, the patient receives a maxillomandibular advancement.

Based on this protocol, a prospective study was completed that had 135 patients with mild to moderate OSA, and 42 patients with severe OSA. Their goal was to minimize surgical interventions and avoid unnecessary surgery while achieving a cure. Success in the study was defined as an RDI reduction of at least 50% or an absolute drop of at least 20. The study was completed in two phases. In phase I, all patients were placed into one of three groups. Group 1 was determined to have obstruction at the level of the oropharynx and received a UPPP. Group 2 had combined obstruction at the oropharynx and hypopharynx and received a genioglossus advancement, a hyoid suspension, and a UPPP. Group 3 only had obstruction at the

hypopharynx and received a genioglossus advancement and a hyoid suspension. Of note is that a hyoid suspension was not performed if intraoperatively the patient was considered to have achieved adequate enlargement of the hypopharynx with genioglossus advancement alone, or if airway edema was considered to be likely after the genioglossus advancement was completed. Patients who did not have success in phase I as determined by a 6 month postoperative sleep study moved onto phase II, which was maxillomandibular advancement. The success rates for phase I were 71-78% for mild to moderate OSA and 42% for severe OSA. For phase II of the study, the success rate for patients that failed phase I was 100%. As evidenced by the high success rate of the study, the Stanford protocol was recommended as a method of achieving a cure for OSA via surgical intervention.

Conclusion

There is a large amount of literature concerning the surgical treatment of OSA. Many of the procedures have variable success rates that may make physicians wary of performing them as a method of treatment. In light of this, more prospective studies are needed that specifically compare these procedures alone or in combination. Additionally, the studies should be based on procedures that are specifically tailored to the sites of airway obstruction in the patient.

Also of note is that the accepted definition of success is often not acceptable clinically. If a patient has an RDI of 35 and it drops to 15 with intervention, this is considered a success. However, the patient still has an increased overall mortality based on their RDI. Additionally, the RDI does not correlate completely with the amount of daytime sleepiness or decrease quality of life they are experiencing. Quantitative measures that have been found to better correlate with these symptoms are total oxygen desaturation time, number of desaturation episodes below 90%, and the lowest oxygen saturation value.

Finally, in research studies and in clinical practice, patients often feel subjectively better after surgical intervention and are reluctant to undergo further studies. It should be emphasized to patients that postoperative sleep studies are always important to assess the effect of their procedure. Overall, OSA is an underdiagnosed and undertreated disease that affects a large portion of the population. As the population becomes more obese, so will the number of people with OSA, thus making it imperative that further research be conducted to discover practical and effective therapy.

DISCUSSION: Vicente Resto, MD, PhD, FACS

Andrew, that was a very nice review of a topic that's becoming increasingly relevant and recognized. I have several comments on it: first of all we can never forget the fact that CPAP cures all apnea. It really does. There are issues with treatment with CPAP as whether you are going to have a patient who is going to be compliant. Compliance has been studied some and to a degree this is correlated with the amount of pressure required to overcome the collapse and in others it's just behavioral. For example, some people travel a lot and others simply don't want to be bothered with a hose and a mask every night. The numbers out there are about 50% for compliance. In my personal practice I tailor my surgery around the patient's disposition towards CPAP.

On another separate note, it's clearly important to have a gradation of surgical results so you can have a method of following just how much of a contribution the surgical procedure(s) have made to the patient's health and comfort. The Stanford group is probably the most experienced group in dealing with sleep apnea in the country. I will argue, however that from a clinically relevant perspective, reducing the RDI to less than fifty percent of their pre-intervention values is not necessarily correlative with clinical results. You can have someone with an RDI of 35 and you reduce it to 15, and they may still be somnolent enough that they may be at high risk for injury at work or while driving. Again, it's important to understand that in order to gauge what benefits particular interventions can bring about it is one thing to think about research and clinical relevance.

In my practice I consider anybody who has an RDI greater than 10 to have an abnormal RDI. And it's unusual that I see anybody show up in the office without symptoms having a value lower than that. So at that point in time, anything with a value greater than 10 calls for an intervention, at least the most behavioral based intervention such as weight loss or potential treatment of nasal allergy to improve patency of nasal airway at night that can perhaps improve their quality of life.

As you have pointed out, the RDI is kind of a blunt instrument, very objective and quantitative but at the same time blunt in describing disease. In my actual practice I talk to patients about CPAP as well as severity of disease. In my mind there is really two classes: mild-to-moderate, and severe. Mild-to-moderate is anywhere between 10 to 30. Greater than 30 I call severe. It matters greatly that people with RDI's between 10 and 30 can be treated with anything. You can treat them with CPAP and they'll get better. You can have someone who says "I don't want to use CPAP- I've tried it and I hate it..." and you can offer them a number of relatively benign, well-tolerated surgical interventions and more often than not cure them. That degree of and percentage of success rate is inversely correlated with that number. The closer you get to 30 The less likely you're going to get a complete cure.

The surgeries I'm referring to are low-complexity surgeries: nasal altering surgeries- intranasal- septoplasties, turbinate reduction, UPPP's, tonsillectomies, which in my mind their contribution aside from tissue bulk reduction is really a secondary contribution and that is that when you do your tonsillectomy and you do your "triple P" there's often a remodeling that occurs which tends to stiffen up the tissue increasing the benefit of the procedure.

I actually draw the line in terms of low complexity surgery there because I think the next step, talking about tongue-reposition maneuvers whether they be tongue base reduction maneuvers or genioglossal advancement procedures, both have significant potential morbidity. Whereas the previous procedures in the hands of well-trained individuals are rather well-tolerated with well-described complications that are relatively well-mannered. That changes when you transcend into the next level. As such I generally consider them as high-complexity surgeries together with mandibular/maxillary advancement, and there are things that I won't offer a patient generally until they have a true, sincere trial of CPAP even if they come back and complain of their inability to tolerate it I will still offer them low-complexity surgery with the aim not to do away with CPAP compliance completely, but to improve their compliance by potentially decreasing pressures and improving anatomy so that they are better supported. Only at that time, in a patient with severe apnea, who has failed to tolerate CPAP, who has failed to

benefit from low-complexity surgery for improved compliance, who still comes back and still has symptoms and potential co-morbidities that I will engage in high-complexity surgical procedures. I shy away from tongue-base procedures because of the potential to damage nerves such as the hypoglossal nerve which is a rather severe consequence of the this. I like to stay away from hyoid suspension, which is simply a maneuver that in my mind makes no sense in terms of increasing airway patency. In fact, we often use it when we do partial laryngeal surgery to tuck up a larynx underneath a tongue base so that you minimize aspiration. So it's really a maneuver that works counter to what you're looking for in sleep apnea surgery. And I suspect that the benefit is really due to the genioglossal advancement maneuver that is often part of the hyoid suspension. These are all things that are deserving of further study and clarification. This is a disease that's only going to increase, since in America there's an epidemic of obesity and we're all aware of how difficult it is for most individuals to lose weight . I think we will see more of this in the future.

References:

- Couch ME, Senior B. Nonsurgical and surgical treatments for sleep apnea. *Anesthesiology Clin N Am*. 2005 Sep;23(3):525-34, vii.
- Cummings Otolaryngology: Head and Neck Surgery. Editors: Cumming CW, Haughey BH, Thomas JR, Harker LA, Flint PW. 4th edition. Philadelphia: Mosby 2005.
- Head and Neck Surgery Otolaryngology. Editors: Bailey BJ, Johnson JT, Newlands SD, Calhoun KH, Deskin RW. 4th edition. Ne York: Lippincott Williams and Wilkins 2006.
- Li KK. Hypopharyngeal airway surgery. *Otolaryngol Clin N Am*. 2007 Aug;40(4):845-53.
- Li KK, Powell NB, Riley RW, Troell R, Guilleminault C. Overview of phase I surgery for obstructive sleep apnea syndrome. *Ear Nose Throat J*. 1999 Nov;78(11):836-7, 841-5.
- Li KK, Powell NB, Riley RW, Troell R, Guilleminault C. Overview of phase II surgery for obstructive sleep apnea syndrome. *Ear Nose Throat J*. 1999 Nov;78(11):851,854-7.
- McMains KC, Terris DJ. Evidence-based medicine in sleep apnea surgery. *Otolaryngol Clin N Am*. 2003 Jun;36(3)539-61, viii.
- Prinsell JR. Maxillomandibular advancement surgery for obstructive sleep apnea syndrome. *J Am Dent Assoc*. 2002 Nov;133(11)1489-97.
- Riley RW, Nelson NB, Guilleminault C. Obstructive sleep apnea syndrome: A review of 306 consecutively treated surgical patients. *Otolaryngol Head Neck Surg*. 1993 Feb;108(2):117-25.