Treating obstructive sleep apnea: The case for surgery

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Obstructive sleep apnea (OSA) is a chronic, progressive, and potentially life-threatening disorder that can be effectively treated with surgery. It is also a condition that orthodontists see in their offices every day; thus, they are ideally suited to diagnose and treat it. OSA is related to an anatomic obstruction of the upper airway; surgical correction of the obstruction is effective and definitive, and should be considered for appropriate patients with mild, moderate, or severe OSA.

OSA is a multifactorial condition, and diagnosis and treatment must be individualized, with multidisciplinary management. The definitive diagnosis and treatment plan is formulated after a comprehensive medical and dental history and examination. Adjunctive diagnostic studies such as cone-beam computerized tomographic imaging for airway analysis, fiber-optic nasopharyngoscopy, polysomnography, and 3-dimensional cephalometrics are included in the workup.

OSA occurs during sleep as a result of an obstruction or partial collapse of the upper airway. Signs and symptoms include tiredness or sleepiness during the day, memory loss, irritability, depression, decreased libido, and headache. If OSA is not treated, it can cause diabetes, hypertension, heart disease, and sudden death while asleep.[1] Exacerbating factors include a high body mass index (>34).[2] Continuous positive airway pressure (CPAP) is currently considered the gold standard for the treatment of OSA.[3,4] Positive airway pressure can be divided into continuous (CPAP), bilevel, and auto titrating modes, through a nasal, oral, or oronasal interface during sleep. Unfortunately, compliance with CPAP is variable for numerous reasons including social stigma, feelings of claustrophobia, and complaints of inability to sleep peacefully.[5] Side effects include nasal congestion, thickening of the soft tissues with prolonged use, skin ulceration, and eye irritation.[6] CPAP failure because of poor compliance has been reported to be as high as 25% to 50%.[7,8] OSA is most severe during deeper sleep; thus, patients using CPAP for less the 4 hours a night still suffer from the consequences of OSA.

ORAL APPLIANCES

Oral appliances have also been successfully used for the treatment of mild to moderate OSA. Custom-made oral appliances improve upper airway patency during sleep by enlarging the airway or by decreasing the upper airway's collapsibility (improving upper airway tone). However, oral appliances are not as effective as CPAP and thus are indicated for patients with mild to moderate OSA, those who prefer oral appliances to CPAP, or those who do not respond to CPAP.[9] Oral appliance tolerance is variable but generally better than that with CPAP. Patients who can tolerate oral appliances tend to use them for the entire duration of sleep, thus making them more effective for those who only use CPAP for part of the night.

Optimally designed oral appliances are generally well tolerated but can cause muscle pain, aggravate temporomandibular joint disorders and periodontal disease, and cause dental misalignment and malocclusion with long-term use.[6]

BEHAVIORAL STRATEGIES

All patients should be educated and counseled regarding the etiology of OSA and the possible treatment options including behavioral strategies such as weight loss, exercise, positional therapies while sleeping, and avoiding sedatives, hypnotics, or alcohol before sleeping. Successful dietary weight loss can improve the apnea hypopnea index in obese patients with OSA. Patients sleeping in the supine position have been shown to exhibit a significant decrease in the upper airway area, especially in the lateral dimension, exacerbating OSA.

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SURGERY

Since OSA is a multifactorial condition, it requires a multidisciplinary approach. Surgery, when appropriately prescribed and proficiently performed, is effective and definitive and should be considered as part of a multidisciplinary approach. Inclusion criteria for surgery are the following.[10]

1. OSA diagnosed by polysomnography with an apnea hypopnea index score greater than 5, a decrease in oxygen saturation (<90%), poor sleep efficiency with clinical symptoms (eg, excessive daytime sleepiness).
2. Unsuccessful behavioral therapies such as weight loss, positional therapy, and the elimination of hypnotics or alcohol before sleeping.
3. Medically and psychologically able to tolerate surgery.
4. An inability to tolerate CPAP or oral appliances, or a preference for a surgical solution.

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A comprehensive medical history, a sleep history, and the Epworth sleepiness scale are recommended as part of all routine orthodontic examinations.[11] Patients with suspected OSA should be examined with fiberoptic pharyngoscopy and tested with overnight polysomnography. A cone-beam computed tomography airway analysis and 3-dimensional cephalometrics are used to identify and quantify the site of obstruction and analyze the skeletal and dental relationships. The goal of surgery is to permanently enlarge the airway by repositioning or removing the obstruction at each level without creating complications. The airway can be conveniently divided into 3 anatomic sections for evaluation and thus treatment.

1. The nose. Any deformity of the internal nose will affect airflow; thus, the orthodontist and the surgeon should evaluate nasal aerodynamics. Deformities or collapse of the alar cartilage will cause airflow reduction at the external nasal valve. Septal deviations can obstruct the nose and cause airflow turbulence. Enlarged turbinates can also obstruct the nose and reduce airflow; thus, surgical reduction might be indicated. An anatomically narrow nasal floor can adversely affect nasal airflow. Since the floor of the nose is the hard palate, maxillary constriction and crossbites must be considered as causative factors.
2. The retropalatal area and the lateral pharyngeal walls. In adolescents, the most common cause of airway obstruction is lymphoid hyperplasia with enlargement of the adenoids and tonsils. This reduces the retropalatal airway, causing OSA, and is reported to be the cause of airway obstruction 60% of the time.[12] Removal of the obstruction by appropriate surgery is often the most effective solution. A retrusive maxilla and a Class III malocclusion will also result in decreased retropalatal airway space and OSA. Airway problems can also be seen after cleft palate surgery, especially after pharyngeal flaps or sphincter-type procedures. Adults with a long palate can snore and develop progressive thickening of the palatal tissues, compounding the airway obstruction.
3. The retroglossal area and the tongue. The retroglossal region is mostly influenced by the position of the mandible and the tongue. Mandibular retrognathia will cause the base of the tongue to position posteriorly during sleep, obstructing the airway and causing OSA. Secondarily, mandibular retrusion can cause obstruction at the palatal level also. These deformities can be evaluated with nasophyargoscopy and cone-beam computed tomography scans with 3-dimensional cephalometric and 3-dimensional airway analyses.

Successful surgery depends on many factors, including the health, age, and psychological condition of the patient; the skill and experience of the surgeon; and the type of surgery performed. Surgical procedures can be classified as intrapharyngeal or skeletal.

Intrapharyngeal procedures are performed on the soft tissues of the velo-oro-hypo-pharyngeal airway including the soft palate, the velopharynx, hypertrophied tonsils, the base of the tongue, or the body of the tongue in patients with macroglossia. Primary surgical treatment is indicated for patients with any obstructing anatomy that is surgically correctable such as hypertrophic tonsillar tissue obstructing the pharyngeal airway. Nasal procedures include septoplasty, functional rhinoplasty, nasal valve surgery, turbinate reduction, and polypectomy. Uvulopalatopharyngoplasty is rarely

curative for OSA but might improve the clinical symptoms of snoring. Laser-assisted uvulopalatoplasty is not recommended for OSA.[13] Skeletal surgery involves the maxilla, the mandible, the chin, and the hyoid bone, and corrects the obstruction by moving the jaws or the chin forward to better support the velo-oro-pharyngeal soft tissues from collapsing during sleep. Surgical treatment of adults with severe OSA generally involves a maxillomandibular advancement of 10 mm and is 90% to 100% successful.[14-17] Conley and Legan[18] showed the importance of including correction of the transverse dimension as part of the maxillomandibular advancement. The long-term stability of this skeletal surgery with rigid fixation is good.[2] The maxillomandibular advancement procedure is effective because the soft tissues and the tongue are attached to the maxilla, the mandible, and the hyoid bone. Thus, advancing the maxilla, mandible, and chin (genioglossus advancement) results in the soft palate and the tongue being pulled forward, enlarging the entire velo-oro-hypopharyngeal airway. The tonicity of the pharyngeal dilated muscles—eg, tensor veli palatini and genioglossus—is also enhanced.[19] Maxillomandibular advancement is therefore prescribed as a functional and curative surgery for OSA.[18,20-22] It can be prescribed by surgeons without orthodontics, by using arch bars for fixation. This is contraindicated for several reasons. Bonded orthodontic appliances are quicker and easier to install and are much less traumatic to the periodontium. Patients benefit from an optimal functional occlusion, facilitated by orthodontic treatment. Optimal skeletal facial and dental esthetics are best achieved by the joint efforts of the orthodontist and the surgeon.

An accelerated presurgical phase of treatment is advocated for patients suffering from OSA because of the health advantages gained by normalizing the airway and improving the oxygen saturation during sleep—in lieu of a traditional, prolonged presurgical orthodontic regimen.[11] A 3-dimensional diagnostic surgical treatment animation is prescribed, superimposing a cone-beam computed tomography image with 3dMD soft-tissue imaging (3dMD, Atlanta, Ga). Traditional cephalometric radiographs are relatively inaccurate and thus inadequate.[23] A 3-dimensional orthodontic diagnostic setup, virtual or on an articulator, allows the orthodontist to evaluate the final occlusion for presurgical equilibration and to make a customized bracket-based prescription with individualized torque, angulation, and offset. Intermediate and final surgical splints are made by using an accurate bite registration on an adjustable hinge-access articulator.

Complications of surgery have been reported, including neurosensory deficit, infection, bleeding, the need to remove hardware, skeletal instability, and temporomandibular joint problems. However, patient satisfaction with maxillomandibular advancement is reported to be as high as 95%.[24] Skilled, experienced surgeons can complete the maxillomandibular advancement in less than 3 hours, allowing an easier recovery with less time in the hospital or a recovery center (2-3 days). Long-term stability and function are good. Variables that influence the result include the body mass index, the amount of skeletal advancement, and the skill and experience of the surgeon.

CHILDREN

Pediatric sleep apnea is a frequent condition that can result in irreversible changes in the growth and development of the face and associated complications if not diagnosed and treated in a timely manner. Snoring in children is not normal, and the prevalence of OSA has been reported to be as high as 21% for children with noninfectious respiratory complaints.[25] In patients with cleft palate, the incidence is 30%.[26] Since the early 1970s, a dentofacial morphology with excessive inferior vertical facial height and facial retrusion has been recognized and described as adenoid facies, extreme clockwise rotation, high mandibular angle, and skeletal open bite.[27] These terms were described by Schendel et al[28] as the long-face syndrome.[29-32] Airway obstruction and enlarged tonsils and adenoids are commonly associated with this dentofacial morphology.

Recently, Lee et al[33] used craniofacial photographs to predict OSA, with 76% accuracy. Affected persons tended to have a dolichocephalic skeletal pattern with mandibular retrognathia. Sixty percent of children with airway obstruction have adenoid and tonsillar hypertrophy; however, a tonsillectomy and an adenoidectomy alone do not resolve the obstruction in 27% of these patients. Thus, it is important to identify all sites of obstruction in patients with OSA, such as skeletal malocclusions.[13] Many children have daytime symptoms as early as age 5 and have crossbites, steep mandibular planes, divergent open bites, decreased rhino-pharyngeal space, and aberrant tongue position. Orthodontists can play a major role in improving the skeletal and dental relationships by interception therapy at this young age. Coincident medical management is also imperative, including CPAP, maxillomandibular advancement, and soft-tissue surgery when indicated. Maxillomandibular advancement is typically prescribed at full maturity, but, in severe skeletal craniofacial anomalies, Bell and Turvey[34] have shown good results

with skeletal advancement for the treatment of OSA in children. Mandibular micrognathia associated with congenital malformations such as Pierre Robin, Treacher Collins, and Nager's syndromes, and hemifacial microsomia are causes of OSA in infants and young children.[35] In these children, the most frequent cause of OSA is obstruction of the airway by the tongue, secondary to glossoptosis, resulting from micrognathia. Choanal atresia, tracheal malformations, and macroglossia can also cause OSA in this group. Mandibular distraction has been shown to be a safe and effective means of relieving the airway obstruction in these micrognathic infants.

CONCLUSIONS

Surgery plays an important role in the treatment of OSA and is also indicated as the treatment of choice for OSA, even in patients with mild and moderate OSA. Maxillomandibular advancement is a potentially definitive, single-stage surgical treatment for OSA; it can result in significant improvement in the quality of life and reduction in OSA health-related risks. Soft-tissue surgery is also indicated as a corrective treatment in some patients and as an adjunctive treatment in others to assist the CPAP. Projected over an average, normal lifetime, this can also result in a considerable financial savings for the patient and the health system.

Maxillomandibular advancement for OSA should be relegated to surgeons willing to spend a significant amount of time learning the principles and practices of sleep medicine along with the associated soft-tissue and hard-tissue surgical procedures. Maxillomandibular advancement is not just a variant of orthognathic surgery, since many patients have major medical conditions. Surgeons should always work with orthodontists trained in sleep medicine, since their combined treatment expertise, optimally exercised, yields superior short-term and long-term results.

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