CHAPTER 17

Upper Airway Surgical Management of OSA

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Adult OSA is a heterogenous disease and its management has evolved to become increasingly individualized. Modern variants of upper airway salvage procedures to treat multilevel obstruction are guided by examination and endoscopic findings in each patient. In this chapter we will review the standard surgical assessment, treatment options, and outcomes for OSA.

Philosophy of OSA Surgery

Surgical treatment of OSA encompasses a wide variety of procedures with the purpose of widening and/or stabilizing the upper airway to reduce the severity and impact of SDB. Traditional paradigms of treatment deem CPAP as the first-line therapy (see chapter 13). In this approach, for patients who are intolerant or suffer side effects of treatment, salvage therapies such as surgery or OAT may be considered.[1] In patients with favorable or significantly contributing anatomy, surgery can be considered as first-line therapy to address OSA given that it is not limited by patient compliance or adherance.[2]

In clinical practice, patients have heterogenous anatomy and physiology (see chapters 7 and 15), and hence decisions need to be based on the context of their individual priorities and symptom resolution goals. Those who fail to tolerate or persist with devices (PAP or OAT) would remain untreated if not for salvage options such as upper airway surgery. While traditional endpoints such as AHI reduction are more variable and difficult to predict, significant improvement in disease burden is achieved in most cases to mitigate severe and recurrent oxygen desaturation profiles and reduce cardiovascular and mortality risk. Surgery is not constrained by the main limitation of both PAP and OAT—patient compliance.[3]

The goals of treatment should be clearly identified with patients (ie, assessing expectations and explaining risks and benefits) prior to embarking down a surgical pathway. Motivating factors may be snoring, daytime somnolence or tiredness, as well as the desire to mitigate long-term cardiovascular risks associated with moderate-to-severe OSA.[4] These targets may be address with staged multilevel surgical protocols in isolation or within multimodality treatment plans, incorporating the strategies to address weight loss, nasal obstruction, and supine sleeping position. Finally, surgery may facilitate device usage (PAP or OAT) due to reduced nasal resistance or positive airway pressure requirement.[5,6]

Comprehensive Clinical Assessment

Consultations ideally include the patient's sleep partner and begin with a thorough patient history (see chapter 11) with the assistance of validated assessment tools. Comorbid conditions must be considered, as must the goals of therapy. General examination, as well as transoral, transnasal, and endoscopic examination allow the clinician to identify contributory, correctable, and unfavourable anatomy. Table 17-1 describes the significant components of the surgical consultation.

In-laboratory polysomnography is recommended by American Academy of Sleep Medicine in patients considering surgery for OSA. If unavailable, a home sleep study conducted and reviewed by a sleep physician may be performed pre- and postoperatively.[15] Following the above thorough assessment, patients are considered candidates for staged multilevel surgical protocols in the following situations:

1. Salvage therapy in moderate-to-severe OSA following exhaustion of device options (PAP or OAT) due to intolerance, complications, or failure.
2. Salvage therapy in moderate-to-severe OSA as part of a multimodality approach (incorporating positioning devices, OAT, weight loss, and treatment of nasal obstruction)

TABLE 17-1 Surgical assessment in OSA

Assessment		Components
History	Symptoms of OSA	Witnessed apnea Snoring Daytime somnolence Tiredness Disrupted sleep Other
	Comorbid sleep disorders	Insomnia Idiopathic hypersomnolence/narcolepsy Circadian rhythm disorders
	Comorbid medical disorders	Depression Hypothyroidism Iron deficiency
	Complications of OSA	Hypertension Stroke Ischaemic heart disease Type 2 Diabetes
	Modifiable factors	Sleep position Weight gain/loss
Validated tools	Questionnaires	Snoring severity scale[7] Epworth Sleepiness Score[8] FOSQ-30[9]
Examination	General observations	Blood pressure BMI Neck circumference Abdominal circumference
	Nose	Septum Turbinates Polyps Signs of rhinitis/sinusitis
	Bony anatomy	Facial skeleton Occlusion Dentition Maxillary and mandibular width and length
	Soft tissue anatomy	Tonsil size Tongue size and position Friedman tongue grade[11] Soft palate phenotype[10]
Endoscopy	Static	Nasal airway Postnasal space Soft palate phenotype[10] Tongue base size and position Lingual tonsil size Epiglottis Laryngeal abnormalities
	Dynamic	Mueller maneuver[12] Woodson hypotonic method Esmarch maneuver[13]
	Drug-induced sleep[14]	Velopharynx Oropharynx Tongue Epiglottis

3. Primary therapy for snoring, upper airway resistance syndrome, or mild OSA in surgically suitable patients with realistic goals [Au: Edit okay?]
4. Surgery to facilitate improved tolerance of device use (ie, PAP or OAT).

Nasal Surgical Options

Nasal obstruction is a risk factor for the development of OSA. Unfortunately, isolated correction of nasal obstruction has not led to significant improvements in disease severity.[16] PAP may exacerbate nasal obstruction, with symptoms occurring in 25% to 40% of cases.[17] Surgical relief of obstruction leads to lowered PAP pressures and improved usage.[5] Correction of septal (ie, septoplasty) and external nasal deformities (ie, rhinoplasty) as well as surgical reduction of inferior turbinate hypertrophy, adenoidectomy, and endoscopic sinus surgery are procedures to improve nasal function and reduce nasal resistance. Elevated nasal resistance has also been shown to predict OAT failure.[6] For these reasons, nasal surgery is not considered in isolation for the treatment of OSA but may be indicated "pre-phase" for device failure or complications related to elevated nasal resistance, symptoms due to nasal inflammatory disorders, and significant correctable structural or dynamic nasal anatomy.

Velopharyngeal Surgical Options

Procedures to address the retropalatal airway have been used for over 35 years and may be performed in isolation or as part of a multilevel approach. Retropalatal obstruction is implicated in 50% to 80% of patients,[18] so palatal procedures form the basis of the majority of sleep surgery protocols. Contemporary variants of uvulopalatopharyngoplasty (UPPP)[19] include tonsillectomy but are differentiated from older techniques with a focus on mucosal preservation, soft tissue reposition and reconstruction, and creation of lateral pharyngeal wall tension.[20] In anatomically suitable patients with severe disease, or if UPPP has been or is likely to be inadequate, transpalatal advancement (TPA) is employed to advance the hard-and-soft palate junction anteriorly to increase the diameter of the pharyngeal lumen.[19]

Retrolingual Surgical Options

The retrolingual segment contributes in only 20% to 30% of cases, but when present, it is usually associated with multilevel obstruction.[18] Reduction of lingual tonsillar hypertrophy may be combined with epiglottopexy to deal with epiglottic collapse. Excessive bulk of the tongue itself can be dealt with conservatively by minimally invasive radiofrequency channelling—a repeatable, simple, and well-tolerated procedure. More excessive tongue bulk can be managed by way of surgical reduction (open midline submucosal or robotic glossectomy).[19]

Bony Framework Surgical Options

Conservative advancement of bony islands of the maxilla and mandibule are known as TPA and *geniotubercle advancement*, respectively. Once a popular operation, geniotubercle advancement is now less common due to recrudescence of symptoms from stretching of the genioglossal tendon. TPA is discussed above and has established efficacy although it is subject to the unique complication of oronasal fistula. Maxillomandibular hypoplasia may be amenable to maxillomandibular advancement to expand the entire bony vault containing the pharynx, although this is typically reserved for patients with severe disease and clear anatomical benefit from advancement.[21]

Alternative Surgical Options

Transoral robotic surgical approaches to the tongue base are utilised in oncologic practice, and these techniques have been applied to OSA procedures. Although transoral robotic surgery offers significant advantages of visualization and instrumental access, it is limited by cost, labor intensity, and complications such as bleeding and taste change (occurring in 22% of patients).[19]

Cranial nerve stimulation is a surgically implanted, titratable means of OSA management. Primarily targeting the hypoglossal nerve, neurostimulation devices are implanted to one or both nerves to selectively activate protrusor muscles of the tongue (see chapter 18). Large multicenter trials with follow-up to 5 years have demonstrated durable symptomatic and polysomnographic outcomes in the majority of patients treated, with relatively low complication rates.[22]

Tracheostomy results in a complete bypass of the upper airway but is rarely performed given the significant morbidity and lifestyle implications of an open system respiratory tract. When employed (usually in very severe disease) one can expect almost complete resolution of disease parameters (AHI and oxygen desaturation index) and sequelae (excessive daytime somnolence and cardiovascular and all-cause mortality), except in obesity hypoventilation syndrome.[19]

Finally, minimally invasive techniques exist in a variety of forms, many of which can be undertaken under local anaesthetic. These methods use injectable, radiofrequency, or implant technology to produce tissue reduction and scar tissue formation with the intention of producing airway stabilization.[19] Minimally invasive techniques may be performed in isolation or as part of a larger multilevel procedure.

Complications

OSA is a risk factor for adverse event incidence in perioperative patients. Anaesthetic and postoperative monitoring considerations are focused on minimizing sedation, opioid requirements, respiratory compromise, and cardiac events. Postoperative PAP usage may reduce the risk of perioperative complications (see chapter 19 for detailed discussion of perioperative management).[23]

Bleeding, pain, odynophagia, and dehydration are risks common to all OSA procedures and are largely equivalent to risk exposure following tonsillectomy. Bleeding and clot formation within the airway, as well as hematoma formation within an operative site all have the potential to cause airway obstruction. Pain is an issue for most patients postoperatively and is usually managed with multimodal analgesia with or without systemic steroids. Palatal surgery can be complicated by palatal dysfunction, with a minority of patients suffering velopharyngeal insufficiency and oronasal fistula (a specific risk of TPA). Procedures to reduce lingual tonsils or tongue muscle volume can result in damage to the neurovascular bundle, with bleeding, hematoma, and lingual and hypoglossal nerve dysfunction. Compared with soft tissue surgery, maxillomandibular advancement demands a much longer recovery period and carries a higher risk of significant complications such as malocclusion, paraesthesia, temporomandibular joint dysfunction, hardware failure, and facial cosmetic changes. Finally, all upper airway procedures can (rarely) cause long-term problems with foreign body sensation, swallowing dysfunction, and aspiration.

Outcomes

Observational[4,24,25] and randomized trials[8] now support the deployment of multilevel airway surgery in the treatment of OSA. Improved polysomnographic indices, overall survival, and cardiovascular risk[25] are seen in patients who have undergone single and multilevel airway surgery after failing or rejecting CPAP.[1] Quality of life and snoring outcomes are equivalent in those undergoing upper airway surgery compared with those successfully treated with CPAP.[24] In many cases, surgery can facilitate the re-establishment of device-based therapies (eg, CPAP or OAT) if OSA persists. Finally, salvage surgery following CPAP failure has been shown to be a cost-effective strategy, with improvement values roughly equivalent to primary coronary angioplasty.[26]

Conclusion

Contemporary airway reconstruction surgery plays an important role in the management of adult OSA, particularly in the setting of device-use failure (for CPAP or OAT) and/or favourable surgical anatomy.

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