Chapter 19

Upper airway surgery

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Introduction

Surgery for adult obstructive sleep apnoea (OSA) is not a new concept: the earliest uvulopalatopharyngoplasty was described by Ikematsu in 1964. Since relating his 30-year experience with palatal surgery and the subsequent modifications of this procedure by Fujita in 1981, there have been significant advances in the field. This is apparent both in the role of surgery, reflected in the shift towards the concept that surgery is a salvage option, not a primary treatment modality, and in technical descriptions, with a move away from ablative surgeries towards reconstructive procedures that minimise the effects of scarring and optimise airway space without compromising function.

While continuous positive airway pressure (CPAP) remains the mainstay of therapy in adults, it is important for clinicians to recognise the difficulties patients face with an appliance-based approach to OSA. Adherence rates are variable, with only 30–60% of patients using CPAP as prescribed, and many rejecting therapy within the first few months of their intended treatment.[1] Thus alternative options for patients who are unable to tolerate CPAP therapy remain important. These treatments include mandibular advancement splints (MAS) (see Chapter 18), weight loss therapy including bariatric surgery (see Chapter 16), and some newer and experimental approaches (Chapters 20 and 21), as well as upper airway surgery, considered in this chapter. Ideally, the goal of upper airway surgery in the management of OSA is to improve quality of life,[2] enhance longevity,[3] and reduce the risk of medical morbidity[4] in those who are unable to tolerate the more commonly prescribed therapies. Large cohort studies to date demonstrate effectiveness that supports a role for upper airway surgery in these domains.

Surgical assessment and patient selection

Preoperative workup is critical in optimising surgical outcomes and in minimising postoperative complications. Ideally, adult patients who have failed CPAP are assessed in conjunction with a dedicated sleep physician, but the assessment does require comprehensive upper airway evaluation to identify those individuals with the most suitable anatomy for surgery.

This workup should begin with a targeted sleep history, including the partner where relevant. Details that pertain to a surgical evaluation do not differ from any other sleep apnoea history, and include: snoring history, witnessed apnoeas, sleepiness, waking unrefreshed, daytime somnolence, prior motor vehicle or industrial accidents, nasal symptoms, previous surgical outcomes, previous device use and outcomes, weight and weight progression, partner disruption, cardiovascular morbidities, and family history.

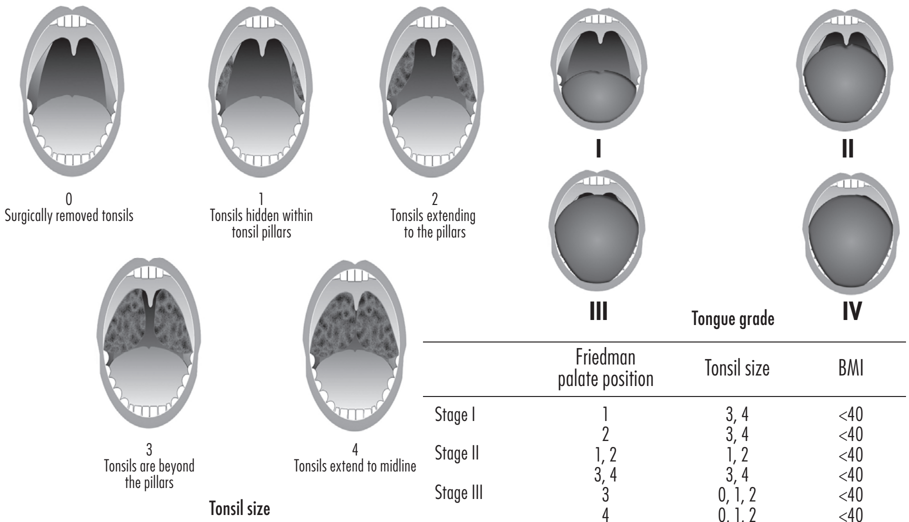
The surgical examination focuses on three main areas listed in Box 19.1, including oropharyngeal/dental, nasal, and nasendoscopy assessments. Friedman grading (Figure 19.1) is based on the degree of visualisation of the oropharyngeal structures with the mouth open. Dynamic nasal valve collapse is an often overlooked examination finding that is demonstrated by having the patient inspire and watching closely for in-drawing of the lower one-third of the lateral nasal cartilages. With upper airway endoscopy the modified Mueller manoeuvre is often employed. This involves a deliberate forced inspiratory effort against an occluded nasal/oral airway that causes upper airway pressure to fall to facilitate collapse of the surrounding

Box 19.1 Surgical examination areas of focus

Oropharyngeal/dental, including:
- Friedman grade tonsil/transoral view
- Malocclusion

Nasal, including:
- Anterior nasal airway
- External nasal valve/nasal tip
- Mucosal disease

Nasendoscopy, including:
- Structural assessment
- Modified Mueller manoeuvres
- Woodson's hypotonic method
- Erect and supine assessment
- Jaw thrust assessment
- +/– Sleep nasendoscopy



	Friedman palate position	Tonsil size	BMI
Stage I	1	3, 4	<40
	2	3, 4	<40
Stage II	1, 2	1, 2	<40
	3, 4	3, 4	<40
Stage III	3	0, 1, 2	<40
	4	0, 1, 2	<40
Stage IV	1, 2, 3, 4	0, 1, 2, 3, 4	>40
All patients with significant or other anatomic deformities			

Figure 19.1: Modified Friedman staging system for patients with obstructive sleep apnoea/hypopnea syndrome.

structures to mimic the airway occlusion that occurs in sleep apnoea. Woodson's hypotonic method involves full expiration after full inspiration and then assessing airway collapse. Sleep endoscopy may be performed to measure upper airway cross-sectional area while the patient is under propofol-induced anaesthesia.

Quality of life (QoL) indicators, including Epworth Sleepiness Scale, Snoring Severity Scale, and Functional Outcomes of Sleep Questionnaire (FOSQ-30), should be completed by the patient with the support of their partner. Investigations include an in-laboratory polysomnogram, or a level 2 home study under the supervision of a sleep physician. Critical review of apnoeas, hypopnoeas, oxygen desaturations, position, and depth of sleep is undertaken.

Pre-phase surgery

Nasal surgery

The aim of nasal surgery in OSA is to improve nasal patency and facilitate CPAP or MAS usage, or prior to subsequent multilevel staged surgical interventions.[5] Three main anatomical areas of the nose may contribute to obstruction: the alar cartilage/nasal valve region, the septum, and the turbinates. The most common nasal surgical procedure will consist of a septoplasty and turbinate reduction. While correcting nasal obstruction is unlikely to cure OSA, it has been shown to significantly improve disease-specific and generic QOL in adults with OSA who also have nasal obstructive symptoms,[6] and, most importantly, reduce CPAP pressure and promote CPAP use.[7] This is sometimes performed in conjunction with weight loss, which may also facilitate lower CPAP pressures.

Staged surgical protocol

Surgery on the soft palate (with or without tonsillectomy)

A wide range of soft palate surgeries are employed in sleep apnoea, including, but not limited to, modified uvulopalatopharyngoplasty (mUPPP),[8] expansion sphincter pharyngoplasty,[9] lateral pharyngoplasty,[10] and relocation pharyngoplasty.[11] While these techniques differ in their surgical steps, the basic rationale remains the same. The aim is to reposition the redundant soft tissues of the palate and lateral pharyngeal walls in such a way that they do not collapse during sleep. The basic premise should always be relocation or reconstruction rather than resection, as ablative soft palate surgery is associated with significant morbidity without the necessary additional treatment effect. Sometimes tonsillectomy or adenotonsillectomy alone is indicated.

Trans-palatal advancement

The retro-palatal airway is a major contributor to airway obstruction in sleep apnoea. The airway can be significantly altered by shifting the palate forward. This involves creating a posterior portion of the palatine bone that remains attached to palatine aponeurosis in the midline, and advancing it into a palatal defect manufactured by removing around 1 cm of bone (Figure 19.2). It results in the palate being moved forward and superiorly.[12] This procedure can be used alone or in combination with other soft palate tissue surgeries as selected for the individual patient. Woodson's initial work demonstrated a reduction in critical closing pressure of 10 cmH_2O at the retropalatal level.[13]

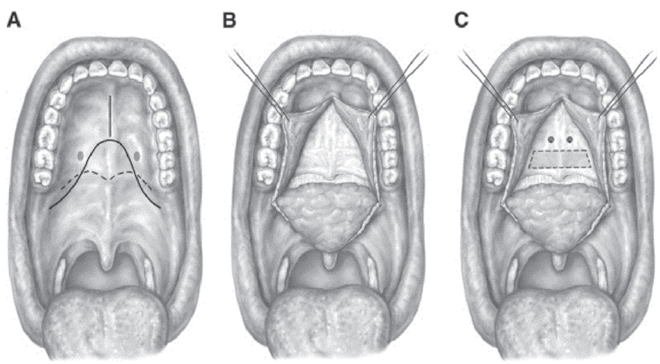


Figure 19.2: Trans-palatal advancement. A is the mapped out incision/approach, B shows the exposed palate, and C the drill holes that will hold the advanced palatal segment.

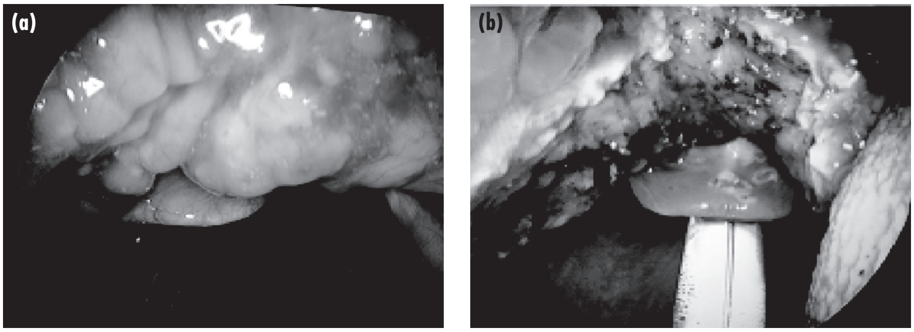


Figure 19.3: (a) Prominent lingual tonsil hypertrophy (b) Lingual tonsil reduction.

(See Chapter 10 for explanation of critical closing pressures in OSA.) This procedure has demonstrated clinical effectiveness in domains including sleepiness, snoring, and quality of life in staged surgical protocols.[2]

Tongue volume reduction

Treatment of macroglossia is a common intervention in contemporary multilevel surgery. Surgery ranges from the lesser end of the spectrum, using radiofrequency or coblation (radiofrequency in saline medium that breaks down tissue, reducing bulk) to channel into the tissue of the posterior tongue with low morbidity but less impact,[14] to major reduction as in submucosal lingualplasty,[15] creating greater impact with increased surgical risk. Between these extremes is volumetric reduction as in midline glossectomy and the coblation-assisted Lewis and Mackay operation (CobLAMO).[15] Surgical decision-making in this realm relates to clinical assessment of macroglossia utilising a modified Malampatti/Friedman classification (Figure 19.1), tongue position relative to occlusal plane, and assessment of the contribution of the posterior third of tongue bulk to collapse on awake or sleep dynamic manoeuvres. On occasion, imaging is utilised (CT or MRI) to confirm clinical impression. Limited tongue reduction surgery results in improvements in psychomotor vigilance task testing and apnoea index,[14] with more extensive tongue base reduction leading to improvement in AHI and sleepiness.[15,16]

Hypertrophied lingual tonsils located in the vallecula (Figure 19.3) can be reduced with suction-diathermy or coblation systems, often utilising microlaryngoscopy for access, and can be combined with radiofrequency/coblation tongue channelling, although it is often staged when larger tongue volume reduction procedures are indicated.

Geniotubercle advancement

When clinical assessment suggests tongue hypotonicity as a major contributory factor in airway collapse, patients may benefit from box osteotomy geniotubercle advancement (GTA) as a part of their staged surgical intervention. Longest tooth root measurements and careful planning are required to reduce risk of complication. There are valid concerns about longevity of outcome in tongue tensing operations, and long-term follow-up is necessary.

Hyoid suspension

The hyoid bone forms an intricate mechanism with the tongue base and pharyngeal musculature. It may be surgically repositioned anteriorly by attaching it to the thyroid cartilage. This technique is used in the surgical treatment of lower oropharyngeal obstruction in OSA, and is often used in combination with GTA. The results of hyoid advancement are variable and surgery is associated with postoperative dysphagia.

Rapid maxillary expansion

Rapid maxillary expansion is an orthodontic treatment for maxillary constriction. It increases maxillary width and reduces nasal resistance, with a low morbidity profile. The technique is most commonly recognised within the paediatric population, or prior to maxillomandibular advancement in adults.

Maxillomandibular advancement

This procedure advances the mandible and maxilla forward as a unit. It represents a 'global' airway procedure, with a resultant increase in the cross-sectional area at both the retropalatal and retrolingual levels. This is the most polysomnographically successful surgical procedure (after tracheostomy) for OSA, with 'cure' rates of 87%.[17] However, it can result in aesthetic changes to the facial structure and carries the risk of significant morbidity, which has limited its uptake by patients.

Tracheostomy

Tracheostomy is a highly effective treatment for patients with severe obstructive apnoea because it bypasses all collapsible upper airway structures. Tracheostomy placement is associated with rapid reversal of conditions associated with OSA, including arrhythmias, pulmonary hypertension, and hypoxia.[18] Airway bypass has been shown to improve QoL and be well tolerated compared to the burden of living with severe symptomatic OSA, but it is obviously an end paradigm treatment. Patients with very few other options or admitted to intensive care units with cardiopulmonary complications of their OSA are most likely to receive tracheostomy.

Recent innovations in sleep apnoea surgery

Trans-oral robotic surgery

Vicini and colleagues first introduced the concept of trans-oral robotic surgery (TORS) as a treatment option for OSA in 2010. Recent publication of a multicentre retrospective analysis of results and complications from seven academic centres suggests that TORS may represent an effective and safe treatment option in OSA surgery.[19] Advocates of TORS suggest it improves surgical access to the base of tongue. The robot system allows for high-quality endoscopic optics for improved visualisation with three-dimensional (3D) depth perception and articulated robotic instrumentation. While this approach is still in its infancy, a growing body of evidence will help to elucidate how it can best be integrated into the sleep surgeon's armamentarium.

Postoperative management

Patients with OSA undergoing any form of surgery are at higher risk of perioperative complications.[20] In OSA-specific surgery, most operations include a variant of uvulopalatopharyngoplasty. In a large US-based study of over 3000 patients, the incidence of non-fatal serious complications was 1.5%, with a very low fatality rate within 30 days of surgery.[21] Recent guidelines from the American Society of Anesthesiologists recommends postoperative monitoring for most patients undergoing surgery for OSA. The initial postoperative observation should be undertaken in a high dependency unit, given the potential for airway oedema after surgery and the remote possibility of need for re-intubation or creation of definitive airway. Continuous pulse oximetry is recommended, as is the ready availability of positive airway pressure if needed. Postoperative intravenous steroids can also help with nausea, airway oedema, and pain from the inflammatory response. Careful analgesia charting (particularly opioid-based analgesics) requires experience and agreement across disciplines of surgery, anaesthesia, and high dependency units.

Future directions

Current practice parameters published by the American Academy of Sleep Medicine (AASM) recommend CPAP should be considered both first-line and the gold standard treatment for OSA. When used as prescribed, CPAP improves both quality of life and long-term health consequences of OSA. However, a significant proportion of patients are not able to tolerate this treatment. For those patients, alternative treatment pathways need to be available, including other devices and surgery.

An important direction for future research in surgical pathways includes controlled trial comparison of CPAP failure/non-adherent patients having traditional treatment advice (weight loss, sleep positioning, and partial use) versus multilevel airway surgery. There is currently a multicentre randomised controlled trial underway in Australia comparing such traditional 'when CPAP fails' therapy with surgery. It is hoped this will significantly add to the evidence base for surgical treatment of OSA. Similarly, as new and emerging

OSA surgeries have arrived in clinical practice, future controlled studies of these exciting interventions are warranted.

Acknowledgements

With thanks to SueEllen Holmes in preparation of this manuscript.

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