Obstructive sleep apnoea (OSA) syndrome is a potentially serious disorder affecting millions of people around the world. Many of these individuals are undiagnosed while those who are diagnosed, often exhibit poor compliance with nightly use of continuous positive airway pressure (CPAP), a very effective nonsurgical treatment. Various surgical procedures have been proposed to manage and, in some cases, treat OSA. In this article we review methods used to assess the sites of obstruction and a number of surgical procedures designed to address OSA.

Effective surgical management of OSA depends upon developing a complete database and determining different levels of obstruction, which may include nasal, nasopharyngeal, oropharyngeal, and hypopharyngeal/retrolingual, or a combination of these sites. A systematic approach to clinical evaluation, treatment planning and surgical management is recommended and is likely to result in more predictable outcomes. Surgical treatment may involve various procedures that are performed in different stages depending on the patient’s sites of obstruction. The most commonly performed procedures include nasal reconstruction, uvulopalatopharyngoplasty (UPPP), advancement genioplasty, mandibular osteotomy with genioglossus advancement, and hyoid myotomy and suspension. In more severe cases, maxillomandibular advancement (MMA) with advancement genioplasty may be indicated. Even after appropriate surgical treatment, some patients may demonstrate continued obstruction with associated symptoms. Published indications for surgical treatment include an elevated respiratory disturbance index (RDI) with excessive daytime somnolence (EDS), oxygen desaturations below 90 per cent, medical co-morbidities including hypertension and arrhythmias, anatomic abnormalities of the upper airway and failure of medical treatment. The success of surgery in OSA is generally measured by achieving a (RDI) of less than 5, improvement of oxygen nadir to 90 per cent or more with no desaturations below 90 per cent and quality of life improvements with elimination or significant reduction of OSA symptoms. From a practical point of view, achieving these goals may be extremely difficult without patients’ cooperation, most notably in the realm of weight loss and maintenance of a healthy lifestyle.

Key words Hypopharyngeal obstruction - mandibular osteotomy - maxillomandibular advancement - nasal obstruction - obstructive sleep apnoea - uvulopalatopharyngoplasty
Pathophysiology of obstructive sleep apnoea

Three factors that play a significant role in the development of OSA are: (i) a reduction in the dilating forces of the pharyngeal dilators, (ii) the negative inspiratory pressure generated by the diaphragm, and (iii) abnormal upper airway anatomy, the element most effectively addressed by surgery. The multifactorial nature of this condition may explain why surgical procedures in the upper airway often address the sound of snoring but do not necessarily result in the complete elimination of OSA.

The most common sites of obstruction are located in the pharynx. The muscles of the upper airway, including the sternohyoid, genioglossus, and tensor veli palatini, work synergistically to dilate or stiffen the extrathoracic airway and to maintain its caliber (Fig. 1). Airway collapse often occurs when patients sleep on their back and the base of the tongue abuts the posterior pharyngeal wall and soft palate. Elongated or excessive tissue of the soft palate, a bulky tongue, enlarged uvula, large tonsils, and redundant pharyngeal mucosa are the most common causes of snoring and obstructive sleep apnoea (Fig. 2). Along with the narrowing of the airway, an increased inspiratory pressure is needed to maintain adequate ventilation.

<table>
<thead>
<tr>
<th>Table I. Adult upper airway abnormalities in sleep apnoea</th>
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<tr>
<td>Enlarged and elongated uvula</td>
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<td>Hyperplastic or thick soft palate</td>
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<td>Constricted oropharynx</td>
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<td>Macroglossia</td>
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<td>Enlarged tongue base</td>
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<td>Prominent oropharyngeal folds</td>
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<td>Skeletal deformities, Maxillary &amp; Mandibular Retrognathism</td>
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<td>Adenoids</td>
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<td>Deviated septum</td>
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<tr>
<td>Enlarged nasal turbinates</td>
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<tr>
<td>Nasal polyps or any other obstructive masses</td>
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A virtual vacuum on inspiration promotes further collapse of the upper airway, which often has poor tone in patients who snore or have obstructive sleep apnoea due to repeated vibratory trauma (Table I).

The success of airway surgery depends on an accurate diagnosis of the sites of obstruction and the appropriate selection of procedures to address these sites. Rather than applying a standardized approach to the surgical management of OSA, it seems preferable to tailor treatment to the specific needs of each patient. A growing body of evidence supports the effectiveness of multiple site surgery to effectively treat snoring and OSA. Looking at a variety of surgical procedures proposed and performed in past and the results of extended follow up studies, it appears that multilevel treatments are more likely to provide significantly better results than focusing on single site procedures. The goal of treatment for snoring and OSA is to improve quality of life, daytime sleepiness and psychomotor vigilance, and to reduce or eliminate snoring and sleep apnoea. An algorithmic approach to select the sites as well as modalities of surgical intervention should not
only produce more favourable outcomes but may allow patients to avoid procedures that are less likely to be beneficial. The focus of this article is on describing various techniques intended to manage multiple sites of obstruction.

**Nasal obstruction**

The role of nasal obstruction in snoring and OSA. Increased resistance produces turbulent flow in the nasal cavity, induces oral breathing, and promotes oscillation of pharyngeal airway, which can lead to snoring have been identified. Oral breathing alters the functional dynamics of the upper airway, which predisposes it to obstruction. In patients with OSA, high nasal resistance increases negative inspiratory pressure, which may lead to upper airway collapse during sleep. Another consequence of nasal obstruction is increased negative pressure and functional narrowing of the pharyngeal airway, resulting in hypoxia and sleep apnoea. Nasal obstruction is most easily diagnosed by direct physical examination with a nasal speculum, a zero-degree intraoral camera, or by nasal endoscopy. Although it is unlikely that nasal pathology is the sole source of snoring or OSA, these entities should not be overlooked (Fig. 3). The most commonly encountered and relevant anatomic abnormalities are nasal polyps, deviated nasal septum and hypertrophic inferior turbinates (Table I).

The treatment for nasal polyps is surgical removal with cauterization, if needed. The goal of this treatment is to improve turbulent airflow through the nasal passages and to allow more laminar flow of air with a corresponding decrease in snoring and OSA parameters. Hypertrophic turbinates create an obstructive phenomenon that can substantially reduce the flow of air through one or both nares. If the flow of air through one nostril is obstructed, then the airflow on the contralateral side becomes turbulent and may cause excessive snoring. If both nares are obstructed, the patient becomes an obligate mouth breather, which may further alter the functional dynamics of the upper airway and predispose the patient to obstruction at other levels. Treatment at this level may include turbinectomy or nasal radioablation procedures.

**Oropharyngeal obstruction**

Obstruction at the level of the soft palate, pharynx, and tonsillar pillars is a more common finding in patients with snoring and OSA. These sites are the focus of many of the surgical procedures traditionally labelled phase I therapies. The goals of surgery here are to expand and open the oropharyngeal airway and to remove obstructing or redundant tissue leading to a reduction in the resistance to airflow.

Uvulopalatopharyngoplasty (UPPP), initially described by Fujita & colleagues, is used to correct obstruction at the oropharyngeal level by modification of the uvula, removal of redundant pharyngeal and palatal tissue, and primary closure of the posterior and anterior pillars to enlarge the retropalatal airway. Numerous experts have subsequently attempted to modify the initial procedure, with proposed changes aimed at enlarging the pharynx and reducing the redundancy and collapsibility of hypopharyngeal tissues. These modifications include complete removal of the uvula and distal soft palate, removal of part of the palatopharyngeus muscle and the use of an uvulopalatal flap.

Laser also has been used to reduce the vertical height of the uvula or remove the elongated or enlarged tissues in the oropharynx. Kamami, a French surgeon, first described laser-assisted uvulopalatoplasty (LAUP) in the 1980s to reduce the uvula and distal portion of the soft palate without total excision of the muscle uvulus. A laser was used to vaporize the uvula and a specified portion of the palate in a series of small procedures. He suggested that scar contracture would lead to a reduction in the redundancy of the soft palate and to dilatory effect on the pharynx (Fig. 4). Although the procedure may be conducted in a single sitting, LAUP has been described in the past as a staged procedure with incremental treatments avoiding excessive reduction that could result in velopharyngeal

*Fig. 3.* Enlarged nasal turbinates, deviated septum and presence of nasal polyps are few contributing factors to snoring and obstructive sleep apnoea. *Source:* Ref. 4. (Reproduced with permission).
insufficiency (VPI). VPI is a complication that may be associated with LAUP or UPPP particularly if the resection includes the levator veli palatini muscle. While LAUP may reduce or eliminate snoring in many patients, the procedure does not seem very effective as a treatment for OSA. Madani first described a modified version of the procedure using laser to perform traditional UPPP in an office setting, “laser-assisted uvulopalatopharyngoplasty” (LA-UPPP) with a 70 per cent reduction in snoring and up to 50 per cent improvement in OSA symptoms in appropriately selected patients.

The concept of radiofrequency (RF) tissue ablation or volumetric tissue reduction has recently generated considerable interest. Ellis et al. presented preliminary work on stiffening of palatal tissue using Nd-YAG laser in 1993. In 1995, Whinney et al. described an approach for stiffening of the soft palate by creating 10-15 penetration sites on the palatal mucosa using diathermy. Powell and colleagues initiated the use of radiofrequency for the treatment of snoring and sleep apnoea in an animal model. This and other animal and human studies demonstrated that using RF energy could safely reduce tongue and soft palate volume in a controlled manner. Madani studied the effect of radiofrequency for volumetric reduction of enlarged turbinates and obstructive tonsils as well as soft palate and tongue from 1997-2006.

Radiofrequency generates frictional heating of the tissue around an electrode by ionic agitation. The electrode tip is placed into the soft tissues and the heat causes localized ablation of the soft tissue leading to reduction in volume and stiffening of the tissues. These procedures can be repeated several times until clinical success is observed with reduction in snoring sounds or in the degree of obstruction. Re-treated 62 per cent of patients who had relapse after palatal radioablation with LA-UPPP showed that radioablation procedures are only effective if patients are chosen properly and the length of the uvula is short, the tongue is not enlarged and not significantly retropositioned, and the patient has a body mass index (BMI) of less than 25. Relapse after radioablation has been far less of an issue with nasal surgery than with similar procedures done on the tongue and other tissues.

Another method proposed for the reduction of airway collapse at the oropharyngeal level is the placement of palatal implants. Polyethylene terephthalate (PET) implants are approved by the Food and Drug Administration of the United States for reduction of snoring and for the treatment of mild to moderate OSA. These palatal implants measuring 18 x 1.8 mm, are cylindrical and braided. The technique involves transmucosal placement of 3 implants into the central portion of the soft palate with the most proximal portion of the implants near the junction of the hard and soft palate. This serves to stiffen the soft palate tissues and reduce dynamic flutter while the braided material encourages tissue in-growth and stabilizes the implant, usually within 4 to 6 wk. The effectiveness of these minimally invasive procedures also relies on patient selection and lower BMI.

**Tonsillectomy**

Although rare in adulthood, obstructive tonsils, if present, are an important element of upper airway anatomy and may be a major factor in obstructive sleep apnoea. Many studies support the notion that enlarged tonsils play a significant role in oropharyngeal airway obstruction. In severe cases of obstructive tonsillitis, tonsillectomy at any age might prove beneficial and is likely to have a positive impact on upper airway obstruction.

In addition to traditional tonsillectomies, several techniques have been utilized in recent years. Post-operative bleeding and pain can complicate the traditional use of a guillotine with a blade. Bleeding may be significantly decreased with the use of...
electrocautery or an ultrasonic blade, however, post-operative pain is still reported consistently regardless of the technique used\textsuperscript{31-35}.

Krespi and Ling\textsuperscript{36} have described serial tonsillectomy with carbon-dioxide laser in the outpatient setting. Tonsillar tissue is removed, resulting in a faster surgical procedure with decreased blood loss and reportedly, with lower levels of post-operative pain when compared with traditional tonsillectomy. Performed over a few visits, serial tonsillectomy is associated with an increased risk of tonsillar tissue regrowth and the chance for recurrent infection as well as some degree of pain.

Radiofrequency ablation of the tonsils is used to accomplish volume reduction and stiffening and may be accompanied by similar treatment of the tongue base. Energy is delivered with a needle device resulting in soft tissue volume reduction. Usually, a single procedure is adequate in reducing the size of the tonsils; however, an additional procedure may be indicated. Clinical trials suggest decreased pain when reducing, rather than removing, the tonsils\textsuperscript{37,38}. However, some have expressed concern about the potentially increased risk for haemorrhage using this technology\textsuperscript{39-40}.

**Hypopharyngeal obstruction**

Hypopharyngeal obstruction of the retrolingual area is commonly encountered in the snoring and OSA population. Surgical management is directed toward either a reduction in the volume of tongue mass or advancement of the tongue’s anterior attachments. Radiofrequency ablation of the tongue follows the principles described for the soft palate, nose and tonsils. This procedure, as described by Powell and colleagues\textsuperscript{26}, can be performed on an outpatient basis with conscious sedation and local anaesthesia. Numerous modifications of this procedure have been reported. Most of them, however, still involve radiofrequency ablation at various sites located near the circumvallate papillae with treatment taking place over several sessions a few weeks apart. Madani has noted comparable improvements in hypopharyngeal obstruction resulting from moderate weight loss and he reported significant relapse with tongue radioablation, particularly in those patients who have gained weight\textsuperscript{7}.

The advancement genioplasty is a skeletal procedure used to reposition the insertion point of the genioglossus musculature\textsuperscript{41-43} (Fig. 5). The genial tubercles also bear the attachments of the geniohyoid muscles, whereas the anterior bellies of the digastrics attach laterally along the posterior aspect of the mandibular symphysis. The muscle attachments of the digastrics and geniohyoid muscles are also advanced when the bony segment is repositioned. The procedure not only results in a more anterior post-operative position of the tongue, but it also improves the post-operative position of the hyoid bone. Horizontal osteotomies with genial advancement may offer more benefit than anterior positioning of the genial tubercles and their connections using anterior mandibular osteotomies. This more limited genial advancement procedure does not reposition the digastic muscle or the hyoid bone, and delayed muscle detachment associated with these procedures has been reported.

![Fig. 5. The advancement genioplasty: is a skeletal procedure used to reposition the insertion point of the genioglossus musculature. This procedure not only results in a more anterior postoperative position of the tongue but it also improves the postoperative position of the hyoid bone. Source: Ref. 41. (Reproduced with permission).](image-url)
Genioglossus advancement for mild to moderate obstructive sleep apnoea with or without hyoid advancement is a demonstrated technique for relieving airway obstruction by anteriorly repositioning the tongue. Genioglossus advancement with hyoid myotomy/suspension (GAHM) may be indicated when the hypopharynx is a site of obstruction. The procedure is performed through a transoral incision. The chin is exposed and small rectangular cuts (approximately 1 x 2 cm) are made in the bone to capture the area of attachment of the genioglossus muscle. The rectangle of bone is moved forward and turned slightly. A 2.0 mm titanium screw is used to secure the bone fragment to the underlying mandible in an anterior position dictated by the thickness of the segment. This results in advancement of the genial musculature without a change in the skeletal position of the chin and with no impact on the tooth-bearing portion of the jaw26.

This procedure with or without hyoid myotomy appears to be an effective method for enlarging the retrolingual space. The hyoid myotomy operation involves moving the hyoid bone forward, detaching the muscles (sternohyoid, omohyoid, thyrohyoid and stylohyoid) and fixating the hyoid bone to the thyroid cartilage with non-resorbable sutures. The success rate of hyoid advancement is variable, from 17 to 65 per cent44. This procedure may be performed in conjunction with UPPP or maxillomandibular (MMA) advancement for patients with multilevel obstruction. Data regarding success and failure are complicated by the frequent combination of this procedure with others.

Maxillomandibular advancement (MMA)

A number of authors have reported on the success rates of MMA for the treatment of OSA42. While it is viewed as aggressive surgery and traditionally relegated to phase II, MMA has consistently produced results that make it the most predictable surgical method in the management of OSA. Patients who have severe maxillofacial skeletal disharmony, particularly mandibular and maxillary retrusion, and patients who suffer from severe OSA are candidates for MMA. Source: Ref. 41. (Reproduced with permission).

The mean age for MMA in the OSA population is significantly higher than for patients undergoing traditional orthognathic surgery. This can lead to differences between the two groups involving parameters such as vascular supply, bone healing, stability and general health. The American Society for Anesthesiologists Classification (ASA) status of patients who have OSA is also likely to be higher so that surgical as well as anaesthesia-related complication rates may be higher for MMA in OSA patients than for patients without OSA who undergo similar orthognathic procedures45.
Although concerns with velopharyngeal incompetence (VPI) resulting from MMA have not been substantiated in recently published studies, that possibility should be considered and, if indicated, appropriate assessment may be conducted prior to advancement surgery. VPI is most commonly associated with cleft palate and submucous cleft palate, and can occur following adenoidectomy. A diagnosis of VPI can best be determined with multiview videofluorography and flexible nasal endoscopy. These methods accurately assess the velopharyngeal sphincter and can help to plan and direct treatment for VPI. Published results of MMA in the OSA population and data gathered from potentially higher risk patients with cleft palate suggest that VPI is not likely to be a significant issue unless the patient exhibited that tendency preoperatively.

A serious concern is the impact of MMA on the airway in the immediate post-operative period. While the procedure is done to improve airway anatomy, early post-operative oedema in this at risk population has been reported. Mild to moderate lateral pharyngeal oedema and ecchymosis of the pyriform sinus and aryepiglottic fold have been noted in a significant number of MMA patients. Fiberoptic nasopharyngolaryngoscopy is a useful instrument in the early post-operative period to assess this oedema. Peri-operative medical management as well as close post-operative airway monitoring and possible intubation may be necessary if airway compromise is present.

There are limitations to the surgical outcomes obtained with MMA. The magnitude of advancement is generally no greater than 10-12 mm due to soft tissue limitations. The well-known tendency for relapse due to the soft tissues can be better appreciated in the adult MMA patient. In the adult OSA patient, an advancement of usually at least 1 cm is required to achieve treatment objectives. In patients for whom such a movement is likely to be difficult or impossible, there may be a role for combined treatment with distraction osteogenesis.

Studies have consistently shown that MMA is the most definitive, successful and predictable surgical procedure in the management of OSA other than tracheostomy. The reported success rate of these procedures ranges from 75-100 per cent and long-term improvements in apnoea hypopnoea index (AHI) and quality of life are seen in about 90 per cent of those who have had MMA. Even in patients who have significant weight gain, the results of MMA remain stable. The relegation of MMA to “phase II” by many is related to the invasiveness and complexity of the surgery and acknowledged complications such as potentially catastrophic bleeding, infection, sensory changes, malocclusion, and aesthetic changes that may not be desirable in this population.

**Distraction osteogenesis**

Distraction osteogenesis may be a viable alternative to MMA or, more likely, can be used in conjunction with MMA. With distraction osteogenesis, there is a slow and controlled advancement of the tooth-bearing segments of the jaws that allows for regeneration in the distraction site and for growth of the surrounding soft tissue envelope along the vector of distraction. Distraction osteogenesis is classically divided into four phases: surgery, distraction, consolidation, and hardware removal. In toddlers and young children, a lag phase of 24 to 72 h is generally advocated, while in adults, distraction is generally initiated 5-7 days after the osteotomy. Various rates and rhythms of distraction have been proposed, but most authors agree on a rate of 1 to 2 mm per day. Once the desired advancement has been achieved, the consolidation phase begins and continues for about twice the length of time needed for the distraction, often two months or more. The final stage of distraction osteogenesis is the removal of hardware and occlusal splint placement to aid in retention. Distractions of up to 25 mm have been reported and relapse after distraction may be less significant than after conventional MMA, particularly with larger advancements. Lu et al. describe distraction osteogenesis as a reliable surgical method to alleviate the narrow upper airway in growing OSA patients, especially those with severe cranio-maxillomandibular deformities.

**Anaesthesia for OSA surgery**

Given the nature of the OSA population, the risks of anaesthesia must be carefully considered for any of the surgical procedures that may be offered. While there are a few definitive studies to quantify and define the increased risk, the effects of anaesthesia, sedation and analgesia on the integrity of the upper airway and on ventilatory drive are potentially troublesome. The risk of anaesthesia-related peri-operative complications is elevated not only by the OSA, but by its co-morbid conditions. Most notably, hypertension and other cardiovascular diseases are common in the OSA populations and these are likely to contribute to the increased risk. In addition, for patients who have a maxillofacial skeletal dysmorphology that is associated with OSA, mandibular retrognathia, retrogenia and the position of the hyoid bone may also contribute to
airway difficulties during attempted intubation as well as during open airway sedation. OSA patients who have unrelated surgery such as orthopaedic procedures have been shown to have double the anaesthesia risk compared to those without OSA who undergo the same operations. For OSA patients undergoing general anaesthesia for upper airway surgery and MMA, concerns have been expressed about extubation, particularly when postsurgical oedema or haematoma complicates an already difficult situation. Respiratory depression and periods of apnoea have been reported in this patient population immediately following extubation. This problem may be exacerbated by the use of opioids for post-surgical pain management.

There is little evidence to support a particular approach to anaesthesia for patients at risk for OSA or with known OSA. Nonetheless, the following is derived from common sense along with available data. Most importantly, screening for OSA should be part of the routine pre-anaesthetic work up with surgeons and anaesthesiologists asking appropriate questions during history taking. These should include inquiries about snoring, daytime somnolence and sleep disturbed breathing witnessed by a bed partner. For patients who have had prior exposures to anaesthesia, a history of difficulty with intubation is associated with OSA and certainly alerts the anaesthesia team to the likelihood that the airway may again be problematic and intubation might prove challenging. Elements of the physical examination of particular significance include neck circumference, BMI, chin-throat length, Mallampati classification and the position of the mandible relative to other facial structures. Findings suggestive of undiagnosed OSA should prompt additional evaluation prior to elective surgery while individuals with diagnosed OSA presenting for elective surgery of any type should be medically optimized. Patients perceived to be at risk should be encouraged to select regional anaesthesia when applicable and reasonable. Premedication with sedatives or opioids is undesirable and is best avoided. During induction, snifing position has been shown to improve airway dimensions and reduce its collapsibility. Published algorithms and recommendations for difficult airways should be followed and challenging endotracheal intubation should be anticipated. Post-anaesthesia, those who use CPAP at home must have it available for use during recovery. For patients who are not CPAP users but may be at risk in the post-anaesthesia care unit, lateral positioning may be appropriate when possible. If tolerated, a nasopharyngeal airway may also contribute to the effective delivery of oxygen beyond the compromised upper airway.

For procedures that can be accomplished on an outpatient basis using local anaesthesia and sedation, an unprotected and potentially problematic airway remains a serious concern. Nonetheless, titrated sedation is a reasonable choice for appropriately selected, well-positioned patients who require short procedures. The usual parameters must be monitored carefully and the clinician must be prepared to manage complications that may arise. Rapid desaturations are not uncommon in obese patients due to a smaller functional residual capacity. Outcomes may be enhanced by careful patient selection as well as by the use of agents and techniques least likely to exacerbate the underlying condition.

| Table II. Causes of obstructive sleep apnoea in younger age |
|-----------------|-----------------|-----------------|
| **Structure**   | **Neonates & infants** | **Toddlers - Teens** |
| Nasal           | Aplasia, Stenosis, Atresia, Masses | Enlarged turbinates, Deviated septum, Polyps, Stenosis, Masses, Rhinitis & post nasal drip |
| Tonsils         | Macroglosia, Vascular malformations of the tongue and pharynx, Congenital cysts of the vallecula of tongue. | Obstructive tonsils, Recurrent infection |
| Tongue          | Macroglosia, Vascular malformations of the tongue and pharynx | Macroglosia, Vascular malformations of the tongue and pharynx |
| Skeleton (Craniofacial anomalies) | Facial or skull abnormalities, Birth injuries | Skeletal deformities, Maxillary &/or mandibular retrognathism or hypoplasia, Receded chin |
| Muscular        | Neuromuscular Disorders | Neuromuscular disorders |
| Other Factors   | GERD, Hypoglycaemia, poor sleep posture, Down syndrome, Apert, and Crouzon syndromes, Pierre-Robin syndrome leading to a narrow airway, poor sleep posture | Obesity, Soft palate collapse, elongated uvula, Down syndrome, Apert, and Crouzon syndromes, Pierre-Robin syndrome leading to a narrow airway, poor sleep posture |

Neonates and infants rarely have significant lymphoid hyperplasia, on the other hand with increasing age and development, the likely causes of disordered breathing changes. In toddlers and teenagers may demonstrate other issues as listed above. GERD, gastroesophageal reflux disease
It is clear that those who relegate surgical procedures to third line treatment for OSA after CPAP and oral appliances do so in part because of elevated anaesthesia risks in patients with OSA. Clinicians who are involved in the surgical management of snoring and OSA should understand the anaesthesia-related risks and weigh those along with potential surgical complications when assessing the risks and benefits of surgery for patients with OSA.

Children

In the pediatric population, airway anatomy is different than in adults, as are the most likely causes of sleep-disordered breathing. Surgical procedures such as those described for adults, are generally deferred in children, central causes of sleep apnoea must be ruled out and careful evaluation of the tonsils and adenoids must take place. In younger children, the distance between the tonsils, adenoids and the pharyngeal soft tissue may be short. This can result in stertor, stridor, or both, making the source of the breathing disorder difficult to localize. In children with at least mild adenotonsillar hyperplasia, adenotonsillectomy is considered to be the first-line surgical treatment. For patients with craniofacial anomalies impacting on airway anatomy such as the Robin anomaly, surgical procedures including tongue reduction, labioglossopexy, distraction osteogenesis and even tracheostomy are utilized for airway management. Children who suffer from apnoea show continued sleepiness after awakening in the morning and tiredness and attention problems at school and throughout the day. Some children who are diagnosed with attention deficit hyperactivity disorder (ADHD) may actually have attention problems in school because of disrupted sleep patterns caused by obstructive sleep apnoea (Table II).

References


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