Brief Overview about Obstructive Sleep Apnea Management

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Abstract

The obstructive sleep apnea (OSA) results from interaction between the unfavorable anatomic upper airway susceptibility and the sleep-related changes in upper airway function. The wakeful state provides compensatory neuronal activation of dilator muscles of the hypopharynx. At sleep onset, this activation will be lost. Thus, in an anatomically compromised collapsible pharynx, the airway narrows and/or collapses resulting in a degree of OSA.The simplest treatment for OSA in obese patients. Even a 10 % weight loss may eliminate apneic episodes by reducing the mass of the posterior airway. Unfortunately, a small fraction of people can permanently lose weight.The nasal continuous positive airway pressure (n-CPAP) can be used, even at home. The patient wears a quietly fitted nasal mask attached to a fan that blows air into the nostrils to keep the collapsed pharyngeal tissue open and improve airflow during sleep. Effective delivery pressures are usually titrated in the sleep laboratory.Surgical treatment of hypo-pharyngeal area are designed to prevent tongue collapse into the airway during sleep. Although obstruction at the base of the tongue level is surgically challenging, multiple techniques have been used. They include tongue reduction procedures, such as midline glossectomy, lingualplasty, lingual tonsillectomy, and radiofrequency reduction, or tongue advancement/stabilization procedures, such as GA, HS, and tongue suspension.

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Introduction

The obstructive sleep apnea (OSA) results from interaction between the unfavorable anatomic upper airway susceptibility and the sleep-related changes in upper airway function. The wakeful state provides compensatory neuronal activation of dilator muscles of the hypopharynx. At sleep onset, this activation will be lost. Thus, in an anatomically compromised collapsible pharynx, the airway narrows and/or collapses resulting in a degree of OSA **(1).**

The prevalence of OSA is two to three times greater in males (4%) than females (2%). Moreover, the reported prevalence rates vary widely, and asymptomatic sleep apnea is more common than symptomatic, clinically significant obstructive sleep apnea**(2).**

The pathophysiological causes of OSA likely include upper airway anatomy, the ability of the upper airway dilator muscles to respond to respiratory challenge during sleep, the propensity to wake from increased respiratory drive during sleep, the stability of the respiratory control system, and the potential for state-related changes in lung volume to influence these factors **(2).**

OSA could be classified into: Type I disease involves narrowing or collapse of the retropalatal region. Type II disease involves collapse in the retrolingual area (tongue base). Type III disease involves narrowing or collapse of both the retropalatal and retrolingual areas. Major OSA: a multi-level disorder, with tissues of the soft palate, lateral pharyngeal walls, and tongue base all contributing to airway narrowing. Intra-nasal tissue, adenoids, and tonsils may also play a role. Differentiation between non-traumatic sleep related breathing disorders and those followed maxillofacial trauma and\or its treatment is very essential because management of each of them is widely different **(**3**)**.

Qaseem et al. (4**)** classified measures that can be used for treatment of OSA in adults into:

A) Non-surgical Approaches:

The following measures could be used in combination with surgical treatment, or as an alternative therapy **(**5**)**.

1- General treatment measures: They include:

a- Myofunctional therapy: It represents a set of exercises for the lip, tongue, soft palate and lateral pharyngeal wall, aimed at training the upper airway dilator muscles to maintain the patency of the upper airway during sleep. **Camacho et al. (5)** demonstrated a statistically signifcant reduction of AHI; associated with improvement of lowest oxygen saturation, snoring and sleepiness scale.

b-Appropriate weight management: The simplest treatment for OSA in obese patients. Even a 10 % weight loss may eliminate apneic episodes by reducing the mass of the posterior airway. Unfortunately, a small fraction of people can permanently lose weight **(**6**)**.

c- Major changes in lifestyle and behavior modification: This means improving sleep hygiene, avoiding additional sleep deprivation, and avoidance of supine positioning during sleep **(**6**)**.

d- Avoidance of ethanol and sedative medications(2).

2-Positive pressure support: The nasal continuous positive airway pressure (n-CPAP) can be used, even at home. The patient wears a quietly fitted nasal mask attached to a fan that blows air into the nostrils to keep the collapsed pharyngeal tissue open and improve airflow during sleep. Effective delivery pressures are usually titrated in the sleep laboratory. It can improve most symptoms of OSA and reduce cardiovascular mortality. However, it is often limited by poor patient compliance, and other possible adverse effects like those related to pressure, airflow, and the mask-face interface. Therefore, dry mouth, barotrauma, pneumo-thoraces, and aerophagia, air leaks and pressure sores at the mask interface, may be observed **(7)**.

3-The customized oral (dental) appliances designed to increase airway size and to facilitate airflow by advancing the mandible or tongue or lifting the soft palate. They may offer a valid treatment option in non-obese patients with micrognathia or retrognathia who have mild or mild-to-moderate apnea **(8)**.

B)SurgicalAlternatives:

Morganet al. (9) stressed that depending on the surgical goals, consideration may be given to performing minimally invasive surgery or staged surgery to: a- Facilitate CPAP usage, b- Be as a primary treatment after CPAP failure, c-Reduce the soft tissue volume, e- Modify tension around the upper airway, or

d- Enhance dynamic airway with hypoglossal nerve pacing to tone up tongue muscle.

The following points have to be taken into account:

a- Patients' aim for surgery: Snoring reduction, AHI severity reduction, bedpartners' sleep, and\or daytime functioning.

b- Reducing long-term morbidity and mortality associated with OSA, even in the absence of a complete cure.

c-The presence of severe cardiorespiratory, neuromuscular, or cerebrovascular diseases and related drug treatment, or symptoms of other sleep disorders **(10)**.

General indications for surgery: include moderate-severe OSA, severe excessive daytime sleepiness (even when the AHI is < 20), OSA with comorbid conditions (e.g., arrhythmias, hypertension), OSA with anatomic airway abnormalities, and failure of medical OSA management **(11)**.

Relative contraindications to surgery: include morbid obesity (except for bariatric surgery and tracheostomy), severe or unstable cardiopulmonary disease, active alcohol/illicit drug abuse, older age, unstable psychological problems, or unrealistic expectations from surgical therapy **(12)**.

Surgical success:

Although no surgical treatment is 100% effective, **Sher (13)** reported that the outcome of sleep surgery is successful if the postoperative AHI was < 10. On the other hand, patients with AHI from 10 to 20 were recorded as responders, while patients with a postoperative AHI >20 (or an unchanged/increased AHI) were nominated as non-responders.

Later on, successful surgery was defined as a reduction in AHI <20 with > 50% reduction from the patient's baseline. In successful cases, there are significant improvements in AHI, apnea index, % of rapid eye movement sleep, lowest saturation of oxygen (%), and Epworth Sleepiness Scale**(14)**.

The surgical plan:

Apart from anatomical considerations, attention should be paid to other factors such as the age of the patient, severity of OSA and patient's preferences. In addition, it is important to avoid the restricted thinking of hypopharyngeal surgery as a singular event **(15)**.

Generally, volumetric reduction surgery is more suited for correction of soft tissue excess or hypertrophy, such as in bulky tongue base or lymphoid tissue hypertrophy. Conversely, tension enhancement surgery aims to reduce overall tissue laxity such as those of lateral pharyngeal wall (constrictor muscles), those with floppy epiglottis and/or a collapsing tongue base not attributable to excess volume **(9)**.

The recommended **surgical approaches** for treatment of OSA include:

1-Procedures designed to increase upper airway size:

Weaver and **Kapur (7)** recognized the following procedures:

- Tonsillectomy
- Adenoidectomy
- Septoplasty
- Turbinate reduction
- Nasal valve repair
- Uvulopalatopharyngoplasty (UPPP)
- Transpalatal advancement pharyngoplasty
- **Hyoid advancement/suspension (HS)**
- Genioglossus advancement (GA) /suspension
- Tongue suspension (TS)
- Maxillomandibular advancement (MMA)

- Midline glossectomy/lingualplasty
- **Tongue radiofrequency** (TR)
- Lingual tonsillectomy
- Epiglottoplasty
- Cranial nerve (hypoglossal nerve) stimulation

2- Procedures designed to bypass the upper airway:

Tracheostomy remains the standard for the surgical relief of upper airway obstruction. It may be considered as a temporary or permanent option in patients with severe oxygen desaturation in whom CPAP therapy is refused, poorly tolerated, or unsuccessful. Also, it is highly beneficial in those patients in whom underlying cardiac, pulmonary, or neuromuscular disease is exacerbated by the severity of the OSA. However, it is reserved for the most severe cases because of the very significant psychosocial implications and potential complications **(16)**.

3-Procedures that ensure weight loss (bariatric surgery): should be done for patients with morbid obesity who are refractory to diet and drug therapy **(17)**.

Single- or multi-level palatal surgery:

Sher et al. (13) demonstrated that failure of single-level palatal surgery in the treatment of OSA was largely attributed to the presence of a concomitant hypopharyngeal obstruction. They added that decision for treatment of a hypopharyngeal obstruction in OSA is difficult due to the complex interaction of the tongue, lateral pharyngeal wall, aryepiglottic folds, and the epiglottic collapse. **Riley et al. (18)** reported thatinthe staged multilevel protocol surgical success rate reached 95% compared with the single-site therapy.

In contrary, **Kezirian** and **Goldberg** published in **(19)** a meta-analysis of hypopharyngeal surgery. They concluded that multimodality surgery does not always guarantee increased efficacy. Also, combination procedures such as GA with HS or tongue radiofrequency treatment with tongue stabilization have lower surgical success rates and poorer AHI improvement compared with the same procedures performed alone. Moreover, a meta-analysis of MMA found that patients with previous UPPP before MMA were less likely to obtain surgical cure (25% vs 45%) compared with those without previous surgery following MMA **(12)**.

However, the goal of determining which patients will respond most favorably to certain treatment options ahead of time (i.e., CPAP vs. oral appliances vs. surgery) and the development of alternative treatments remains largely elusive. Thus, measures to stabilize ventilation (e.g., oxygen) may be particularly effective in those with unstable ventilatory control or high loop gain. Similarly, those with a low arousal threshold may benefit from sedatives, whereas some sedatives may have a deleterious effect on patients with a high arousal threshold **(20)**.

Surgical Procedures for Hypopharyngeal Obstruction

Surgical treatment of hypo-pharyngeal area are**designed to** prevent tongue collapse into the airway during sleep. Although obstruction at the base of the tongue level is surgically challenging, multiple techniques have been used. They **include**tongue reduction procedures, such as midline glossectomy, lingualplasty, lingual tonsillectomy, and radiofrequency reduction, **or** tongue advancement/stabilization procedures, such as GA, HS, and tongue suspension **(7)**.

Trans-oral robotic surgery (TORS) has gained a central role as a tongue reduction surgical procedure. Despite its high costs, robotic technology might give slightly better results, allowing a wider surgical view and more consistent removal of lingual tissue **(21)**

Radiofrequency reduction (coblation) of Tongue Base

Radiofrequency (RF) is a high frequency temperature, controlled, alternating current used to ablate tissue **(22).**

Coblation radiofrequency (CRF) is a bipolar radiofrequency applied through an ionic fluid such as saline, creating a plasma field which is able to break down intercellular bonds in the tissue, causing minimal damage to the surrounding healthy tissue because of the low temperature. It allows extraction of significant amounts of tissue without necrosis or scar contraction at the tongue base. Coblation radiofrequency of the tongue base (CRFTB) had been used as a method of therapy for patients who have sleep apnea with a high therapeutic success rate. CRFTB decreases upper airway collapse by producing a volumetric reduction in tongue-base tissue. Its energy is introduced into several areas of the tongue base. The procedure is often performed in an outpatient setting under local anesthesia (**18)**. Published studies showed wide variances which may be due to technical differences, including the number of treatment sessions and/or patient selection criteria **(23)**.

The advantages of CRFTB over electrocautery and laser energy surgery reside in its precision and safety. With RF, the targeted tissue temperatures stay within 60 to 90 °C, thus limiting heat dissipation and damage to adjacent tissue. Electrocautery and laser temperatures are significantly greater (750–900 °C) and in excess of the desired therapeutic need. Statistically significant improvements in subjective daytime sleepiness and health-related quality of life were observed in most studies. Moreover, neither speech nor swallowing is affected by any of these ablations **(24)**.

However, it has some disadvantages, such as the risk of damaging the lingual neurovascular bundle, infections, pain that cannot be controlled by pain medication, tissue edema with temporary dysphagia and odynophagia, as well as unexpected results that may require speech therapy afterwards. (**24).**

To decrease the extent of edema, CRFTB was designed to be performed with sequential application of the RF energy with a healing period of 4–6 weeks between treatmentsessions. The increased risk of airway edema must be anticipated and properly managed **(19)**.

Hyoid Suspension

The hyoid complex helps to maintain and improve the upper airway space behind the tongue through its forward movement. In the mid-1980s, **Riley et al.(18)** developed a hyoid suspension (HS) procedure to improve the posterior (retrolinguinal) airspace. They added that, generally, HS might be used within a multimodality approach in the form of single or staged procedure.

HS can be performed via suspension to the mandibular periosteum (hyo-mandibular suspension) or toward thyroid cartilage (thyro-hyoidopexy; THP). Theoretically, this creates an anterior vector and movement of the hyoid bone, leading to the tension of the laryngeal pharyngeal wall **(25)**.

den Herder et al. (26) reported that HS should be considered in particular asprimary treatment in cases of obstruction at the tonguebase level. They added that in patients with UPPP failure orpatients who refuse nCPAP or have difficulties usingit, THP should be considered. Selection criteria aremoderate to severe OSA, with, preferably, a BMI lessthan 27, major obstruction at the base of the tongue, smalltonsils, and normal uvula, without a floppy epiglottis or a palatal stenosis after UPPP.

Toh et al. (27) reported, after a case series of hyoid expansion in cadaveric study, that hyoid expansion increased the airway dimension. Furthermore, many studies preferred the isolated HMS surgeries as they are less invasive than the more widely used GA with hyoid myotomy. In addition, they had reduced OSA severity and improved sleepiness in adults. The results revealed that hyothyroidopexy provided a 50.7% reduction in AHI, followed by hyoid myotomy with suspension (38.3% reduction in AHI) and hyoid expansion (7.1% reduction in AHI) **(28)**.

Thyrohyoid suspension (THS) was designed for patients with moderate to severe OSA without enlarged palatine tonsils or for patients with a short (< 40 mm) hyomental distance. This procedure involves passing a loop suture around the hyoid bone, then advancing it with several sutures anteriorly and inferiorly over the thyroid lamina. This procedure draws the base of the tongue forward, making it less likely to fall back against the posterior pharyngeal wall during sleep **(29)**.

Tantawy et al. (30) reported that THP using absorbable suture seems to produce a good outcome in treating OSA. Moreover, it could be an effective and safe technique to be combined with other palatal procedures in the multilevel surgery for OSA. It waspublished a modified THP technique. He concluded that THPis superior over the midline glossectomy, as a safer and more effective procedure for treatment of OSA.

Recently,**Shaikhet al. (31)** reported that the magnitude of improvement in polysomnographic parameters after THP appears to be more significant in patients with lower BMI. Even patients with an obese BMI and severe OSA achieve significant improvement from this procedure.

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