Review Article

Treatment of Obstructive sleep apnea- A Review

Fahad Ahmad[1], Anish Chopra[2]

From, [1]Registrar Surgeon, Department of Oral and Maxillofacial Surgery, Al-Jahra Specialty Dental Center and Hospital, MOH, Kuwait, [2]DM Fellow, Department of Pulmonary Medicine, ESI PGIMSR, New Delhi.

Correspondence to: Dr. Fahad Ahmad, Department of Oral and Maxillofacial Surgery, Al-Jahra Specialty Dental Center and Hospital, MOH, Kuwait. Email: drfahadahmad@gmail.com

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ABSTRACT

Obstructive sleep apnea (OSA) is a serious disease with neurocognitive and cardiovascular sequelae. Various population-based studies show that 2% of women and 4% of men are affected with symptomatic OSA; however, the prevalence of asymptomatic OSA is quite high which affect 20%–30% of the middle-aged population. It can be diagnosed on the basis of characteristic history (snoring, daytime sleepiness) and physical examination (increased neck circumference); nevertheless, overnight polysomnography is the gold standard to confirm the presence of the disorder. Many treatment modalities have been evolved to address the disease which include lifestyle modification; medical therapy; CPAP; oral appliances; and surgical correction. Although the initial choice of treatment is CPAP in most of the patients, it can be tailored according to Apnea-hypopnea index (AHI) and the need of the individual patient. In addition, surgical interventions are the preferred option in certain cases which not only provide a quick cure of OSA but also correct many facial anomalies.

Keywords:- *Obstructive sleep apnea; CPAP; Klearway Appliance; Uvulopalatopharyngoplasty; Maxillomandibular advancement*

Obstructive sleep apnea (OSA) is a disease of increasing importance due to its alarming cardiac and neurocognitive consequences, characterized by complete cessation or occurrence of shallow or infrequent breathing during sleep for seconds to minutes [1-6]. According to various studies, the prevalence of OSA among middle-aged men ranges from 1–4%; however; in the same age range women, its occurrence is only1.2–2.5% [7-11]. Usually, the airway patency is preserved by activation of the pharyngeal dilator muscle (e.g. genioglossus) and by an increase in lung volume, which tend to keep the airway open by longitudinal traction [12-16]. However, variables tend to promote pharyngeal collapse include negative pressure within the airway (e.g. during inspiration) and positive pressure outside the airway (e.g. fat deposition around the neck, small mandible). As a result, dilating forces (muscle activation) have a complex interaction with collapsing forces (anatomy, airway negative pressure) [17-21]. Thus, apneas are more likely to occur when obesity, retrognathia or a supine posture is present [22]. The site at which the obstruction occurs may vary, usually; the posterior aspect of the tongue comes to rest on the posterior pharyngeal wall [22-23].

OSA has many consequences like impairment in quality of life, cognitive functioning, and most commonly excessive daytime somnolence (EDS) which predispose the patient to traffic or occupational accidents. In addition, untreated OSA patient is under risk of developing systemic hypertension, polycythemia, cardiovascular events, and cerebrovascular accidents [22-23]. Diagnostic evaluation of OSA includes a complete history and physical examination, fiberoptic endoscopy, radiologic evaluation, and polysomnography; however, the latter one is considered a gold standard diagnostic test for it [24]. (In our previous article; Obstructive Sleep Apnea: Prevalence

and Diagnosis- A Review, prevalence, and diagnosis of OSA have been discussed in detail) [22]. Various medical and surgical treatment modalities have been evolved to treat the OSA for the last few decades; however; every treatment has its own advantages and limitations. This review provides an overview of available options for treatment of this serious disorder.

CONSERVATIVE/MEDICAL TREATMENT

The treatment of obese patients with moderate OSA must initially start with some of the lifestyle changes. Some of these modifications include exercise, weight loss, [25-27] decreased alcohol consumption, smoking cessation, altered sleeping position, and nasal continuous positive airway pressure [28-29]. There are certain medications which should be avoided as those drugs may worsen OSA such as alcohol which reduces the tone of the genioglossus and increases collapsibility of upper airway [30]. Then, there is opioids which decrease the rate and depth of respiration, induce chest and abdominal wall rigidity, reduce upper airway patency and blunt respiratory response to carbon dioxide and hypoxia. Also, other central nervous system depressants like benzodiazepines cause reduced upper airway muscle tone and decrease ventilatory response to hypoxia, thus potentially increasing the AHI and prolonging apnea events. Recently, a Cochrane review found no worsening of OSA with most of the hypnotic and sedative drugs; however; decreases in minimum overnight SpO2 was observed. Testosterone replacement therapy (increases Apnea Hypopnea Index and prolonged hypoxemia time) has also been suggested to worsen OSA.

The medication which causes weight gain should also be avoided like atypical antipsychotics, antidepressants, anticonvulsants, etc [31]. In addition, there are several endocrine conditions that may present as OSA or may contribute to OSA. Thus, all initial evaluations of patients should include consideration of whether the patient has clinical signs and symptoms of hypothyroidism, acromegaly or Cushing's syndrome. Among these conditions, hypothyroidism is the most common (2% of adults), and its presentation may overlap with OSA symptoms: fatigue, weight gain, myalgias, memory loss, decreased libido, and depressed mood. Symptoms of OSA may improve by the treatment of the underlying endocrine disorder. The tricyclic antidepressant Protriptyline is the most effective drug studied in the treatment of OSA. Protriptyline produces its beneficial effect by stimulation of upper airway muscle tone and by decreasing the percentage of time spent in REM sleep, thereby reducing the more severe REM-related apneas.

Another remarkable drug is Modafinil, [32,33] a non-amphetamine CNS stimulant, which is used to reduce the daytime somnolence and increase alertness, but it is essential to understand that Modafinil cannot be used as a substitute for CPAP or an oral appliance. Additionally, Acetazolamide, a carbonic anhydrase inhibitor stimulates respiration by producing metabolic acidosis, thus, reduce the number of apneas and decrease the severity of oxygen desaturations in patients with OSA. Some patients with OSA benefit from the respiratory stimulant effect of progesterone, especially those with the obesity-hypoventilation syndrome. Recently some studies have found that Bariatric surgeries lead to resolution/improvement of the patient's OSA, as measured by AHI.

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP)

Currently, CPAP is the most successful non-surgical treatment of OSA. The nasal CPAP is administered by means of a tight-fitting mask (Figure 1) while the patient is asleep.

Figure 1: CPAP Machine & Mask

A CPAP of 7 to 15 cm of water acts as a pneumatic splint of the upper airway and prevents the passive collapse of soft tissues during respiration while sleeping. Stimulation of mechanoreceptors of the genioglossus muscle leading to increased airway tone has also been suggested as a mechanism of action. By this means, it provides

unobstructed breathing, (Figure 2 & 3). Before CPAP intermittent episodes of absent air flow that improve markedly on application of CPAP in flow tracings. Thereby reducing apneas and hypopneas; therefore, it has been proved to be effective in reducing day time sleepiness levels in OSA patients [34-36]. Sullivan et al firstly reported the successful treatment of sleep apnea with nasal CPAP in 1981.

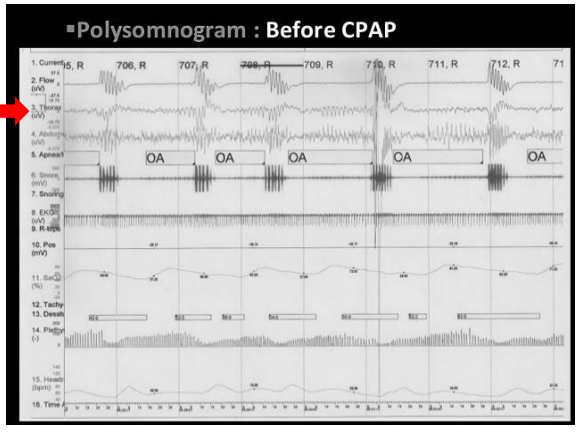


Figure 2: Polysomnography before CPAP

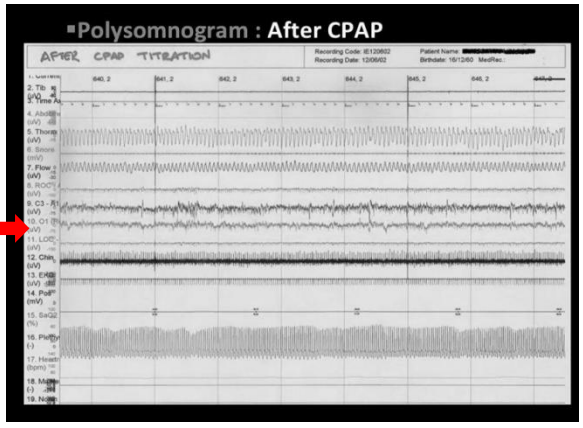


Figure 3: Polysomnography after CPAP

Recently, bi-level positive airway pressure (Bi-PAP) systems that allow independent regulation of inspiratory and expiratory pressures and the newest modification in CPAP systems, Auto-CPAP, have been used to more effectively treat obstructive sleep apnea and increase tolerance and compliance. Noticeably, Auto-CPAP units adjust the CPAP throughout the night rather than delivering one fixed pressure. In addition, the newer models provide masks of adjustable size for patient comfort. Although CPAP therapy has been proved very successful, patient's compliance is low. According to one study compliance rates at 12 months have been reported as low as 54%. On the other hand, disadvantages of CPAP are nasal dryness, congestion, sore throat, dryness of the skin, eyes, and noise [37-40].

Recently, Stephen A. Marsh has invented a micro CPAP device and claimed it as a world's first mask-less, hoseless, cordless micro-CPAP device; named Airing. Although he claims that this device having a revolutionary design that will work like any other CPAP machine and patients will not have to deal with cumbersome, uncomfortable masks, it needs FDA approval and clinical studies first, to be marketed in the future [41].

ORAL APPLIANCES

The use of a variety of prosthetic devices is another approach to treatment. The American Sleep Disorders Association recommends that oral appliances may be used in patients with primary snoring, mild obstructive sleep apnea, or in patients with moderate to severe obstructive sleep apnea who refuse or are intolerant of nasal continuous positive airway pressure. These devices help to maintain an unobstructed airway by repositioning of the lower jaw and stabilization of the tongue [41-44]. There are various oral appliances available in the market such as tongue-retaining device, Klearway appliance (Figure 4), Herbst appliance, Elastic Mandibular Advancement, Elastomeric Sleep Appliance, Equalizer Airway Device etc. [45,46].

Figure 4: Klearway appliance

Side effects of oral appliance therapy are excessive salivation, xerostomia, soft tissue irritations, transient discomfort of the teeth and temporomandibular joint

(TMJ), minor occlusal changes, and stiffness or pain of masticatory muscles; however, literature shows few cases with loosening of teeth during long term appliance therapy [47-49].

SURGICAL TREATMENT

Numerous studies show that over half the patients will not follow the conservative treatment for an extended period or patients do not obtain sufficient relief from their snoring with conservative methods and look for surgical modalities to correct their problem. Currently, the procedures used in the surgical treatment of obstructive sleep apnea include tracheostomy, nasal surgery, Uvulopalatopharyngoplasty, and several orthognathic surgical procedures. Tracheostomy was the first efficacious surgical procedure for treating obstructive sleep apnea, firstly done successfully by Kuhlo et al in 1969. It is almost 100% curative in relieving the signs and symptoms of obstructive sleep apnea. But lifelong tracheostomy causes social and other medical problems so having least acceptance and should be used as the last option [50]. However, surgery is considered a quick cure of OSA, it has its own indications and limitations as well.

SURGICAL INDICATIONS

- Apnea-hypopnea index (AHI) ≥ 20 events/hr of sleep
- Oxygen desaturation <90%
- Esophageal pressure (P_{es}) more negative than -10 cm of H_2O
- Cardiovascular derangements (arrhythmia, hypertension)
- Neurobehavioral symptoms [excessive daytime somnolence (EDS)]
- Failure of medical management
- Anatomical sites of obstruction (nose, palate, tongue base)

(Surgery may be indicated with an AHI<20 if accompanied by excessive daytime fatigue). In 1993, a surgical protocol for dynamic upper airway reconstruction in the treatment of obstructive sleep apnea syndrome was presented by Riley and Powell [51]. On the basis of their study on 239 cases, they presented two-phase protocol. Phase I, which included a conservative approach and involved Uvulopalatopharyngoplasty and/or mandibular osteotomy with genioglossus advancement-hyoid myotomy and suspension. Polysomnography was repeated at 6 months, and patients with unsuccessful surgical results were offered phase two treatment which included maxillary-mandibular advancement.

POWELL–RILEY OR STANFORD PROTOCOL SURGICAL PROCEDURES

Phase I

- Nasal surgery (Septoplasty, turbinate reduction, nasal valve grafting)
- Tonsillectomy
- Uvulopalatopharyngoplasty (UPPP) or Uvulopalatal flap (UPF)
- Mandibular osteotomy with genioglossus advancement
- Hyoid myotomy and suspension
- Temperature-controlled radiofrequency (TCRF)—turbinates, palate, tongue base

Phase II

- Maxillomandibular advancement osteotomy (MMO)
- Temperature-controlled radiofrequency (TCRF)—tongue base

NASAL SURGERIES

A patent nasal airway is essential for normal respiration and sleep. Any obstruction can increase airway resistance and result in mouth breathing. Opening of the mouth rotates the mandible posteriorly, which in turn allows the tongue to prolapse into the posterior airway space (PAS) and narrow the hypopharyngeal airway. Nasal obstruction can occur due to septal deviations, incompetent nasal valves, or enlarged turbinates. Various techniques (Septoplasty, alar grafting, and turbinate reduction) exist to treat nasal obstruction [52].

THE PILLAR PROCEDURE (SOFT PALATE IMPLANTS)

The Pillar procedure is a minimally invasive approach that can relieve habitual snoring and mild to moderate cases of sleep apnea as well. It involves the placement of three to five polyester rods into the soft palate. Each implant

measures 18 mm in length and 1.5 mm in diameter. The rods initiate an inflammatory response of the surrounding soft tissues that results in stiffening of the soft palate. Subsequently, the stiffer soft palate is less likely to make contact with the back wall of the pharynx during deep stages of sleep as the muscles relax, thereby reducing snoring and apnea. Additionally, this procedure can be done under local anesthesia in the clinic [53] (Figure 5)

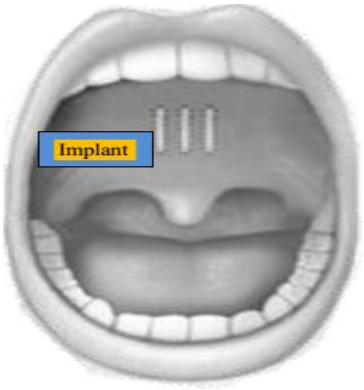


Figure 5: Placement of implant in the Soft Palate

UVULOPALATOPHARYNGOPLASTY

Uvulopalatopharyngoplasty (UPPP) is a surgical procedure which is used to remove excess tissue in the upper airway to widen the posterior airway space. This surgical intervention is mainly focused on the shortening of the uvula, removal of a portion of soft palate tonsils, adenoid and part of pharynx [54-56] (Figure 6).

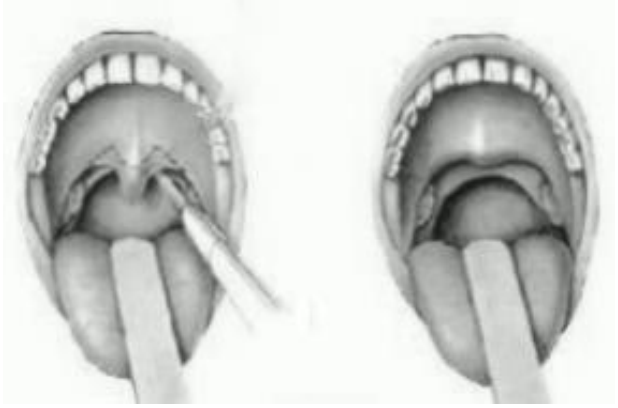


Figure 6: Before and after UPPP

Type of UPPP: Traditional UPPP; Laser-Assisted UPPP; Temperature-controlled radiofrequency (TCRF) UPPP. A long term side effect of UPPP is change in the pattern of voice and worsening of GERD.

TONGUE PROCEDURE

As the tongue base is one of the most common sites of obstruction in OSA, reduction of tongue mass, especially it's base resection; has been proved an effective method to control the disorder. Djuperlandet al [56] (1992) and Midjejeig (1992) described an operation termed uvulopalatopharyngoglossoplasty (UPPGP) which included modified Uvulopalatopharyngoplasty (UPPP) with limited resection of the tongue base. In another study, Fugita et al. [57] performed midline glossectomy (Figure7) in 12 patients to create an enlarged hypo-pharyngeal airspace using the carbon dioxide laser, and they found promising results.

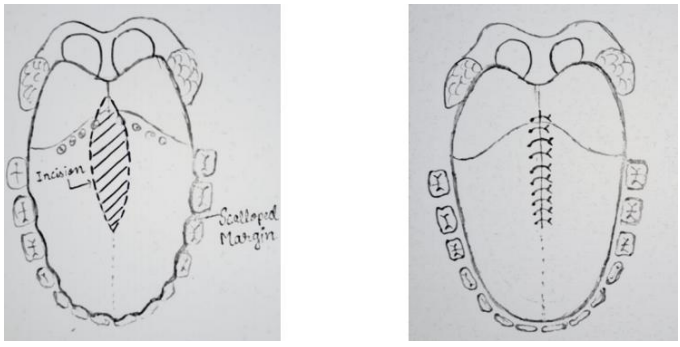


Figure 7: Midline Glossectomy

While Chabolle et al. (1999) combined tongue base reduction with hyoepiglossoplasty in a small study of 10 patients and reported considerable improvement. The intra-operative complications; however, that may occur in such procedures are those of any surgical intervention in the oral and pharyngeal cavity; namely that of hemorrhage and airway obstruction. Moreover; tongue numbness, transient changes in taste, dysphagia, and infection may also occur postoperatively [58-59].

MANDIBULAR OSTEOTOMY WITH GENIOGLOSSUS ADVANCEMENT

Genioglossus advancement is indicated for patients with documented hypo-pharyngeal obstruction (Fujita type II-III). It may be used as a sole or in combination with other surgical procedures.

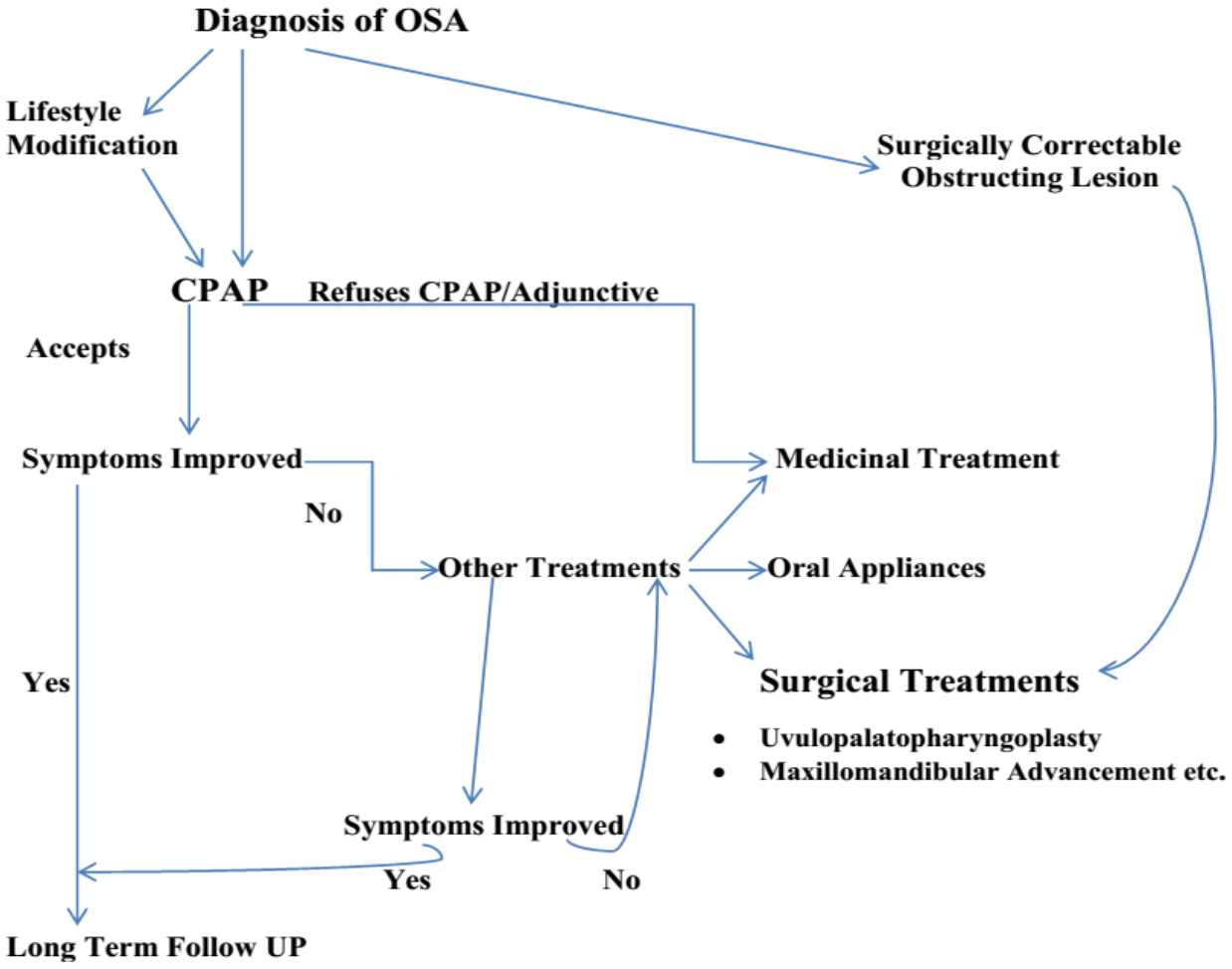
HYOID MYOTOMY AND SUSPENSION

The rationale for hyoid myotomy and suspension is to alleviate hypopharyngeal obstruction by advancing the hyoid complex in an anterior direction. Originally, this surgery involved suspending the hyoid to the mandible with fascia lata. However, this required additional incisions and dissection to harvest the fascia lata and

However, this required additional incisions and dissection to harvest the fascia lata and expose the mandible. To reduce the extent of surgery, the technique has been modified to suspend the hyoid bone to the superior border of the thyroid cartilage.

MAXILLOMANDIBULAR ADVANCEMENTS

Combined advancement of the maxilla and mandible with or without hyoid suspension is the most recent and efficacious surgical procedure for the treatment of obstructive sleep apnea, and it is considered as Phase II of Powell Riley protocol. Kuo et al., and Bear and Priest were the first to report the treatment of obstructive sleep disorder with skeletal surgery; the success rate is 65-100% [60-63]. MMO enlarges both the hypo-pharyngeal and pharyngeal airway in anteroposterior and lateral dimensions by expanding the skeletal facial framework (Figure 8).



Flowchart for the Treatment of OSA

Figure 8:Mandibular Advancement

It is the only surgery in the protocol that physically creates more space for the tongue in the oral cavity. In addition, it exerts further tension on the velopharyngeal and Suprahyoid musculature to prevent their posterior collapse. Drawbacks include complications like intraoperative hemorrhage, obstructive airway or post-operative TMJ dysfunction and damage to inferior alveolar neurovascular bundle [64-65].

RECOMMENDATIONS

- Management of OSA requires long-term, multidisciplinary care. It should start with patient education. Most importantly, patients should be made aware of the consequences of untreated OSA, especially day time sleepiness and road traffic accidents.
- Lifestyle and behavior modifications are indicated for most OSA patients that include reducing weight, physical exercising, avoiding alcohol and certain medications.
- Mild to moderate OSA, we suggest CPAP as initial therapy. However, a patient who anticipates problems with CPAP adherence, an oral appliance can be a reasonable alternative as first-line therapy.
- Surgical therapy is an option for the patients in whom CPAP or an oral appliance is either declined, not an option, or ineffective. Nevertheless, patients whose OSA is due to a surgically correctable obstructing lesion, surgical intervention can be first-line therapy.

CONCLUSION

In this review, various treatment measures for OSA: conservative and surgical have been discussed; however, both the modalities have their own pros and cons. Inevitably, conservative methods are considered the first line of therapy for OSA, and CPAP has been proved as the most successful conservative modality, though, poor patient compliance is a critical issue in these methods. On the other hand, surgical interventions which provide fast relief from snoring and apneas; include different type of procedures consisting of intraoperative and postoperative complications like any other surgery [51, 52, 54]. Kryger et al [66] and Osman et al [67] also recommended the same guidelines for OSA patients. However, correct diagnosis of the disease and detection of the site of obstruction are equally important before starting any therapy, and treatment can be tailored according to the individual need. This review is an attempt to overview of different methods to treat patients of OSA; nevertheless, detailed descriptions of the procedures are beyond the scope of this article. To conclude, OSA is a serious disorder with highly detrimental cardiac and neurocognitive effects which needs early and multispecialty treatment approach. Thus, various specialty especially physician, dentist, and surgeon should work together with good communication to treat the patient of OSA.

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