Review of modern methods of diagnosis and treatment of obstructive sleep apnea

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Abstract

Sleep apnea is a condition characterized by repetitive upper airway obstruction leading to nocturnal hypoxia and sleep fragmentation. It is estimated that between 2% and 4% of the middle-aged population suffer from sleep apnea, with more men than women. Risk factors for sleep apnea include obesity, gender, age, menopause, family factors, craniofacial anomalies, and alcohol. Sleep apnea is increasingly recognized as a serious health problem, linked to hypertension and an increased risk of cardiovascular disease and death. Increased airway collapse and impaired respiratory control are the main pathological features of this disorder. Polysomnography (PSG) is the gold standard for diagnosing sleep apnea and assessing the severity of sleep apnea; however, portable sleep monitoring has a diagnostic role in establishing a high pre-test probability of sleep apnea in the absence of significant comorbidities. Positive pressure therapy is the primary treatment for sleep apnea. Other treatments, such as upper airway surgery or mouth appliances, may be used to treat sleep apnea in selected cases. In this review, we will focus on describing the definition of sleep apnea, risk factor profile, underlying pathophysiological mechanisms, associated adverse effects, diagnostic methods, and treatment strategies. **(TCM-GMJ March 2023; 8 (1):P50-P56)**

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Introduction

Obstructive sleep apnea (OSAS) is definied as recurrent episodes of complete or partial collapse of the upper airways during sleep, resulting in complete interuption (apnea) or reduction (hypopnea) of airflow, leading to agitation and hypoxia.1 Apnea is defined as complete interuption of oronasal air flow for at least 10 seconds. Alternatively, the definition of hypopnea requires (1) a reduction in oronasal airflow of ≥ 30% from baseline associated with a reduction in oxyhemoglobin saturation of ≥ 4%, (2) a reduction of ≥ 50% from baseline and a reduction of ≥ 3%. oxyhemoglobin saturation, (3) decreased airflow as above, along with concomitant electroencephalographic stimulation. In monitoring sleep studies, the frequency of apnea and hypopnea per hour of sleep (Apnea-Hypopnea Index [AHI]) is a key indicator for determining and stratifying the severity of OSAS, although limitations inherent in this indicator include not taking into account the degree of concomitant hypoxia, the duration of respiratory events, etc. Levels AHIs of 5, 15, and 30 were used as cut-offs to define mild, moderate, and severe OSA, respectively.1 Apnea can be divided into obstructive and central depending on the presence or absence of thoracoabdominal effort.2

Symptoms of OSA includes daytime sleepiness, impaired concentration and mood, morning headaches, snoring, and apparent sleep apnea seen in a bed partner. There are varying sensitivities and specificities for these particular clinical symptoms, and clinical prediction rules that include these symptoms have been shown to be poor predictors in identifying OSA and assessing the severity of OSA.3 Many studies has shown an association between the severity of OSAS and other common causes of increased mortality, such as hypertension,4 stroke,5 coronary heart disease,6 occupational,7 as well as car accidents.8 For this reason, OSAS is increasingly recognized as a serious public health problem that imposes a large economic burden that requires early detection and treatment.

Prevalence of OSA

Although OSA was described in the middle of the lastcentury, data describing the prevalence of this disease werenot available until 1993 when the results from the WisconsinSleep Cohort Study were reported. This study involved 602 participants who were 30–60 years of age and evaluated using overnight polysomnography. The prevalence ofOSA (defined as AHI ≥ 5) in this study was 24% in menand 9% in women, and the prevalence of OSA syndrome(OSAS), ie, OSA with associated symptoms (defined asAHI ≥ 5 and daytime sleepiness) was 4% in men and 2% inwomen.9 The prevalence of OSA was estimated in SouthernPennsylvania households, 1,741 participants between theages 20 and 100 years were evaluated using overnight PSG.The prevalence of OSA in this cross-sectional study wassimilar to the Wisconsin Sleep Co-

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hort Study: prevalence ofOSA (AHI ≥ 10) was 17% in men and 5% in women andthe prevalence of OSAS with concomitant symptoms was3.3% in men and 1.2% in women.10,11 OSA prevalence studies have been performed in variouscountries involving individuals of various ethnicities. Forexample, in an Australian study, the prevalence of OSAwas investigated in 485 male participants between the ages 40 and 65 years using a portable, sleep monitoring system.The prevalence of OSA and symptomatic OSAS were 25.9%and 3.1%, respectively.12 In Europe, 560 patients were evaluated between the ages 30 and 70 years using overnight PSG.Twenty-six percent of men and 28% of women had OSA(AHI ≥ 5), and 3.4% of men and 3% of women had OSAS(AHI ≥ 5 and daytime sleepiness).13 One of the first Asianepidemiological studies estimated the prevalence of OSA in259 patients in Hong Kong. The prevalence of OSA (AHI = 5)was 8.8% in men and 3.7% in women, and the prevalence ofOSAS (AHI = 5 and daytime sleepiness) was 4.1% in menand 2.1% in women.14,15 It is interesting to note the comparable OSA prevalenceestimates in this study involving Asians with a lower body mass index (BMI) compared with the participants of theWisconsin Study, who have a notably higher BMI suggestinga risk factor profile contributing to OSA in Asians involvingfactors other than overweight/obesity such as genetic orcraniofacial anatomical factors. Epidemiological studiesfrom other Asian countries including Korea and India, haveshown similar findings.16 In summary, the prevalence of OSA (defined as AHI ≥ 5) were 17%–27% in men and 3%–28% in women.This disparity in the prevalence among these studies,particularly the Spanish study in which 26% of men and 28%of women have OSA,13 may be attributed to methodologicaldifferences including varying population age, health statusof participants, ethnicity, methods of participant enrollment,use of different definitions of hypopnea, use of differenttechniques in measuring airflow, and using portable homemonitoring such as in the Australian study.12

Clinical presentation of OSA

Snoring Snoring is caused by the vibration of anatomical structures in the oral cavity, and oropharynx is considered one of the most common symptoms for which patients or partners seek medical attention. Habitual snoring is common in the general population; in one report, 40% of women and 60% of men snore constantly.9 When considering snoring as a symptom of OSA, approximately 70–80% of patients who snore have OSA,17-19 and 95% of patients with OSA snore.20 Daytime sleepiness is the most common daytime symptom in patients with OSA. Since there are many causes of drowsiness such as insufficient sleep, mood disorders, drug side effects, etc.; drowsiness does not correlate well with OSA severity,3 and daytime sleepiness is not a specific marker of OSA.Nevertheless,daytime sleepiness is a very useful screening tool to assess response to therapy in patients with OSA.21 Various scales used to subjectively assess the degree of sleepiness include the Mood State Profile,22 the Stanford Sleepiness Scale,23 and the Epworth Sleepiness Scale.24 Of these scales, Epworth's sleepiness. The scale is widely used because it assesses the likelihood of dozing off in various everyday situations over the past month, rather than reflecting an instant mood state. Objective measures of sleepiness include multiple sleep latency testing and a wakefulness maintenance test.

Other symptoms Other symptoms of OSA include, but are not limited to, observed apnea, nocturnal breathlessness, unrefreshing sleep, morning headaches, sleep maintenance insomnia, and fatigue. Although clinical symptoms do not correlate well with OSA severity, several predictive models have been developed to provide a screening tool for OSA. Most of these models depend on clinical symptoms, anthropometric measurements, and an assessment of the anatomy of the upper airways. Although highly sensitive, these predictive rules are of minimal clinical value due to low specificity and are of limited use in the pediatric population. 25-32

Risk factors of OSA Some of the major risk factors of OSA and their respective pathophysiologic mechanisms are summarized in Figure 1.

Aging- The Sleep Heart Health Study shows a simple positive linear correlation between age and OSA until about 65 years of age, after which the prevalence stabilizes.33Gender - OSA is more common in men, with a male to female ratio of 2–4:1 in community-based studies9,10,13,15,16 and approximately 10:1 in sleep clinic samples.35 Obesity - OSA is widespread among obese and overweight people. Several cross-sectional studies have identified monotonous relationship between OSA and body weight, BMI, neck circumference, waist-to-hip ratio, and other physique indicators. 9–11,14,15,33 In addition, weight fluctuations have been shown to affect the severity of OSA.Genetics - In earlier reports describing the high prevalence of OSA among family members, it was assumed that OSA has familial component, in addition to the influence of obesity.36,37 Several small family studies have focused on determining the genetic basis of OSA. In a case series, non-overweight relatives of OSA patients were found to have more daytime sleepiness, snoring, apnea, and awakening compared to controls.38 Menopause - Various cross-sectional studies have identified menopause as a risk factor for OSA. The prevalence of OSA in postmenopausal women is 2.7% compared to 0.6% in premenopausal women.10 Consistent with these results, another study estimated the odds of having an AHI ≥ 15 in menopausal women to be 3.49 compared to 1.07 in premenopausal women after adjusting for potential confounders including age and BMI.39 Ethnicity - Current cross-sectional data evaluating the prevalence of OSA in different ethnic groups have shown comparable estimates. However, earlier population-based studies, which included predominantly Caucasians, found no difference in the prevalence of OSA between Caucasians and African Americans.33 However, African Americans had a more severe course of OSA than Caucasians in the younger than 25 and older than 65 age groups.36,40 Nasal Obstruction

-Nasal passages are the gateway of ambient air into the body. Nasal obstruction causes airflow restriction, an effect that is more pronounced during sleep and may exacerbate the apnea and nocturnal desaturation associated with OSA. Nasal congestion can be caused by various mechanical factors, including anatomical abnormalities such as a deviated septum and an inflammatory disease that causes swelling of the mucous membrane, namely rhinitis. Craniofacial Anatomy - Various craniofacial characteristics have been associated with the development of OSA, causing narrowing of the upper airways and increased upper airway collapse, including inferior hyoid, posterior maxilla and mandible, enlargement of the tongue and soft palate, and a smaller palate. pharyngeal transverse section area.41-45 Smoking- Smoking causes difficulty falling asleep, sleep fragmentation and daytime sleepiness.46,47 Alcohol - Alcohol causes decreased sleep latency and, in larger quantity, increase the occurence of slow wave sleep.48

Pathogenesis of OSA

In patients with OSA, the airways are smaller and more elastic than normal. In the waking state, the airways are open due to the activation of the dilators of the pharynx. However, in the sleep state, the activity of these muscles is markedly reduced, and the volume of the lungs decreases in the supine position, causing a significant restriction of airflow, which leads to hypopnea or apnea.49 This mechanical load and CO2 retention activate the pharyngeal muscles in order torestore patency of the upper respiratory tract.52,53 Recruitment of the pharyngeal dilators and restoration of upper airway patency can be achieved in some individuals without cortical excitation, while in others excitation is necessary for effective muscle recruitment; this phenomenon has been described as compensatory efficiency.54 Ventilatory instability plays a role in OSA, as supported by work describing that loop amplification is higher in patients with severe OSA during non-REM sleep than in patients with mild OSA.50,55 Indeed, after each apnea in OSA patients hyperventilate, CO2 drops to the apnea threshold, expiratory time is lengthened, and the upper airways may collapse again. In addition, several reports describe decreased sensitivity of the pharyngeal muscles to negative pressure in the upper airways due to damage to sensory nerves in the upper airways or to the muscles themselves. This damage may be due to inflammation caused by vibration, snoring, or trauma.56-59 The data also support the notion of sleep-to-wake ventilation variability as a predictor of OSA severity.60 In addition, humoral and inflammatory mediators released from visceral adipose tissue may play a role in ventilator regulation. The best studied is leptin, which binds to its receptors in the hypothalamus, causing a decrease in satiety and an increase in ventilation.61 Leptin stimulates respiratory activity, as shown in leptin-deficient or resistant mice that showed signs of central hypoventilation and obesity.62 In general, there are many respiratory control mechanisms that can predispose to upper airway instability, including changes in loop gain, alterations in upper airway motor and neural control and reactivity, and humoral mechanisms.

Diagnosis of OSA

The diagnosis of OSA is based on clinical signs and physical findings indicative of the disease, combined with objective data obtained from sleep monitoring. OSA is a widespread disease and, if left untreated, can lead to significant social, economic, and health consequences. With this in mind, early recognition by the healthcare provider is of paramount importance.

Polysomnography PSG is the gold-standard method to diagnose OSA and provides a method to determine the PAP level required for treatment. During PSG, detailed information is obtained by using electroencephalogram, electromyogram, electro-oculogram, electrocardiogram, snore microphone, body position and leg movement, oronasal airflow, chest wall effort, and oxyhemoglobin saturation, as well as video recording. Full sleep study monitoring is performed during usual sleep hours with 6 hours of recording optimally needed to establish the diagnosis.63

Home portable monitoring With an increasing number of patients who are referred for the evaluation for OSA and by following current guidelines for the diagnosis of OSA, it has been estimated that 600 sleep studies per 100,000 individuals per year would be required.65 This has placed great pressure on the limited number of sleep laboratories and may contribute to delay in OSA diagnosis and treatment. For this reason, portable home sleep monitoring emerged as a potential alternative for the diagnosis of OSA. Per the American Academy of Sleep Medicine guidelines, there are different levels of sleep monitoring with levels II–IV categorized as unattended monitoring involving a minimum of 7 channels (Level II), 4 channels (Level III), or 1 channel (Level IV). Although portable sleep monitoring is less costly and more convenient for the patient, there are several disadvantages.64

Treatment of OSA

Treatment of OSA is aimed at eliminating the underlying pathology. Positive airway pressure (PAP) has been used as a pneumatic splint to keep the pharyngeal pressure above the critical pharyngeal pressure and therefore prevent re-obstruction of the airways. However, some subgroups of patients with craniofacial anomalies as a major risk factor for OSAS may benefit from upper airway surgery or oral appliances to restore normal upper airway anatomy. In addition, counseling patients about their sleeping position (i.e. avoiding sleeping in the supine position), sleep hygiene (maintaining regular sleep and wake times, and avoiding the use of sedatives, hypnotics, and alcohol, especially given their ability to reduce upper airway muscle tone and worsen OSA), and weight loss is an integral part of OSA treatment.

Positive airway pressure PAP was first introduced for the treatment of OSA in 1983.70 Since then,

and with advances in technology, various PAP delivery methods have been developed, and a large number of clinical trials have been conducted investigating their effectiveness in improving various clinical outcomes. Continuous PAP, known as CPAP, is commonly used to treat OSA by providing constant pressure during inhalation and exhalation to maintain an open airway during sleep. It consists of a flow generator that delivers a stream of air at constant pressure to the patient through the mask through a tube system. CPAP was evaluated in clinical trials and compared with sham CPAP, pills, or no treatment using parallel or cross-over regimens. The results were in favor of CPAP comparatively reducing AHI and improving daytime sleepiness assessed subjectively by Epworth sleeping scale and objectively by using multiple sleep latency testing. Although the effect of CPAP on other outcomes is less established, several reports noted improvement in sleep quality (increased stages 3 and 4) and quality of life.67-82

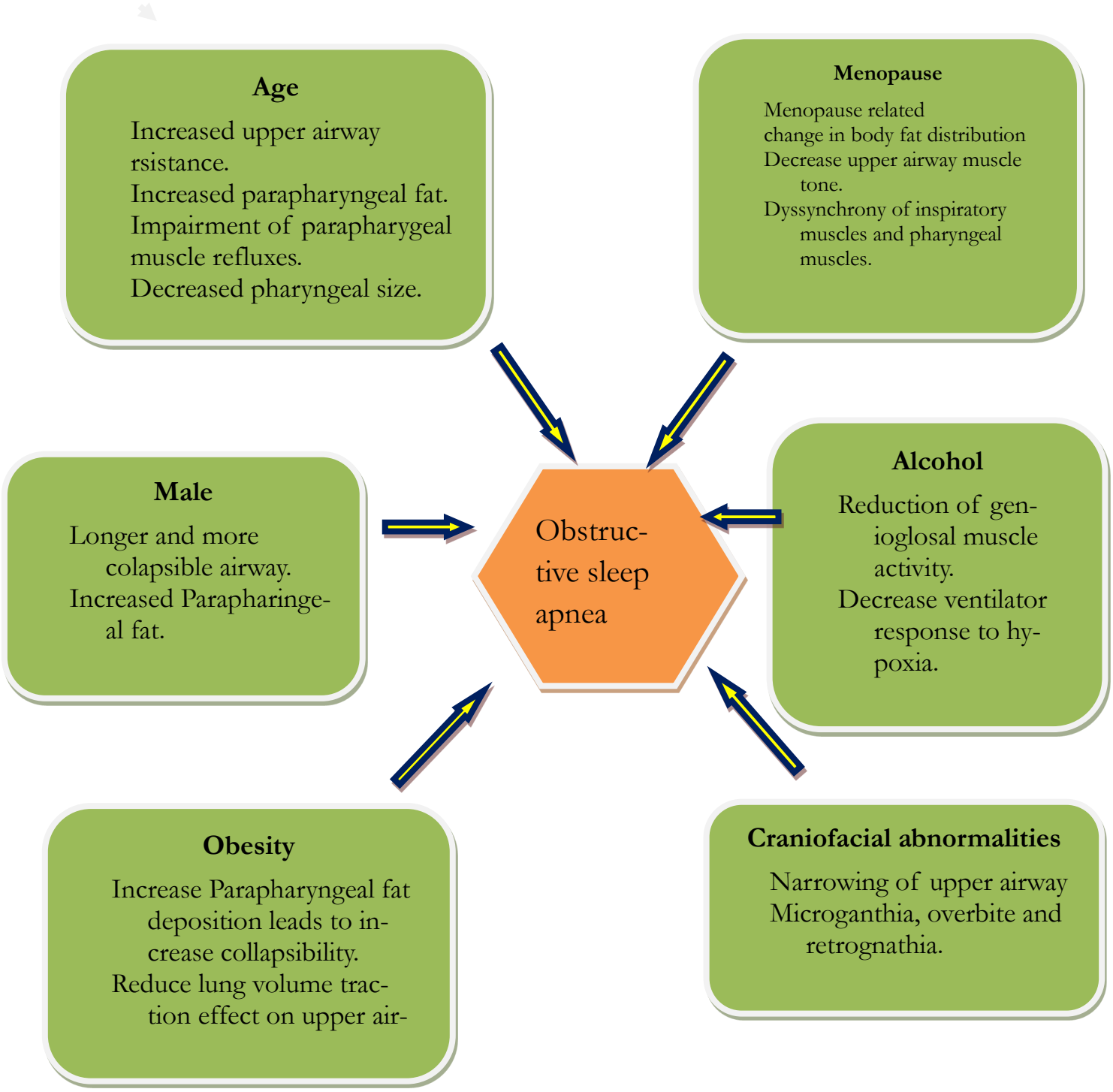
Oral appliances Since PAP has become an effective treatment for OSA, oral appliances have been identified as an alternative treatment. According to the American Academy of Sleep Medicine guidelines, oral devices are indicated for the treatment of mild and/or positional OSA. Oral appliances are broadly divided into devices that push the mandible forward, known as mandibular advancement devices, and tongue retention devices.83,84.

Surgery- Surgical treatment of OSA aims to increase the cross-sectional area of the upper respiratory tract by removing excess tissue and therefore eliminating obstructive episodes during sleep. Various procedures have been described, including uvulopalatopharyngoplasty (UPPP), which was first introduced in 1891,85 and involves the removal of the tonsils, uvula, and part of the soft palate. In general, UPPP effectively treats OSA in only 50% of cases treated with this method.86 Potential complications of this procedure include palatopharyngeal insufficiency and postoperative pain. With advances in technology, various other techniques have been used, such as multi-level, temperature-controlled, radiofrequency tissue ablation, laser uvulopalatoplasty, and mandibular osteotomy. Compared with no treatment, there were no differences in daytime sleepiness and quality of life in patients undergoing laser uvulopalatoplasty.87,88 Similar results were obtained using thermocontrolled tissue radiofrequency ablation or radiofrequency soft palate surgery.89-92 However, some patients with OSA may benefit from surgery. Using an anatomical staging system to stratify patients with OSA was more effective in predicting outcome than staging based on severity.93

Conclusion

Over the past 3–4 decades, OSA has been increasingly recognized as a widespread disease and a source of adverse health effects, resulting in a serious public health burden. In the United States, approximately 12 million people aged 30–60 years have OSA,9 and 38,000 people die each year from OSAS-related cardiovascular disease.94 OSA is associated with a variety of signs and symptoms that adversely affect quality of life, including snoring, daytime sleepiness, neurocognitive deficits, and irritability. Significant morbidity and economic costs are associated with untreated OSAS, including those associated with daytime sleepiness and hypertension, as well as comorbid cardiovascular diseases. Despite the belief that OSAS is a common and treatable disease associated with negative health outcomes, at least 75% of severe cases of OSA are not diagnosed.95,96 Thus, there is an urgent need to increase the level of recognition of this disorder and consider the impact of this common condition on public health, including the extent to which treatment of OSA may alter the course of other chronic diseases such as insulin resistance, cardiac dysrhythmogenesis, heart failure, cardiovascular disease. vascular diseases.

Figure 1. Schematic representation of different risc factors and proposed mechanisms by which they result in obstructive sleep apnea.



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