



Review article

**Advances in diagnosis and treatment  
of obstructive sleep apnea**

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ABSTRACT

**Introduction:** Obstructive sleep apnea (OSA) is a sleep disorder which is very common among obese patients, and which is mostly observed in highly developed societies.

**Aim:** The purpose of this article is to present the methods of OSA treatment.

**Material and methods:** Medline searches were conducted in context of OSA, basing on literature from 2014 and 2015.

**Results and discussion:** We can divide OSA treatment methods into three groups. There are methods based on positive airway pressure (PAP), which are proved to be the most efficient, but are often hardly accepted by patients due to the need of wearing an uncomfortable mask during sleep. The second group are methods based on the use of the mandibular repositioning devices, which are less efficient than positive airway pressure, but more willingly accepted by patients; these methods have proven quite successful in treating mild to moderate OSA. The third group are surgical methods which can be very efficient, but at the same time, can cause danger to the patient's life.

**Conclusions:** Using intraoral devices is recommended to patients with mild to moderate OSA symptoms and to patients with a severe form of the disorder who cannot cope with the PAP treatment. The surgical treatments of OSA are not recommended despite being efficient, since they produce many dangerous side effects.

## 1. INTRODUCTION

The definition of obstructive sleep apnea (OSA) is a partial or complete airway obstruction which takes place during sleep and lasts for at least 10 s.<sup>1</sup> It is caused by airway expansion muscles which cannot withstand the underpressure created by the breathing muscles. OSA is determined to affect approximately 4% of middle-aged men and 2% of adult women; the figures climb up to the age of 60 to 70 years old.

The causes of OSA need to be differentiated among muscles disorders, respiratory reflexes disorders and the central causes.<sup>2</sup> While waking up, these muscles are activated by the pharyngeal and laryngeal mechanoreceptor reflexes. In OSA patients, these reflexes are weakened due to the lesser innervation and smaller susceptibility to temperature changes and vibrations.<sup>3</sup> OSA is associated with obesity which is a common disorder in developed countries. This phenomenon is to be seen in over 50% of patients with body mass index (BMI) of over 40 kg/m<sup>2</sup>. OSA is also clearly associated with cardiologic and metabolic disorders or opioid medication. Research on OSA helped develop a group of anatomic and physiologic disorders which create a higher risk of OSA prevalence. The group consists of adenotonsillar enlargement, laryngopharyngic disorders, macroglossia, acromegaly, midface hypoplasia and retrognathia.<sup>4</sup> Breathing disorders during sleep may also be caused by central neurological system disorders like the Cheyne-Stokes syndrome or arousal disorders. They can also result from the larynx nerves stimulation during upper airway infection.<sup>4</sup> It was suggested that OSA is connected with a low adiponectin level, but research did not demonstrate a correlation between the continuous positive airway pressure (CPAP) treatment and adiponectin level changes.<sup>5</sup>

One of the most typical signs of the upper airway contraction is snoring which is caused by the soft palatal tissue vibration. OSA also causes partial hypoxemia and sleep laceration which is particularly dangerous for it may resolve in lack of concentration leading to traffic accidents.<sup>4,6</sup> Research conducted on a group of Canadian drivers revealed that drivers suffering from OSA had a higher traffic accidents factor than healthy drivers during a 3 year period.<sup>7</sup> Other OSA symptoms are xerostomia, increased saliva secretion, change in sleep rituals and dyspnea. Daytime symptoms usually include headaches, irritability and stomach reflux.

The diagnosis of OSA is based on polysomnography or nighttime heart work and breathing diagnostics.<sup>1,8</sup> It shows the quality of the sleep, the airflow in the upper airways, the number of awakenings during sleep, sleep position, electrocardiogram and blood saturation.

The severness of OSA is measured with the apopnea/hypopnea index (AHI) which shows how many times during an hour of sleep the patient suffers from partial or complete upper airway obturation lasting for at least 10 s. AHI of 5–15 represents a benign/mild form of OSA, 16–30 is moderate, and 30 and higher is defined as a severe form of the disorder.<sup>1</sup>

## 2. AIM

The purpose of this article is to present the methods of OSA treatment.

## 3. MATERIAL AND METHODS

Medline searches were conducted in context of OSA, basing on literature from 2014 and 2015.

## 4. RESULTS AND DISCUSSION

Treatment methods of OSA can be divided into three groups. There are methods based on positive airway pressure delivered to the patient's airway through a mask, surgical treatment and treatment based on using intraoral devices which are supposed to move the mandibula and/or the tongue forward to reduce the pressure on the patient's airway. Other ways of treating OSA are reducing the patient's body weight and phrenic and glossopharyngic nerve stimulation.<sup>4</sup> Based on 17 articles from 2014–2015, this review shows the most popular methods of treating OSA.

CPAP – the device treats OSA by delivering air to the patient's airway under pressure which is higher than the pressure which causes the patient's soft palatal tissues to collapse. The air is provided by a nasal mask or a nasomouth mask. A higher pressure is needed throughout the rapid eyes movement (REM) sleep phase and in obese patients.<sup>8</sup> The CPAP shows good results in sleepiness, tiredness and concentration disorders treatment; however, 20% to 50% of patients are unable to cope with the therapy due to the associated discomfort. Common side effects are air leaks and uncomfortable face squeeze. The side effects are mostly caused by the airpressure and can be removed by device adjustment.<sup>3</sup> Patients often complain about airways mucosa dryness thus the devices are often equipped with air warmers and humidifiers.<sup>9</sup> Other limitations include the fact that these devices need electricity to work, which makes them impossible to use in some environments.<sup>6,10</sup> According to research,<sup>11</sup> phone coaching can help the patients with motivation and instructions on how to use the CPAP device. As a result, patients may be more willing to wear the mask for a longer time during the night. Other methods of helping the patients to cope with the CPAP are sleeping medications, medical education and behavioral therapy.<sup>9</sup> CPAP is one of the most popular methods of treating OSA and there are many modifications of it which are to help reduce the percentage of treatment failures.

Bi-level positive airway pressure (BPAP) is characterized by different airway pressure – it is reduced during the exhale, which helps the patient to exhale.<sup>9</sup>

Adaptive servo-ventilation (ASV) is a BPAP device modification in which the inhale and exhale pressures are not consistent, but they change during the sleep.<sup>9</sup>

Auto-titrating positive airway pressure (APAP) are the devices which, contrary to CPAP, are not set on one particular pressure value. Instead, they constantly check the patient's sleep to establish the optimum minimal pressure needed to keep the patient's airways open. Correct pressure is changing through the night and depends on several conditions, such as the body position or sleep phase. Different producers have developed different algorithms which are responsible for maintaining the correct pressure at a given moment. Compared to CPAP, APAP shows a small but significant advantage in the time it takes a patient to get used to the device (11 minutes), and also in reducing daytime sleepiness. On the other hand, CPAP is more efficient in reducing the patient's blood pressure and helping other cardiometabolic disorders. Another advantage of the APAP device is reducing the cost of the diagnostics, while the device does not require many therapist appointments to be set on the correct working pressure.<sup>9</sup>

Another device which is to help the patients to use the positive airway pressure (PAP) devices is expiratory pressure relief (EPR). It is similar to the BPAP device, but it does not have a set air pressure for the exhale. With every exhale, it measures the airflow and according to its value, it lowers the air pressure for early exhale opposite to the late exhale.<sup>9</sup>

Expiratory positive airway pressure (EPAP) is a device placed on the patient's nose and consisting of a flap which lets a free inhale, and at the same time, lets an exhale only when the exhale air pressure is high enough. At first, the device showed good results, but later research on the group of patients who had previously used CPAP showed that the EPAP results were not significantly better than the placebo.<sup>9</sup>

One of the suggested ways of treating OSA is to stimulate the airways expanding muscles by constantly providing air pressure at high frequency and low amplitude. On that basis, an oscillating positive airway pressure (OPAP) device prototype was created. The device was planned to be used with CPAP, but clinical research showed that there were no significant differences between using CPAP with and without OPAP.<sup>3</sup>

Intraoral devices are the optimal treatment option for patients with mild to moderate OSA form and also for patients with severe OSA who cannot cope with CPAP devices. Intraoral devices work by changing the position of the lower jaw and/or the tongue to relieve the pressure they can put on the airways by obstructing it. The most important advantages of these devices are low price, working without the need of electrical charging, easiness of transportation due to their small size and weight, as well as immediate effects. Their most considerable disadvantage is smaller efficiency in comparison to the PAP devices.<sup>4,6,10</sup>

Mandibular advancement device (MAD) is an intraoral device used in treatment of OSA and snoring. By changing the position of the lower jaw to a more protruded and open one, it increases the airflow in the patient's airways. Additionally, MAD stabilizes the jaws and the hyoid bone position, preventing the airways obturation. The hyoid bone becomes more protruded, which changes the suprahyoid muscles equilibrium position and additionally increases

the airflow. A 75% mandible protrusion shows to be the most efficient in OSA treatment.<sup>10</sup> Setting the MAD is usually done with the use of the inch by inch method to set the optimal mandible position. The mandible position is set by the screws located on the palatal side of the device or in the front in the midline. It can also be equipped with two regulation levers located on the sides of the device. Some MADs allow the jaw to be open, some set it fixed. Using MAD may cause side effects, such as jaw pains, teeth hypersensitivity and increased saliva secretion. Some patients may require an adaptation time of up to a few months. MAD users should have at least 10 teeth in one dental arch to provide a correct anchorage for the device; however, using MAD with dental prosthesis shows satisfying results.<sup>12</sup> In edentulous patients, the best support is provided by dental implants; however, patients often refuse to accept such treatment due to its high cost and the need of a surgical treatment. When MAD is used with partial or complete dentures, it is highly recommended to perform systematic dental examinations due to the possibility of jaw process resorption. Some researchers also question the safety of occlusion in MAD users. Authors<sup>13</sup> claim that intraoral devices made without the correct central relation registration may lead to teeth and mandibular position disorders. Research conducted in France also shows that the intraoral devices therapy is mostly performed in patients with a high socioeconomic status, which means it is hardly available to the less wealthy part of the society.<sup>14</sup> The research from 2014 suggests that there may be a relation between cephalometric factors and the percentage of intraoral devices treatment success.<sup>15</sup>

Devices which are based on tongue protrusion are mostly recommended for edentulous patients. These devices also have disadvantages. They do not fit very well, they may cause bruising of the mucosa and they increase saliva secretion.

Surgical methods of treating OSA are mostly uvulopalatopharyngoplasty (UPPP) which involves a tonsillectomy, excision of the uvula and posterior palate and trimming of the posterior pillars. This procedure provides satisfying results only in 33% patients and it can also cause the patient to be non-compliant with/for the PAP devices in the future.<sup>9</sup>

Surgical maxilla and mandible protrusion provides the AHI decrease to an average level of 7.7 per hour; however, due to high mortality, the procedure is rarely conducted. Similarly, the tracheostomy is very efficient providing the full upper airway bypass; nevertheless, due to complications, such as recurring lungs inflammations, near stomy complications, psychologic trauma and high morbidity, it is rarely performed.<sup>9</sup>

In 2011 a new idea of OSA treatment emerged. Strollo and associates proved that bilateral hypoglossal muscles stimulation with a surgically mounted neurostimulator is efficient in reducing OSA symptoms, such as daytime sleepiness.<sup>16</sup> Disadvantages of this treatment are high cost and the need of performing a surgical procedure. A continuous transcutaneous electrical stimulation (CTES) might become an alternative, but the efficiency of this method is still to be confirmed.<sup>16</sup>

## 5. CONCLUSIONS

All the authors of the cited publications agree that there is a need to continue the research on OSA, as it may have a considerable influence on the public health/ health level in society. There is still no agreement on what the right tool to establish the OSA severeness in a patient. On what method should be used for OSA severeness diagnosis. Some authors<sup>17</sup> suggest that AHI should be replaced with the length of the airways obturation index, blood saturation level index or awakening length index. The CPAP therapy remains the official standard of OSA treatment. Using intraoral devices is recommended to patients with mild to moderate OSA symptoms and to patients with a severe form of the disorder who cannot cope with the PAP treatment. The surgical treatments are not recommended despite being efficient, since they produce many dangerous side effects.

### Conflict of interest

None declared.

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