

Non-Cpap Conservative Treatment Alternatives for Patients with Obstructive Sleep Apnea/Hypopnea Syndrome

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Abstract: *Obstructive Sleep Apnea is a challenging issue for diagnosis and treatment. Considering the significant co-morbidity and mortality OSA poses a serious issue. Throughout the years a great variety of therapeutic modalities have been developed. In the current review we are making an attempt critically to revise the advantages and disadvantages of the proposed conservative methods. The decision for treatment strategy should be based on the improved contemporary knowledge pathophysiology of the disease and toward to improved effectiveness and usefulness in clinical practice.*

Keywords: obstructive sleep apnea, snoring, medical devices, conservative treatment, sleep disordered breathing

1. Introduction

Sleep disordered breathing (SDB) is a complex descriptive term, which in consistence with the 2nd International Classification of Sleep Disorders (ICSD II), published in 2005, includes three different pathological entities: Obstructive Sleep Apnea/Hypopnea Syndrome (OSAHS), Central Sleep Apnea Syndrome (CSAS) with /without Cheyne-Stokes Respiration and Obesity-related Hypoventilation Syndrome (OHS) ¹. The OSAHS in terms comprises of Upper Respiratory Tract Resistance (URTR) and Obstructive Sleep Apnea (OSA), combined in one group by close diagnostic criteria but in the same time defining different clinical conditions. Despite the controversial and debatable arguments against existence of those different pathological entities ², OSA is characterized by desaturations no less than 4% drop from the baseline in awake condition and decrease on airflow at least 50% or complete cessation of breathing for minimum 10 seconds. The polysomnographic (PSG) characteristics of URTR are sleep fragmentation, accompanied by less than 5 apnea/hypopnea episodes (Apnea /Hypopnea Index, AHI) without significant desaturation events. Another essential PSG criterion is Respiratory Effort-related Arousals (RERA), which consists of clear drop in inspiratory flow, increased respiratory effort and PSG-recorded arousals during sleep. RERA needs to be correctly diagnosed using nasal cannula with pressure transducer or pneumotachograph, while still some PSG-labs use oronasal thermistors unable to detect those sleep-related abnormalities ³. It is considered that ≥ 10 abnormal respiratory events per hour indicate URTR, while less than 10 / hour (≥ 5) are distinctive for OSA ⁴. Respiratory Disturbance Index (RDI) embodies: apneas registered during sleep, hypopnea episodes and RERAs per hour and represents more precise PSG criterion determining the gravity of OSA ⁵.

In daily routine clinical practice of the ENT-specialists it is essential to make distinction between OSA and URTR in order to build proper diagnostic and treatment strategies, which is possible only with close collaboration with PSG-labs. The results from physical examination are crucial to determine the level and degree of upper airway resistance - craniofacial abnormalities, septum deviation, nasal polyposis, allergies, adeno-tonsillar hypertrophy, soft palate abnormalities, enlarged lingual tonsil, etc. A combination between that information and the PSG-lab results defines the effectiveness of the chosen treatment modalities. Presumably OSAHS can affect any age, but typically appears between 4th and 6th decade ⁶. Usually patients with URTR are considered to be younger than patients with moderate to severe OSA ^{7 8}. The estimated female to male ratio in OSA is 1:8, while in URTR is four fold higher - 1:2 ⁹. In children female to male ratio in OSA and URTR is almost equal 1:1, without statistically significant difference ¹⁰. Obesity is frequently associated with OSA ¹¹ and the neck circumference more than 40 cm is considered to be more precise predictive criterion for OSA ¹². In contrast, patients with URTR are usually non-obese ⁸. Clinical presentation of SDB consists of daytime and nighttime symptoms which exhibit some differences between URTR and OSA. The excessive daytime sleepiness (EDS) typically observed in patients with OSA contrasted with the frequently reported fatigue rather than sleepiness in URTR ¹³. On the other hand, patients with URTR commonly exhibit orthostatic hypotension ¹⁴, while patients with OSA are diagnosed with hypertension ¹⁵. Typically registered through the PSG study short sleep onset in cases of moderate to severe OSA differentiates from more frequently detected sleep-onset insomnia, sleep-maintenance insomnia ¹⁶, and parasomnias (sleep-walking, night terrors) registered in patients with URTR ¹⁷.

Nevertheless strict diagnostic criteria (both clinical and PSG) have been set, the pathophysiology of sleep disordered breathing overlap and usually have been misdiagnosed in clinical practice. The disturbing numbers representing undiagnosed moderate to severe cases of OSA among men (82%) and women (93%)¹⁸ defines significant co-morbidity and mortality of the disease¹⁹. On the other hand, the gravity of complaints of so called "habitual" snorers or primary snorers (PS) is usually underestimated both by the patients and primary physicians and categorized as minor symptoms without taking into consideration that the snoring could be an alarming initial symptom of OSA. According to Bernoulli's principle, passing through a narrowed segment of upper respiratory tract (URT) the airflow transform from laminar to turbulent mode, inducing vibration of the soft pharyngeal structures predominantly in the inspiratory phase of breathing. PS is not associated with flow limitations, desaturation events or arousals in habitual snorers. There is a slight correlation between snoring and daytime sleepiness measured by Epworth Sleepiness Scale (ESS), only in patients with mild OSA (> 15 AHI) and could be attributed rather to the pathophysiology of OSA, than the snoring itself²⁰. The site of obstruction in the URT is determined by ENT specialist using routine clinical examination, nasopharyngoscopy, acoustic rhinometry and rhinomanometry, etc. Considering the fact that the obesity, drinking alcohol and taking sedatives (benzodiazepines) deteriorate snoring - an appropriate behavioral therapy should be recommended respectively.

Medications reducing snoring – 3 different groups has been implemented in the clinical practice for treatment of snoring. Tissue lubricants are considered to increase the muscle tone by moisturizing oropharyngeal soft tissues, reducing tissue flaps and subsequently diminishing vibrations and snoring. They exist as sprays, mouthwash solutions or oral strips, typically administered before bedtime. The main ingredients are essential natural oils and vegetable extracts and usually are not suitable for pediatric age. Tissue lubricants have symptomatic relief and their action is limited to several hours. Local corticosteroids are frequently used in the treatment of the nasal obstruction associated with different pathological conditions such as: allergic rhinitis, nasal polyposis, adenoid hypertrophy, etc. It has been reported encouraging results from application of mometasone furoate in treatment of patients with OSA and allergic rhinitis²¹, while different studies report no significant effect of local corticosteroids in the PSG-validated snoring both in patient with OSA and habitual snorers²². Successful results from the usage of oral decongestants on patients with severe snoring have been reported, without taking into consideration whether they are habitual snorers or patients with obstructive sleep apnea²³. In the same time, the side effects of pseudoephedrine on the sleep onset, heart beat and blood pressure limit their usage for a long period of time.

Didgeridoo playing requires special techniques of so called "circular breathing", exercising the muscles responsible for preventing the oropharyngeal structures from collapse. This wind instrument has been developed by native northern Australian aboriginal tribe and represents long 1 to 3 m cylindrical or conical wooden (eucalypt) pipe. The sound is

produced by inhaling the air through the nose whilst simultaneously expelling stored air out of the mouth using the tongue and cheeks. A skillful performer could play continuous sound for more than 40 minutes. In the randomized controlled trial has been demonstrated that practicing didgeridoo playing for 4 months decreases the snoring, reduces daytime sleepiness and improves AHI in patients with OSA²⁴.

Chin Strap is a simple device providing lower jaw support during sleep, when usually muscles tone decrease. As a result chin drops down and the base of the tongue falls back blocking the airway and increasing the URT resistance, resulting in amplified vibration of the soft tissues and snoring. The sling-like design of the device firmly supports the chin and forwards the mandibula and the base tongue. Chin straps are proved to be effective in habitual snorers and patients with temporomandibular joint dysfunction (TMJD). Recently, it has been demonstrated that chin straps could be an effective supplement in the fixed positive airway pressure (PAP) therapy, improving both PAP compliance (by reducing the air leak and increasing the nightly usage of machine) and residual AHI²⁵, while other reports remain completely skeptical about the application of chin strap even as anti-snoring device²⁶. It has been established that chin straps diminish mouth dry complaints and air leaks-associated arousals²⁷ and could improve significantly clinical and PSG data in patient with OSA as a standalone therapy with effectiveness comparable to PAP therapy²⁸. Moreover, the American Academy of Sleep Medicine recommends as a best clinical practice for PAP titration to use chin strap as a supplement to the nasal mask to reduce air leakage²⁹. On the other hand, the usage of the chin strap should be avoided when severe nasal obstruction is diagnosed (allergy, chronic sinusitis, nasal polyposis, deviated nasal septum, etc.), especially in cases associated with heavy snoring and patients with OSA in regard with the possible blockage of the mouth breathing as a compensative mechanism.

Patients with impaired nasal breathing due to the nasal valve dysfunction could be subjected to surgery or could take advantage from application of **nasal dilators**. Two types of nasal dilators are used in clinical practice – external and internal. While external dilators lift the lateral parts of the alar cartilages improving the limitations in the airflow, the great variety of commercially available internal dilators stent the nasal valve from the inside improving nasal patency. External dilators are proved to be effective in healthy athletes increasing nasal flow, respiratory efforts and oxygen uptake³⁰. In the randomized placebo-controlled single blinded trial the effectiveness of external dilators was evaluated in a combination with topical nasal decongestants in patients with OSA³¹. Major improvements were demonstrated in the nasal obstruction and airway patency, as well as positive effect on the sleep architecture and snoring-relief. In the same time, the PSG-validated effects - reduction of AHI and respiratory disturbance index (RDI), was insignificant. Internal dilators vary in shape and their usefulness in the treatment of OSA was assessed by overnight polysomnography³². Reduction of the nasal airway resistance was documented by rhinomanometry as well as PSG-recorded substantial decrease in snoring. At the

same time, no significant effect on the subjective daytime sleepiness and arousals frequencies has been noted. There is a risk of internal dilators displacement, disintegration by material weakening and subsequent inflammation³³. The major reason for failure of the nasal dilators as an effective tool in treatment of OSA is the fact that in most cases patency reduction of URT is multilevel determined. This drawback could be overcome to some extent by the usage of self-expanding stents with different sizes. The AlaxoStent[®] is a self-expanding pharyngeal nitinol braid, made by metal with memory effect, which is introduced by the patient through the nose and expands the whole area from the nasal cavity to the pharynx. It has been reported^{34,35} in a clinical PSG-validated clinical study for reduction of AHI and improvement of desaturation levels in patient with OSA using AlaxoStent[®], but still there is no official publication supporting the effectiveness of this device. New meta-analysis revealed different level of tolerance toward nasopharyngeal airway stenting devices and their benefits in OSA treatment³⁶.

Expiratory positive airway pressure (EPAP) devices are novel adhesive nasal appliances, acting as one-way valve with increased resistance through the expiratory phase of breathing. Three possible mechanisms of action have been proposed³⁷: 1. the positive pressure generated by the increased resistance at the end of expiratory efforts expands the URT soft tissues, preventing them from collapsing throughout the next inspiratory event; 2. increased expiratory resistance generates hypoventilation with subsequent mild hypercapnia, resulting in amplified respiratory drive; 3. at the end of expiration is registered enlarged functional respiratory volume of the lungs exerting tracheal traction and thus preventing URT collapsibility. Patients with mild to moderate OSA who are using EPAP devices prefer them to CPAP therapy because of the subjective reduction of daytime sleepiness and improvement of AHI³⁸ and even for a long period of time (12 months) the adherence to nasal EPAP was significantly high (approximately 89% of the time)³⁹.

Positional therapy is applicable both for snoring-relief and treatment of positional sleep apnea (POSA). POSA is considered as a version of OSA, where changing body position from supine to lateral posture in bed leads to 50 % decrease of AHI⁴⁰. POSA is assumed as a transient stage of obstructive sleep apnea development, which gradually evolves with deterioration of PSG markers, regardless of the sleeping position. The prevalence of POSA in mild (AHI = 5-15/h) and moderate (AHI = 15-30/h) OSA cases was reported to be higher than 50%⁴¹. Usually, patients with POSA are younger, slimmer, express less severe breathing abnormalities during sleep, (lower RDI, lower rate of desaturation), better sleep architecture and lesser daytime sleepiness in comparison with non-positional OSA⁴². In regard with effective snoring therapy anti-snoring pillows have been proposed. There are 2 types of pillow. The first one is tilting the head backward and extends the patients' neck assuming that in this position will have a favorable effect on snoring. Variable and inconsistent results on snoring-relief and RDI improvement have been reported in patients with mild to moderate POSA using cervical pillow⁴³. The second type promotes prone position of the

body during sleep overcoming the negative effect of gravity on the dimensions and collapsibility of URT⁴⁴ with subsequent improvement of AHI and desaturation rate⁴⁵. Tennis ball technique (TBT) was introduced for the first time in 1985, ensuring uncomfortable position during sleep and thus preventing patients to sleep in a supine position⁴⁶. Shifting from supine to lateral posture in bed, the muscles of the jaw and pharyngeal walls driven by the gravity forces expand the lumen of URT and reduce the resistance, which leads to subjective decrease of snoring intensity, improving daytime sleepiness predominantly in elder patients⁴⁷. Sewed on the back of the pajama or t-shirt, tennis ball sometimes is not sufficient obstacle for some patients and paradoxically they slept over the tennis ball lying in supine position. To overcome this inconsistent result and to increase the compliance of the equipment several devices have been developed. The usage of thoracic anti-supine band proved to be more effective than tennis ball technique with higher compliance rate⁴⁸. Bumper belts (made by neoprene with adjustable straps and inflatable bumpers on the back) and vests (with semi-rigid foam on dorsal parts)⁴⁹ are characterized with different compliance rate for a long period of time⁵⁰. As major reasons for quitting PT, patients define: difficulties in falling asleep, restless sleep, frequent awakening, sweating, etc. Sleep Position Trainer (SPT) is a novel device, different from the typical bulky and uncomfortable equipments described previously. SPT is positioned on the front part of the thorax, placed in specially designed pocket on a belt worn across the chest. SPT incorporates: a 3D sensor for determining body position, battery, SD card to record individual data and USB port to transfer data for further analysis. SPT is an active device, which analyzes sleeping habits, detects undesirable supine position in bed and gradually adapts the vibrating signals encouraging the patient to switch to lateral position. Made by soft materials, without adding unnecessary bulk on the back as well as the opportunity to postpone the beginning of the actual treatment after the patient has already felt asleep, determine the significantly higher percentage of compliance of SPT over the TBT⁵¹. In patients with mild to moderate POSA, the SPT effectively diminish subjective daytime sleepiness and sleep-related quality of life even for long period of time⁵².

The **Oral Pressure Therapy (OPT)** has been implemented in clinical practice as a treatment alternative for snoring and sleep apnea, based on the suction effect pulling out the uvula and soft palate, and stabilizing the tongue. This new equipment consists of 3 parts: nightstand unit (including pump and saliva reservoir), mouth piece with lips seal and tubing, connecting these parts. The generated constant negative pressure by the pump retracts the soft palate forward enhancing the oropharyngeal space and preventing soft tissues from collapse. Patients breathe in and out through the nose, which requires an adequate nasal patency (excluding allergy, nasal polyposis, nasal septum deviations and etc.). Several mouthpieces in different sizes have been developed to ensure perfect fit for individual patients' need. In the mouthpiece is incorporated vacuum aspiration port taking away the produced saliva in the provided container in nightstand unit. Clinically significant improvement of the daytime sleepiness haven reported, accompanied with significant reduction of AHI and desaturation levels⁵³. In

the same time the compliance rate is adequate and no significant side effects of OPT was observed for period of 1 month usage⁵⁴.

Oral appliances (OA) are simple and inexpensive devices for treatment of primary snoring⁵⁵ as well as mild to moderate OSA⁵⁶. The application of OA in the treatment of URTR is limited to several studies^{57 58 59}. The major effect of OA is accomplished by pulling forwards genioglossus muscle and other muscles of the oropharynx and hypopharynx, expanding antero-posterior dimensions of the pharynx and reducing resistance of URT. Tongue retaining devices (TRD) are made of soft plastic material, which hold on the tip of the tongue by vacuum, without advancing the mandibula, creating a seal with the lips and preventing the base of the tongue to fall backwards against the posterior pharyngeal wall during the sleep. TRD come in different sizes and are suitable for edentulous patients, patients with TMJD and patients with hypothyroidism which usually have macroglossia (owing to increased accumulation of mucopolysaccharides) and increased regional subcutaneous fat deposits. TRD side effects are minor and frequently are associated with tongue discomfort and excessive salivation⁶⁰. TSD are designed to treat mild to moderate OSA^{61 62}. Mandibular advancement devices (MAD) repositions the mandibula anteriorly with subsequent tongue protruding and changing position of the soft palate by pulling out palatoglossus muscle. MAD are fabricated either as a monoblock or consists of two separated parts with coupling mechanisms allowing different level of adjustment, variable mandibular movements in vertical and lateral directions and oral respiration. MAD requires preserved dentition and are not suitable for patients with TMJD. Nevertheless off-the-shelf devices are available on the market; the preferences are towards customizable MAD for reduction of patient discomfort and side effects. The most pronounced short term side effects are - dry lips, difficulties falling asleep, increased dental tenderness, hypersalivation, sore throat, pain in the temporomandibular joints, which are considered mild and transient⁵⁶. The long term side effects - broken / loosened teeth, periodontal complications, muscle spasms and occlusal changes appeared in the first 2 years of MAD usage⁶³. This requires regular visits to the dentist to perform frequent adjustments and to determine risk/benefits ratio for the patients and if it's necessary to recommend an alternative treatment. Even in cases with severe OSA, MAD are considered to be better alternative than TRD in addition to enhanced compliance and tolerability⁶⁴. Recently it has been reported that the SPT could be used as supplemental therapy to mandibular advancement devices in patients with POSA significantly improving the AHI reduction⁶⁵.

2. Conclusion

For the last years based on the extensive clinical investigations and critical data interpretation strict criteria for treatment of sleep-related breathing disorders have been delineated. Patients, who are not suitable for surgery or there are contraindication for operative therapy, should be referred for conservative treatment. CPAP therapy is believed to be a golden standard for conservative treatment of OSA. Nevertheless significant improvements and technological achievements have been implemented in the contemporary

CPAP equipment; the compliance rate is still low. Patients who don't tolerate CPAP therapy should consider wide spectrum of CPAP alternatives. The role of the otorhinolaryngologist as medical specialist who is intimately familiar with the anatomy of the URT and pathophysiology of OSA is essential and should direct patients to thorough sleep exam in the PSG lab in case a SDB is suspected. Based on the data collected from the physical examination and PSG results a critical estimation of patient's medical condition should be done. Considering the complexity of OSA, it is important that the ENT specialist builds up a useful therapeutic strategy combining different medical devices to ensure increased effectiveness and satisfactory compliance.

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