

DOI: <https://doi.org/10.17816/uds622878>

Review Article

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

Roman A. Fadeev, Alexandra Yu. Smolentseva

North-Western State Medical University named after I.I. Mechnikov, Saint Petersburg, Russia

ABSTRACT

This study aimed to provide an overview of the diagnostic methods and treatments for snoring and obstructive sleep apnea syndrome. The average incidence of snoring is 40% among men and 20% among women aged 30–60 years. The average incidence of obstructive sleep apnea syndrome is 4% among men and 2% among women. These data are close to the incidence of diabetes and are twice as high as that of severe bronchial asthma. Currently, approximately 1 billion people have obstructive sleep apnea syndrome. The average incidence rates of snoring and obstructive sleep apnea among children are 27% and 1.2%–5.7%, respectively, with peak incidence recorded at the age of 2–8 years because of the hypertrophy of the tonsils and adenoids. In this study, modern diagnostic methods and treatments for snoring and obstructive sleep apnea syndrome are considered. A complex approach to patient treatment justified.

Keywords: snore; apnea; polysomnography; individual mouth guards.

To cite this article

Fadeev RA, Smolentseva AY. Review of modern methods of diagnosis and treatment of snoring and obstructive sleep apnea syndrome. *Acta Universitatis Dentistriae et Chirurgiae Maxillofacialis*. 2023;1(1):15–22. DOI: <https://doi.org/10.17816/uds622878>

Received: 31.10.2023

Accepted: 07.12.2023

Published: 05.02.2024

DOI: <https://doi.org/10.17816/uds622878>

Обзорная статья

Обзор современных методов диагностики и лечения храпа и синдрома обструктивного апноэ сна

Р.А. Фадеев, А.Ю. Смоленцева

Северо-Западный государственный медицинский университет им. И.И. Мечникова, Санкт-Петербург, Россия

АННОТАЦИЯ

Представлен обзор методов диагностики и лечения храпа, в том числе осложненного синдромом обструктивного апноэ сна. В среднем распространенность храпа отмечается у 40 % мужчин и 20 % женщин в возрасте от 30 до 60 лет, у 4 % мужчин и 2 % женщин — синдром обструктивного апноэ сна. Данные по распространенности синдрома обструктивного апноэ сна близки к распространенности сахарного диабета и в 2 раза превышают частоту встречаемости тяжелой бронхиальной астмы. По последним данным, на сегодняшний день не менее 1 млрд человек во всем мире страдают синдромом обструктивного апноэ сна. Распространенность храпа отмечается у 27 % детей, синдрома обструктивного апноэ сна — у 1,2–5,7 %, пик распространенности — 2–8 лет, что связано в основном с гипертрофией миндалин и аденоидами. Рассмотрены существующие на сегодняшний день методы диагностики и лечения храпа и синдрома обструктивного апноэ сна и обоснован комплексный подход к ведению пациентов, страдающих этим заболеванием.

Ключевые слова: храп; апноэ; полисомнография; индивидуальные каппы.

Как цитировать

Фадеев Р.А., Смоленцева А.Ю. Обзор современных методов диагностики и лечения храпа и синдрома обструктивного апноэ сна // Университетская стоматология и челюстно-лицевая хирургия. 2023. Т. 1. № 1. С. 15–22. DOI: <https://doi.org/10.17816/uds622878>

BACKGROUND

Snoring is an acoustic phenomenon caused by the vibration of laryngeal and pharyngeal soft tissues during inhalation, with incomplete obstruction of the upper airways [3]. Snoring was once considered a sign of good health; however, it causes sleep disturbance and decreases work capacity. Recently, snoring has been recognized as a disease (ICD 10 code R06.5). It can sometimes reach a volume of 112 dB, which is comparable to a powerful siren. Although snoring does not have serious consequences, it is often associated with obstructive sleep apnea syndrome (OSAS; ICD 10 code G47.3). The causes of OSAS include excessive body weight, pathology of ENT organs, and dentomaxillofacial anomalies, primarily mandibular retrognathia [4, 5]. OSAS, a sleep-breathing disorder, is characterized by the cessation of lung ventilation for >10 s. In severe cases, this period can last 2–3 min. Prolonged apnea leads to hypoxia and hypercapnia, resulting in metabolic acidosis and worse symptoms. Upon reaching a certain threshold of these changes, an individual undergoes awakening or transitions to the superficial stage of sleep. At this stage, the tone of the muscles in the pharynx and mouth increases, leading to the restoration of airway patency. This is often accompanied by a series of deep breaths, typically accompanied by loud snoring. As the blood gas parameters normalize, a deeper phase of sleep begins [6].

In patients with OSAS, blood pressure increases significantly during an apnea episode, which can cause serious complications. Patients with OSAS may experience cardiovascular and pulmonary disorders because during apnea, bradycardia occurs, which is then replaced by tachycardia upon normal ventilation restoration [7]. Apnea episodes can reach 10–15 per hour and affect up to 60% of the night's sleep time. In addition, some cases have asystole periods lasting 8–12 s and severe tachyarrhythmias. These heart rhythm disturbances can lead to sudden death during sleep. To evaluate the association of OSAS with the risk of sudden death in sleep, researchers at the University of Pennsylvania conducted a systematic review of 22 studies involving 42,000 patients worldwide [8]. The meta-analysis revealed that patients with OSAS have a twofold higher risk of sudden death compared with those without OSAS. OSAS also increases the risk of death from cardiovascular disease by twofold. Furthermore, episodes of asphyxia and frequent nighttime activations can lead to secondary pathophysiological disorders, including neuropsychiatric and behavioral

changes, decreased memory and intelligence, personality changes, and daytime sleepiness that persists throughout the day regardless of activity [9, 10]. OSAS can lead to a decrease in performance and threatens life. For instance, a study demonstrated that drivers with OSAS are involved in accidents 2–3 times more frequently [9, 10].

Diagnostic methods for snoring and OSAS

Polysomnography is the only reliable method for diagnosing snoring and OSAS. It can be performed in a hospital or at home for 8 h. During sleep, 18–24 sensors are attached to the body to record physiological parameters such as body position, respiratory and cardiac parameters, eye and limb movements, chin muscle tone, brain activity, chest and abdominal wall excursions, saturation, oronasal airflow, and snoring [11]. Polysomnography enables a dependable evaluation of the disease form and severity and associated sleep disorders, including bruxism [12, 13]. According to the classification of the American Academy of Medicine [14], four types of polysomnography are available. Type 1 is the most reliable, is performed in a hospital, and requires medical personnel. Types 2–4 do not require an inpatient stay, and the study is recorded on the polysomnograph memory card. Computerized pulse oximetry and respiratory and cardiorespiratory monitoring may be performed to determine the need for polysomnography. Pulse oximetry is a screening diagnostic method used to determine the blood oxygenation level. It can establish moderate and severe degrees of OSAS because cyclic drops in oxygen levels occur in these cases [15]. Respiratory and cardiorespiratory monitoring is more accurate and, in most cases, allows for the diagnosis of snoring and OSAS. However, they are limited to recording oxygenation, respiratory, and cardiac activity parameters.

CONSERVATIVE TREATMENT

Both surgical and conservative methods are used to treat snoring and OSAS. Conservative treatments include position therapy and the use of standard or customized mouthguards during sleep and electronic devices.

Position therapy methods are based on the idea that breathing disorders worsen when lying on one's back, as the soft palate, uvula, and root of the tongue move backward. Elevating the head can prevent these movements; thus, tilting the patient's bed and using orthopedic contoured pillows are recommended to maintain an optimal head position and reduce snoring.



Fig. 1. Individual rigid mouth guard with neuromuscular and mandibular position regulation

Рис. 1. Индивидуальная жесткая лабиальная каппа с нейромышечной регуляцией и регуляцией положения нижней челюсти

In cases of position-dependent snoring, a recommended solution is to sew a pocket between the shoulder blades of the nightgown and place a tennis ball or miniature bells inside. This will prevent the patients from sleeping on the back and help them adopt a different sleeping position. However, this method can induce insomnia.

The use of intraoral mouthguards during sleep is considered the most effective treatment for patients with mandibular retrognathia-associated snoring [16, 17]. Mouthguards come in standard silicone, which fix the mandible in a given position, or thermolabile, which regulate the mandible's position. To use the thermolabile mouthguard, it is placed in hot water for a few minutes after fitting and then inserted into the mouth. A disadvantage of the latter approach is the subjective nature of determining the correct position of the mandible, which can negatively affect the treatment outcome or even lead to the development of temporomandibular joint (TMJ) dysfunction. Individual nonlabial mouthguards with a fixed mandibular position are also introduced, which allow for the reliable determination of the correct position of the mandible but do not permit the patient to make mandibular movements, including yawning or sneezing. S.P. Rubnikovich, Doctor of Medical Sciences, Professor, and Rector of the Belarusian State Medical University, suggested the most accurate and comfortable mouthguard. Sergey Petrovich proposed an original design for an individual rigid labial mouthguard with regulated neuromuscular and mandibular positions. The patient's upper

and lower teeth are scanned to create the appliance. The mouthguard's contact points with the teeth are evaluated after computer modeling in the articulator. The position of the mandibular head in the TMJ is assessed based on computer tomography results. Electromyography is used to consider the tone of the masticatory muscles. When designing the appliance, the position of the mandible is determined to ensure maximum airway patency. The airway volume can be adjusted by >2.5 times if necessary. The mouthguards are modeled and printed on a 3D printer and then fitted. The design of the appliance includes an adjustable screw to allow for mandibular movements (Fig. 1).

Electronic devices are available for treating snoring. These devices detect snoring and send electrical signals through conductive electrodes to the surface of the patient's skin for 5 s. This causes the sleeping person to change sleeping positions and change from the deep to superficial sleep phase while increasing the tone of the laryngeal and pharyngeal muscles.

Extraoral devices are available to treat snoring, such as stickers on the wings of the nose or special clips that facilitate nasal breathing, and bandages on the chin that limit lower jaw movements. However, their effectiveness is not always guaranteed.

Constant positive airway pressure (CPAP) devices are commonly used to treat patients with moderate to severe OSAS [18, 19]. The technique involves slightly inflating the airways during sleep, which prevents pharyngeal soft tissues from collapsing and eliminates the main mechanism

of snoring. Different types of CPAP devices are available, including automatic and nonautomatic CPAP, as well as two-level bipositive airway pressure (BiPAP). Nonautomatic CPAP delivers air at a fixed pressure, whereas automatic CPAP allows for pressure adjustment within a predetermined range and can detect apnea episodes, increasing airway pressure accordingly. BiPAP allows for separate pressure adjustment during inhalation and exhalation; thus, it is suitable for patients with respiratory insufficiency.

To prevent OSAS, recommendations include losing weight, quitting smoking, and limiting intake of alcohol and sleeping medications. Strengthening the palatal, nasopharyngeal, and laryngeal tissues can be achieved by playing the Australian didgeridoo. The following exercises are prescribed for snoring:

- Moving the jaw back and forth and preventing forward movements by pressing on the chin with the palm or fist. Thirty repetitions are recommended.
- Clamping a wooden stick in the teeth and holding it for 3–4 min.
- “Moving” the root of the tongue back toward the throat. The mouth should be closed, and breathing should be done through the nose. Thirty repetitions are recommended.
- Making 10 circular movements of the lower jaw, first clockwise and then counterclockwise. The mouth should be ajar.
- Pressing the tongue on the upper palate for 1 min with force. Three attempts with 30-s intervals are recommended.
- Pronouncing aloud 20–25 times vowel sounds “I” and “u,” with a strong tension of the neck muscles.

SURGICAL TREATMENT

If conservative therapy is ineffective or snoring must be treated, surgery may be prescribed. Indications for surgical treatment include uncomplicated snoring, absence of significant obesity, elongated and hypotonic palatine uvula, moderately redundant soft palate, normal pharyngeal structure type, and absence of other significant causes of upper airway obstruction such as nasal obstruction, tonsil hypertrophy, obesity, or retrognathia of the mandible [20]. The following procedures are the most common:

Uvulopalatoplasty corrects the soft palate, palatine palate, and uvula. The surgeon makes incisions to form a framework that compacts the tissues and increases the airway's lumen.

Uvulopalatopharyngoplasty, also known as staphyloplasty, involves the removal of an enlarged palatine uvula and palatine cords.

Injection plasty, also known as snoreplasty, involves injecting a hardening agent into the area beneath the uvula. This reduces the tissue volume and tightens the soft palate, which can help alleviate snoring.

Laser ablation reduces the size of the palate and uvula, thereby minimizing unwanted vibration.

The Pillar procedure involves the insertion of microscopic implants made of complex polyester into the soft palate that provides structural support and strengthens the soft palate.

CONCLUSIONS

Effective management of snoring and OSAS requires a comprehensive approach and accurate diagnosis. The treatment strategy chosen depends on the combination of factors that contribute to this pathology and its severity. To confirm the diagnosis, patients suspected of having OSAS require cardiorespiratory monitoring or polysomnographic examination. In most cases, a team of specialists from various fields is necessary.

ADDITIONAL INFORMATION

Authors' contribution. All the authors made a significant contribution to the preparation of the article, read and approved the final version before publication. Personal contribution of each author: R.A. Fadeev — collecting material, writing and editing the text of the manuscript; A.Yu. Smolentseva — collecting material, analyzing the data obtained, writing the text of the manuscript.

Funding source. The authors claim that there is no external funding when writing the article.

Competing interests. The authors declare the absence of obvious and potential conflicts of interest related to the publication of this article.

Ethics approval. The material of the article demonstrates an analysis of the literature on methods for diagnosing and treating snoring and obstructive sleep apnea syndrome.

Informed consent to publication. All participants voluntarily signed an informed consent form prior to the publication of the article.

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AUTHORS' INFO

Roman A. Fadeev, MD, Dr. Sci. (Medicine);
ORCID: 0000-0003-3467-4479; Scopus Authors ID: 6503892124;
eLibrary SPIN: 4556-5177; e-mail: sobol.rf@yandex.ru

***Alexandra Yu. Smolentseva**, senior assistant;
address: 41, Kirochnaya St., Saint Petersburg, 191015, Russia;
ORCID: 0009-0002-0977-8743; e-mail: sandrasm@yandex.ru

* Corresponding author / Автор, ответственный за переписку

ОБ АВТОРАХ

Роман Александрович Фадеев, д-р мед. наук;
ORCID: 0000-0003-3467-4479; Scopus Authors ID: 6503892124;
eLibrary SPIN: 4556-5177; e-mail: sobol.rf@yandex.ru

***Александра Юрьевна Смоленцева**, старший лаборант;
адрес: Россия, 191015, Санкт-Петербург, ул. Кирочная, д. 41;
ORCID: 0009-0002-0977-8743; e-mail: sandrasm@yandex.ru