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Sleep apnea and mandibular advancement device. Revision of the literature

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Abstract
Sleep apnea and hypopnea syndrome (SAHS) is a disorder characterized by intermittent and repetitive obstruction of the upper airway provoking pharyngeal collapse. It is characterized clinically by a triad of daytime hypersomnia, snoring and pauses in breathing during sleep that are normally reported by the partner. Polysomnography is the chosen method for diagnosing this pathology. Patients with this disorder tend to have the following dental and orofacial signs: a retrognathic jaw, a narrow palate, a wide neck, deviation of the nasal septum and relative macroglossia, among others. Dentists should be ready to evaluate the risk-benefit of certain dental treatment options for this public health problem. The treatment of this problem will depend on its severity, with one of the options being the Mandibular Advancement Device (MAD) that is used especially in the treatment of slight or moderate SAHS and in the treatment of snoring, with results that are occasionally very successful. The objective of this study is to carry out an up-to-date literature review of SAHS and to evaluate the role of the dentist when faced with this pathology.

Key words: *Sleep apnea, mandibular advancement device, polysomnography.*

Introduction
Obstructive sleep apnea syndrome (SAHS) is a disorder that derives from the intermittent and repetitive occlusion of the upper airway during sleep. This occlusion is due to the inspiratory collapse of the walls of the pharynx, which determines the complete closure (apnea) or partial closure (hypopnea) of the airway. Apneas or hypopneas are of varying duration and have distinctive repercussions on cardiorespiratory homeostasis. Its repetition during sleep, sometimes several hundred times in one night, and day after day for years, ends up producing significant alterations in the central nervous system, in myocardial and cerebral circulation and in pulmonary and systemic circulation (1).

From a clinical point of view, SAHS is characterized by the daytime triad hypersomnia, snoring and nocturnal apnea generally reported by the affected person's partner and are symptoms simultaneously present in nearly all patients. What is more, other neuropsychiatric and cardiorespiratory disorders frequently occur, that are secondary to the constant oxygen desaturations and the transitory and subconscious awakenings ("arousals") that cause apneas (1).

SAHS is currently a public health problem of great importance. Firstly, its main clinical manifestation, daytime hypersomnia, has an important impact on the family, work and society, including a deterioration in personal relationships, job absenteeism, traffic accidents, etc. Secondly, its prevalence is estimated to be quite high (2-4). Studies recently carried out in our country have found varying figures, for the adult population, between 4% and 6 % in males and around 2 % in females (2,3).

After the Spanish consensus of 2005 (3), a recommendation was made to use the term "Sleep Apnea Hypopnea

Syndrome" and its acronym "SAHS" given that this includes a specific reference to hypopneas, which are considered to be growing in importance in adults as well as children. This acronym omits the term "obstructive" and includes mixed and central apneas. Finally, this acronym coincides with the English definition of Sleep Apnea and Hypopnea Syndrome making it easier to use (1).

Objectives

- To carry out a bibliographical revision of Sleep Apnea-Hypopnea Syndrome (SAHS).
- To describe the many dental and mouth problems that these patients have.
- To detail the treatments used for SAHS including the Mandibular Advancement Device (MAD).
- To determine the dentist's role in the multidisciplinary treatment of this pathology.

Materials and Methods

We have carried out a search of articles published during the last 10 years (1997-2007). The search was carried out in the following databases: Medline, PubMed, Base, web of sciences and Cochrane Library. For the search we used the words "sleep apnea", "treatment of apnea", "apnea and oral problems" and "degrees of mandibular advancement".

Results

We selected a total of 32 articles that were of many different types (clinical reviews, therapeutic procedures, case studies and controls). Those considered to be most important have been summarized in the following table 1.

Physiopathology and systemic clinical manifestations

Snoring, an expression of the narrowing of the pharynx, is due to the vibration of the soft parts of the upper airway (the pharyngeal walls, the veil of the palate and the uvula). Furthermore, it is the most common symptom reported by patients with SAHS or by their partners on the patient's behalf (1,3).

The main daytime manifestations are xerostomia, gastroesophageal reflux, impotence, irritability, depression, decreased libido, non-restorative sleep, concentration difficulties and headaches. Whilst nocturnal manifestations include diaphoresis, xerostomia, salivation, altered sleep-patterns, awareness of apnea and sensation of suffocation or panting (3).

SAHS in these patients is frequently associated with neuropsychiatric and cardiorespiratory disorders (arterial hypertension, cardiac insufficiency, bradycardia and nocturnal arrhythmias, dilated myocardiopathy, pulmonary hypertension and ischemia in severe SAHS.) In these cases it is advisable to include an echocardiography in the clinical evaluation of this type of patient.

It is common to find these patients to be obese and this disorder is linked to the habit of alcohol and tobacco consumption (3).

Orofacial manifestations

The most common mouth and facial characteristics found include retrognathic jaw, a narrow palate, a wide neck, a deviated nasal septum and relative macroglossia (15-17).

Dental manifestations

It is very important to evaluate whether the patient is following a specific treatment for SAHS. A medical history is essential for evaluating the pressure that dental treatment generates for the patient. In non-diagnosed patients or those not treated for SAHS, arterial hypertension can be difficult to control, in fact some researchers have reported the worsening of asthma and epilepsy (16). It is very important to evaluate the use of vasoconstrictors in local anesthesia given to patients that might not be properly controlled. Tooth decay frequently occurs in these patients due to the medication that produces xerostomia. If a patient requests dental treatment together with intravenous sedation, the dentist should know that a subgroup of the SAHS population suffers from airway obstruction after the administration of sedation. The dentist could be the first to recognize SAHS due to the repetition of apneic episodes during sedation. What is more, patients with SAHS might have associated gastroesophageal reflux disease (GERD), that increases the risk for the patient of experiencing accidental aspiration and subsequent lung inflammation. What is more, the discomfort due to GERD can be similar to chest pain during a dental appointment. When a patient with heart disease associated with SAHS, has a complaint about chest pain this is an obvious source of tension in the appointment (17).

Diagnosis

The polysomnography is the most precise diagnostic method, although it is also the most laborious, complex and expensive, given that it requires the constant presence of specialized personnel for supervising and attending to the study throughout the whole night (15). Furthermore, this instrument is frequently badly-tolerated by patients, given the discomfort involved and the hospital setting in which it is carried out. On the other hand, the nocturnal cardiorespiratory polygraphy, that can be used in the home, is a much simpler method, that does not require monitoring and is quite well-accepted by the patient. Its specificity in the identification of SAHS is high and its sensitivity is also good. Therefore, in recent years it has been promoted as an alternative to conventional polysomnography (16).

Treatment

SAHS treatment is multifactorial and should encompass several aspects, which are not necessarily mutually exclu-

Table 1. Summary of the most important articles.

Authors	Year	Type of study	conclusions
Clark GT, Sohn JW, Hong CN. (5)	2000	Prospective study of 65 patients with a mandibular device.	There are complications due to the mandibular advancement device that we should evaluate as dentists.
Prinsell JR. (6)	2002	The author presents a retrospective review of 20 patients who were treated surgically with maxillomandibular advancement (MMA) and who were diagnosed pre- and post-operatively using polysomnography.	MMA is an extremely appropriate and potentially definitive type of surgery that can significantly reduce SAHS health problems and provide financial savings for the healthcare system.
Petit FX, Pépin JL, Bettega G, Sadek H, Raphaël B, Lévy P. (7)	2002	Prospective study of contraindications of mandibular advancement treatment in 100 patients.	34 % of patients had TMD and dental problems. It is necessary to adequately evaluate these problems when a treatment is applied.
Robertson C, Herbison P, Harkness M. (8)	2003	To determine occlusal changes in 100 patients who suffer after wearing the mandibular advancement device for SAHS.	Although the replies given by the subjects were very varied, the variation of the vertical dimension and "over biting" were evident 6 months after wearing the apparatus.
De Oliveira Almeida MA, de Britto Teixeira AO, Vieira LS, Quintão CC. (9)	2006	Bibliographical review.	Treatment with mandibular advancement devices should be the treatment of choice for slight-moderate SAHS.
Bucca C, Cicolin A, Brussino L, Arienti A, Graziano A, Erovigni F et al. (10)	2006	Prospective study in 48 patients for evaluating whether there is a relationship between edentulism and the appearance of apnea.	Edentulism favors the appearance of sleep apnea. It could be due to the decrease in the retropharyngeal space.
Ziliotto KN, dos Santos MF, Monteiro VG, Pradella-Hallinan M, Moreira GA, Pereira LD et al. (11)	2006	Study of cases and controls for relating SAHS and auditory treatment.	Based on the results of this study, it could be concluded that there is a relationship between SAHS and auditory problems.
Vidal S, Ferrer M, Masuet C, Somoza M, Martinez JI, Monasterio C. (12)	2007	31 patients with SAHS were included in the study who were diagnosed using the conventional polysomnography and compared to 31 healthy individuals. The objective was to find out the values of the Spanish version of the FOSQ (questionnaire) and its benefit for evaluating the impact of hypersomnolence in people with suspicion of SAHS.	With this study it has been seen that the Spanish version of FOSQ is a good instrument for evaluating the impact of drowsiness on the daily activities of people with suspicion of SAHS.
Arias MA, Garcia-Rio F, Alonso-Fernandez A, Sanchez AM. (13)	2007	Bibliographical review.	The presence of respiratory disorders during sleep in patients with heart failure is very frequent. In many of these patients, these disorders could favor the progression of the disease, and even have a causal role.
Masa Jiménez JF, Barbé Illa F, Capote Gil F, Chiner Vives E, Díaz de Atauri J, Durán Cantolla J et al. (4)	2007	A descriptive, observational and transversal study has been carried out. Contact was made with the public and private centers included in the catalogue of healthcare institutions of the Ministry of Health of 2005. Those that habitually evaluated patients with SAHS were included. The person responsible for each center completed a questionnaire about the availability of resources and delays in diagnosis.	It has been seen that there is a notable deficiency in resources leading to unacceptable waiting lists. Although the situation of diagnosing SAHS has changed favorably with respect to previous studies, it could still be improved. It is essential for health authorities to dedicate more resources to this public health problem.
Johal A, Patel SI, Battagel JM.(14)	2007	Study of cases and controls. The objective was to establish whether there were pharyngeal and craniofacial anatomical differences in 99 patients diagnosed with SAHS compared to the healthy control group.	There are structural and anatomical differences in patients with SAHS diagnosed as an intermaxillary space who have a narrower nasopharyngeal airway.

sive (1). It is important for treatment to be approached using a multidisciplinary team.

1º. *General measures*

Obesity, nearly always present, should be treated with great energy, although it is true that in the long term, significant success is rarely achieved. Good sleep hygiene should be attempted, looking to achieve regularity in habits and timetables, and suppression, at least after a certain time in the afternoon, of alcohol and hypnotics or sedatives (18).

2º. *Sahs treatment with positive continuous upper airway pressure (cpap)*

The treatment of choice for SAHS is CPAP. This is carried out at night using a nasal mask. A specific level of pressure is applied in the upper airway (UA), preventing its collapse. The phenomenon produces a mechanical widening in the area of the UA. It has very few after effects and its treatment is efficient for obstructive, mixed and sometimes also central apneas. It is necessary for a sleep specialist to conduct patient follow-ups (1).

3º. *Pharmacological treatment*

Medroxyprogesterone acetate, almitrine, protriptyline and theophylline are some of the pharmaceuticals tested until now for the treatment of SAHS, although they are not very efficient. They might be recommended in certain specific cases (5) when CPAP does not work.

4º. *Intraoral devices*

The utilization of intraoral apparatus (fig. 1) in the treatment of obstructive problems of the upper airway (UA) is not a new concept. The first publications about intraoral apparatus related to SAHS appeared in the 1980's in an attempt to look for therapeutic alternatives to surgical procedures and CPAP (19).

Although there are more than 50 reported types of efficient apparatus for treating snoring on the market, mandibular advancement devices (MAD) in their two versions (fixed advancement and adjustable advancement), are really efficient for managing obstructive problems of the UA.

MAD's carry out an anterior and inferior movement of the jaw generating anatomical variations in the UA that enable an increase in the pharyngeal area. This movement stabilizes and fixes the jaw and the hyoid bone, preventing the posterorotation of these structures during the decubitus preventing blockage of the airway (20,21).

Although its main effect appears in the velopharyngeal area, they have repercussions for all the pharyngeal segments. There is initially an increase in rigidity and a swelling of the space between the anterior and posterior pharyngeal pillars. It has also been confirmed with axial magnetic resonance imaging how a significant reduction in the width of the pharyngeal lateral walls can be produced that is even greater than the anteroposterior luminal increase. The soft palate is displaced ventrally and this increases the caliber of the lateral walls of the velopharyngeal area which are both factors that drastically reduce snoring (22).

Fig. 1. Mandibular advancement device (MAD) Snorban®.

MADs generate changes in local pharyngeal pressure that contributes to normalizing the physiological properties of the UA (23). The altered anatomical relationship (rotation and mandibular advancement) induce an increase in neurosensorial stimulation that increases the motor muscular tone and reduces the collapsibility of the VAS. In the same way there is an increase in the action vector of the pharyngeal dilating muscles that, on being displaced centrally, increase in length and improve their contractility (20-21). MAD's carry out a similar function to what happens during conscious sedation and in cardiopulmonary resuscitation procedures, where, after ensuring and preserving the permeability of the UA freeing it of any type of strange object, an anterior traction and inferior mandibular procedure is carried out (22,23).

Functional mandibular advancement induces changes in the position of the hyoid bone towards a more forward position. It creates a new position of balance of the suprahyoid musculature, that favors an increase in volume and permeability of the upper airway (24). Although the response is not the same in all patients, some authors admit that there is a dosis-dependent effect, given that as the grade of mandibular advancement is increased there is an improvement in the patient's clinical situation.

In spite of the considerable variability that we find between the many MADs (25-28), there are enough proponents in the scientific literature who have demonstrated its efficiency. All of these published studies document the validity of the method polysomnographically, although initially the design of the apparatus does not seem to be related to its effectiveness (28). There are also patients for whom good results are not achieved: those with severe SAHS, given that although there is evidence and positive data for this group, the success rate is lower than in slight and moderate cases (29). These severe cases include patients with deficient protrusive (scarce mandibular advancement), great "over biting", cases with dental and/or periodontal problems and patients with temporomandibular disorders.

The MAD is very efficient in the treatment of snoring (elimination of this in 50% of cases) achieving a significant reduction in 90%-100% of patients, as well as an improvement in the patient's sleep quality (19).

General dentists could collaborate in SAHS therapy, using mandibular repositioners but they should be aware of the potential occlusion shift that could result from the therapy. The researchers have reported occlusion shifts in patients who use mandibular advancement devices, with the appearance of signs such as the development of posterior open bite, inclination of the incisors, anterior open bite and problems in temporomandibular articulation (17).

5ª. *Surgical treatment*

As already indicated, some structural and anatomical anomalies of the upper airway require surgical treatment. Gastroplasty is recommended for the treatment of SAHS together with morbid obesity when CPAP is not efficient and there is considerable comorbidity (30).

Surgical treatment is controversial when SAHS is not related to specific anomalies of the upper airway (1). Its results are not easy to predict before intervention and its use in the medium and short term is not very clear. Many types of technique are used. Tracheostomy is the most efficient surgical procedure, although the psychosocial consequences it causes have meant that it is specifically recommended only in serious cases in which other therapeutic options have failed. Surgical mandibular advancement, is another option in these cases (7). However, partial palate resection (PPR) and uvulopalatopharyngoplasty (UPPP) (31) are currently the surgical techniques most commonly used due to their relative simplicity (32).

Conclusions

- The dentists or odontologists are sometimes the first professionals to suspect SAHS.
- The diagnostic method of choice for this pathology is polysomnography.
- A good early diagnosis permits the choice of a treatment that prevents future complications.
- There are more and more tests showing that mandibular advancement devices (MAD) improve subjective somnolence rates and breathing disorders during sleep, especially in cases of slight/moderate SAHS.
- It is necessary to be in touch with other healthcare professionals, in order to offer good multidisciplinary treatment in which the dentist has an important role.

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