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GUIDELINE

Obstructive sleep apnea and primary snoring: treatment☆

Authors

Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico Facial (Brazilian Association of Otolaryngology and Neck and Facial Surgery)
Academia Brasileira de Neurologia (Brazilian Academy of Neurology)
Sociedade Brasileira de Cardiologia (Brazilian Society of Cardiology)
Sociedade Brasileira de Pediatria (Brazilian Society of Pediatrics)
Sociedade Brasileira de Pneumologia e Tisiologia (Brazilian Society of Pneumology and Tisiology)

Participants

Zancanella E, Haddad FM, Oliveira LAMP, Nakasato A, Duarte BB, Soares CFP, Cahali MB, Eckeli A, Caramelli B, Drager L, Ramos BD, Nóbrega M, Fagondes SC, Andrada NC

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Descrição do método de coleta de evidência

An active search was conducted in the Pubmed/MEDLINE, EMBASE, Scielo/LILACS, and Cochrane Library databases using the following descriptive terms (MeSH terms): Sleep Apnea Syndromes, Sleep Disorders, Sleep Apnea, Obstructive; Sleep Initiation and Maintenance Disorders, Circadian Rhythm, Sleep, REM/physiology*, Snoring, Disorders of Excessive Somnolence, Restless legs Syndrome, Comparative Effectiveness Research, Polysomnography, Actigraphy, Sleep; Monitoring, Physiologic; Monitoring Ambulatory, home care services, laboratory techniques and procedures, complications, adverse effects, Severity of Illness Index, Mortality, Patient Compliance, Patient Education as Topic, Patient Selection, Attitude of Health Personnel*, Decision Making, Physician-Patient Relations*,Therapy, adverse effects, quality of life, Continuous Positive Airway Pressure, Positive-Pressure Respiration, CPAP, BI-level Positive Airway Pressure, BIPAP, Automatic Positive Airway Pressure, APAP Servo, Orthodontic Appliance Design, Orthodontic Appliances, Oral; Occlusal Splints, Orthodontic Appliances, Dental Arch/pathology, Airway resistance, nasal cavity/physiopathology; nasal obstruction, rhinomanometry, supine position, Removable, Hygiene, weight loss, Drug Therapy, Speech Therapy, Position, Patient Positioning, Posture; Surgical Procedures, Operative; Oral Surgical Procedures, Surgery, Surgery, Oral; Catheter Ablation, Laser Therapy, Cryosurgery, electrocoagulation, Otorhinolaryngological Surgical Procedures, Tracheostomy, Nose/surgery, Pharynx/surgery, Palate/surgery, Tongue/surgery, Uvula/surgery, Adenoids/surgery, Adenoidectomy, Tonsillectomy, Facial Bones/surgery, Maxilla/surgery, Mandibular Advancement, pain, postoperative; postoperative hemorrhage, postoperative complications.

Degree of recommendation and strength of evidence

A: Experimental or observational trials of higher consistency.
B: Experimental or observational trials of lesser consistency.
C: Case reports (non-controlled trials).
D: Opinions without critical evaluation, based on consensuses, physiological studies, or animal models.

Objective

To evaluate the modalities of treatment for obstructive sleep apnea and snoring, focusing on data about clinical treatment, use of intraoral devices, positive pressure, and surgical treatment.

Introduction

The treatment of obstructive sleep apnea syndrome (OSAS) is of utmost importance. Current knowledge about the physiology and physiopathology of the disease still needs further consolidation, both by health professionals and patients in need of diagnosis and treatment.

The natural course of the disease with the onset of severe comorbidities needs to be emphasized at an early stage, since adherence to any therapeutic modality requires the involvement and persistence of both the health professional and the patient.

The choice of the best treatment is yet to be elucidated. The several methods of treatment presuppose a specific, individualized treatment for each patient, taking into account anatomical factors, disease severity indices, comorbidities, treatment adherence, and the need for sporadic follow-up based on objective criteria.

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A multidisciplinary and multi-professional involvement is the best alternative to be offered, regardless of the treatment option chosen.

1. Are there benefits in indicating positive airway pressure (PAP) devices for the treatment of OSAS?

PAP is a non-invasive method of applying positive pressure in the upper airway, preventing its collapse through the formation of a pneumatic cushion. It is effective in improving symptoms of OSAS, daytime sleepiness in the ESS, and quality of life measured by specific questionnaires, and in reducing cardiovascular complications[1,2] (A)[3] (B). There is a significant difference of -9.48 in the Epworth sleepiness scale (ESS) on daytime sleepiness, decreasing from 16.13 (± 1.03) before treatment to 6.65 (± 0.68) after it. When evaluating the physical and mental health using the Short Form Health Survey (SF -36), a physical health improvement of +4.18 ($p < 0.002$) was observed, from 46.53 (± 1.92) to 50.71 (± 1.58), with no difference for mental health ($p = 0.606$). Analysis of the impact of excessive daytime sleepiness (EDS) by the Functional Outcomes Sleep Questionnaire (FOSQ) showed improvement in overall productivity of +3.99 ($p < 0.002$) and alertness of + 8.52 ($p < 0.00$)[1] (A).

The use of PAP, with a level of applied pressure of 8.8 cm H_2O (± 1.6), is associated with a significant reduction of 1.5 mmHg (95% CI: 0.4-2.7) in the mean 24-hour ambulatory blood pressure measurement (ABPM) and a decrease of 2.1 mmHg (95% CI: 0.4-3.7) in systolic and 1.3 mmHg (95% CI: 0.2-2.3) in diastolic pressure. There is significant recovery of the physiological nocturnal blood pressure (BP) reduction in hypertensive patients with OSAS, with a decrease of 2.1 mmHg (95% CI: 0.5-3.6), with a positive impact on cardiovascular risk reduction[4] (A).

It is estimated that the use of PAP results in a mean decrease of 0.89 mmHg in 24-hour BP for each ten-point improvement in the apnea-hypopnea index (AHI), and a decrease of 1.39 mmHg for each increased hour of PAP effective use[5] (A).

Patients with OSAS treated with PAP and submitted to an automobile driving test demonstrate better performance and shorter reaction time to stimuli when compared to a placebo group, suggesting that treatment with PAP can reduce the rate of traffic accidents in patients with OSAS[6] (B).

There are different types of PAP: the conventional and most widely used PAP is that with fixed or continuous pressure (CPAP). In an attempt to increase patient comfort and compliance, CPAP modifications were developed, resulting in higher costs, such as CPAP with pressure reduction in the expiratory phase. Another type is the automatic PAP (APAP), which provides automatic pressure adjustment based on variables such as snoring, flow, and O_2 saturation.

However, studies comparing conventional CPAP with expiratory relief CPAP and APAP observed no superiority among them in terms of patient compliance or better clinical outcome[7] (A)[8-11] (B). There are significant differences in the reduction in the ESS ($p = 0.031$) and a higher tolerable PAP time ($p = 0.047$) for APAP when compared to fixed PAP. All other parameters evaluated were not significantly different between the two types of PAP: mean pressure used, residual AHI, psychomotor vigilance test (PVT), objective sleepiness in the Osler test, and improvement in quality of life both in physical and mental health[7] (A).

Bilevel PAP is a variation that uses independent levels of inspiratory and expiratory pressure. It is indicated for specific cases of patients with OSAS and pulmonary disease, obesity hypoventilation syndrome, and patients who need high CPAP pressure (> 15 cmH_2O)[12] (B)[13] (C). There is also the servo-ventilator, which automatically adjusts pressure through ventilation-to-ventilation analysis, effective for treating cases with predominance of mixed apnea, Cheyne-Stokes respiration, and complex sleep apnea[14] (B).

Thus, PAP is indicated to treat patients with symptomatic OSAS, especially moderate and severe cases. There are controversies regarding the effectiveness of PAP in mild OSAS, with the limitation of lower adherence by these patients, who are generally less symptomatic. Therefore, PAP could be a second option for mild cases[1,2] (A) [3,17] (B). Patients with mild OSAS use PAP for a mean time of 3.53 h/night, which allows for a reduction in the AHI to 4.24 at night. The use of PAP in mild OSAS improves symptoms of snoring, daytime sleepiness, and irritability, but does not lead to significant improvement in the ESS, quality of life (SF-36), neurocognitive function, mood, or BP control[18] (B).

Recommendation

PAP treatment is recommended for patients with moderate and/or severe symptomatic OSAS (AHI > 15 and Epworth ≥ 8), since treatment adherence results in the improvement of symptoms, daytime sleepiness[1] (A), time of reaction to stimuli[6] (B), and quality of life[1] (A). Hypertensive patients with OSA demonstrated a small but significant reduction in BP levels and improved nocturnal dipping, leading to a reduction in cardiovascular risk[4,5] (A). CPAP, expiratory relief, and APAP showed similar effectiveness for the treatment of OSAS[7] (A). Bilevel CPAP benefits patients who require higher pressure (> 15 cmH_2O)[12] (B). The servo-ventilator is effective when treating cases of mixed apnea, Cheyne-Stokes respiration, and complex sleep apnea[14] (B).

2. How should the follow-up of patients using PAP be conducted?

The indication for the use of PAP for the treatment of OSAS assumes a lifelong treatment. The criteria for adherence to PAP treatment define the minimal use of four hours per night on 70% of nights during a period of 30 consecutive days[17] (B).

Adherence to PAP therapy presents quite variable rates. When defining adherence as a minimum of four hours per night, rates of noncompliance have ranged from 29% to 83%. Even with the high effectiveness attained in OSAS control, poor adherence determines treatment failure[18] (D).

The follow-up of PAP should be conducted through objective measures. Information storage is performed by the equipment itself, and allows for the issuance of a report containing all data. Periodic analysis of these reports allows for the follow-up, as well as helps resolve factors that hinder the proper use of the equipment[9,19] (B)[20] (D).

The assessment of different impacts on quality of life of PAP users measured by different questionnaires such as the ESS and FOSQ, as well as the Multiple Sleep Latency Test (MSLT), demonstrates that the ideal time should be a minimal use of six hours per night[21] (B).

Several predictive factors have been listed for improvement in adherence to long-term therapy with PAP, from the type of titration, different types of pressure, use of humidifiers, and change of interfaces (masks) to educational and behavioral measures[22] (D).

The use of different PAP equipment, with the incorporation of technological resources and consequent increase in costs, such as reduced expiratory pressure, automatic equipment (APAP), as well as bilevel and servo-ventilator, has not demonstrated improvement in long-term adherence. Apparently, patients prefer the use of APAP, but there was no statistically significant improvement in comparison with fixed pressure equipment. Additionally, the use of humidifiers was not associated with improvement in adherence[18,22] (D)[23] (B).

Different available interfaces or masks exist. The nasal types, such as oronasal and nasal pillow masks, should be used as alternatives in cases of failure to use the nasal mask, which is the first option. The facial mask is an option in patiens with nasal obstruction and nasal dryness that limit the use of nasal masks[24] (B). The adequate use of masks with the correct adjustment must be a frequently monitored factor when assessing adherence[18,22] (D).

To improve adherence, it is important to implement educational measures, such as prior presentation of PAP therapy[25] (B), as well as to encourage patients and to reinforce the importance of their use, which requires a closer physician-patient relationship. It is estimated that only 48% of patients with PAP indication will effectively use it; the patient's body mass index (BMI), a higher degree of disordered breathing, a higher level of knowledge about OSAS, and a higher socioeconomic status contribute to this adherence[26] (B)

An alternative to increase adherence is to provide intensive support to patients starting PAP therapy, which includes monthly home visits, strengthening the educational measures, and monitoring the obtained results through a new polysomnography. These measures have succeeded in increasing the use of PAP (no significant differences between CPAP or bi-level) from 68% to 88% of patients[27] (B). Cognitive behavioral therapy has an important role in increasing the mean time of equipment use[28] (B).

Disease severity, with more significant AHI values, has not been individually identified as a facilitating factor in adherence. The presence of EDS assessed by the ESS (> 10) has been associated with higher adherence[19] (B).

Recommendation

The indication of PAP therapy should involve concern with long-term treatment: lifelong, with a daily use of at least four hours, which must be objective and periodically followed in order to assess treatment adherence[17,19,27] (B). Treatment indications are preceded by a titration in a laboratory[29,30] (B). When evaluating different impacts on quality of life of PAP users, it was defined that the ideal time comprises a minimum of six hours of use per night[21] (B).

The incorporation of technologies and consequent increase in costs regarding the use of equipment such as expiratory relief, APAP, and humidifiers did not result in improved adherence in the long term[23] (B); the nasal mask is the best therapeutic option[24] (B).

Access to educational measures regarding the use and monitoring of PAP therapy has been an important factor in long-term adherence[25-27] (B), along with cognitive behavioral therapy[28] (B).

3. What are the indications, limitations, and possible complications of the intraoral appliance (IOA)?

IOAs can be divided into mandibular advancement devices and lingual retainers. These devices have different designs and can be created from different materials. Their use is recommended in patients with mild to moderate OSAS or primary snoring who preferred IOA to CPAP or who had problems adapting to CPAP[31] (D).

The mandibular advancement devices provide a mean reduction of 14.1 obstructive respiratory events in AHI (95% CI: 7.4-20.8, p = 000.1); when compared to IOA use without mandibular advancement, they showed a mean reduction of 0.9 events (p = 0.69) and the control showed a mean reduction of 1.0 events (p = 0.67), both without statistical significance. Mandibular advancement devices reduced the ESS score by 3.3 (95% CI: 1.8-4.8) and had a treatment dropout rate of 14.8% of cases[32] (B).

When comparing IOA with mandibular advancement to IOA with no advancement, there was no significant reduction in the ESS score (9 ± 1 *vs.* 7 ± 1, respectively; p < 0.0001). The multiple sleep latency testing was used as an objective measure of sleepiness, in which the use of the appliance with mandibular advancement has a mean latency of 10.3 ± 0.5 minutes when compared to 9.1 ± 0.5 minutes with the placebo device (p = 0.01)[33] (B).

IOA with mandibular advancement, after weeks of use, provided a reduction in the 24-hour mean arterial pressure, mainly due to reductions in systolic BP (SBP) and diastolic BP (DBP) when awake, a decrease of -3.0 ± 1.0 mmHg for SBP (95% CI: - 5.7-0.4; p = 0.003) and -3.1 ± 0.8 for DBP (95% CI: -5.2-1.1; p < 0.001). The polysomnography showed increased oxygen saturation of 2 ± 1 (95% CI: 1-4; p < 0.001) and AHI reduction of -12 ± 1 (95% CI: -16 8; p < 0.0001[34] (B).

When comparing IOA with mandibular advancement with CPAP, the latter is more effective for every degree of OSAS severity. Complete response (reduction of AHI > 50% and AHI < 5/h) is achieved in 73.2% of CPAP users and in 42.8% of patients treated with mandibular advancement device. Considering treatment failure when a 50% reduction of AHI is not reached, there was 5.3% of failure in cases using IOA with mandibular advancement, and 3.5% with CPAP. Considering patients with moderate OSAS, complete response with IOA increases to 58.3%, whereas in patients with severe OSAS, it decreases to 31.2%. There is a greater acceptance of the IOA use (71.2%) when compared to CPAP (8.5%), but the dropout rate is higher with IOA (16.6% *vs.* 6.9% of intolerance to treatment)[35] (B). IOA is also considered easier to use than the CPAP (scale from 1 to 6; IOA: 1.8 ± 1.1; CPAP: 3.1 ± 1.5; p < 0.05)[36] (B).

Compared with placebo IOA, the device with mandibular advancement showed a higher number of side effects: mandibular discomfort (p < 0.0001), tooth sensitivity (p < 0.0001), and excessive salivation (p < 0.05), but these complaints were considered mild by the patients[33] (B).

In one study, the lingual retainer failed in 54.5% of cases, while the mandibular advancement device was not successful in 31.8%. All patients who used the mandibular ad-

vancement device were satisfied with the device, while only 59.1% considered the lingual retainer to be satisfactory. A preference for the mandibular advancement device was observed in 90.9% of the studied individuals[37] (B).

Recommendation

IOAs are therapeutic alternatives for the treatment of mild to moderate OSAS. IOAs with mandibular advancement provide a reduction in AHI[32,34] (B), daytime sleepiness[33,34] (B), and mean BP[34] (B). These devices are less effective than CPAP, but have better acceptance[35] (B). Their side effects are common, but considered to be mild[33] (B). The lingual retainer should only be used when there is no possibility of using another type of IOA, as it is considered to be less effective, with treatment failure in 54.5% of cases, and less accepted than a mandibular advancement device[37] (B).

4. What are the other options for medical treatment of snoring and OSAS?

In addition to the PAP and IOA devices, there are other options for non-surgical treatment of patients with primary snoring and OSAS; the most relevant are: sleep hygiene, weight loss, positional therapy, drug therapy, and speech therapy (mio- and orofacial exercises).

Weight loss through bariatric surgeries and low calorie diets was shown to be effective[38] (A), and has been recommended as one of the first treatment options for OSAS in obese patients[38,39] (A). It can be stated that treatment with low-calorie diets for obese patients with moderate and severe OSAS significantly reduces the AHI from 37 to 23 events/h after a mean loss of 20 kg, and, in those patients with severe OSAS, these benefits are even more significant with this type of intervention[38] (A). There is a significant reduction in the BMI accompanied by a reduction in AHI[3] (B)[40,41] (D).

Morbidly obese patients evaluated through polysomnography before and three months after bariatric surgery showed weight loss that ranged from 17.9 kg/m^2 to 55.3 kg/m^2, moving from severe apnea with AHI = 54.7 events/h (95% CI: 49-60) to mild-moderate apnea with AHI = 15.8 events/h (95% CI: 12.6-19.0). Thus, bariatric surgery significantly reduces apnea/hypopnea, and although it does not cure OSA, it minimizes its complications[42] (B).

Sleep hygiene, a set of measures with the potential to interfere with habits that might affect the quality of sleep or induce sleep-disordered breathing, is theorized to be beneficial measure for patients with overall sleep disorders. The measures included in the hygiene denomination are: to avoid sleep deprivation, to sleep on a comfortable bed, to avoid caffeinated beverages or wakefulness-promoting stimulants before sleep, to perform physical activity during the day, to avoid naps at unusual hours, and to avoid alcohol consumption before sleep[39] (A). Few studies evaluating sleep hygiene are available, but one study demonstrated increased collapsibility of the upper airway (UA) in patients undergoing sleep deprivation[43] (B).

The real importance of these first measures of sleep hygiene is yet to be established, as well as how effective they are in reducing symptoms in patients with sleep disordered breathing. There is a lack of prospective, randomized controlled trials to assess the effectiveness of sleep hygiene techniques for OSAS[39] (A). Despite the absence of scientific evidence, these measures should be conducted in patients with OSAS as an initial option, as it does not preclude other treatment options that are known to be effective, such as PAP.

Using measures of sleep hygiene is important, as sleep time per night is associated with higher risk of death. Short duration and sleep increases the relative risk (RR) of death by 12% (RR = 1.12; 95% CI: 1.06-1.18; $p < 0.01$), and many hours of sleep also increase the relative risk of death by 30% (RR = 1.30; 95% CI: 1.22-1.38; $p < 0.0001$)[44] (A). Short sleep duration is also related to obesity in children (OR = 1.89; 95% CI: 1.46-2.43) and adults (OR = 1.55; 95% CI: 1.43-1.68), $p < 0.0001$[45] (A). Sleep deprivation negatively impacts the mood more than it impacts cognitive or motor performance[46] (A).

Another type of non-surgical treatment for OSAS is oropharyngeal exercises, which consists of isometric and isotonic exercises involving the tongue, soft palate, and lateral pharyngeal wall, including the functions of suction, swallowing, chewing, breathing, and speech, requiring a prior assessment of the temporo-mandibular joint. This modality was shown to be beneficial in patients with moderate OSAS.

The evaluation criteria were objective (polysomnographic parameters) as well as subjective, such as subjective sleep symptoms, including intensity of snoring, EDS, and subjective sleep quality. The oropharyngeal exercises allowed for a significant reduction in AHI from 22.4 ± 4.8 to 13.7 ± 8.5 events/h, improved subjective sleep parameters, and significantly reduced the neck circumference measurement (39.6 ± 3.6 to 38.5 ± 4.0 cm), when compared to the control group[47] (B).

Drug therapy has been investigated as an alternative for the treatment of snoring and OSAS. Although some studies have indicated that clinical treatment for allergic rhinitis in patients with snoring or OSAS without indication for nasal surgery is ineffective in reducing AHI and intensity of snoring, a study has demonstrated a reduction in OSA severity (through AHI analysis), with no change in the intensity of snoring (evaluated objectively) using intranasal fluticasone propionate at a dose of 100 mg per day for four weeks[48] (B).

Drug treatments for hypothyroidism and acromegaly control, with thyroid hormone replacement and GH secretion suppression, respectively, were shown to be effective in reducing the AHI and improving other polysomnographic parameters, even before the weight loss that occurs as a result of these treatments[40] (D).

Patients who have AHI at least two-fold higher in the supine position when compared with other positions during sleep have the so-called positional apnea. Positional therapy is the treatment performed to avoid the supine position during sleep. A comparative study to observe the effectiveness of positional therapy with CPAP in patients with positional apnea (AHI < 5 in non-supine position) study demonstrated that CPAP significantly reduces AHI and increases the minimum oxyhemoglobin saturation in relation to positional therapy.

It is important to note that positional therapy was effective, even with inferior results when compared to CPAP, and it was highly efficient in reducing the time during which the patient was in the supine position during sleep[49] (B). Comparing

patients with positional apnea (AHI < 5 in non-supine position) receiving positional therapy or CPAP, it can be observed that both treatments presented similar results in reducing AHI and increasing the minimum O_2 saturation, maintaining sleep architecture and efficiency without significant differences[50] (B). The study of patients with positional apnea undergoing treatment with positional therapy and CPAP showed normalization of AHI (AHI < 10) in 13 of 18 patients treated with positional therapy and in 16 of 18 treated with CPAP. Furthermore, the degree of reduction in AHI was greater during treatment with CPAP[51] (B).

Recommendations

Obese patients and snorers with moderate or severe OSAS benefit from weight loss, either through a low-calorie diet[38] (A) or bariatric surgery, with a reduction in the AHI, but without curing OSAS[42] (B) .

Patients with positional apnea benefit from positional therapy, with a reduction in AHI and increased O_2 saturation, without changes in sleep architecture[50] (B).

Patients with hypothyroidism and acromegaly undergoing treatment have reduced AHI, even before the weight loss occurs as a result of these specific treatments[40] (D).

The benefits of sleep hygiene techniques are not well established, but since they do not cause any harm to other therapeutic options, they can be used as guidelines for patients with snoring/OSAS[39] (A).

5. What is the impact of nasal treatment in the control of snoring/OSAS?

The role of nasal obstruction in the physiopathology of OSAS is uncertain, and the best time for indication for surgical correction of nasal obstruction is still debatable[52] (B).

A recent systematic review on nasal surgery for obstructive apnea treatment showed improvement in quality of sleep ($p < 0.001$), reducing daytime sleepiness, and snoring ($p < 0.05$); however, it did not improve the AHI of polysomnographic assessments ($p = 0.69$)[53] (B). Patients with OSAS have a higher frequency of nasal symptoms and alterations when compared to controls, with 49.8% of cases of nasal turbinate hypertrophy versus 31% in patients without apnea ($p = 0.01$) and more deviated septa. There are no significant differences between the septal deviations grades I and II, but patients with apnea have more deviated septa grade III (5.8% *vs.* 1%, $p = 0.048$)[54] (B).

There have been several studies that used rhinomanometry or acoustic rhinometry to evaluate the nasal cavity of patients with OSAS, and many of them have demonstrated that patients with OSAS manifest higher nasal resistance and smaller values of nasal cavity area and volume when compared with controls[55-57] (B).

There is no benefit of weight loss for the correction of nasal obstruction, as weight loss in overweight or obese patients (BMI: 28-40 kg/m^2) and in those with moderate OSAS allows for a reduction in AHI values without rhinomanometry alterations, while maintaining nasal resistance[58] (B). By contrast, in non-obese patients, nasal resistance is an independent predictor of apnea[57] (B).

Since nasal alterations are more frequent in patients with OSAS, surgery in this anatomical site is assumed to have some impact on disease control. The nasal surgeries performed in patients with OSAS include mainly correction of septal deviation and inferior turbinate hyperplasia.

When assessing patients with OSAS and deviated septum who underwent septoplasty, it was observed that 85.2% of them showed improved nasal resistance, but without effective correction of apnea[59] (B). Those with nasal polyps with at least 50% of nasal obstruction when submitted to endoscopic polypectomy showed reduced nasal resistance ($p < 0.01$), which improved sleep quality, but not AHI ($p = 0.55$)[60] (B).

Nasal surgeries can improve snoring symptoms, daytime sleepiness, and quality of life of patients with OSAS, but these findings are not usually accompanied by improved respiratory parameters at polysomnography (AHI and oxyhemoglobin saturation)[61-63] (B). There is an improvement in AHI in some patients undergoing nasal surgery, with better outcomes associated with lower grades of the modified Mallampati index (good association between tongue and oropharynx) and larger retroglossal space, observed by nasofibrolaryngoscopy[61] (B). The best results are obtained in nasal surgery in patients with lower BMI, with fewer complaints of daytime sleepiness and lower grades of modified Mallampati index[63] (B).

Nasal surgeries have also been performed to optimize the use of PAP devices, the main treatment modality for moderate to severe OSAS, especially the CPAP[64] (B). Values < 0.6 cm^2 of the cross-sectional area at the level of the head of the inferior turbinates presented a sensitivity of 75%, specificity of 77%, providing a low likelihood ratio, but significant in predicting non-adherence to CPAP with LR+ = 1.09 (95% CI: 0.66-1.78)[65] (B).

These studies have demonstrated that the correction of nasal anatomical alterations can reduce the therapeutic CPAP pressure levels, which could make its use more comfortable and perhaps improve treatment adherence[64,66,67] (B), especially in patients who require higher pressures[68] (B). However, only one study with 11 patients objectively evaluated adherence to CPAP after surgery, showing a mean increase of 48.6 minutes in CPAP use after nasal surgery ($p = 0.003$)[67] (B).

Brazilian patients intolerant to CPAP, patients with severe OSAS (AHI = 38 ± 19), and overweight or obese patients (BMI = 30 ± 4 kg/m^2) underwent surgical treatment of the upper airways (reduction of inferior turbinate hyperplasia by radiofrequency [RF], septoplasty, turbinectomy, tonsillectomy, and adenoidectomy). There was a reduction in nasal CPAP titration from a previous mean of 12.4 ± 2.5 cm H_2O to 10.2 ± 2.2 cm H_2O ($p = 0.001$). A reduction of 1 cm H_2O occurred in 76.5% and of 3 cm H_2O in 41.1% of cases 66 (B). Nasal surgeries are capable of improving snoring, daytime sleepiness, and quality of life[53,61-63] (B), as well as decreasing the therapeutic pressure of CPAP use[66] (B); however, there was no benefit in controlling OSAS, especially regarding objective parameters measured by polysomnography[53,61-63] (B).

Recommendation

Nasal surgical treatment has an impact on the control of snoring, EDS, and quality of life, but there is no benefit for the treatment of OSAS, especially when objective parameters are evaluated at the polysomnography[53,61-63] (B). Nasal surgeries performed are basically correction of inferior tur-

binate hyperplasia[60] (B) and septal deviation[59] (B), aiming at decreasing nasal resistance[55-57] (B), observing that nasal resistance is an independent predictor for apnea in non-obese patients[57] (B) and in patients with OSAS who have higher nasal resistance[55-57] (B). Since they modify nasal resistance, surgical corrections are being used in patients with intolerance to CPAP use, with significant reduction in therapeutic CPAP pressure levels,[66] (B) which may favor the increase in the mean time of CPAP use[67] (B).

6. What is the role of pharyngeal surgery in the treatment of OSAS in adults?

The main pharyngeal surgical procedures for the treatment of OSAS are uvulopalatopharyngoplasty (UPPP), laser-assisted uvulopalatoplasty (LAUP), uvulopalatoplasty by RF ablation, and lateral pharyngoplasty. There is great heterogeneity in studies on the main pharyngeal surgery techniques for OSAS treatment, which prevents adequate comparison between the different types of surgeries and between surgical procedures and treatment with CPAP or IOAs. Studies on the surgical treatment of OSAS have biases related to small sample sizes, patient selection, and short follow-up time68 (D). The studies also have flaws regarding data collection and the criteria used to consider surgical success[69] (B).

Considering surgical success a 50% reduction in AHI and a reduction of this index to less than 20 events/h, there was a 55% improvement; however, when using AHI ≤ 10, success rates decreased to 31.5%. Considering a successful procedure as the cure of OSAS, AHI ≤ 5, surgical success was observed in only 13% of cases[70] (B). Pharyngeal surgery is indicated in the presence of tonsil hypertrophy and options for patients non-adherent to CPAP or IOA[71] (B).

UPPP was followed by peri- and post-operative complications including death, bleeding, or respiratory impairment in 0% to 16% of patients; the highest rates of complications were reported in studies from the 1980s and the lowest, in more recent studies[71] (B). A comparative study between the classical technique of UPPP and a modified technique in which there is partial resection of the uvulae muscle demonstrated a significant reduction in AI and AHI. A successful procedure was considered when there was a reduction > 50% in AHI; AHI < 20 events/h was obtained in 30% of patients undergoing the classical technique and 40% in patients submitted to the modified technique[72] (B).

The performance of the surgery on multiple pharyngeal levels has been proposed for the treatment of OSAS. The performance of UPPP associated with resection of the base of the tongue by RF has shown success in 51.7% of patients with moderate and severe OSAS; UPPP associated with elevation of the base of the tongue, a higher-morbidity surgery, was successful in 57% of patients, with no significant differences between the techniques. However, when the study population included obese patients with OSAS, UPPP associated with resection of the base of the tongue by RF showed success in only 12.5% of cases, and UPPP with elevation of the base of the tongue had 10% success; normal BMI was predictive of success.

Therefore, none of the techniques should be used in obese patients with OSAS. In this study, success was considered as 50% reduction in the RDI (respiratory disturbance index) associated with AHI < 15 and the ESS < 11[73] (B).

For the treatment of patients with simple snoring, BMI < 35 kg/m^2 and mild OSAS (AHI < 15), RF ablation reduces the subjective assessment of snoring and decrease in ESS in up to 69% of cases. However, there is no significant reduction in measures of AIH or RDI, and it is not effective as a single treatment for mild OSAS[74] (B). There was no significant improvement in daytime sleepiness, apnea index and quality of life after LAUP and RF ablation.

The need for longer follow-up for assessment of adverse effects, especially those related to swallowing, is emphasized[71] (B). There have been studies demonstrating that both methods are effective for the treatment of simple snoring, and the ablation was less painful in the first post-operative week[75] (B). Aiming to reduce snoring objectively measured with a microphone, both LAUP and UPPP were shown to be effective for patients with a vibrating soft palate at the sleep endoscopy and AHI < 20[76] (B).

UPPP improved daytime sleepiness when compared to controls using CPAP. However, there was no significant improvement in the desaturation index (decrease of 4% of oxyhemoglobin saturation) in the group treated with surgery. UPPP associated with mandibular osteotomy for hyoid suspension showed no difference when compared to UPPP alone[2] (B).

Lateral pharyngoplasty showed improvement in the clinical picture (reduction in ESS from 14 to 4, p < 0.001) and polysomnographic results (mean AHI of 41.6 to 15.5 events/h) superior to those obtained with UPPP in the treatment of OSAS[77,78] (B).

In a systematic review of surgical procedures for the treatment of OSAS, only seven studies met the eligibility criteria. Among these, there is no evidence to support surgical treatment for OSAS, as the overall long-term benefit of surgical treatment has yet to be demonstrated[78] (B).

Recommendation

Pharyngeal surgery may be an option to CPAP or IOA, without significantly improving daytime sleepiness, apnea index and quality of life[71] (B).

The long-term benefit of pharyngeal surgery for treatment of OSAS in adults remains to be demonstrated[71,78] (B). The immediate benefits and what should be considered surgical success are still under debate[69,70] (B).

UPPP associated with resection of the base of tongue by radiofrequency or UPPP with elevation of base of tongue are not recommended for obese patients with OSAS[73] (B).

7. When should palate or tongue procedures be performed?

The use of radiofrequency on the palate reduces snoring according to the visual analogue scale reported by roommate. There was a mean reduction of 8.1 to 5.2 (p = 0.045) when using the radiofrequency and from 8.4 to 8.0 when using control[71] (B), without evidence of objective reduction in level of snoring[79] (B). Palatal RF showed no improvement in AHI or ESS, and should not be considered as therapy in a single session[80] (A). The complications of this procedure include bleeding, infections, and rare cases of velopharyngeal fistula[71] (B). It results in less postoperative pain than the other palatal or tongue procedures, but to date, the time of follow-up in this procedure is short[81] (B).

LAUP showed a reduction in snoring reported according to the visual analog scale, from 9.2 to 4.8 ($p < 0.0001$), whereas in the control group it decreased from 8.9 to 8.5. There were no significant differences at the ESS, but there was a reduction in AHI from 19 to 15 in the patients submitted to surgery, while in the controls it increased from 16 to 23, with $p = 0.004$. The complications of this procedure include bleeding, infections, and a report of a death from septicemia. Persistent adverse effects can occur in 48% to 62% of cases, such as difficulty swallowing, nasal regurgitation, and alterations in voice, taste, and smell. Thus, the technique has fallen into disuse[71] (B).

There are benefits of palatal implants in patients with mild to moderate OSAS. Success rates range from 26% to 41.9%, when success is defined by a reduction of at least 50% in AHI, with a value < 20/h, with significant improvement in AHI at visual analog scale of snoring intensity and in quality of life (QOL and SF-36) questionnaires[82] (A). There is controversy regarding improvement in the ESS or snoring[82,83] (A).

Patients assessed within 18 months after the primary snoring correction procedure maintained the reduction in the analog scale of snoring intensity, from 9.1 ± 1.1 to 5.1 ± 3.15, $p < 0.05$, and maintenance of 52.3% of patients with snoring reduction > 50%. There was a decrease in scores at the ESS from 7.8 to 5.5, $p < 0.0584$ (B). The complications of these procedures are extrusion of the implant and infection[82,83] (A); they are more frequent in women ($p = 0.001$) and in those who needed general anesthesia to undergo the procedure ($p = 0.009$)[85] (B).

Patients with moderate or severe OSAS who do not adapt to or refuse to use CPAP may benefit from procedures on the tongue associated with pharyngeal surgery. Therapeutic success is considered a reduction of at least 50% of the AHI; this index should become less than 15/h and show a score at the ESS below 11, whereas the use of RF at the base of tongue and the elevation of the base of tongue associated with UPPP have a success rate of 51.7% and 57.1%, respectively, with no statistical differences.

The efficacy of RF use at the base of the tongue and the tongue base elevation was lower in obese patients (12.5% and 10%, respectively) when compared to non-obese patients (66.6% and 83.8%, respectively). The complications of these procedures include pain, ulceration of the tongue mucosa, swelling of the tongue and mouth floor, tongue abscess, submandibulitis, pseudoaneurysm of the lingual artery, and severe bleeding after 14 days of RF application; these complications are more frequent in cases submitted to elevation of the base of tongue[71,77] (B).

Recommendation

AThe use of RF on the palate is an alternative therapy for patients with primary snoring without EDS[71] (B), but still requires longer follow-up for evaluation[81] (B). In patients with primary snoring, palatal implants can improve the quality of life, intensity of snoring, and sleepiness[84] (B).

There appears to be initial benefits in quality of life and reduction in AHI with palatal implants in patients with mild to moderate OSAS[82] (A), with controversies regarding the benefits on snoring and sleepiness[82,83] (A).

Procedures on the base of the tongue associated with pharyngeal surgery may be an alternative for patients with moderate to severe OSAS, when there is no tolerance or there is refusal to use CPAP[71,74] (B), with better results in patients with BMI < 30 kg/m^2 [74,79] (B).

8. What is the impact of surgical treatment of the facial skeleton on snoring/OSAS control?

Among the possible surgical procedures for treatment of OSAS, with the exception of tracheostomy, the maxillomandibular advancement (MMA) has shown to be the most effective in OSAS control[86] (B). The success rate (HAI reduction of 50% from baseline, as long as it is < 20/hour) of MMA is 82%, with possibility of cure (AHI < 5 events / hour) of 43.2%. There are few postoperative complications, ranging from 1 to 3.1%. It can significantly reduce AHI from 63.9 events/h to 9.5 events/ h. The following are predictors of surgical success: younger age at surgery, lower BMI, lower preoperative baseline AHI and achieving a higher degree of MMA[86] (B).

Tracheostomy is a procedure used in the presence of acute respiratory failure or all types of OSAS treatment failure[87] (D).

The Stanford group was a pioneer in craniofacial surgery for OSAS control. Initially, they proposed the advancement of the genioglossus muscle achieved by the advancement of the genial tubercle obtained through a horizontal mandibular osteotomy. This surgery aims at increasing retrolingual space and preventing pharyngeal collapse in patients with OSAS. This technique was proposed by Riley and colleagues in 1984 and is usually associated with uvulopalatopharyngoplasty (UPPP), being called phase I of the Stanford protocol[88] (B). Most studies associate pharyngeal surgery with genioglossus advancement, making it difficult to determine the improvement in OSAS through a single procedure. The success rate of this procedure varies from 39% to 79% (mean 67%) in the literature and should preferably be indicated when the suspected obstruction site is the base of the tongue, with few postoperative complications[89] (B).

The MMA includes LeFort I osteotomy of the maxilla and sagittal osteotomies of the mandible with their posterior advancement and fixation[88] (B).

With the anteriorization of the mandible and maxilla and consequent traction on surrounding tissue, it is possible to increase the size of the pharynx and consequently prevent pharyngeal collapse during sleep, observed in patients with OSAS[90] (D).

The MMA was initially indicated as rescue surgery for patients submitted to pharyngeal surgery, especially uvulopalatopharyngoplasty with or without genioglossus advancement (Phase I of Stanford) with no success in OSAS control; it was called phase II (Stanford treatment protocol)[88] (B). Currently, it can also be indicated as the primary form of surgical treatment in patients with severe OSAS that have not adapted to CPAP, or in patients that have not adapted or showed no therapeutic response to mandibular advancement IOA (most effective in patients with mild OSAS), regardless of whether or not they have craniofacial alterations[87] (D).

The MMA has been shown to be an effective short- [91] (B) and long-term[92] (B) treatment, with improvement in quality of life, daytime sleepiness and memory[93,94] (B). During the 13 ± 2.5 months of follow-up of OSAS patients that were randomized to treatment with CPAP or MMA, no significant

differences were observed in AHI improvement, sleepiness scale scores or decrease in BMI between treatments[92] (B). The most frequent complications are dental malocclusion, transient facial paresthesia and velopharyngeal insufficiency[91] (B) [95,96] (C).

Other craniofacial surgeries are described for the treatment of snoring/OSAS in adults, among them maxillary and mandibular distraction[97] (B) and maxillomandibular expansion[98] (C); however, there have been few studies in order to determine which patients this treatment should be indicated to and to establish the real benefit of these techniques in OSAS control.

Recommendation

Surgical treatment of the facial skeleton is indicated in patients with severe OSAS that have not adapted to CPAP or have not shown therapeutic response to IOA with mandibular advancement, regardless of whether or not they have craniofacial alterations[87] (D), as the improvement in AHI, decreased ESS and reduced BMI are similar between surgical treatment and CPAP use[92] (B). Surgical treatment of OSAS can be performed through the MMA, with a success rate of 82% and chance of cure in 43.2% of cases[86] (B). Another technique uses the genioglossus muscle advancement associated with UPPP, with a mean success rate of 67% 89 (B). The surgical procedures increase the size of the pharynx and attempt to prevent pharyngeal collapse during sleep in patients with OSAS[90] (D).

9. What are the treatment options for OSAS in children?

It is estimated that approximately 3% of children have OSAS, with clinical picture of snoring, breathlessness, and hypoxia. Therapeutic options include intranasal corticosteroids, intraoral apparatus, PAP, surgical correction of maxilla and mandible, surgery by RF ablation, cryosurgery, and conventional adenotonsillectomy.

There is no evidence that intraoral appliances are suitable for children; the use of intranasal corticosteroids is better than placebo or saline solution, but their use does not solve all cases of OSAS in children[99] (A)[100] (B).

In cases of children with enlarged adenoids with no association with tonsillar hypertrophy, treatment with nasal corticosteroids should be considered[101-103] (B), which may even prevent an adenoid surgery[104,105] (B). Obese children (mean age 10.8 ± 2.3 years and BMI 27.4 ± 5.1), when compared with normal weight children (mean age 11.7 ± 2.1 years and BMI 18 ± 1.8), had an increased risk of OSAS, ranging from 26% to 32.6%; the association of adenotonsillar hypertrophy increased this risk, with OR = 12.67 (95% CI: 2.14-75.17)[106] (B), requiring a more accurate assessment of this population107 (B).

The main treatment of OSAS in children is surgical, by adenotonsillectomy, based on the fact that its most common etiology is adenotonsillar hypertrophy. The success rate of surgery is variable, from 25%[108] (C) to 82.9%[109] (C), considering polysomnographic criteria (AHI < 1/h), but almost all patients show a significant reduction in AHI when compared to the preoperative index[110] (B)[108,109,111] (C), resulting in improved quality of life, behavior, and cognitive function of the child in the long term[112,113] (B)[114] (C). Obesity, age > 7 years, asthma, and severe OSAS are risk factors for residual OSAS[110] (B)[108] (C).

The mean reduction in AHI after adenotonsillectomy was 18.2 ± 21.4 events/h to 4.1 ± 6.4 events/h, $p < 0.001$[110] (B), with increased oxygen saturation of 71.1 ± 11.1% to 91.2 ± 3.4%, $p < 0.001$[114] (C). Considering OSAS cured when AHI < 1/h, it is estimated that 59.8% of children undergoing adenotonsillectomy achieve this result, which justifies performing a control polysomnography postoperatively[111] (C).

Traditionally, tonsillectomy is performed with cold scalpel, but other techniques have been developed. The dissection with electrocautery has the advantage of improving hemostasis, but increases postoperative pain. Children undergoing tonsillectomy with electrocautery dissection required more analgesics when compared to those who were submitted to cold tonsillectomy, took longer to return to normal diet, and sought outpatient treatment for sore throat, ear pain, low food intake, fever, or bleeding in 54% versus 23% of cases, with statistical significance. Therefore, although it improves hemostasis, tonsillectomy performed with an electrocautery increases morbidity in pediatric patients[115] (B).

An alternative technique is the partial intracapsular tonsillectomy, which can be performed by RF, CO_2 laser, microdebrider, or coblation. When comparing the traditional tonsillectomy with partial intracapsular tonsillectomy by RF, there is less bleeding, less pain after the second hour after surgery, and no pain three days after the procedure, requiring less prescription of analgesics and/or anti-inflammatory drugs. On the ninth postoperative day, children undergoing traditional tonsillectomy lost a mean weight of 660 g, while children who underwent the RF procedure gained 127 g. The surgical outcome was similar between the groups[112,116] (B). There were no statistically significant differences between traditional tonsillectomy and that performed with CO_2 laser[117] (B).

Children treated with microdebrider had a two-fold higher chance to return to normal activities within 2.5 days, and a three-fold higher chance to stop taking drugs for pain within four days, with no significant differences regarding the return to normal diet. In the follow-up, they had a five-fold higher chance of having residual tonsil tissue, whereas the incidence of obstruction caused by this fact remains unknown[118] (A). At a mean follow-up of 20 months, this residual tonsil tissue did not increase the risk of infection[119] (B).

When comparing the traditional tonsillectomy with coblation, the latter resulted in faster healing, reduced postoperative pain, earlier return to normal diet, and no significant differences in primary or secondary hemorrhage[120,121] (A). Regarding the efficacy of OSAS resolution, there is no significant difference between the techniques[122] (A)[123] (B). This last alternative technique is not affordable for the majority of health services, which do not have access to higher-cost equipment[122] (A)[123,124] (B)[125] (C).

In the presence of craniofacial anomalies, orthognathic surgery or orthodontic treatments are indicated, such as mandibular distraction, maxillary distraction and rapid maxillary expansion, combined or not with adenotonsillectomy, with significant improvement of OSAS[126-128] (B)[125] (C).

Recommendation

Adenotonsillar hypertrophy is the most common cause of OSAS in children; its treatment is surgical[110] (B), achieving cure (AHI < 1/h) in 59.8% of cases[111] (C). The following are risk factors for residual OSAS: obesity, age older than 7 years, asthma, and severe OSA before surgery[110] (B). Children with adenoid hypertrophy without association with tonsillar hypertrophy should be considered for clinical treatment with nasal corticosteroids initially[101,102] (B), with the possibility of not requiring adenoid surgery[104] (B).

Obese children have a higher risk of OSAS, particularly when associated with adenotonsillar hypertrophy, requiring careful evaluation[106] (B).

Several surgical techniques exist for adenotonsillectomy[118,121] (A)[112,117] (B) without significant differences between techniques for removal of lymphoid tissue (there are no studies on the manipulation of the pillars) when evaluating the effectiveness in the resolution of OSAS in children[122] (A)[123] (B).

Children with OSAS and craniofacial anomalies are likely to need several corrections, although there is no definition on which must be initially performed[126] (B).

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