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Obstructive sleep apnea syndrome (OSA) in adolescents: therapeutic management

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SUMMARY

Obstructive sleep apnea (OSA) in adolescents is characterized by a predominance of OSA type 2 which is associated with overweight/obesity. The treatment of OSA in adolescents depends on the cause of OSA and its risk and / or precipitating factors. Adenotonsillectomy is the cornerstone of OSA treatment in case of hypertrophy of the adenoids and/or tonsils. An anti-inflammatory treatment has proven its efficacy in mild to moderate or mild residual OSA after adenotonsillectomy. Orthodontic treatments such as rapid maxillary expansion or jaw positioning are indicated in case of dentofacial disharmonies. Continuous positive airway pressure (CPAP), is mainly indicated in type-3 OSA, which is associated with craniofacial or upper airway malformations or anomalies and should be performed by a pediatric multidisciplinary team having an expertise in sleep and OSA. Finally, maxillofacial or craniofacial surgery may be indicated in adolescents with type-3 OSA. In conclusion, the treatment of OSA in adolescents is based on the type of OSA, its severity and the medical characteristics of each patient.

KEYWORDS

Obstructive sleep apnea, Adolescent, Adenotonsillectomy, Obesity, Continuous positive airway pressure

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INTRODUCTION

Obstructive sleep apnea (OSA) is defined as the complete (apnea) or partial (hypopnea) closure of the upper airway during sleep. Its prevalence is estimated at approximately 2% in children, with a peak between the ages of 3 and 5 years, which corresponds to the period when the risk of adenoid and tonsillar hypertrophy is greatest. Indeed, in the majority of cases, the child's OSA is linked to hypertrophy of the lymphoid organs of the upper airways. But other causes or cofactors are frequently associated, especially in very young children and adolescents. This is how the three OSA[13,20] clinical phenotypes are described: Type 1 is seen in young, normal-weight children with marked adenotonsillar hypertrophy. Type 2 is also seen in children, but more likely seen in adolescents, who are overweight with visceral and truncal obesity, increased neck diameter, and moderate adenotonsillar hypertrophy, which is less marked than in type 1. Type 3 concerns is seen in with malformative or craniomaxillofacial pathologies and/or airway and/or neuromuscular or skeletal disorders in which OSA is primarily associated with anatomical abnormalities of the upper airways. Among adolescents, type-2 OSA associated with overweight or obesity is the predominant type. Treatment of adolescent OSA depends on the cause (s) of OSA and factors that increase its risk or aggravate it. In this review, we will sequentially discuss medical, orthodontic, and surgical treatments, knowing that all management must be individualized and evaluated by polysomnography.

MANAGEMENT OF RISK FACTORS

Childhood overweight and obesity is a major public health problem, not only in Western countries but also in developing countries. Many dietary, physical, psychological, and sociofamilial factors help to explain this worrying trend. Childhood obesity affects many organs, including the respiratory system. In fact, obesity along with adenoid and tonsillar hypertrophy is one of the main risk factors of childhood OSA[30]. In adolescents, obesity is the main risk factor for OSA and its management is a priority (Figure 1). The vast majority of adolescents would be cured of their OSA if they could achieve sufficient weight reduction. Unfortunately, weight loss programs usually fail because of family, cultural, and psychological factors. Studies that have evaluated the benefit of weight loss on OSA in obese adolescents are rare and mostly focus on morbid obesity[41,44].

Verhulst et al. analyzed the effectiveness of weight loss through dietary and psychological management, combined with physical activity in children with OSA and morbid obesity[44]. In this

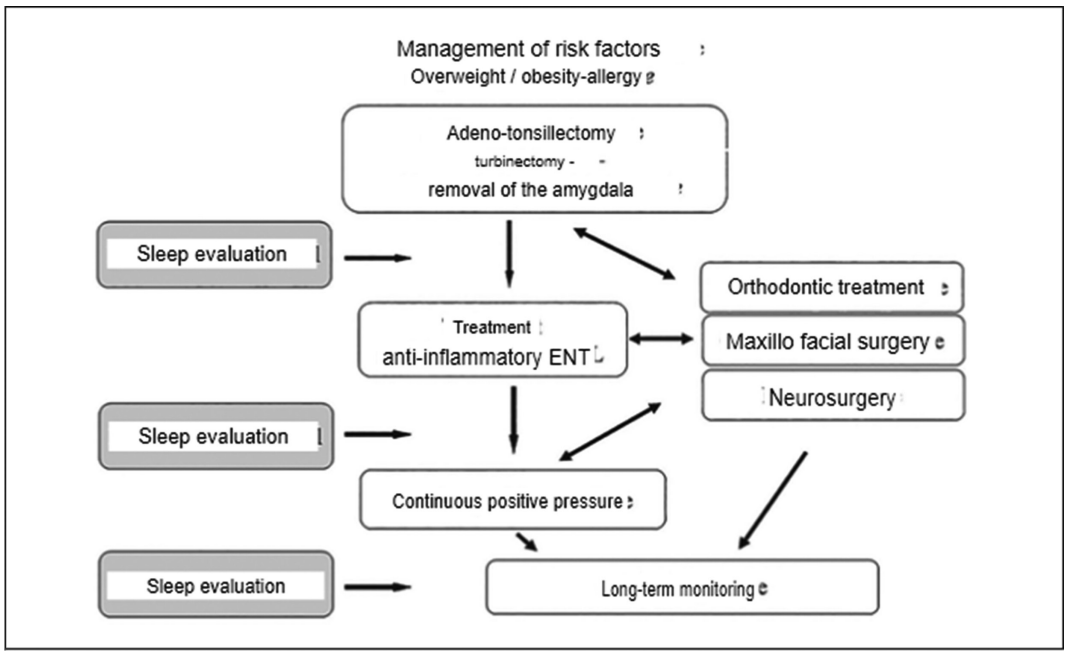

Figure 1
Diagram of the treatment of obstructive sleep apnea syndrome in adolescents.

study, the mean apnea–hypopnea index (AHI) decreased from 3.8/h to 1.9/h (p = 0.002) after an average weight loss of 24 kg and a mean decrease in z-score of the body mass index (BMI) of 34.8%. OSA persisted, however, in 38% children. The persistence of OSA was 33% in another group of 38 obese children (mean BMI 45 kg/m^2), but the weight loss was not reported in this study[41]. Two other studies have evaluated the benefit of bariatric surgery in adolescents with morbid obesity[2,21]. After an average weight loss of 58 kg, the AHI decreased from 9.1/h to 0.65/h ($p < 0.01$) in a group of 34 adolescents with an average BMI of 57 kg/m^2[2,21]. In the second study, weight loss was not specified and OSA was evaluated only on symptoms reported by patients[2].

In conclusion, even though there are few studies on the benefit of weight loss in adolescent OSA, especially in children with morbid obesity, the control of weight must be a priority for any adolescent, regardless of age, regardless of subsequent management.

Allergic rhinitis in atopic adolescents is rarely responsible for OSA. It is important, however, to treat this allergy component, which may reveal moderate OSA or aggravate severe OSA (Figure 1). We will see later that this anti-inflammatory ENT treatment may even be indicated in cases of moderate OSA in a nonatopic adolescent.

ENT SURGERY

Adenotonsillectomy is the standard treatment for OSA in children with adenoid and tonsillar hypertrophy, including in adolescents regardless of obesity status (Fig. 1). In fact, particularly in obese adolescents, the role of tonsillar volume in the pathophysiology of OSA has been well established. A study performed polysomnography and exhaustive three-dimensional analysis of all facial structures (bone, soft tissues, lymphoid organs, caliber, and airway walls) by nuclear magnetic resonance in adolescents aged 12–16 years, who have a normal weight or obesity with and without OSA. Its results showed that the volume of pharyngeal lymphoid tissue plays a vital role in adolescent OSA[40]. This highlights the importance of tonsillectomies as the first-line treatment of OSA in adolescents regardless of BMI[20]. Adenotonsillectomy is also recommended as a first-line treatment in adolescents with type-3 OSA, i.e., the type of OSA associated with an anatomical malformation of the upper airways, such as hypomandibulia, craniofacial stenosis, and achondroplasia[7,42].

There are several tonsillectomy techniques, the choice of which depends on the experience of the surgeon and the anesthesia team, the equipment available, and the patient's medical characteristics and comorbidities. Several recent studies are in favor of an intracapsular tonsillar reduction (partial tonsillectomy), especially in case of type-1 or type-2 OSA. This partial tonsillectomy would be associated with decreased pain and risk of postoperative hemorrhage, while having an efficiency comparable to total tonsillectomy[16,17,48]. On the other hand, there is a risk, albeit a weak one, of tonsillar regrowth, which can be responsible for a recurrence of the OSA, justifying medium-term and long-term monitoring[39,48].

Although the benefit of adenotonsillectomy on sleep parameters, metabolic syndrome, and neurocognitive disorders is well established, its efficacy is not universal and complete in all patients[8,28,31]. The risk factors associated with residual OSA include overweight and obesity as well as OSA severity assessed on preoperative AHI[8,28]. In fact, the persistence of a residual OSA is 4–5 times higher in obese children than in nonobese children with a prevalence between 40% and 76%[6,8,31]. Perioperative and postoperative complications are also increased in obese children. In a study that analyzed the perioperative morbidity of adenotonsillectomy in 2,170 children between 2005 and 2008 according to the severity of the obesity, obese children had an increased risk of anesthetic induction difficulties: desaturation ($p = 0.004$), intubation difficulties ($p < 0.001$), mask ventilation difficulties ($p = 0.001$), and postoperative airway obstruction ($p < 0.001$)[34]. BMI and the presence of medical comorbidities were predictive factors independent of hospitalization duration. The risk of postoperative obstruction of the airway was also significantly more frequent ($p = 0.0003$) and the duration of hospitalization significantly longer ($p < 0.0001$) in a group of 49 obese children than in a group of nonobese children[14]. Finally, in the case of total tonsillectomy, the risk of postoperative hemorrhage is 2–3 times more frequent in obese children

than in nonobese children[24]. This increased risk of complications explains why outpatient surgery is contraindicated in obese children. Finally, adenotonsillectomy is frequently associated with postoperative weight gain, which can be problematic in overweight or obese children, emphasizing the importance of dietary and lifestyle management before and after surgery[43].

Lower turbinoplasty is possible in cases of symptomatic obstructive turbinate hypertrophy that is resistant to medical treatment, regardless of age[11]. However, it is rarely indicated in adolescents and is reserved for very young children with a maxillofacial malformation, such as achondroplasia[19].

Finally, volume reduction of the lingual tonsil is indicated when its hypertrophy has been confirmed by fibroscopy and after failure of adenotonsillectomy[1,22]. This surgical technique has mainly been reported in children with Down syndrome in whom hypertrophy of lymphoid organs is part of the clinical picture[22,26].

In conclusion, adenotonsillectomy is the most effective surgical intervention for OSA[12]. It should therefore be performed whenever there is severe OSA associated with tonsillar hypertrophy, with other ENT procedures depending on the evaluation of the patient's upper airway by the ENT surgeon.

OTHER TREATMENTS

Anti-inflammatory medical treatment

Anti-inflammatory treatment for 3 months with local corticosteroids and/or Singulair (montelukast) has been shown to be effective in mild to moderate or mild residual OSA after ENT surgery, regardless of the underlying allergy[10,15,23] (Fig 1). This local treatment may be attempted in this indication in adolescents, with a type-1 or type-2 OSA.

Management of dentofacial orthopedics

Dentofacial orthopedics include maxillary disjunction with rapid expansion and mandibular propulsion. Rapid maxillary disjunction is indicated in adolescents with transverse maxillary hypodevelopment (narrow and deep palate) associated with a malocclusion (Fig. 1). Using an orthodontic appliance sealed on the molars to "disjoin" the intermaxillary and interpalatal sutures, which remain unfused in children, to obtain a skeletal expansion. It increases the volume of the nasal fossae and decreases any resistance thereof[18]. Mandibular advancement orthoses are intraoral devices that hold the mandible in an anterior position (in propulsion) and exert a mechanical traction of the hyolingual mass that suppresses or limits the pharyngeal collapse during sleep, similar to the ones used in adults[45]. The forces transmitted by these devices generate dreaded dentoalveolar side effects in adults but stimulate mandibular growth in children.

Although these treatments are commonly used in adolescents with a

occlusal disorder responsible for OSA, few studies have evaluated their effectiveness[18]. Rapid maxillary disjunction, however, has shown efficacy on AHI with persistent benefit into adulthood[9,36]. These treatments can be combined with adenotonsillectomy for maximum efficiency on OSA[46]. These orthodontic treatments are compared with myofacial rehabilitation (or "myofunctional therapy"), which aims to strengthen the tone of the tongue, correct its position, and therefore promote nasal breathing[47].

Continuous positive pressure therapy

Continuous positive airway pressure (CPAP) is the treatment used for the most severe forms of OSA[5,20] (Fig 1). It consists of the delivery of positive pressure to maintain airway opening throughout the respiratory cycle to suppress obstructive events and it helps in normalizing gas exchange and sleep quality. The optimal pressure level is determined during a titration test during a laboratory sleep study[25].

CPAP devices operate with a single-branch circuit, the purification of the carbon dioxide being carried out during exhalation by a calibrated leakage system, integrated either in the interface or in the device's circuitry. The air delivered by the CPAP device is humidified and warmed naturally by the nasal cavity, but the addition of a heated humidifier can improve the tolerance and comfort of use in patients. Many options are available for adolescents, whose choice is determined by facial morphology and oral or nasal breathing and comfort[37]. Nasal cannulas are particularly well accepted and tolerated by adolescents. This is important because the main problem of CPAP in adolescents is adherence to treatment. In addition, obese children find it less comfortable than nonobese children. Indeed, the average compliance reported in the studies is approximately 3–4 h of use per night, which is insufficient[29,32,33]. A therapeutic education program, carried out by an expert team, is essential. Indeed, combined with a judicious choice of equipment, it makes it possible to obtain better compliance, even in adolescents, with up to 8.5 h per night on average in our experience[38]. Finally, home-based monitoring must be performed by the home healthcare provider, whose technician and/or nurse must be trained in pediatrics, in conjunction with the pediatric referral team[5].

CPAP treatment is primarily aimed at adolescents with type-3 OSA, that is to say, associated with malformations of the upper airways such as in craniofacial stenosis, Pierre–Robin syndrome, Treacher–Collins, Goldenhar, Down syndrome, achondroplasia, pycnodysostosis, etc.[3,4,7,19,27] or syndromic obesity such as Prader–Willi syndrome or Rohhadnet syndrome[35]. Management in a specialized multidisciplinary pediatric center is essential.

Other surgical treatments

For adolescents with type-3 OSA, other surgical treatments may be indicated such as mandibular distraction (in case of hypomandibulia), maxillary distraction (in case of anteroposterior hypomaxillia), orthognathic surgery at the end of the growth stage, or frontofacial advancement in case of craniofacial stenosis[7]. These treatments are generally

combined with ENT surgery and CPAP to provide comprehensive care that considers account the adolescent's age and growth, and in particular the pubertal development stage. Finally, it is only as a last resort that a tracheotomy is exceptionally proposed, which is reserved in cases where all the abovementioned treatments have failed.

In conclusion, the treatment of adolescent OSA should take into account OSA type, OSA severity, and the patient's own medical characteristics. Patient adherence to any treatment is fundamental to this crucial and vulnerable period of adolescence. Finally, long-term follow-up that integrates polysomnography is needed to verify the correction of OSA and to avoid all the deleterious consequences of persistent OSA in adulthood.

Conflict of interest: The authors declare no conflicts of interest.

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