GUIDELINES OF HELLENIC SOCIETY OF SLEEP DISORDERS (HSSD)

Guidelines for Diagnosing and Treating Sleep related Breathing Disorders in Adults and Children (Part 3: Obstructive Sleep Apnea in Children, Diagnosis and Treatment)

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Obstructive sleep apnea syndrome (OSAS) in childhood is characterized by intermittent partial or complete collapse of the upper airway (obstructive hypopnea or apnea). Airflow reduction or even cessation may be associated with lung hypoventilation and hypoxemia or compromise normal sleep architecture.

Definitions in pediatrics

The term obstructive sleep related breathing disorders includes a variety of pathologic conditions ranging from primary snoring and upper airway resistance syndrome to obstructive sleep apnea- hypopnea syndrome.

Apnea: It is defined as absence of oral and nasal airflow for at least two respiratory cycles. Central apnea is characterized by absence of respiratory effort, whereas obstructive apnea is characterized by continuous respiratory effort without airflow. Mixed apneas have both central and obstructive features without intervention of normal respiration.

Obstructive apnea is considered clinically significant regardless of presence of desaturation or arousals. Central apnea is clinically significant only if it is followed by hemoglobin desaturation by at least 3% or by an arousal. It is also evaluated as significant when it lasts more than 20 seconds, regardless of presence of arousal or desaturation.

Hypopnea is defined as reduction in airflow waveform width by at least 50% compared to width recorded at the longest period of normal sleep, for at least two respiratory cycles. Clinically significant hypopneas have duration greater than two respiratory cycles and are associated with hemoglobin desaturation by at least 3% or with an arousal.

Primary snoring describes presence of snoring without apnea or hypopnea, hypercapnia, hypoxemia, high arousal index, disruption of normal sleep architecture or daytime symptoms.

Epidemiology

Sleep related breathing disorders are met at all ages from infancy to puberty[1]. Prevalence of repeated snoring (> 3 nights/week) is estimated at 3.2%-12.1%[2-4], whereas frequency of OSA is 0.7%-2.9%. A study in 3,680 patients from Thessalia, Greece, aged 1-18 years old revealed a history of repeated snoring in 4.2% and OSAS in 4.3%.

Clinical presentation

Snoring is the most common and characteristic symptom of OSAS and it is caused by partial pharyngeal occlusion. It is produced during inhalation. Its frequency may be low, when it is produced by vibrations of uvula, soft palate, tongue and other soft tissues of the oropharyngeal wall or high, when adenotonsillar hypertrophy is obstructing soft palate movements.

Many children with OSAS experience increased respiratory effort during sleep. Signs of laborious respiration are intercostal retractions, use of auxilliary respiratory muscles and paradox breathing.

Apneas are usually witnessed by parents as short breathing intervals[8-10]. Moreover, OSAS can be associated with unrefreshing sleep, arousals, unusual body position, increased perspiration and oral breathing[11-13]. Children with OSAS usually suffer from daytime sleepiness, hyperactivity and behavioral disorders[1,14-16].

Pathogenesis of OSAS and adenotonsillar hypertrophy

Obstructive sleep apnea-hypopnea syndrome is a combination of anatomic and neuromuscular parameters. Contrary to nose, larynx and trachea, the pharyngeal airway is not supported by bones or cartilages but mostly comprises of soft tissues. During inspiration, diaphragmatic contraction produces negative (suctional) pressure, which is further raised when there is increased upper airway resistance (adenoidal hypertrophy, tonsil-

lar hypertrophy, rhinitis) predisposing to airway collapse. The latter is prevented and airway patency is ensured by the combined muscular tone of genioglossus, geniohyoid, sternohyoid, sternothyroid and thyroid muscle[17-19]. However, this muscular tone is attenuated during sleep (especially in REM stage) and negative inspiratory pressure may lead to complete or partial collapse, resulting in airflow reduction or cessation (obstructive hypopnea or apnea, respectively).

It is common knowledge that prevalence of OSAS is highest in the ages between 2-8 years old, as the development of pharyngeal lymphatic tissue causes maximum narrowing of airway lumen[20]. Brain MRI sagittal planes from 189 children and adults without clinical evidence of adenoid hypertrophy revealed that pharyngeal tonsill reaches its maximum size between 7-10 years old and minimum size at the age of 60[21]. Adenoid size and airway lumen were not correlated in that study. In a second study, MRI from children who did not snore showed that increase of pharyngeal lymphatic volume is symmetrical to upper airway diameter[22]. Therefore, palatine and pharyngeal tonsillar hypertrophy is considered pathologic in subgroups of children and associated with OSAS[23-25].

Despite recent advancements in the study of pharyngeal lymphatic tissue development during the first years of age, few studies have been published so far. Moreover, none of these studies has described alterations in tonsillar and adenoid volume during childhood with CT or MRI in patients with obstructive sleep apnea. Therefore, the acknowledgement that pharyngeal lymphatic tissue reaches its maximum volume in children who snore between 2-8 years old is mostly empirical.

Pathogenesis of OSAS and Obesity

Obesity is a well- known significant risk factor for obstructive sleep apnea in adults, despite lack of a distinct pathogenetic mechanism. On the contrary, the correlation between body mass index and apnea-hypopnea index varies from extremely strong to weak in pediatric literature[26-29].

A study in Greek children demonstrates that, in ages under 6 years old, the risk of developing OSAS is similar among obese or overweight children and children with normal body weight[30]. A probable explanation for this observation is that upper airway occlusion is mostly caused by adenotonsillar hypertrophy in this age. However, older obese or overweight children appear to be at greater risk. Data from a prospective study in Cleveland clearly supports that between 13-16 years old, obese or overweight teenagers are at greater risk of developing obstructive sleep apnea compared to normal weighed teenagers[31].

Diagnosis

Current diagnostic methods aim at detecting patients with obstructive breathing disorders who are at risk of developing complications. History and physical examination, pulse oximetry, daytime polysomnopraphic study, unattended limited sleep study and full polysomnography have been adequately evaluated.

History and physical examination are unable to distinguish between children with OSAS and primary snoring; however they are useful in selection of those who should be screened for OSAS in a sleep centre[32,33]. A reliable evaluation tool is pulse oximetry, as positive results are predictive of pathologic polysomnographic findings. It should be noted that negative results cannott rule out the possibility of a pathologic sleep study[34,35].

Daytime polysomnographic study has an acceptable predictive value and pathologic findings should lead to initiation of treatment of OSAS without requiring a second nocturnal polysomnography. Nevertheless, negative results should be confirmed by nocturnal polysomnographic study[36,37]. Limited polysomnography at home is cost-effective compared to in-laboratory study but it underestimates the number of obstructive hypopneas and overestimates the number of central apneas[38]. Current data is insufficient to allow application of this method in clinical practice.

Full night polysomnography is the only diagnostic method able to quantify sleep related breathing disorders and is considered the gold standard for the diagnosing of OSAS. It can be easily performed at any age, provided appropriate equipment and trained health care providers are available. The following parameters are recorded during polysomnography: respiratory movements, oronasal airflow, hemoglobin oxygen saturation, end-expiratory CO_2, electrocardiogram, electroencephalogram, electrooculogram, chin and tibial electromyogram. Combined analysis of these parameters can lead to an accurate diagnosis.

Complications of OSAS

Since the original recognition and description of OSAS in children, it has become evident that it is associated with serious complications such as growth delay, pulmonary hypertension and cor pulmonale[1]. In the recent years, growth delay is rarely reported owing to early diagnosis of breathing disorder. One interesting observation is that growth rate is improved after adenotonsillectomy even in obese children[39]. It seems that one major factor responsible for postoperative weight gain is reduction in respiratory effort.

Higher blood pressure levels have been reported in children with OSAS and they seem to persist in wakefullness[40,41]. Children with primary snoring who are referred to sleep centers have higher blood pressure compared to normal children[43]; however history of snoring is not considered a risk factor for high blood pressure in the general pediatric population[43].

Several case reports of children with severe OSAS have been described, who developed right heart failure (cor pulmonale) probably due to episodes of nocturnal hypoxemia and resulting pulmonary vasoconstriction[44,45]. Other studies detected reduction in right ventricular flow volume and increase in left ventricular mass with radioisotope ventriculography and ultrasonography[46,47].

Recent data support that obstructive sleep disorders in childhood are associated with alterations predisposing to cardiovascular disease in adulthood. OSAS in childhood has been related to chronic inflammation (higher levels of C-reactive protein)[48,49], metabolic disorders (higher levels of insulin, cholesterol, triglycerides)[50], vascular[51,52] and myocardial alterations[53]. Until recently development of right ventricular hypertrophy was considered of great importance, whereas currently a positive correlation between left ventricular mass and apnea-hypopnea index has been recognized[53].

Another possible complication of OSAS in children is increased prevalence of neurodevelopmental disorders such as learning difficulties and low school performance, behavioral disorders, attention deficit syndrome, daytime sleepiness and hyperactivity[54,55]. It is indicated that children with primary snoring are also at risk of developmental and behavioral disorders[56]. It is unknown whether these disorders are fully reversible after treatment initiation.

Treatment

Diagnosis of OSAS in childhood is established with polysomnographic study in a sleep center. Selection of the appropriate therapeutic intervention is based on apnea hypopnea index (AHI), which corresponds to the number of obstructive and mixed apneas and hypopneas per hour of sleep[57]. Performing sleep studies in all children who snore is considered impossible even in countries with a costly health system and development of screening criteria is required for the detection of patients at high risk of having sleep apnea and associated morbidity.

The treatment of choice for management of moderate-to-severe OSAS (AHI > 5/hour) in children with adenoid and/ or tonsillar hypertrophy is combined adenotonsillectomy[58]. Polysomnographic data shows remission of clinical symptoms and improved findings. Many children with OSAS have been improved and the efficacy of the method has been correlated to preoperative assessment of the severity[59]. Obesity is a predictive factor of poor outcome[60]. However, recent studies demonstrate that postoperatively even obese children experience significant improvement of intermittent airway obstruction during sleep[61], as well as reduction in cholesterol and triglyceride levels[62].

Regional nasal corticosteroids have been administered to children with mild OSAS established by polysomnography (AHI 1-5/hour) who do not meet the criteria for surgical management but experience severe breathing symptoms during sleep[63,64]. Administration of regional nasal corticosteroids for a period of 4-6 weeks improves symptoms and polysomnographic findings and this benefit has been attributed to reduction of adenoid size and to remission of chronic inflammation in nasal mucosa[65].

Use of positive nasal pressure is indicated in children with persistent symptoms and polysomnographic findings of obstructive apnea, despite tonsillectomy/adenoidectomy and administration of nasal corticosteroids[58]. It is also indicated in children with body mass index compatible with obesity who do not respond to other therapeutic methods as well as children with neuromuscular deficits and craniofacial disorders[66]. The level of AHI beyond which positive nasal pressure is suggested has not been determined in children, but morbidity due to the disorder seems to increase in AHI > 5/hour[67].

Conclusions

Snoring in children is not always benign and can be associated with serious complications.

All children should be screened for snoring during regular medical visits and those who are found positive should be referred for further investigation.

Early diagnosis and management of OSAS improves quality of life and probably prevents possible complications.

Pharyngeal and palatine tonsillar hypertrophy and obesity are the most common causes of the syndrome.

DIAGNOSTIC CRITERIA

Diagnosis of OSAS in children cannot be established upon history of snoring and physical examination. Determination of the presence and severity of OSAS requires a polysomnographic study. However, it is extremely difficult, if not impossible, to perform sleep studies to the large number of children who experience frequent snoring (about 10% of childhood population). Therefore, the clinical physician should be able to identify a child who is at high risk of having moderate-to-severe OSAS by the presence of a number of symptoms indicating upper airway obstruction during sleep or signs of associated morbidity (apnea related clinical or laboratory findings).

The next section presents a simple classification of these diagnostic criteria. It should be noted that **the following criteria were developed for children with pharyngeal lymphatic hypertrophy and/or obesity as the primary cause of apnea**. Children with neuromuscular disease, genetic deformities or craniofacial defects comprise a different group of patients that should be evaluated by specialized physicians.

CLINICAL PRESENTATION

The following parameters from patient history, physical examination and laboratory tests have not been comparatively evaluated for their contribution to the diagnosis of OSAS. Therefore, they are mentioned in random order.

PATIENT HISTORY

Main nocturnal symptoms: Loud and constant snoring, apnoic events witnessed by parents, unrefreshing sleep sleep, frequent arousals, increased respiratory effort during sleep, cervical stretch during sleep.

Main daytime symptoms: Oral respiration, difficulty in waking up, morning headaches.

Signs of apnea related morbidity: Daytime sleepiness, hyperactivity, behavioral disorders (e.g. aggressive-

ness, bad manners), lack of concentration and attention, low school performance, nocturnal enuresis.

PHYSICAL EXAMINATION

General assessment: Body weight measurement and calculation of body mass index (BMI), blood pressure measurement

Nose examination for: Nasal diaphragm scoliosis, nasal mucosa thickness, nasal polypodes, signs compatible with allergic rhinitis.

Rhinopharynx assessment for: Adenoid tonsills, choanal atresia, space- occupying abnormalities.

Oropharynx assessment for: Tongue size, uvula morphology and size (bifid uvula), soft palate morphology (e.g. short, long), tonsillar volume and position (classification by Mallampati).

Facial profile: Orthognathic, convex, cavernous.

Lips at rest: In contact, not in contact.

LABORATORY TESTS

C- reactive protein (CRP), total cholesterol, LDL cholesterol, HDL cholesterol, Triglycerides.

The subgroups of patients who should undertake this assessment have not been determined in current literature.

Suggested management

Children with neuromuscular disorders, genetic syndromes and craniofacial disfigures: They are a special population group frequently with a complex pathophysiology. They should be referred to a group of specialists in the management of such conditions.

Children with adenotonsillar hypertrophy who experience:

Nocturnal and daytime symptoms compatible with OSAS, signs of apnea related morbidity, or laboratory findings of apnea related disorder, are highly probable to report improvement after adenoidectomy and tonsillectomy.

Sleep study in children with severe signs and symptoms can lead to preoperative detection of those who are at higher risk of developing postoperative complications or recessive disease.

Children with adenoid and palatine tonsillar hypertrophy and mild clinical presentation (e.g. without laboratory disorders or associated morbidity): The necessity of adenotonsillectomy depends on the physician. However, polysomnographic estimation of AHI > 5/hour indicates surgical management.

Nocturnal hypoxemia is an alternative method provided there is no available sleep center.

Nasal corticosteroid administration for 4-6 weeks can limit the severity of obstructive sleep disorder in those children.

Obese children with adenoid and/or tonsillar hypertrophy: Surgical management is indicated, as in normal weighed children. Concomitant weight control is a significant complementary treatment target.

Obese children without pharyngeal/ palatine tonsillar hypertrophy: Weight control and possibly use of positive nasal pressure is indicated.

Children with recessive disease (persisting episodes of apnea- hypopnea postoperatively) are managed with:

a. Nasal corticosteroid administration (provided there is nasal congestion)

b. Body weight control (in obese children)

c. Use of positive nasal pressure if AHI> 5-10 events/ hour (especially in obese patients, with neuromuscular diseases or craniofacial disfigures)

Summarizing indications of sleep study

1. In children when necessity of surgical management is questionable.

2. In children with very severe symptoms and significant upper airway obstruction in physical examination, in order to detect the subgroup of patients at higher risk of developing operative and postoperative complications as well as recessive disease.

3. Assessment of further management in this subgroup with a second sleep study.

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