

Toddler with Sleep Apnea for Strabismus Repair

Cari Meyer MD, Madison, WI

Rita Agarwal MD, Denver, CO

GOALS AND OBJECTIVES

After this case discussion, participants should be able to:

1. Understand the different criteria that are used to diagnose a child with obstructive sleep apnea (OSA).
2. Understand the pathophysiologic changes that occur in children with OSA.
3. Understand the anesthetic implications of OSA.
4. Develop an anesthetic plan, including premedication, induction, maintenance, extubation, pain management, and post-operative monitoring.
5. Predict which patients will be at the highest risk for post-operative complications.
6. Discuss the Practice Guidelines that exist for the perioperative management of patients with OSA.

STEM CASE

A 2-year-old, 12 kg boy presents on the day of surgery for an out-patient strabismus repair. When obtaining the history, his parents state that he snores at night. They also report a history of wheezing related to “allergies and cold”, but no formal diagnosis of reactive airway disease. Currently, he has a mild runny nose, but no cough, congestion, wheezing, or other symptoms. His parents are fairly certain that his runny nose is due to “allergies”.

What are the ways in which the diagnosis of obstructive sleep apnea is made?

What is the gold standard for diagnosing OSA? And how is it interpreted?

What percent of patients presenting for adenotonsillectomy have had a sleep study?

What are the sequelae and pathophysiologic changes that occur in children with OSA?

Upon further questioning of the parents, they report that their son had a sleep study a few weeks ago, and that it showed “some sleep apnea”. They have an appointment with ENT scheduled, but it is not for another few weeks.

After much searching, a copy of the report from the sleep study is found. The study showed moderate to severe obstructive sleep apnea.

Would you proceed with this case in a free-standing, out-patient surgicenter?

Would you do the case as an out-patient in a center that was within a hospital?

Would you insist that this patient be admitted overnight after strabismus surgery?

What do the ASA Practice Guidelines for the Perioperative Management of Patients with Obstructive Sleep Apnea support?

What about the American Academy of Pediatrics Clinical Practice Guideline: Diagnosis and Management of Childhood Obstructive Sleep Apnea?

You believe that based on the patient's age (less than 3 years old), sleep study proven evidence of moderate to severe OSA, the need for general anesthesia, and his comorbidities of reactive airway disease and rhinitis, that he is someone for which inpatient observation overnight is clearly indicated. The ophthalmologist, however, does not want to admit the child.

Would you cancel the case? Go ahead with the case?

What if it was "just an MRI with propofol sedation"?

Would you be responding the same way if he had not had a sleep study done, and the parents had just reported a history of snoring??

Luckily, your friendly pediatric otolaryngologist is in the next OR, and he agrees to see the patient. After reviewing the sleep study, examining the patient, and talking with parents, he agrees to go ahead and do an adenotonsillectomy. He will also admit the patient overnight to his service. After all of the attention so far, the patient is getting anxious and fearful.

Will you give him a pre-med? Is midazolam safe in these patients?

Induction and intubation proceed uneventfully. The strabismus repair is done first, followed by the adenotonsillectomy.

Would you limit or decrease your intra-operative dose of opioid in this patient?

Will you extubate this patient deep or awake? What if the patient had not had a sleep study; would you extubate deep?

During surgery, the patient received morphine 0.05 mg/kg IV, acetaminophen 30 mg/kg PR, dexamethasone 0.5 mg/kg IV, and ondansetron 0.15 mg/kg IV. The patient is extubated awake without incident, and transported to the recovery room with blowby oxygen. The recovery room stay is uneventful, an additional dose of morphine is given for analgesia, and the patient is able to tolerate a popsicle.

What kind of monitoring do you want for this patient overnight? ICU? Floor bed?

Can you predict which pediatric patients are at the highest risk of continued OSA even after adenotonsillectomy?

PROBLEM BASED LEARNING DISCUSSION

Sleep-disordered breathing is a general term that describes a spectrum of disorders including primary snoring and obstructive sleep apnea (OSA). Primary snoring, which is defined as snoring without obstructive apnea, frequent arousals from sleep, or gas exchange abnormalities, is usually considered to be benign. This may change as more studies are done on the effects of primary snoring. Snoring is more common than OSA, and occurs with a prevalence of 8-27% in children. Studies of OSA show a prevalence of approximately 2% in children.

OSA is commonly defined as a disorder of breathing during sleep characterized by prolonged partial upper airway obstruction and/or intermittent complete obstruction that disrupts normal ventilation during sleep and normal sleep patterns. In children, persistent partial obstruction is more commonly observed. The opposite is true in adults, who more commonly have intermittent total obstruction during sleep. The symptoms of pediatric OSA include nightly snoring (often with intermittent pauses, snorts, or gasps), disrupted sleep, arousals from sleep, and daytime neurobehavioral problems.

Pediatric OSA syndrome (OSAS) is associated with narrowing of the upper airway that leads to obstruction during sleep. The most common cause of this narrowing is adenotonsillar hypertrophy, which peaks between 2 and 8 years of age. (Other risk factors for OSAS include obesity, craniofacial anomalies, and neuromuscular disorders.) During REM sleep, which children spend proportionately more time in than adults, the musculature of the upper airway relaxes and leads to a further increase in airway resistance. The central chemoreceptors also become less sensitive and the intercostal muscles are subject to supraspinal inhibition. These factors limit the child's ability to compensate for the airway resistance during REM sleep.

Left untreated, children with OSAS can develop serious complications that are related to the cardiovascular system, neurocognition, and growth. Systemic hypertension, particularly diastolic hypertension, may occur. Repeated episodes of hypoxia and hypercarbia can also lead to pulmonary hypertension in up to 40% of children with OSAS. Although rare now, this can eventually result in cor pulmonale. The neurocognitive sequelae include behavioral problems, attention-deficit hyperactivity disorder, poor learning, and poor school performance. Finally, OSA is known to impair normal somatic growth. It is thought that this is due to increased caloric expenditure during sleep, stress response, and abnormal growth hormone secretion.

The best method for diagnosing OSAS is a subject of much on-going debate and research. The history and physical alone are often used to make a diagnosis of OSAS. Important aspects of the history include nightly snoring, labored breathing during sleep, choking episodes while asleep, witnessed apneas, cyanosis, restless sleep, frequent nighttime arousals, enuresis, unusual sleep positions, hyperactivity, daytime somnolence,

and chronic mouth breathing. On physical examination, adenotonsillar hypertrophy is often noted. When studied, none of these findings have been shown to be sensitive or specific for OSAS. Studies have also shown that there is no relation between the size of the tonsils and adenoids and the presence of OSAS. This is because the neuromuscular tone of the upper airway contributes to obstruction, and this is not seen on routine physical exam. While the history and physical examination are useful screening tools, studies have shown that this information alone poorly predicts the diagnosis of OSAS in children. In a recent systematic review of the literature using an evidence-based technique, Brietzke et al found a positive predictive value of only 55.8% for the clinical diagnosis of OSAS, when compared with the “gold standard” of polysomnography.

Audiotaping and videotaping have been studied, and the sensitivity for diagnosis of OSAS ranged from 71 to 94%, and the specificity ranged from 29 to 80% (high number of false positives). Overnight pulse oximetry has also been studied. This was found to have a positive predictive value of 97%, but a negative predictive value of only 47% (high number of false negatives).

Polysomnography (PSG) is regarded as the gold standard for the diagnosis of pediatric OSAS. It is able to confirm the presence of the disease, and determine its severity by identifying and quantifying the ventilatory and sleep abnormalities that occur. The information typically obtained from a study includes the number of arousals, the mean and nadir oxygen saturations, the number of obstructive apneic events, the number of hypopneas, and the apnea hypopnea index (AHI). Obstructive apnea is defined as the absence of airflow with continued chest wall and abdominal movement for a duration of at least 2 breath cycles. Hypopnea is a decrease in nasal flow of $\geq 50\%$ with a corresponding decrease in oxygen saturation of $\geq 4\%$ or arousal. The AHI is the total number of apneas and hypopneas per hour of total sleep time. While interpretation does vary among centers, typical pediatric interpretation is AHI < 1 is normal, AHI 1-5 is mild, AHI 6-10 is moderate, and AHI > 10 is severe OSAS.

Recently, the role of PSG in diagnosing and determining which patients should undergo adenotonsillectomy (T&A), has been questioned. There is a shortage of centers that do pediatric PSG, and this limits the accessibility of this study. Surveys have shown that nationally only about 10-12% of children presenting for T&A have had a PSG. At least one study has shown significant post-op benefit from T&A in children who had “normal” PSG findings. There is also some evidence that children with primary snoring may have improved neurocognitive parameters after T&A.

The group of children who may benefit the most from PSG are the high-risk surgical patients. Retrospective chart review studies have looked at the ability of pre-op PSG to predict post-op respiratory complications in high risk patients. Wilson et al found that mild, moderate, and severe OSAS was associated with a 6, 14, and 31% incidence of respiratory complications. They also found that children less than 2 years of age, and those with a pre-op oxygen saturation nadir of $< 80\%$ had a significantly increased risk of post-operative respiratory complications.

The American Academy of Pediatrics developed a clinical practice guideline in 2002 for the diagnosis and management of childhood OSAS. One of their recommendations is that high-risk patients should be hospitalized overnight and monitored continuously with pulse oximetry. The patients that they consider to be high risk include: younger than 3 years of age, severe OSAS on PSG, cardiac complications of OSAS, failure to thrive, obesity, prematurity, recent respiratory infection, craniofacial anomalies, and neuromuscular disorders.

The American Society of Anesthesiologists published Practice Guidelines for the Perioperative Management of Patients with Obstructive Sleep Apnea in 2006. These guidelines address the identification and assessment of severity of OSAS. They then outline factors to guide in the determination of increased risk due to OSAS. Age less than 3 years and severe OSAS, again appear as risk factors. Invasive surgery, airway surgery, general anesthesia, the need for post-operative parenteral opioids, or high-dose oral opioids are also factors that the ASA feels increase the risk of post-operative respiratory complications. Patients who have significant risk factors are not considered to be good candidates for outpatient surgery, and should be hospitalized and monitored overnight with continuous pulse oximetry.

Historically, sedative medications have been limited or avoided in children with OSAS for fear of over-sedation and respiratory complications. Francis et al did an uncontrolled prospective study of midazolam 0.5 mg/kg po in 70 children with OSAS presenting for T&A. Only two of the patients had an obstructive event with desaturation that was similar in severity to that observed on their pre-operative PSG. Both of these children were under 3 years of age, and both had severe OSAS by PSG (one had an AHI of 39.4 events/hour and nadir SaO₂ of 74%, and the other had an AHI of 17.6/hour and nadir SaO₂ of 82%). Although controlled studies are necessary, it appears that midazolam may be safely used, especially in patients with less severe OSAS.

The post-operative administration of opioids in patients with OSAS has been linked to an increase in the risk of respiratory complications. Brown et al has attributed this to an effect of recurrent oxygen desaturations on endogenous opioid mechanisms that then alter responsiveness to subsequent administration of exogenous opioids. In a prospective study, they showed that children with OSAS who had an asleep, pre-op SaO₂ nadir of < 85 % required half the amount of morphine to achieve the same behavioral pain score as those children with OSAS whose SaO₂ nadir was > 85%. Clinically, it is important to know if children have a history of recurrent hypoxemia, since this is associated with an increased analgesic sensitivity to morphine.

T&A is considered to be first-line therapy for pediatric OSAS, and it is thought to be highly effective. It is not, however, 100% curative. In a meta-analysis, the treatment success with T&A was found to be 82.9%, and the mean pre-op AHI of 16.8 was decreased to 2.4 post-operatively. The patients who have the highest likelihood of residual OSAS are those with comorbidities like obesity, neuromuscular disorders, Trisomy 21, and other craniofacial syndromes. These patients may warrant follow-up

PSG evaluation, and possibly trials of other treatment modalities, such as CPAP, to avoid the consequences of long-term OSAS.

REFERENCES

1. Gross JB, and the American Society of Anesthesiologists Task Force on Perioperative Management of Obstructive Sleep Apnea. Practice guidelines for the perioperative management of patients with obstructive sleep apnea. *Anesthesiology* 2006; 104: 1081-93.
2. Marcus CL, and the American Academy of Pediatrics, Section on Pediatric Pulmonology, Subcommittee on Obstructive Sleep Apnea Syndrome. Clinical practice guideline: diagnosis and management of childhood obstructive sleep apnea syndrome. *Pediatrics* 2002; 109: 704-12.
3. Ray RM, Bower CM. Pediatric obstructive sleep apnea: the year in review. *Curr Opin Otolaryngol Head Neck Surg* 2005; 13: 360-5.
4. Shine NP, Coates HL, Lannigan FL. Obstructive sleep apnea, morbid obesity, and adenotonsillar surgery: a review of the literature. *Int J Pediatr Otorhinolaryngol* 2005; 69: 1475-82.
5. Brietzke SE, Katz ES, Roberson DW. Can history and physical examination reliably diagnose pediatric obstructive sleep apnea/hypopnea syndrome? A systematic review of the literature. *Otolaryngol Head Neck Surg* 2004; 131: 827-32.
6. Wilson K, Lakheeram I, Morielli A, Brouillette R, Brown K. Can assessment for obstructive sleep apnea help predict postadenotonsillectomy respiratory complications? *Anesthesiology* 2002; 96: 313-22.
7. Rieder A, Flanary V. The effect of polysomnography on pediatric adenotonsillectomy postoperative management. *Otolaryngol Head Neck Surg* 2005; 132: 263-7.
8. Francis A, Eltaki K, Bash T, Cortes S, Mojdehi K, Goldstein NA. The safety of preoperative sedation in children with sleep-disordered breathing. *Int J Pediatr Otorhinolaryngol* 2006; 70: 1517-21.
9. Brown KA, Laferriere ABA, Moss IR. Recurrent hypoxemia in young children with obstructive sleep apnea is associated with reduced opioid requirement for analgesia. *Anesthesiology* 2004; 100: 806-10.

10. Brown KA, Laferriere ABA, Lakheeram I, Moss IR. Recurrent hypoxemia in children is associated with increased analgesic sensitivity to opiates. *Anesthesiology* 2006; 105: 665-9.