Obesity and Pediatric Sleep Apnea

Obstructive sleep apnea (OSA): affects 2% to 4% of school-aged children; adenotonsillar enlargement primary cause; after adenotonsillectomy, cure rate for OSA 83% among total pediatric population; cure rate lower for obese and overweight population

Obesity: relatively new problem in United States; prevalence has shifted to less affluent countries due to increase in fast food restaurants and global economy; World Health Organization statistics — in 2008 >1.5 billion adults overweight, and one-third of those obese; >65% of population live in countries in which obesity kills more people than malnutrition; associated disease burden — obesity contributes to diabetes in >44% of patients, ischemic heart disease in >23% of patients, and several cancers; fifth leading cause of death worldwide; prevalence — 30% to 40% of population in United States overweight or obese; high percentage in United Kingdom also, but only 10% to 20% in European countries; rates lower in Mexico, South America, and Australia; rates have doubled in children 6 to 11 yr of age and tripled in those 12 to 17 yr of age from 1980 to 2000 (blacks and Hispanics more affected by trend than whites); rates vary by geographic region across United States and have increased globally since 1960s

Etiology: multifactorial; genetic component; social media and environmental factors contribute

Definition: difficult to label children (still growing); American Academy of Pediatrics (AAP) recommends use of body mass index (BMI) rather than, eg, growth curves; BMI easy to monitor and measure (calculators available for smartphones) and serves as proxy measure for adiposity; overweight defined as BMI in 85th to 95th percentile for age and sex; obesity defined as BMI >95th percentile; both apply to children >2 yr of age

Connection between pediatric obesity and OSA: paper published in 1999 indicates that in obese children, risk of developing OSA increases >10% for every unit increase in BMI; however, more recent literature does not support this; adenotonsillectomy not as successful at treating OSA in obese children; association between BMI and OSA not entirely clear; meta-analysis — effect of adenotonsillectomy on obese children with OSA demonstrated on polysonnography (PSG); mean preoperative apnea-hypopnea index (AHI) 30, decreased to 10 postoperatively, and oxygen nadir improved from 78% to 85%; however, only ~50% of patients had postoperative AHI <5, ~25% <2, and only 12% cured of OSA; thus, speaker obtains postoperative PSGs on all children with obesity, possibly repeated in 1 to 2 yr; correlation likely not as simple as adipose deposits in neck (difficult to measure); laboratory criteria not standardized among different institutions and regions; effects of age, sex, and ethnicity yet unknown

Metabolic syndrome: can occur in children; well-defined entity in adults (eg, central obesity, insulin resistance, dyslipidemia, hypertension); 3% to 4% of overweight children and 25% of overweight adults have metabolic syndrome; ethnic variability in children (occurs most frequently in Hispanics, then whites, then blacks); seen in children with OSA; some studies indicate impaired sympathetic activation in patients with OSA and also with metabolic syndrome

Other connections: hormonal — altered lipid and carbohydrate metabolism linked to several hormones; same hormones (eg, insulin, leptin, ghrelin) also linked to poor sleep and increased drive to consume more food; social and behavioral — poor sleep in conjunction with adiposity may promote behaviors that exacerbate obesity (eg, increased food consumption) and worsen symptoms; prevention critical

Weight loss: study of obese adolescents who underwent gastric bypass surgery; average weight loss ~130 pounds; >90% of patients had complete resolution of OSA; median AHI dropped significantly; no correlation between amount of weight lost and improvement in sleep parameters; children who lost most weight did not necessarily have most improvement in sleep (suggests that distribution of adiposity possibly more important than degree of obesity); supported by adiposity studies in adults; weight loss more difficult in children than adults; primary care physicians critical, but recent survey of pediatricians indicates majority of them feel they do not adequately support weight loss in patients (due to, eg, focus on other medical issues, lack of resources); prevention — preferable but difficult to achieve; obese parents more likely to have obese children; school lunch reform attempted; fast food available and inexpensive; electronic games and devices supersede time outside; level of involvement of clinician based on comfort level; referral to nutritionist recommended; speaker has low threshold for recommending PSGs in obese children (for, eg, snoring, daytime fatigue, diminished performance in school); in-office strategies — advise reduced intake of sugar-sweetened drinks, removal of television from bedrooms; encourage breakfast, reduced fast food consumption, and exercise

Liquid calories: New England Journal of Medicine dedicated part of recent issue to this topic; increased consumption of

Educational Objectives

The goals of this program are to improve management of obstructive sleep apnea (OSA) in obese children and those with multiple sites of obstruction. After hearing and assimilating this program, the clinician will be better able to:

1. Counsel families of obese children on weight loss and make appropriate referrals to nutritionists.
2. Choose appropriate intervention for obese children with OSA, based on anatomic factors and clinical judgment.
3. Select the optimal method to evaluate level(s) of obstruction in children with OSA.
4. Use drug-induced sleep endoscopy to evaluate children with multiple levels of obstruction.
5. Select the surgical procedure(s) that is/are most likely to provide maximal benefit to children with OSA.

Faculty Disclosure

In adherence to ACCME Standards for Commercial Support, Audio-Digest requires all faculty and members of the planning committee to disclose relevant financial relationships within the past 12 months that might create any personal conflicts of interest. Any identified conflicts were resolved to ensure that this educational activity promotes quality in health care and not a proprietary or commercial interest. For this program, Dr. Discolo and the planning committee reported nothing to disclose. In his lectures, Dr. Discolo presents information that is related to off-label or investigational use of a therapy, product, or device.
sugar-sweetened beverages contributes significantly to global obesity epidemic; largest single caloric food source in United States; ≤15% of daily calories in adolescents come from sugar-sweetened drinks (equates to ≈ 1 pound every 10 days); sugary beverages also associated with intake of high sodium foods and fast foods and linked to type 2 diabetes, hypertension, and coronary disease; theoretically, high fructose corn syrup promotes hepatic lipogenesis and possibly insulin resistance over time; randomized controlled trial — examined sugar-sweetened beverages in overweight and obese children; control arm received no intervention (only monitoring); intervention arm received counseling about sugar-sweetened beverages and sugar-free beverages delivered to home every 2 wk for 1 yr; at 2 yr, no difference in BMI between 2 groups; at 1 yr, however, statistically significant difference in BMIs; genetic association — study of adult patients demonstrates genetic predisposition to obesity increases susceptibility to effects of sugar

Treatment: adenotonsillectomy reasonable and improves OSA (although may not provide cure); counsel families and have realistic expectations; decision to perform surgery vs continuous positive airway pressure (CPAP) initially in obese children based on clinical judgment (eg, size of tonsils); surgery can also improve tolerance of CPAP by lowering lower pressure settings (promotes adherence); caveat — systematic review demonstrated increased weight gain after tonsillectomy; prospective trial confirmed increased BMI in children 2 to 12 yr of age after tonsillectomy, but proportion of overweight or obese children did not increase; younger children gained more weight than older children (possibly due to “catch-up” feeding after correction of dysphagia from tonsillar hypertrophy)

Efficacy of CPAP: prospective study demonstrates improvement in OSA (eg, sleep parameters, daytime somnolence) with use of mask 5 hr per night; thus, CPAP effective, but adherence challenging and depends on available resources

Future directions: research currently aimed at link between pediatric obesity, OSA, and biochemical markers to help determine children at risk; research needed about anatomic site-specific surgery for obese children to maximize outcomes

Questions and answers: American Academy of Otolaryngology—Head and Neck Surgery recommends ordering routine preoperative PSG on children with obesity (in addition to children with, eg, Down syndrome, craniofacial anomalies); speaker orders PSG on all obese children preoperatively

Surgical Site Selection in Pediatric Patients

Refractory OSA: adenotonsillectomy first-line surgery (even if patient has other sites of obstruction); appropriate site selection important to avoid guesswork, minimize morbidity from potentially unnecessary surgery, and identify children at high risk for failure; endoscopy used to select children most likely to benefit from surgery and those who should be referred for other treatments (eg, CPAP, tracheostomy)

Plain films: traditional lateral neck x-ray can show adenoid regrowth or lingual tonsillar hypertrophy, although it does not allow evaluation of hypopharynx or oropharynx for collapse and dynamic defects; results in radiation exposure; not useful as part of comprehensive sleep evaluation; videofluoroscopy no longer preferred due to radiation exposure; Lancet article about computed tomography (CT) and risk for cancer in children demonstrates increased risk for leukemia and brain tumors in children who had radiation exposure from CT

Cine-MRI: provides high-resolution images of dynamic airway during medically induced sleep; no radiation exposure; option for patients with multisite obstruction; 2-min span of imaging during oxygen desaturations or periods of obstruction; allows fairly reliable evaluation of nasopharynx, oropharynx, and hypopharynx; originally, propofol used for sleep induction; most centers currently use dexmedetomidine (Precedex), which gives sedation with less respiratory depression; requires adequate procedural protocol (eg, sedation, procurement of images); sedation should be performed by anesthesiologist; allows visualization of lymphatic tissue on T2 image, lingual tonsillar tissue and adenoid tissue in nasopharynx on sagittal plane; advantages — reveals primary and secondary sites of obstruction (eg, oropharyngeal obstruction followed by hypopharyngeal collapse seen on dynamic view); disadvantages — requires specialized center with dedicated anesthesia team; high cost; requires additional sedation (unless performed concomitant with surgery); many studies of this technique use nasal trumpets which artificially manipulate airway; travel inconvenient for families who come from distance; also, if sedation not effective, test cannot be performed, which wastes time and resources

Airway endoscopy: preferred method for speaker’s center; ability to obtain useful information from awake endoscopy variable but it remains integral part of physical examination; gives dynamic view of child’s airway; assesses adenoid regrowth; helpful for laryngomalacia; disadvantages — potentially time-consuming; difficult for many children to cooperate (especially 3-6-yr-olds); does not provide information about dynamics during sleep

Drug-induced sleep endoscopy (DISE): surgeon able to diagnose and treat during single anesthesia; examination can be recorded and compared to others; allows visualization of other potentially important sites (eg, septum, turbinates, lar ynx, trachea); provides comprehensive examination for otherwise complicated patients (eg, Down syndrome, craniofacial issues); disadvantages — need precise level of sedation for success (too little can trigger laryngospasm and too much can stop snoring and obstruct endoscope); procedure — propofol titrated to adequate level without excessive apnea; endotracheal (ET) tube sometimes inserted into pharynx to instill oxygen before endoscopy; surgeon must obtain consent for multiple possible procedures preoperatively because exact procedure not determined until DISE performed

Efficacy: retrospective review — patients diagnosed with laryngomalacia on DISE then underwent supraglottoplasty; mean AHI decreased from ≈15 to ≈5 (statistically significant); series review — 26 patients with persistent OSA; all 26 had lingual tonsillar hypertrophy; all patients underwent lingual tonsillectomy with significant decrease in mean respiratory distress index; study of children with OSA after adenotonsillectomy — includes 13 children; 11 had multilevel obstruction and 2 had obstruction only at base of tongue (BOT); mean of ≈3 sites per patient; most common sites include obstruction at BOT (85% of children), adenoid regrowth (70%), and turbinate hypertrophy (≈50%); retrospective study of DISE after failure of adenotonsillectomy — review of 36 patients who failed adenotonsillectomy or had small tonsils before primary surgery; found to have laryngomalacia on DISE and underwent supraglottoplasty; mean AHI dropped from ≈13 to ≈4, and 33 patients benefitted from procedure

Supraglottoplasty: performed with cold steel microinstruments, laser or microdebrider; ET tube placed in pharynx away from laryngoscope; aryepiglottic fold lysed with microlaryngeal scissors back to transition point into epiglottis, and superior hemostasis; typically straightforward procedure; patients can be intubated or not and can go home next day; requires good anesthesiologist; topical lidocaine applied to larynx before procedure initiated

Lingual tonsillectomy: speaker uses Lindholm laryngoscope with suspension in older children; requires frequent readjustment of tongue; if anatomy favorable, can insert side-biting mouth gag with silk stitch through tongue, pull tongue out of mouth and use 30° or 45° endoscope in mouth (usually allows good visualization of epiglottis and vallecula); coblator device works well for this procedure; less painful than tonsillectomy,
and patients can usually go home day after procedure (soft diet for ~1 wk); some surgeons use robot but not commonly used in pediatrics yet; children always admitted to hospital overnight if procedure involves BOT due to risk of, eg, swelling, bleeding

**Challenging case:** morbidly obese girl with Down syndrome; AHI ≈40 despite previous surgery; no jaw thrust present but has epiglottic prolapse; completely obstructs at level of larynx, with large amount of pharyngeal lymphoid hyperplasia; oxygen nadir ≈60%; patient weighs ≈300 pounds; supraglottoplasty not likely to cure her OSA; family refuses tracheostomy; patient not compliant with CPAP; speaker does not feel she would benefit from further surgery; even if CPAP pressure settings lowered, patient likely to continue to pull mask off (cognitive issue)

**Questions and answers:** limited septoplasties can be performed in children; taking down turbinates simple and low risk; if DISE performed and purely obstruction of BOT observed, families counseled on reduction of BOT (eg, radiofrequency reduction); suspension of BOT particularly helpful in children with neurologic disease and diminished tone; families counseled that problem may require multiple treatments and may not completely resolve; conservative procedures attempted first; multilevel airway obstruction not addressed simultaneously due to risks; intensity of procedure increased in stepwise fashion

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**Suggested Reading**

1. Compared to the total pediatric population, the cure rate for obstructive sleep apnea (OSA) in obese and overweight children is _______ after adenotonsillectomy.
   (A) Higher  (B) Lower

2. Identify the true statement(s) about the metabolic syndrome.
   (A) Present in 3% to 4% of overweight children
   (B) Varies according to ethnicity in children
   (C) Is seen in children with OSA
   (D) A, B, and C

3. Weight loss has been demonstrated to be a potential cure for OSA in adolescents who are obese.
   (A) True  (B) False

4. Which of the following is linked to the consumption of sugar-sweetened beverages?
   (A) Type 2 diabetes  (C) Coronary disease
   (B) Hypertension  (D) All the above

5. A prospective trial demonstrated that the proportion of overweight or obese children increased significantly after tonsillectomy.
   (A) True  (B) False

For questions 6-8, match the diagnostic procedure in column I with a potential drawback associated with it in column II.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
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<tbody>
<tr>
<td>6. Cine-MRI</td>
<td>(A) Requires a precise level of sedation for success</td>
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<tr>
<td>7. Airway endoscopy</td>
<td>(B) Potentially time-consuming</td>
</tr>
<tr>
<td>8. Drug-induced sleep endoscopy</td>
<td>(C) Does not demonstrate dynamic defects</td>
</tr>
<tr>
<td>9. Identify the incorrect statement about lingual tonsillectomy.</td>
<td>(D) Requires a specialized center with a dedicated anesthesia team</td>
</tr>
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9. Identify the incorrect statement about lingual tonsillectomy.
   (A) Less painful than tonsillectomy
   (B) Lindholm laryngoscope can be used in older children
   (C) Coblator device not appropriate for this procedure
   (D) Patients can usually go home the day after the procedure

10. Identify the correct statement about surgery in children with OSA.
    (A) Multilevel airway obstruction can be corrected simultaneously to reduce multiple exposures to anesthesia
    (B) Suspension of the BOT is not effective in children with neurologic disease and diminished tone
    (C) Limited septoplasties can be performed in children

Answers to Audio-Digest Otolaryngology Volume 46, Issue 21: 1-B, 2-A, 3-D, 4-A, 5-A, 6-B, 7-D, 8-C, 9-D, 10-A

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