



Pediatric Asthma and Obstructive Sleep Apnea

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On Some Causes of Backwardness and Stupidity in Children: And the Relief of these Symptoms in Some Instances by Naso-Pharyngeal Scarifications

- *"it is not at all uncommon to find children who suffer from deafness, the result of enlargements of the lymphoid tissues of the nasopharynx and fauces, described by their parents and teachers as being backward or even stupid!"*
- *"The fact, however, that children, the victims of nasal and pharyngeal obstructions, often suffer headaches, especially when engaged in study, and frequently evince marked inability to fix their attention on their lessons or work for any length of time, has in recent years led many to suspect that these symptoms were not altogether due to the deafness, and that the stupid adenoid physiognomy, though partly explicable on physical grounds, was in part a reflection of some evident hampering of the cerebral functions."*
- The British Medical Journal Sept 28, 1889

Objectives

- Recognize the relationship between pediatric asthma and obstructive sleep apnea
- Understand the diagnosis and treatment of pediatric sleep apnea
- Be familiar with the "cousins" of pediatric sleep apnea
- Identify the indications for ordering a polysomnogram (PSG) for diagnosis of sleep related disorders

Pediatric Obstructive Sleep Apnea

- Sleep disordered breathing due to airway resistance/obstruction leading to impaired gas exchange
- Occurs in children of all ages
- Prevalence of two percent (1%-4%)
- Still remains very underdiagnosed across the nation

OSA and Asthma

- Asthma is the most chronic respiratory disease in children worldwide
- Estimated to affect 7.1 million US children
- Children with asthma are more likely to develop snoring and OSA (Ross et al N=106, 55% of children with severe asthma had sleep disordered breathing)
- 974 preschool children (2-5yrs) found asthma in 42% of snorers vs 26% on non-snorers
- asthma was associated with more severe OSA
- treatment with adenotonsillectomy was associated with significant asthma improvement

Min et al, The Journal of Pediatrics Vol 176 Sept 2016

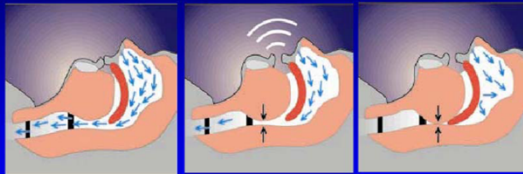
■ What age group has the highest prevalence for OSA?

- 1) 0-2yrs
- 2) 2-8yrs
- 3) 8-13yrs
- 4) 14-18yrs

Who's at risk for OSA?

- Adenotonsillar hypertrophy (but many kids have 3+ tonsils without OSA)
- Obesity
- Cerebral Palsy
- Down Syndrome
- Craniofacial anomalies
- Nasal septal obstruction
- Achondroplasia
- Mucopolysaccharidoses (Hunter/Hurler)
- Sickle Cell Disease
- Prematurity
- African American
- Allergic Rhinitis
- Asthma
- Micrognathia
- Macroglossia
- Myelomeningocele
- Neuromuscular Disorders (Muscular Dystrophy, SMA, etc.)
- Tumors (vascular hemangioma)
- Hx of cleft palate repair

Spectrum of Sleep Disordered Breathing



normal snoring UARS OSAS

Primary Snoring

- Occurs without associated apnea, gas exchange abnormalities, or excessive arousals
- Prevalence varies between 3 and 12 percent
- Clinical evaluation alone **CANNOT** be used to diagnose OSA, nor to differentiate between OSA and primary snoring
- Mounting evidence that chronic snoring alone can lead to neurobehavioral disturbances

Upper airway resistance syndrome (UARS)

- Snoring AND partial upper airway obstruction that leads to arousals and sleep fragmentation. NO evidence of apnea, hypopnea, or gas exchange abnormality during polysomnography
- UARS may result in symptoms similar to those in children with OSA

Snorers.....OSA'ers?

- Observed apnea or gasping by caretakers
- Nighttime sweating
- Restless/agitated sleep
- Unusual sleep positions, extended neck
- Parasomnias may be exacerbated
- Nocturnal enuresis-has been associated with OSA, and appears to improve after adenotonsillectomy

What about Daytime Symptoms?

- Mouth breathing
- Nasal obstruction
- Hyponasal speech
- Morning headache
- Child may be difficult to awaken
- Excessive Daytime sleepiness (13-20%, confirmed by MSLT)
- Poor academic performance
- Association with learning and behavior disorders including ADHD

OSA Clinical Features

Infants:

- More subtle, less snoring, increased WOB, lethargy, failure to thrive
- worse with RT infections

Children:

- Naps beyond age 5, daytime sleepiness unusual
- Mouth breathing, difficulty swallowing, speech problems, enuresis
- Difficulty waking child in am

Pediatric OSA

- Associated with poor neurocognitive outcomes including behavioral disturbances, learning deficits and poor school performance
- 2007 studies at this results in a 226% increase in healthcare utilization compared to children without OSA

Ped Resp Reviews 31 (2019) 43-51

OSA Evaluation-History

- AAP recommends that all children be screened for snoring at routine health care visits
- If snoring is present, additional history should look for:
 - Poor growth/Development (5% of OSA assoc w/ Failure to Thrive)
 - Family history of OSA
 - Nighttime/daytime symptoms

OSA Evaluation-Physical Exam

- Look for craniofacial abnormalities
- Signs of allergic disease (allergic shiners, transverse nasal crease)
- Thorough nasal exam (septal deformity, mass, mucosal/turbinate swelling)
- Normal exam does not exclude OSA

OSA-Physical Exam (con't)

- Oropharyngeal exam (pharyngeal dimensions, palate shape/size, tongue size, bifid uvula)
- Assessment of pharyngeal/laryngeal tone
- Tonsil size/symmetry
- Thorough cardiac exam listening for signs of pulmonary hypertension (prev 3%)

Labs/Other studies

- Labs rarely needed in otherwise healthy children
- Lateral neck radiograph optional
- Polycythemia/compensated metabolic alkalosis rarely present in children
- Definitive diagnosis made by overnight polysomnography
- Multiple studies have shown that OSA and primary snoring **cannot** reliably be differentiated on the basis of history and physical exam alone

Indications for ordering a sleep study

- Suspected OSA
- Behavior problems
- Suspected Narcolepsy (need f/u Multiple Sleep Latency Test)
- Nocturnal Seizures
- Periodic Limb Movement (Restless Leg Syndrome)
- NOT pure insomnia



Definitions in Sleep Studies

- Apnea Hypopnea Index (AHI) –average number of apneas/hypopneas per hours during sleep
- Respiratory Disturbance Index (RDI) – AHI + respiratory event related arousals per hour
- Obstructive Apnea
- Central Apnea
- Mixed Apnea

Overnight Polysomnography

- 1) Respiratory effort (abdominal and chest wall movement)
- 2) Airflow at nose and mouth
- 3) Arterial O₂ saturation and **End expiratory CO₂**
- 4) ECG rhythm strip
- 5) Electromyography in anterior tibialis region to detect excessive leg movement
- 6) EEG/electrooculography/electromyographic measurements (submental, ant tibialis) to detect sleep staging and leg movement
- 7) Body position sensor
- 8) Snoring Recorder
- 9) Audio/Video recording

Pediatric OSA severity




- AHI/RDI 1-5: mild
- AHI/RDI 5-10: moderate
- AHI/RDI >10: severe

- Nocturnal hypoventilation defined as >25% of night w/ ETCO₂ > 50

PSG-Interpretation

- Adult/adolescent criteria not applicable to children
- Adult/adolescent apnea defined as >10sec, but in children definition is >2 regular breaths (often shorter than 10sec)
- Apnea-Hypopnea Index >1 (more than 1 event per hour) is abnormal
- Guidelines not well established.... **AHI>10** per hour associated with increased risk of respiratory compromise after adenotonsillectomy
- Central Apneas...physiologic or pathologic

Home Sleep Testing

- Level 3 in kids found good data for kids 12-17 especially if severe disease
- Not sensitive for mild to moderate disease when compared to polysomnogram (PSG)
- 18% failure rate (inadequate data)
- This is slowly getting better

Bhattacharjee, Commentary in J Clin Sleep Med 2019;15(5):733-742

OXYGEN SATURATION (SPO2) SUMMARY

Spo2	Time	% Overall	Spo2	Time	% Overall	Overall High:	Wake (1) High:
≥ 90%	00:04:08	1.1%	≤ 80%	00:14:40	4.0%	93	91
≤ 89%	06:00:08	98.9%	≤ 70%	00:00:00	0.0%	Overall Low: 72	Wake Low: 81
≤ 88%	03:51:56	98.6%	≤ 60%	00:00:00	0.0%	Overall Baseline: 84.5	Wake Avg: 86.7

Std. Deviation: 2.230

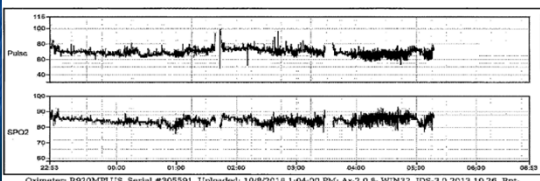
- Spo2 fell more than 5% below baseline of 94.5 for total of: 00:05:00
- Longest continuous period with Spo2 ≤ 88% was: 00:58:20
- Oxygen Desaturation Index (4% ODI): 38.049

PULSE SUMMARY

High: 99 Average Pulse: 69.4
 Low: 48 Pulse Std.Dev: 4.450

OXYGEN QUALIFICATION STATUS (1)

A diagnosis related to Sleep Apnea was provided with the test order: G47.33. Medicare beneficiaries with a known or suspected sleep apnea diagnosis may not qualify for oxygen therapy based on the result of a home pulse-oximetry test. Other testing may still be applicable. (1) Insurance on file: Medicare



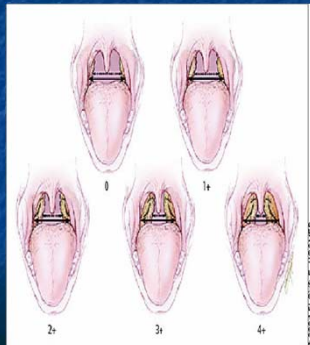
Case Study #1

- 24 mo old girl noted to have snoring at daycare, restless sleep, +oral breathing
- Often woke up in the middle of the night at home, sometimes crying
- Appeared tired in the morning, irritable/moody during the day
- No medications or allergies

Case Study #1

- Ex 34 wk gestation without complications, nl developmental history
- 20 lb (10th percentile) height 31 inches (6th), BMI 17
- Exam notable for no craniofacial abnormalities, 2+ tonsils, no anterior nasal pathology, remainder of exam normal

Tonsillar Hypertrophy

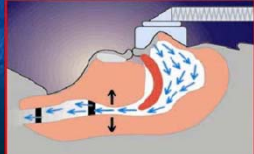


Polysomnogram (PSG)

- AHI of 4
- O₂ ranged from 89-99%
- No ECG or EEG abnormalities
- Normal sleep stages but an arousal index of 16 suggesting sleep fragmentation
- No evidence of hypoventilation
- She went for a T&A

OSA-Treatment

- Weight loss (for obesity)
- Surgery (various options including tonsillectomy, mandibular advancement, tongue reduction, turbinate reduction/septoplasty)
- CPAP/BiPAP
- Intranasal steroids
- Montelukast



Tonsillectomy & Adenoidectomy

- Approx 500,000 performed in USA annually
- Many ENT surgeons refer prior to surgery, cut off criteria is AHI>5, abnormal is AHI>1
- Uncomplicated cases do not need followup PSG, but should be seen clinically
- Red Flags: obesity, neuromuscular disease, trisomy 21, craniofacial syndromes, severe OSA defined as AHI>10
- One meta analysis suggest cure rate of 85% in all comers
- Symptoms can recur as patient ages

Childhood Adenotonsillectomy Trial

- Compared T&A vs. watchful waiting
- Demonstrated improvements in PSG findings
- Improvements in parent related behavior as well as quality of life
- No difference in attention or executive function between these 2 strategies

Marcus et al N Engl J Med 2013;368

Case Study #2

- 11yo male with asthma, obesity, s/p tonsillectomy age 10 presents with snoring, dry taste in mouth in am, wakes up tired, daytime sleepiness, difficulty concentrating, witnessed apnea at night
- Sleeps 9pm to 7:15am M-F, 11pm to 9am Sat/Sun
- Meds: none
- Fam Hx: Dad with OSA, + hx of HTN/DM

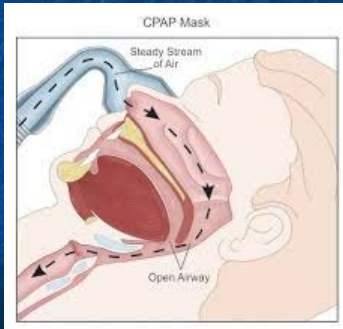
Case Study #2

- Weight 160lbs, afebrile, P 99, O2 sat 100% RA
- Gen: Obese male, NAD
- HEENT: TM clear with good light reflex, nose with midline septum, bilateral inferior turbinate hypertrophy w/o drainage, absent tonsils, class I airway
- CV: RRR nl s1/s2, no m/r/g
- Pulm: CTA bilat; no w/r/r
- Abd: soft NTND +BS

Case Study #2

- PSG revealed moderate to severe OSA with AHI 12, mild disruption of sleep architecture, moderate to severe O2 desaturations (7.3% of night with O2 sat 80-90%, 0.5% with O2 sat 50-80%)
- CPAP not done as did not meet criteria in first half of the night
- Repeat PSG for CPAP titration revealed CPAP effective at reducing AHI and desaturations, optimal setting 9cm H2O

CPAP/Bilevel Therapy



CPAP/Bilevel

- Noninvasive positive pressure ventilation
- Very effective, not tolerated by some
- Requires an in lab titration in pediatrics
- Often will use desensitization techniques
- Used worldwide in kids for over 30 years, threefold increase for in-home Pap in the past decade




CPAP/Bilevel

- Adherence / Compliance not as strict as with adults
- Better adherence in dedicated pediatric sleep centers
- SnoringSchool.com





Can weight loss help?

- Effective, but hard to do
- Losing weight while not sleeping well is really hard to do as leptin and ghrelin levels get skewed
- 25-60% of obese children will have OSA



Can the orthodontist help?

- Rapid Maxillary Expansion
- Limited studies, but several with modest improvement in AHI
- Well tolerated by patients
- Make sure your orthodontist is thinking about airway....not just malocclusion

Can the dentist help?

- Oral appliance therapy (Mandibular Advancement devices)
- For teenagers after mandibular growth plates have fused
- Effectiveness is close to CPAP

Can Myofunctional Therapy help?



- Limited data, Need a trained therapist, Adult study with 3mo of therapy AHI dropped from 25 to 13 (wide variability)
- Requires exercises daily, highly variable in studies but as little as 5min /day 4x/week for 2 months to as many as 10min 3-5x/daily for 3months
- Did show modest drop in AHI in 2 pediatric studies (from 4.9 to 1.8 (+/- 3))
- 24 children w/ retrospective chart review of children "cured" with AT and RME, 11 did MT, 13 controls. At 4 years all children to continued remained OSA free vs control group with recurrence of disease



Cimacho et al, SLEEP vol 38, No 5, 2015

Can the Didgeridoo help?

- BMJ in 2005 Puhan et al worked with 25 patients with moderate OSA, 20min/day x5 days x 8weeks
- AHI dropped from ahi 21 to 12
- Related to circular breathing



OSA and Asthma

- Longitudinal database analysis of 13,506 children w/ asthma revealed adenotonsillectomy associated with 30% reduction in exacerbations, 38% reduction in acute status asthmaticus and 25% reduction in ED visits reduction in asthma med refills
- In adults improvements in nocturnal asthma symptoms and asthma specific quality of life scores on patients with OSA treated with CPAP
- Asthma and OSA are both systemic inflammatory diseases, similar "cousins" of allergic rhinitis, obesity and GERD.

OSA and Asthma-how do they interact?

- Sleep in general is disrupted in uncontrolled in asthmatics, worse during exacerbations
- Asthma may accentuate the hypoxia in OSA
- Intermittent nocturnal hypoxia could initiate and maintain the upper and lower airway inflammation
- Adenotonsillar hypertrophy seems to be more pronounced in children who wheeze (increased cysteinyl leukotriene activity)

Review: Journal of Asthma and Allergy 2016;9:83-91

Summary

- OSA is a common pediatric problem, ask about sleep in your visits
- Sequelae of OSA include abnormal growth and development, enuresis, learning and behavior problems, hypertension, traffic accidents
- Polysomnography is the gold standard and is required to assess severity
- Application of adult criteria for scoring and interpretation of pediatric sleep studies may result in misdiagnosis and mismanagement of children, make sure they have end tidal CO2 detectors

Our Sleep Center

- 4 bed lab
- Pediatric studies done 1:1
- Physicians can order testing directly with or without a consult to follow
- An adult caregiver must be present
- No trach patients or kids <2 yrs at this time
