BEYOND T&A:
TREATMENT OF RESIDUAL SLEEP APNEA IN CHILDREN

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I have no disclosures
Risk factors for recurrence of OSA

- Severe pre-operative OSA
- Gain velocity in BMI
- Obesity
- African American
- Age > 7
- Asthma

Indications for post-op sleep study

• Age < 3
• Cardiac complications of OSA
• Craniofacial anomalies
• Obesity

• Severe pre-operative PSG
• Failure to thrive
• Neuromuscular disorders
• Persistent sleep disordered breathing

12 yo obese male with Down syndrome.

- Snoring at night, worsening over past 3 years.
- Adenotonsillectomy at 7 years of age.
- PSG AHI 56.
S1. How would you further evaluate this patient?

A. No further evaluation required; recommend CPAP
B. Sleep endoscopy and surgical intervention
C. Imaging – plain film, cine MRI
D. Both sleep endoscopy and imaging
E. Other
Sleep endoscopy

- Supine position without a shoulder roll, mimicking the position of natural sleep as much as possible.
- Induction with inhalational mask anesthesia.
- Dexmedetomidine infusion at 1-2 mcg/kg/hr, concurrent ketamine bolus of 1 mg/kg.
- Less muscular relaxation and a more sustained respiratory effort with this current technique compared to propofol.
- Oxymetazoline: 1% xylocaine on a 1 cm × 4 cm cottonoid pledget.
- Spontaneous respiration supported by nasal cannula oxygen.

Sleep endoscopy

No apnea

Circumferential collapse
• Adult outcomes:
  – Valid, reliable method to evaluate site, degree, and configuration of upper airway obstruction
  – Findings are associated with outcomes of palate surgery (Level of evidence 4).
• Children outcomes:
  – Oropharynx/lateral walls - most common site of obstruction with single site obstruction.
  – Combined oropharynx/lateral walls and velum obstruction - most common sites of obstruction with multiple site obstruction.
  – Sleep endoscopy directed surgery improves OSA (limited evidence).

Imaging

- **High kilovoltage lateral neck imaging** – adenoid and tonsil hypertrophy.
- **Chest radiography** - evidence of pulmonary hypertension or right ventricular hypertrophy in a child with severe obstructive sleep apnea.
- **Cine magnetic resonance imaging** - observe airway collapse in 3 planes (axial, coronal and sagittal) to isolate anatomic sites of airway obstruction in children who have persistent apnea after T&A.


S2. What surgical interventions have you performed for OSA after T&A?

A. Lingual tonsillectomy only
B. Palatal procedures only
C. Tongue base procedures – midline glossectomy, repose, geniohyoid suspension only
D. Two or more of these techniques
Sleep Surgery Options in Children

- **Nasal cavity**
  - Septoplasty
  - Turbinate reduction

- **Palate**
  - Pillarplasty
  - Expansion sphincter pharyngoplasty
  - Uvulopalatopharyngoplasty

- **Tongue**
  - Glossectomy
  - Lingual tonsillectomy
  - Radiofrequency ablation
  - Genioglossus stabilization (Repose)

- **Craniofacial**
  - Genioglossus advancement
  - Geniohyoid suspension
  - Mandibular advancement
  - Rapid maxillary expansion

- **Airway**
  - Supraglottoplasty
  - Tracheostomy
Turbinate Volume Reduction

- **Techniques**: Radiofrequency ablation and microdebrider-assisted reduction.
- Both techniques for nasal obstruction are effective, however maintenance of improvement at 2 years better with microdebrider-assisted technique (Level 1 evidence).
- Post-operative course: Mild-to-moderate edema with subsequent nasal obstruction and thick mucus formation for about a week.
- Complications: If mucosal erosion is present, the risk of postoperative bleeding and adherent crust formation increases with radiofrequency ablation.


Pillarplasty

• Oversew anterior and posterior tonsillar pillars over the tonsillar fossa after tonsillectomy.
• Reduces the collapsibility of the pharynx
• Limited evidence: Comparison of children with Down syndrome, the addition of pillarplasty (lateral pharyngoplasty) did not improve outcomes.

http://www.sleepapneasurgery.com/images/PPP-intra-op-lg.jpg
8 year old male with snoring

- Adenotonsillectomy age 3, never stopped snoring
- Difficulty paying attention in school, always fatigued
- AHI 8
- Mallampati 4; sleep endoscopy with elongated palate no lingual tonsil hypertrophy or tongue base collapse
S3. What options would you consider?

A. CPAP
B. UPPP
C. Expansion sphincter pharyngoplasty
Expansion Sphincter Pharyngoplasty

- Rotation and suspension of the palatopharyngeus muscle onto the soft palate, sparing the uvula.
- Stabilizes palate and improves diameter of the oral airway.
- May be incorporated into the initial surgical approach with tonsillectomy or as a secondary procedure in patients who have persistent sleep apnea after T&A.
- Outcomes: reduction in AHI in adults; evidence not available for children.

Expansion sphincter pharyngoplasty
Uvulopalatopharyngoplasty

- Removal of the soft palate and uvula, widens oropharynx
- Limited evidence in children:
  - Reported success in children with cerebral palsy and hypotonic upper airway muscles.
  - Lack of substantial reports in normal children.
- Complications: nasopharyngeal stenosis, palatal incompetence, and speech difficulties.

Glossectomy

- Decrease tongue volume and proportionally increase airway size.
- Population: Beckwith-Wiedemann or Down syndrome.
- Techniques: open or via a submucosal minimally invasive technique
- Success rates for the submucosal technique - 60%
- Complications: airway edema, hematoma, abscess formation, and permanent hypoglossal injury

Midline glossectomy

Woodson Operative Techniques Otol 2012; 23:2:155–161
13-1/2-year-old with Down syndrome

- Adenotonsillectomy age 8.
- BMI 24.9 (94%).
- AHI 11.8
S4. What surgical intervention(s) would you recommend?

A. CPAP
B. Lingual tonsillectomy
C. Repose
D. Genioglossus advancement
E. Combination therapy
Lingual Tonsillectomy
Repose Procedure
Outcomes of Multilevel Surgery

• Little research is available regarding outcomes of multi-level surgeries in children

• 8.2% incidence of oropharyngeal scarring and stenosis in 48 children who underwent multilevel surgery that included lingual tonsillectomy for OSA in children.

• Solitary surgical improvements in airway size can augment airway dynamics and reduce the Bernoulli and Starling effects and collapse at other levels.

• A staged approach should be considered in children

Marcus Pediatric Research (2005) 57, 99–107
14 yo female with Down syndrome

• T&A, lingual tonsillectomy UPPP age 4

• Preop AHI 27, Postop AHI 1.2

• Morbid obesity

• Unable to tolerate bipap 21/17
Intraoperative Findings

- Oropharyngeal stenosis, 1 cm opening
- Normal bronchoscopy
Oropharyngeal Stenosis
Anesthesia Concerns with Severe OSA

- During induction: high risk for airway obstruction, desaturation and laryngospasm.
- Abnormal ventilator response to carbon dioxide
- Greater respiratory depression in response to sedatives, narcotics, and general anesthetics.
- Delay in the return to spontaneous ventilation and emergence from general anesthesia
- Presence of trace volatile anesthetics will further reduce what may be pre-existing abnormal ventilatory drive and potentiate airway obstruction due to reduced function of the genioglossus and other airway muscles.
- Risk for post-extubation obstruction, laryngospasm, desaturation, pulmonary edema, and respiratory arrest.

Discussion

• Multiple options exist beyond T&A
• Procedure selection guided by physical examination and sleep endoscopy
• Post-op sleep studies and follow up
  – Long term follow up for at-risk patients
    • Delayed recurrence
    • Stenosis
  – Patients who report symptom resolution may still have OSA
  – Help understand characteristics of patients that may determine surgical success or failure
Thank you
Supplemental slides
Snoring in children

• Snoring occurs in 3 – 27% of children.
  – **Primary snoring** has implications with associated morbidity of elevated blood pressure and reduced arterial distensibility.
  – **Obstructive sleep apnea** (OSA) occurs in 40% of children who snore.

• Prevalence increasing over time with increased prevalence of obesity.


Why does OSA matter?

• Associated morbidities:
  – Pulmonary hypertension
  – Cor pulmonale
  – Failure to thrive
  – Growth retardation
  – Behavioral disturbances
  – Poor school performance
  – Enuresis

Adenotonsillectomy outcomes

- Success rates for T&A range from 59.8% to 100%, with a significant improvement in AHI from preoperative levels.

- Overall improvement in quality of life, academic performance.

- Postoperative reports of symptoms such as snoring and witnessed apneas correlate well with persistence of OSA after T&A.

Adenotonsillectomy outcomes
Childhood Adenotonsillectomy (CHAT) Study

- Multisite prospective randomized controlled trial.
- 464 children with PSG documented mild-moderate SDB were randomized to either T&A or watchful waiting for 7 months.
- AHI normalized in 30 – 50% in the control group over seven months without surgical intervention.
- Subjects with more severe obstructive sleep apnea showed a larger treatment effect.
- T&A was associated with a more significant improvement in measures of sleep quality and sleep disruption, such as arousal index or hypercapnia.
Adenotonsillectomy outcomes
Childhood Adenotonsillectomy (CHAT) Study

• T&A group improved over controls in:
  – Quality of life measures for obstructive symptoms
  – Behavioral measures (regulation, academics, and internalizing behavior).

• The primary end point, the attention executive function domain of the NEPSY, did not show a statistically significant difference between the two groups.

Redline S; Amin R; Beebe D; Chervin RD; Garetz SL; Giordani B; Marcus CL; Moore RH; Rosen CL; Arens R; Gozal D; Katz ES; Mitchell RB; Muzumdar H; Taylor HG; Thomas N; Ellenberg S. The Childhood Adenotonsillectomy Trial (CHAT): rationale, design, and challenges of a randomized controlled trial evaluating a standard surgical procedure in a pediatric population. SLEEP 2011;34(11):1509-1517.
Septoplasty

- Careful patient selection (> age 6 years) with limited approach.
- Useful in improving CPAP tolerance, particularly in older children.
- Complications: persistent septal deviation, bleeding, and septal perforation.
- Pediatric septoplasty can be performed without affecting most aspects of nasal and facial growth. Not performing or delaying septoplasty when indicated may adversely affect nasal and facial growth with compounding adverse effects in terms of deformity and asymmetry.

Genioglossus advancement

• **Midline osteotomy** of the mandible, advance and secure the tongue with plates.
  – Not amenable in small children due to presence of tooth buds.
• **Repose**: pass suture through the tongue base, stabilize to the medial aspect of the mandible with a screw.
• Complications: wound infection, edema, and seromas.
• Long term effectiveness unknown at this time.

Geniohyoid suspension
Radiofrequency ablation

• Insertion of a 2-pronged probe, generates thermal damage at multiple points in the tongue base.
• Tongue bulk and flaccidity of the tongue base is reduced through fibrosis.
• Complications (3.4%): range from mucosal ulceration, to superficial infection, and transient parasthesia of the hypoglossal nerve.

Mandibular distraction

- In combination with adenotonsillectomy, maxillary distraction has a cure rate of 87.5% in children with sleep apnea.
- May avert the need for tracheostomy in children with Pierre Robin sequence, less successful in children with complex congenital syndromes.
- Complications: premature callus consolidation, cheek abscess requiring incision and drainage, minor lip erosion from pin contact, facial cellulitis, unilateral facial paralysis, and temporal mandibular joint ankylosis.

Mandibular distraction
Rapid maxillary expansion

- Oral appliance adjusted daily to increase palatal width.
- High-arched palates with associated
  - Increased nasal resistance
  - Posterior tongue posture
  - Retroglossal airway narrowing and mild OSA
- Most effective in pre-pubertal children prior to palatal suture closure.
- May be used in combination with adenotonsillectomy to improve the nasal and oral airway

Laryngomalacia

• Primarily seen in infancy, but may present in older children
• Consider supraglottoplasty in the setting of OSA, failure to thrive, or feeding difficulties
• Medical comorbidities are associated with worsened postoperative outcomes, although the majority of children improve after supraglottoplasty


Laryngomalacia