Controversies in Outpatient Tonsillectomy and Adenoidectomy

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Obstruction during induction: children with kissing tonsils or obstructive sleep apnea (OSA) likely to experience airway obstruction during induction of anesthesia; oral airway useful for bypassing obstruction

Obstructive sleep apnea: associated with developmental delays and behavioral problems; tonsillectomy beneficial in 40% to 60% of cases; OSA has anatomic (eg, obesity, large tonsils, extra fat in lateral tissue pads of pharynx) and neurologic components; children who do not derive benefit from tonsillectomy may require continuous positive airway pressure (CPAP)

Preoperative assessment: study onerous procedure for children; half of children at speaker’s facility undergo sleep studies, and results used to determine need for overnight stay or admission to intensive care unit (ICU); monitor with pulse oximeter and continuous observation

Premedication: minimal respiratory effects with midazolam in individuals with normal physiology, but could cause problems in children with large tonsils and OSA; reduce midazolam dose in children with significant OSA; monitor with pulse oximeter and continuous observation

Postoperative issues: potential for upper airway obstruction remains after tonsils removed; neurologic component of OSA still present; postoperative swelling and anesthetic effects can cause obstruction; minimize opioid usage

Brown et al (2004): retrospectively examined children with OSA and postoperative doses of opioids; total postoperative dose of analgesics plotted against O2 saturation on preoperative sleep study; children with lowest preoperative saturations required lowest amount of opioids, with good correlation between saturation and dose; study indicated effect of chronic hypoxia on requirements for opioids

Moss et al (2006): incubated group of rats in hypoxic environment to simulate sleep apnea; administration of fentanyl to hypoxic rats associated with more profound respiratory effects compared with controls; chronic hypoxia decreases requirements of opioids for pain and increases respiratory sensitivity to opioids; opioids should be carefully titrated in children with OSA

Clinical Practice Guideline: Tonsillectomy in Children (2011): literature on tonsillectomy evaluated to formulate recommendations about indications and awareness of chronic effects of OSA before and after tonsillectomy; aimed at pediatricians and family practitioners; dexamethasone definitive treatment for nausea and vomiting, but optimal dose undetermined; antibiotics unnecessary; consider postoperative analgesia; children experience ongoing postoperative pain after tonsillectomy (Kain et al 2006); clinicians should determine rate of postoperative bleeding and compare with national incidence of 2.5% to 3%

Guideline for preoperative polysomnography: indications for sleep study prior to tonsillectomy include, eg, obesity and Down syndrome; sleep study highlights degree of obstruction Management recommendations: inform anesthesiologist of results of sleep study before induction; admit child if age <3 yr; admit child with OSA if apnea-hypopnea index (AHI) >10 events per hour or O2 saturation ≤80%

2012 American Academy of Pediatrics consensus on sleep apnea: screen all children for snoring; use sleep study to diagnose sleep apnea; primary treatment tonsillectomy; admit high-risk patients overnight

Muscle relaxants: intubating with muscle relaxant vs intubating with propofol alone debated; use of neuromuscular blockade requires reversal and may result in residual paralysis in post-anesthesia care unit (PACU), which could lead to upper airway collapse and hypoxia; without neuromuscular blockade, increased inhalational anesthetic required for maintenance and increased propofol required for intubation, which could lead to increased residual anesthetic in PACU; in speaker’s experience, speed of tonsillectomy increasing over time, which renders paralysis impractical

Laryngeal mask airway (LMA): advantages include decreased desaturation on emergence, decreased pain, and decreased requirement for anesthesia; Webster et al (1993) observed higher mean saturations on PACU admission for LMA group; Doksrød et al (2010) observed decreased pain in PACU with LMA compared with endotracheal tube, possibly because of decreased throat pain; not widely used for tonsillectomy or adenoidectomy in United States

Deep extubation: little data to indicate superiority of deep vs awake extubation; von Ungern-Sternberg et al (2013) observed more airway obstructions in PACU with deep extubation than with awake extubation; some facilities extubate in PACU to

Educational Objectives

The goal of this program is to improve the perioperative management of children undergoing tonsillectomy and adenoidectomy and the perinatal care of mothers and infants. After hearing and assimilating this program, the clinician will be better able to:

1. Summarize the perioperative challenges of obstructive sleep apnea.
2. Optimize the perioperative care of children undergoing tonsillectomy and adenoidectomy.
3. Assess the need for hospital or pediatric intensive care unit admission following tonsillectomy and adenoidectomy.
4. Apply knowledge of perinatal physiology to the management of obstetric patients.
5. Choose appropriate medications for obstetric patients and their infants.

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 business or commercial interest. For this program, members of the faculty and planning committee reported nothing to disclose.
improve throughout; deep and awake extubations require PACU staff prepared to manage children with oral airways and potential for obstruction

Postoperative nausea and vomiting (PONV): dexamethasone standard of care; other options include ondansetron, total intravenous anesthesia, and fluids; children undergoing tonsillectomy at high risk for PONV; American Society of Anesthesiologists proposing PONV as indicator for quality of care, to be evaluated by Centers for Medicare and Medicaid Services; at speaker’s facility, each child receives ondansetron and dexamethasone, and <10% experience vomiting

Ondansetron: metabolized by CYP2D6 enzyme; patients lacking enzyme cannot metabolize ondansetron; administer granisetron to children with vomiting after receiving ondansetron, which is metabolized differently; some children experience refractory vomiting despite treatment

Dexamethasone: clear benefit, but optimal dose undefined; at speaker’s facility, children given 0.5 mg/kg to maximum dose of 10 mg; lower doses may also be beneficial; potential for increased postoperative bleeding shown in 1 study, but refuted in others; potential for impaired wound healing, but likely not with tonsillectomy; benefits of dexamethasone include decreased PONV, decreased pain, decreased incidence of refractory vomiting at higher doses; speaker recommends maximum dose of 10 mg

Criteria for admission to pediatric ICU (PICU): no definitive studies or statements defining criteria; criteria at speaker’s facility include children <2 yr of age undergoing tonsillectomy or any child ≤1 yr of age; some indication that children who do well in first hour will continue to do well overnight, but exceptions exist; additional criteria for PICU admission at speaker’s facility include severe OSA and comorbidities; age most important factor for postoperative complications

Safest analgesic: undetermined; important to titrate when using opioids; ketorolac (Toradol) not indicated for tonsillectomy; ibuprofen may cause increased bleeding; intravenous acetaminophen yields mixed results

Codeine: Food and Drug Administration issued warning; deaths occurred in children classified as ultrarapid metabolizers; CYP2D6 enzyme responsible for metabolizing codeine to morphine; ultrarapid metabolizers convert large quantities of codeine to morphine, which leads to high risk for morphine toxicity; poor metabolizers do not efficiently convert codeine to morphine, which leads to poor pain control; do not use codeine or acetaminophen with codeine

Suggested Reading


Perinatal Physiology and Pharmacology

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Embryology: embryo initially nourished through diffusion; specialized vascular system develops that becomes placenta; 2 separate circulation systems develop in close proximity but do not come into contact

Fetal circulation: parallel circulation; blood shunted right to left to minimize flow to nonfunctioning lungs; selective O2 delivery to organs with highest demand; deoxygenated blood carried away from fetus by 2 umbilical arteries and oxygenated blood carried back by single umbilical vein

Placenta: grows in parallel with fetus; ≥500 g and ≥20 cm diameter at term; maternal blood flow ≤1 L/min at term; functions as barrier, endocrine organ, and mechanism of gas and nutrient exchange

Barrier: many components cross, including red cells; small, nonpolar molecules cross most easily; P450 enzyme system enables metabolism of substances that cross

Endocrine organ: alters mother’s physiology to facilitate fetal growth; synthesizes estrogens, progestones, human chorionic gonadotropin, human placental lactogen, gastrin, and other hormones

Maternal circulation: syncytiotrophoblast invades spiral arteries in uterus and vasodilates them; arteries functionally denervated, do not respond to catecholamines, and do not autoregulate; maternal perfusion critically dependent on blood pressure

Fetal circulation: can autoregulate, but inefficient; responds to hypoxia; severe maternal pathophysiology can disrupt fetal autoregulation

Gas exchange: placenta acts as lung for fetus; fetal requirement for O2 (8 mL O2/kg/min) ≥3 times that in adults; placenta inefficient compared with lungs and consumes ≥25% of O2 received; arteriovenous mixing occurs in venous lakes; fetal partial pressure of O2 rarely exceeds 60 mm Hg

O2 delivery: maternal contribution equals content of O2 in maternal blood times uterine blood flow; depends on maternal hemoglobin saturation and blood pressure; fetus acclimated to hypoxic environment; affinity for O2 higher in fetal hemoglobin than in maternal hemoglobin

CO2 exchange: as CO2 moves from fetal to maternal blood, maternal blood becomes more acidic and fetal blood becomes less acidic, which changes O2 affinity of hemoglobin and facilitates increased offloading of O2 from maternal blood; maternal hemoglobin able to carry increased amount of CO2 after offloading O2; half-CO2 transfer at placenta result of CO2 binding to amino groups on hemoglobin

Drug transport: mechanisms include passive diffusion down concentration gradient, passive facilitated transport through channels or transporters, active transport, and pinocytosis; factors affecting transport include relative blood flows, amount of binding to protein, metabolic activity at placenta, and pH differences; ion trapping involves charged molecules becoming trapped behind barrier

Fetal-maternal (FM) ratio: difficult to study transport of drugs in real time; data derived from measuring single-point values of blood concentrations in umbilical vein and maternal venous blood at time of delivery; FM ratio equals concentration in fetal blood divided by concentration in maternal blood; low FM ratio implies substance poorly transferred; FM ratio >1 implies accumulation of drug; FM ratio provides no information about mechanism

Inhalational anesthetics: small, lipid soluble, and able to cross barriers easily; FM ratio ≈0.7 for isoflurane and halothane; sevoflurane and desflurane likely have similar FM ratios;
nitrous oxide equilibrates rapidly; diffusion hypoxia potential concern in infants after cesarean delivery under general anesthesia

**Intravenous agents**: induction agents lipid soluble and cross barrier easily; thiopental, propofol, ketamine, and etomidate all cross; ketamine crosses rapidly and accumulates in fetus; etomidate crosses least rapidly; benzodiazepines small and lipid soluble; diazepam most lipophilic and accumulates, lorazepam equilibrates, and midazolam most hydrophilic and transported least; opioids equilibrate; remifentanil does not rely on enzymatic degradation; fentanyl crosses poorly (FM ratio 0.4); FM ratio 0.3 for alfentanil

**Local anesthetics**: molecules tend to be larger; significant fraction of drug ionized at normal pH; with exception of lidocaine and mepivacaine, local anesthetics transported poorly (FM ratio ≈0.2); mepivacaine not used for obstetric anesthesia; lidocaine used when time critical; lidocaine and mepivacaine have lower ionized fraction and more readily transported compared with other local anesthetics

**Neuromuscular blockers**: larger, polar molecules with quaternary ammonium groups; poorly transported (FM ratio ≈0.2); succinylcholine not detected in fetal cord blood; cholinesterase inhibitors transported poorly; anticholinergics transport variably; glycopyrrolate does not cross well, but atropine does

**Vasoactive medications**: β-blockers transported poorly; hydralazine and nitroprusside cross well; nitroglycerin crosses poorly; vasopressors cross well; ephedrine historically considered better choice for obstetric anesthesia; meta-analyses in humans indicate phenylephrine provides equivalent blood pressure support with better neonatal pH at delivery and may be better choice

**Tocolytic medications**: used to delay delivery by relaxing smooth muscle; magnesium no more effective than placebo as tocolytic but standard of care for seizure prophylaxis in pre-eclampsia and associated with improved neurologic outcomes in premature infants; β-agonists effective for relaxing uterus but can cause tachycardia, hypokalemia, and hyperglycemia; calcium channel blockers first-line drug with minimal side effects; nonsteroidal anti-inflammatory drugs may prolong labor but associated with fetal toxicity

**Fetal metabolism**: P450 enzymes present in fetal liver but not fully expressed until after birth, which leads to longer duration of action of some drugs; higher total body water content leads to higher volume of distribution for water-soluble drugs and potential requirement for higher loading doses of antibiotics and muscle relaxants; lower proportion of fat relative to lean tissue leads to prolonged action of lipid-soluble drugs (eg, most induction agents, lipophilic opioids)

**Suggested Reading**


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1. For children with obstructive sleep apnea (OSA), tonsillectomy is beneficial in _______ of cases.
   (A) 20% to 40%  (C) 60% to 80%
   (B) 40% to 60%  (D) 80% to 100%

2. Which of the following is a conclusion of Brown et al.’s (2004) analysis of O₂ saturation levels previous to tonsillectomy and the dose of opioids required after tonsillectomy?
   (A) Children with the lowest preoperative O₂ saturations required lowest amount of opioids
   (B) Children with the lowest preoperative O₂ saturations required highest amount of opioids
   (C) No correlation existed between preoperative O₂ saturations and opioid requirements

3. According to the Clinical Practice Guideline: Tonsillectomy in Children published in 2011, which of the following is the definitive treatment of nausea and vomiting in pediatric patients undergoing tonsillectomy?
   (A) Ondansetron  (C) Dimenhydrinate
   (B) Bismuth subsalicylate  (D) Dexamethasone

4. Compared with the use of an endotracheal tube, the use of a laryngeal mask airway for tonsillectomy has been shown to be associated with _______ O₂ saturation on admission to the postanesthesia care unit and _______ pain.
   (A) Higher; increased  (C) Lower; increased
   (B) Higher; decreased  (D) Lower; decreased

5. Ondansetron is metabolized by which of the following enzymes?
   (A) CYP1B1  (B) CYP27B1  (C) CYP2D6  (D) CYP4V2

6. Which of the following is the most important factor influencing postoperative complications following tonsillectomy?
   (A) History of OSA  (C) Craniofacial abnormalities
   (B) Obesity  (D) Age

7. The fetal requirement for O₂ is approximately _______ times that in adults.
   (A) 1.5  (B) 2  (C) 3  (D) 4

8. The fetal-maternal ratio for isoflurane is approximately:
   (A) 0.4  (B) 0.5  (C) 0.6  (D) 0.7

9. Which of the following local anesthetics is most readily transported across the placenta?
   (A) Bupivacaine  (B) Chloroprocaine  (C) Lidocaine  (D) Ropivacaine

10. Which of the following antihypertensive medications is transported poorly across the placenta?
    (A) Atenolol  (B) Hydralazine  (C) Nitroprusside  (D) All the above

Answers to Audio Digest Anesthesiology Volume 58, Issue 28: 1-C, 2-C, 3-A, 4-B, 5-C, 6-A, 7-B, 8-A, 9-B, 10-A