Anesthesia for pediatric ENT surgery

Lonneke Staals
Pediatric anesthesiologist
Erasmus MC – Sophia
Rotterdam
Pediatric ENT surgery

- **Ear**
  - Tympanostomy tubes, Tympanoplasty
  - Middle ear surgery / mastoidectomy
  - Cochlear implants

- **Nose**
  - Nasal polypectomy
  - Sinus surgery
  - Choanal atresia

- **Throat**
  - Tonsillectomy and adenoidectomy
  - Surgery of the larynx
  - Endoscopy / foreign body aspiration
APRICOT: more complications?

- Congenital malformations
- Acute / chronic upper respiratory tract infections
  - Higher risk of laryngospasm
- Potentially life-threatening upper airway obstruction
- Severe respiratory insufficiency requiring diagnostic / therapeutic ENT procedures
Middle ear surgery / CI : Anesthesia

- Neuromuscular blocking drugs
  - Electromyography is used to avoid injury of the facial nerve
  - Avoid NMBDs, or use short-acting NMBDs for intubation
- Nitrous oxide
  - Contraindicated during / after placement of tympanic graft
- PONV
  - Surgical stimulation of the vestibular labyrinth
  - Propofol TIVA: superior in reducing PONV
  - Dexamethasone IV
Sign language
Sign language
Choanal Atresia
Choanal Atresia

- Girls affected twice as often as boys
- 60-70% is unilateral
- Bilateral: detected soon after birth
  - Nasal breathing is essential to newborns! Obstruction causes respiratory problems in the neonatal period
  - CHARGE association in 75% of bilateral patients
- 6% of patients: chromosomal abnormalities
- 50% of patients: accompanying congenital abnormalities
  - Bronchial anomalies, micrognathia, palatal defects

**CHARGE association**

- Coloboma, Cardiac anomalies, Choanal atresia, Growth retardation, Ear anomalies
- May have other upper airway and oral cavity anomalies
  - Retrognathia: difficult airway
- Dysphagia: feeding problems, swallowing difficulty
  - Risk of aspiration
Anesthesia for Choanal Atresia

- Detected in neonates: surgical intervention urgently needed
- Consider accompanying anomalies
- Preparation for difficult airway
  - Inhalation induction
  - Airway equipment
- Mask ventilation with oral airway
- Sometimes tracheostomy needed!

(Adeno)Tonsillectomy

- Most common pediatric surgical procedure
  - NL: 42,500 ATE’s /yr. 30,000 adenoidectomies /yr (incl adults)
- Much debate about benefits vs cost / risk
- Indications:
  - Pharyngotonsillitis
  - Chronic tonsillitis
  - Peritonsillar abcess
  - Recurrent or chronic rhinosinusitis
  - Recurrent otitis media (+ear tubes)
  - Nocturnal upper airway obstruction, with / without obstructive sleep apnea

OSAS

- Prolonged partial upper airway obstruction or intermittent complete obstruction (=obstructive apnea)
- Disrupts normal sleeptime breathing and normal sleep patterns
- In children:
  - Peak prevalence: 2-8 years (1-4% of healthy children)
  - Most common cause: adenotonsillar hypertrophy
  - Other neuromuscular factors involved?
  - Syndromal: craniofacial anomalies, neuromuscular diseases
    - > 50% of children with Down (< 8yrs)
- Polysomnography?

Dutch Guideline: OSAS bij Kinderen (2013)
OSAS

https://www.youtube.com/watch?v=3GON9iqIHZ4

- Nocturnal snoring
- Breathing pauses: periodic obstructive apnea
- Increased respiratory efforts
- Oxygen desaturation
- ATE= first line of treatment
- Severe and untreated OSAS (rare!!):
  - Pulmonary hypertension
  - Cave: child with diastolic HT or loud second heart sound!
- Reversible by early ATE
**OSAS: ATE in daycare?**

- **Outpatient:**
  - No comorbidities, mild-moderate OSAS, and > 3 years old

- **Overnight stay postop: 1 or more risk factors:**

<table>
<thead>
<tr>
<th>Neurologic / neuromuscular disease</th>
<th>Morbid obesity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebral palsy, epilepsy, hypotonia</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Down Syndrome / Trisomy 21</th>
<th>Ex premature (&lt; 37 weeks at birth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craniofacial syndromes</td>
<td>Severe OSAS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Genetic/ metabolic diseases</th>
<th>Emergency ATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mucopolysaccharidoses, sickle cell anemia</td>
<td></td>
</tr>
</tbody>
</table>

| Achondroplasia                   | < 3 years of age                  |

<table>
<thead>
<tr>
<th>(Congenital) heart disease</th>
<th>&lt; 15 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension!</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Airway disease</th>
<th>ASA III or higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPD, subglottic stenosis, asthma, recent/ chronic/ rec. upper airway infection</td>
<td></td>
</tr>
</tbody>
</table>

| Failure to thrive                |                                   |


Surgical Technique

- Cold technique: Sluder technique, or cold steel dissection
- Hot technique: LASER, electrocautery dissection, bipolar diathermy (also for hemostasis)
- Hot:
  - Increased risk of hemorrhage
  - More postop use of analgesics
- Or: Tonsillotomy / partial TE:
  - Less postop pain
  - No difference in postop hemorrhage.
- However: no studies on incidence re-TE’s

Elinder K et al, Eur Arch Otorhinolaryngol 2016; 273: 2249-2256
Sluder Tonsillectomy (guillotine)

- [Link to Video](https://www.youtube.com/watch?v=WTEuyet9v9A)
- Less postop pain
- No difference in postop hemorrhage
- Shorter operation time
- No endotracheal tube?
Sluder technique and anesthesia

- Sitting position: better view for ENT... (less control of the airway for the anesthetist)
- No RCT’s on outcome (incomplete TE, bleeding) and hypoxemia during the procedure
- Some evidence for more hypoxemia in sitting position in not-intubated patients, compared to supine and intubated
- Probably higher risk of incomplete TE in sitting, not intubated pt
- No studies! No evidence!
- Advice: only experienced ENT surgeon and anesthetist
  - Anesthetist stays on the OR
  - IV line!
Anesthetic Management of (A)TE

- **Preoperative:**
  - No routine assessment of coagulation profile is needed
  - Loose teeth! (application of the mouth gag!)
  - No sedative premedication

- **Peroperative:**
  - Some children have partial or complete nasal airway obstruction
  - Cuffed endotracheal tube: ↓ aspiration of blood
  - Dexamethasone:
    - Dose 100 mcg/kg IV? (0,5 mg/kg ↑ risk of bleeding)
    - Reduces postop swelling and pain
    - ↓ PONV, Earlier resumption of diet

Steward et al. Cochrane Database Syst Rev 2011
Anesthetic Management of (A)TE

- Postoperative:
  - Increased risk of laryngospasm after extubation
    - Extubation in completely awake patients
    - IV lidocaine
  - Increased risk of airway obstruction (blood, secretions)
    - More often & severely hypoxemia in PACU
  - Children with OSAS: higher incidence of postop respiratory complications
  - PONV = common

- Postoperative pain!
Postoperative Pain

- 30 days postop questionnaire: 60% (32,225)
- Surgical indication:
  - Obstruction: mean age 5,89 yrs
  - Infection: mean age 11,7 yrs
- Indication obstruction:
  - TT ± A: 71,5%
  - TE ± A: 28,5%
- Surgical technique:
  - TT ± A: hot dissection (97,4%)
  - TE ± A: cold dissection (79,0 %)

# Postoperative Pain

Table 3 Patient reported pain-related outcome measures (pain-PROMs) for the total cohort and each surgical method/indication group. Comparison of days with analgesics, days to regular food intake and contacts with health care services due to pain for TT ± A obstruction versus TE ± A obstruction, and TE ± A obstruction versus TE ± A infection

<table>
<thead>
<tr>
<th>Method indication</th>
<th>Total (n = 32,225)</th>
<th>TT ± A obstruction (n = 18,109)</th>
<th>TE ± A obstruction (n = 7204)</th>
<th>TE ± A infection (n = 6700)</th>
<th>TT ± A obstruction versus TE ± A obstruction</th>
<th>TE ± A obstruction versus TE ± A infection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unadjusted mean difference (CI), p value</td>
<td>Unadjusted mean difference (CI), p value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Adjusted mean difference (CI), p value*</td>
<td>Adjusted mean difference (CI), p value*</td>
</tr>
<tr>
<td>(a) Number of days with analgesics after surgery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>6.11 (4.63)</td>
<td>4.64 (3.65)</td>
<td>7.34 (4.70)</td>
<td>8.72 (5.32)</td>
<td>2.71 (2.58; 2.83), &lt;0.0001</td>
<td>1.38 (1.22; 1.56), &lt;0.0001</td>
</tr>
<tr>
<td>Median (q1; q3)</td>
<td>6 (2; 7)</td>
<td>4 (2; 7)</td>
<td>7 (4; 10)</td>
<td>9 (6; 12)</td>
<td>2.72 (2.51; 2.92), &lt;0.0001*</td>
<td>0.45 (0.25; 0.64), &lt;0.0001*</td>
</tr>
<tr>
<td></td>
<td>28,888</td>
<td>16,130</td>
<td>6487</td>
<td>6083</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Number of days to regular food intake after surgery a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>4.07 (3.08)</td>
<td>3.19 (3.14)</td>
<td>4.95 (4.11)</td>
<td>6.19 (4.44)</td>
<td>1.76 (1.55; 1.97), &lt;0.0001</td>
<td>1.24 (0.96; 1.55), &lt;0.0001</td>
</tr>
<tr>
<td>Median (q1; q3)</td>
<td>3 (1; 5)</td>
<td>2 (1; 4)</td>
<td>4 (2; 7)</td>
<td>5 (3; 8)</td>
<td>1.84 (1.53; 2.14), &lt;0.0001*</td>
<td>0.49 (0.15; 0.83), 0.0028*</td>
</tr>
<tr>
<td></td>
<td>8922</td>
<td>5629</td>
<td>1593</td>
<td>1646</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Contacts with health care services due to pain after surgery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.3% (10.3; 12.3%), &lt;0.0001</td>
<td>5.3% (3.9; 6.7%), &lt;0.0001</td>
</tr>
<tr>
<td>Contacts (%)</td>
<td>3610 (12.2%)</td>
<td>1035 (6.2%)</td>
<td>1155 (17.5%)</td>
<td>1394 (22.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29,970</td>
<td>16,695</td>
<td>6589</td>
<td>6114</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n number of responds on 30-day survey, N number of respondents who answered the question, SD standard deviation, CI 95% confidence interval (bootstrapped), TE ± A tonsillectomy with or without adenoidectomy, TT ± A tonsillectomy with or without adenoidectomy

* Adjusted for operation technique, haemostasis technique, age and sex

a Outcome variable B, has been recorded in the register since 2013. TT ± A indication infection group (n = 212) is only presented in total and not as a separate surgical method/indication group
Postoperative Pain

- **Hot technique** compared to cold: 1 day longer use of analgesics
- **Hot technique**: risk factor for contact with health care services due to pain
- **Older children** took analgesics longer
  - ± 2 days longer in the TE ± A infection group
  - ± 1 day longer in the TE ± A obstruction group
- **Older children** returned to regular food intake 1 day later after TE ± A
- Children in infection group are older
- **Inflammatory scar tissue**
- **TE vs TT**
Review article

Swedish guidelines for the treatment of pain in tonsil surgery in pediatric patients up to 18 years

E. Ericsson, M. Brattwall, S. Lundeberg

School of Health and Medical Sciences, Örebro University, Örebro, Sweden
Anesthesia and Intensive Care, Sahlgrenska University Hospital, Mölndal, Sweden
Pain treatment service, Astrid Lindgren Children’s Hospital, Stockholm, Sweden
Department of Physiology and Pharmacology, Karolinska Institute, Stockholm, Sweden

Table 1
Swedish guidelines for the treatment of pain in tonsil surgery in pediatric patients.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose premedication oral</th>
<th>Dose perioperative intravenous</th>
<th>Dose postoperative oral or rectal</th>
<th>Max dose/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paracetamol day 1–3</td>
<td>40 mg/kg</td>
<td>15–20 mg/kg</td>
<td>24 mg/kg × 4 (96 mg/kg/d)</td>
<td>1.5 g × 4</td>
</tr>
<tr>
<td>Paracetamol day 4–8</td>
<td>–</td>
<td>–</td>
<td>18 mg/kg × 4 (72 mg/kg/d)</td>
<td>1.0 g × 4</td>
</tr>
<tr>
<td>Ibuprofen (from 6 months)</td>
<td>–</td>
<td>–</td>
<td>5–7 mg/kg × 3–4</td>
<td>400 mg × 4</td>
</tr>
<tr>
<td>Diclofenac (from 1 year)</td>
<td>1 mg/kg</td>
<td>–</td>
<td>1–1.5 mg/kg × 3</td>
<td>50 mg × 3</td>
</tr>
<tr>
<td>Celecoxib (weight &gt; 25 kg)</td>
<td>–</td>
<td>1 mg/kg</td>
<td>2 mg/kg × 2</td>
<td>200 mg × 2</td>
</tr>
<tr>
<td>Parecoxib (from 2 years)</td>
<td>–</td>
<td>1 μg/kg</td>
<td>–</td>
<td>40 mg × 2</td>
</tr>
<tr>
<td>Clonidine</td>
<td>2–3 μg/kg</td>
<td>0.5 mg/kg</td>
<td>1 μg/kg × 3</td>
<td>150 μg × 3</td>
</tr>
<tr>
<td>Morphine</td>
<td>&lt;50 μg/kg</td>
<td>–</td>
<td>&lt;150 μg/kg</td>
<td>–</td>
</tr>
<tr>
<td>Oxycodone</td>
<td>&lt;50 μg/kg</td>
<td>–</td>
<td>&lt;100 μg/kg</td>
<td>–</td>
</tr>
<tr>
<td>Betamethasone</td>
<td>0.2 mg/kg</td>
<td>–</td>
<td>–</td>
<td>8 mg</td>
</tr>
<tr>
<td>Ondansetron</td>
<td>0.1 mg/kg</td>
<td>–</td>
<td>–</td>
<td>8 mg</td>
</tr>
</tbody>
</table>

Recommended drugs and doses for patients < 18 years and bodyweight < 65 kg. Max dose/d (24 h). Oral premedication with paracetamol, clonidine and betamethasone or intravenously at initiation of anesthesia (perioperative dose). Treatment length maximum 10 days. The need for analgesic treatment after 10 days should be planned after contact with healthcare professionals.
Postoperative Pain

- Steroids (dexamethasone, betamethasone)
- Paracetamol
  - Rectally: more variable, unpredictable effect
  - Cave toxicity: limited nutritional intake might increase risk of hepatic toxicity. Dose reduced by 25% after 4 days
- NSAIDs: no ↑ risk of postop bleeding
- LA at surgical site: gauzes bupivacine 5 mg/ml for 5 min
  - Less side effects than infiltration, as good as or better effect
- Clonidine
  - No respiratory depression, lower incidence of agitation
- No standard anti-emetics
- Opioids: should be avoided in patients with OSAS!
The use of tramadol....

FDA 2017:
- Contra-indication for children < 12 yrs for pain treatment
- Contra-indication for children < 18 yrs postop ATE
- Warning: children 12-18 yrs with obesity, OSAS, lung disease

SPANZA 2017:
- Tramadol overdose is higher risk than fast-metabolizer
- Drops 100 mg/ml = risk!
- Tramadol after TE should be limited
  - Max 1 mg/kg every 6-8 hours (max 400 mg/d)
  - Start with lower dose: 0,5 mg/kg 6-8 h
- Tramadol after OSAS + TE: overnight stay in hospital
  - Assess response + sensitivity to opioids before discharge

Post TE bleeding

- Incidence 1.5-2.5%
- Primary (first 24 hours) or secondary
- Most post TE bleedings: in first 6 hours postop
  - Keep children for 6-8 hours in hospital
- Bleeding may obstruct the view of the larynx
  - ENT surgeon on the OR
- First treat hypovolemia & anemia, shock
- Full stomach: blood clots: modified RSI
- In case of shock: ketamine IV for induction
- Cuffed ETT
Anesthesia in airway surgery
Anesthesia in airway surgery

- Children with a difficult airway
- Sharing the airway
- Airway surgery
  - Bleeding
  - Foreign body /debris
- ENT
  - clear view of the operating area
  - no movements of the vocal cords
  - no time restriction!
Challenges for the anesthesiologist

- Good oxygenation and ventilation
- Patent airway
- Prevention of aspiration
- Preventing cardiac dysrhythmias
- Decreased airway reflexes
- Minimal secretions
- Smooth emergence

COMMUNICATION
OR setting

- Anaesthetic machine
- Airway table
- Anaesthetist
- Surgeon
- Video-tower Screen
- Instrument. table
- Theater-nurse
- Anaesth. nurse
Anesthesia for airway surgery

- TIVA: Propofol / remifentanil
  - Decrease in laryngeal responses / movement of vocal cords
  - Prevention of laryngospasm
  - Challenge:
    - Ability to maintain spontaneous breathing
- Topical anesthesia: Lidocaine 2% 3-4 mg/kg
- Spontaneous breathing or muscle relaxation?
  - Short acting NMBAs!
- Dexamethason: minimize postop mucosal swelling

Ferrari LR, Pediatric Anesthesia 2013; 23: 334-341
Dexmedetomidine? (Dexdor®)

- α2 agonist
- Fast onset of sedation, paralleling natural sleep
- Minimal respiratory depression
- Neuroprotective
- Obtunds airway reflexes while maintaining stable hemodynamic and respiratory profiles in spontaneously breathing children
- Ideal for rigid bronchoscopy, sleep endoscopy, difficult intubation!
- BUT: no approval for administration to children...

Mahmoud M, British Journal of Anaesthesia 2015; 115: 171-82
Anesthesia for rigid bronchoscopy

- Diagnostic (stridor, tracheobronchomalacia)
- Removal of airway foreign body

- Ventilation: side arm of bronchoscope
- High flow resistance
  - neonates and infants!
- Muscle relaxant vs spontaneous breathing
- Leak!
Foreign body aspiration

- Children 1-3 years of age
- Location, degree of obstruction
  - air trapping, atelectasis
- Avoid nitrous oxide

Controversy:

- Controlled ventilation vs spontaneous breathing
- Individualized approach!
  - Foreign body in the larynx vs distal to the carina
- Inhalation induction vs TIVA propofol and muscle relaxant
CO₂ LASER surgery of the larynx

- LASER injury: protective measures!
  - Eyes taped closed, covered with saline soaked pads
- LASER beam can ignite inflammable materials: ETT, circuits, drapes
  - Nonflammable ETTs
    - metallic exterior
    - saline inflatable cuffs
  - FiO2 at max 30%
    - Young children!
  - Avoid nitrous oxide
High frequency jet ventilation (HFJV)

- Frequency 100-150 per minute
- Risk of barotrauma to the upper airways, overdistension of the lungs (pneumothorax), pneumomediastinum
  - Subglottic rarely used in children
  - Supraglottic
- Distension of stomach
- Aspiration of resected material
- Dehydration of mucosa
High Frequency Jet Ventilation
Monitoring

$\text{CO}_2$?
Monitoring of PaCO2

- Neonates:
  - Hypo- and hypercapnia are associated with a bad neurological outcome!
  - Hypocapnia: may cause vasospasms of the cerebral arteries:
    - Decreased cerebral perfusion
    - Higher risk for ischemic periventricular white matter lesions

- Method:
  - ET- CO2?
  - Bloodgas analysis?

Transcutaneous pCO2 and pO2

Different display options:
tcPCO2, tcPO2 and heating power trends

Baseline and Delta values

OxiVenT™ Sensor:
- PCO2
- PO2
tcPO2 measured by dynamic fluorescence quenching
- virtually drift free
- high accuracy

Karlsson V. Anesthesia & Analgesia 2016; 123 (4): 1004-7
Take home messages

- COMMUNICATION
- Thorough preop evaluation of the patient: syndromes, OSAS
- Children desaturate faster, atelectasis
- Postoperative pain treatment after ATE!
  - CAVE use of opioids in OSAS patients
- Airway surgery: individual approach
  - Spontaneous breathing vs controlled ventilation
- New developments
  - Transcutaneous pCO2
  - Dexmedetomidine
References

- Dutch Guideline OSAS bij Kinderen (Nederlands) :

- Dutch Guideline ZATT (Nederlands):