Awake regional versus general anesthesia in preterms and ex-preterm infants for herniotomy

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Anesthesia for Herniotomy in Ex-Preterms

Epidemiology

- Herniotomy needed in 14-17 % of former premature infants, in particular in VLBW babies (<1500 g)
- Risk of incarceration is rare
- Monitoring of hernia in neonatology ward
- Surgery postponed until before hospital discharge
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Respiratory Complications

- Steward 1982: Preterms/Ex-Preterms
- Serious complications (periodic breathing, apnoeas, bradycardia) after general anesthesia for herniotomy
- Deep inhalational anesthesia
- No regional blocks for postoperative pain relief

Steward et al - Anesthesiology 1982
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Respiratory Complications

- Incidence of postoperative apnoea and bradycardia: **20 - 40 %**
- Period of risk: until **44 - 60 weeks** of postconceptional age
- Zurich: Risk is suggested to persist in ex-preterm babies until **50 weeks** of postconceptional age

*Coté - Anesthesiology 1995*
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Aetiology

- Immature respiratory central control
- $CO_2$ response curve flat / right-shift
- Residual effects of anesthetics and sedative analgesics in the postoperative period
- Delayed development of immature respiratory control after birth
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Aetiology

- Risk factors other than prematurity:
  - Anemia
  - History of RDS
  - History of broncho-pulmonary dysplasia
  - History of apnoea or ongoing apnoeas
  - Pain / increased endorphin levels from perioperative stress can induce apnoea
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Anesthesia Management

- **Awake Regional Anesthesia**
  - Spinal Anesthesia
  - Caudal Anesthesia

- **General Anesthesia**
  - Light general anesthesia with regional analgesia blockade
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**Awake Spinal Anesthesia**

- Abajian 1984
- Good results with awake *spinal anesthesia* for lower abdominal surgery in high-risk infants
- Less apnoea and other respiratory complications after *awake regional anaesthesia* (5 controlled studies)

Abajian - *Anesthesiology* 1984
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**Awake Spinal Anesthesia**

- Larger cerebrospinal volumes
- Faster cerebrospinal fluid (CSF) circulation and clearance
- High dose, long acting local anesthetics:
  - 1.0 mg/kg Bupivacaine
  - 0.5 mg/kg Tetracaine
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Awake Spinal Anesthesia

- Spinal blockage established within 1–2 minutes after injection
- Duration: 45 minutes
- Fast, skilled surgeon needs to be present at time of injection
- Unilateral procedures
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Awake Spinal Anesthesia

- Remarkable cardiovascular stability, even with high/total spinal blockade
- Bradycardia caused by hypoxemia, not by spinal blockade
- Deep sedation by lack of peripheral sensory input
Awake Spinal Anesthesia

- Non-cooperative patient
- Small anatomical dimensions
- Often bloody taps
- No CSF / “punctio sicca”
- Stressed, pressed, bent baby
- Excessive failure rate up to 28%
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**Awake Caudal Anesthesia**

- Caudal blockade universally used in children combined with general anesthesia
- Awake caudal blockade in ex-preterm infants for lower abdominal surgery has recently become an alternative for awake spinal anesthesia (3 studies)

Bouchut JC - Paediatr Anaesth 2001
Fear of local anesthetic toxicity and insufficient quality of anesthesia have prevented the use of awake caudal anesthesia in these infants so far.

Awake caudal anesthesia is technically easier than awake spinal anesthesia.
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Awake Caudal Anesthesia

- Maximal doses of long-acting local anesthetics are required for sufficient surgical anesthesia:
  - 3.0 mg/kg Bupivacaine c.A.
  - 1.2 ml/kg Bupivacaine 0.25% c.A.
Awake Caudal Anesthesia

- Important: ECG-control for signs of local anesthetic toxicity (intravenous/intraosseous injection)
- Risk of total spinal anesthesia
- Cardiovascular stability similar to spinal anesthesia
- Less sedation than spinal anesthesia
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**Awake Caudal Anesthesia**

- **Onset**: within 10–20 minutes after injection
- **Duration**: 60–90 minutes
- Bilateral procedures possible
- Slower surgeons allowed
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Awake Caudal Anesthesia

- Provides postoperative analgesia
- No postoperative complications
- Easier and more reliable than awake spinal anesthesia
- Less failure rate (1-2 %) than awake spinal anesthesia (7-28%)
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Awake Caudal Anesthesia

- Fasting 2h for clear fluid and 4h for all other fluids and meals
- 2 x EMLA (Lidocaine & Prilocaine) is applied to the skin 90 minutes before surgery for vein puncture and caudal puncture
- No sedative premedication !!!
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**Awake Caudal Anesthesia**

- Monitoring ECG, NIBP and SpO₂
- Intravenous line is established before caudal injection
- Preoperative 30 mg/kg Paracetamol (Acetaminophen) is rectally applied
- Intraoperative fluid: 20 ml/kg Ringer’s lactate including 2 % glucose
Awake Caudal Anesthesia

ECG signs of local anesthetic toxicity in infants:

ST-Elevation
T-Wave Elevation
Bradycardia
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Awake Caudal Anesthesia

- Postoperative cardio-respiratory monitoring for 24 h (ECG, SpO2)
- No sedative analgetic medications
- Paracetamol 100 mg/kg per day
- Start oral feeding immediately
- Ringer’s lactate including 2 % glucose until sufficient oral intake
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**Awake Caudal Anesthesia**

- No additives for caudal anesthesia should be given into the epidural space:
  - No clonidine
  - No opiates/opioids
  - No ketamine
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Awake Caudal Anesthesia

- Fellmann 2002: inadvertent Clonidine (1.8 µg/kg) admixture to bupivacaine 0.125 % c.A. for awake caudal anesthesia
  - excellent surgical anesthesia (0.125 % !!!)
  - intraoperative desaturation
  - late postoperative periodic breathing, apnoeas, desaturation and bradycardia
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Awake Regional Anaesthesia

- **Contraindications:**
  - Large, strong, big babies (> 4 kg)
  - Coagulation disorders
  - Rough, not-cooperative surgeons
  - Inexperienced surgeons
  - Long (bilateral) surgical procedures
  - Anesthesiologist not experienced with regional anesthesia techniques in infants
Awake Regional Anaesthesia

Absolute indications:

- Compromised airway
- Airway anomalies (stenosis/malacia)
- Broncho-pulmonary dysplasia
- Pulmonary diseases
- Severe periodic breathing
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**General Anesthesia**

- Necessary for other than lower abdominal surgery
- Necessary if regional anesthesia fails or is inadequate
- Recent studies with modern anesthetics did not demonstrate serious postoperative respiratory complications
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General Anesthesia

- Exponential decline in the incidence of apnoeas after the end of general anaesthesia in preterm infants can be explained by the residual effects of anaesthetics agents
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General Anesthesia

- Light, fully reversible general anesthesia with regional analgesic blockade for intra- and postoperative pain relief
- No sedative medication in the preoperative and postoperative period
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**General Anesthesia**

- Inhalational induction with sevoflurane
- **Muscle relaxation for non-traumatic tracheal intubation (LMA/Face Mask)**
- Caudal blockade with 1.5 ml/kg plain bupivacaine 0.125 % c.A. (no additives)
- Paracetamol 30 mg/kg rectally
- Awake extubation
Anesthesia for Herniotomy in Ex-Preterms

General Anesthesia

- Postoperative cardio-respiratory monitoring for 24 h (ECG, SpO2)
- No sedative analgesics
- Paracetamol 100mg/kg per day
- Start oral feeding immediately
- Ringer’s lactate including 2 % glucose until sufficient oral intake
Anesthesia for Herniotomy in Ex-Preterms

**General Anesthesia**

- Benefit of prophylactic administration of caffeine/theophylline not clear
- Prior medications must not be stopped but must be continued some days longer
- In any case of periodic breathing caffeine / theophylline should be given intravenously without delay
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General Anesthesia

- O’Brien 1998:
  - inhalational anesthesia (1 MAC) with caudal block
  - 40 preterm babies
  - 1 self-limiting postoperative apnoea

O’ Brien - British Journal of Anaesthesia 1998
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General Anesthesia

- Williams 2001
  - Inhalational anesthesia with Sevofluran and caudal block versus awake spinal anesthesia
  - No relevant postoperative apnoea occurred in the general anesthesia group
  - Failure rate of 28% in the awake spinal anesthesia group

William JM - British Journal of Anaesthesia 2001
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Conclusion

- Little scientific evidence exists to suggest that regional anesthesia is superior to general anesthesia for herniotomy in preterm infants.
- Regional anesthesia has the theoretical advantage of not exposing sensitive patients to central depressant drugs.
Conclusion

- Awake regional anesthesia as well as modern general anesthesia may be both valuable techniques for preterms and ex-preterm infants for herniotomy, depending on the anesthesiologist’s skills and experience.
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**Conclusion**

- Preterm infants with airway anomalies, pulmonary diseases and severe periodic breathing will benefit from awake regional anesthesia technique in order to avoid postoperative mechanical ventilation.
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Conclusion

- 24 h cardio-respiratory monitoring (ECG, SpO₂) in the PACU, NICU, PICU or intermediate care unit is demanded for all preterms and ex-preterm patients after herniotomy
- No sedative analgesics should be given before and after surgery
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**Open Questions**

- Damage by mechanical trauma or bleeding
- Maximal dose of local anaesthetic
- Long-term outcome studies not available
- Large, randomized trials comparing general anesthesia with awake regional anesthesia are not available