Neuraxial Blockade

Pediatric Pain Management

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Version 1, revised 10/24/19

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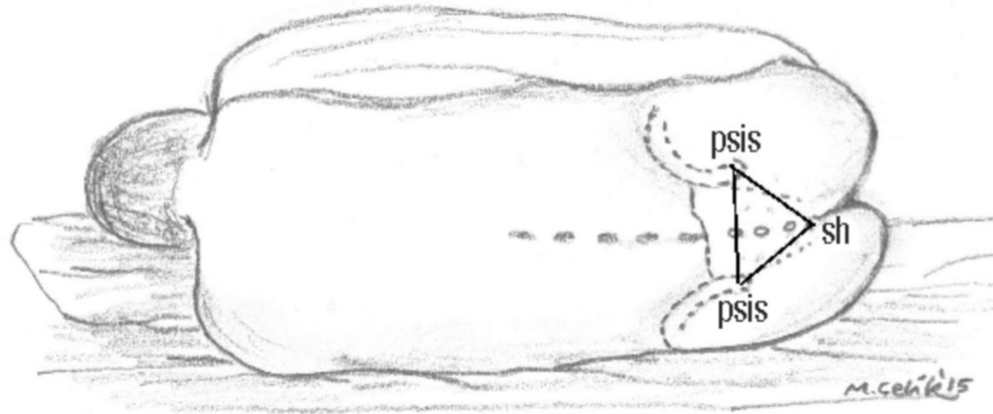
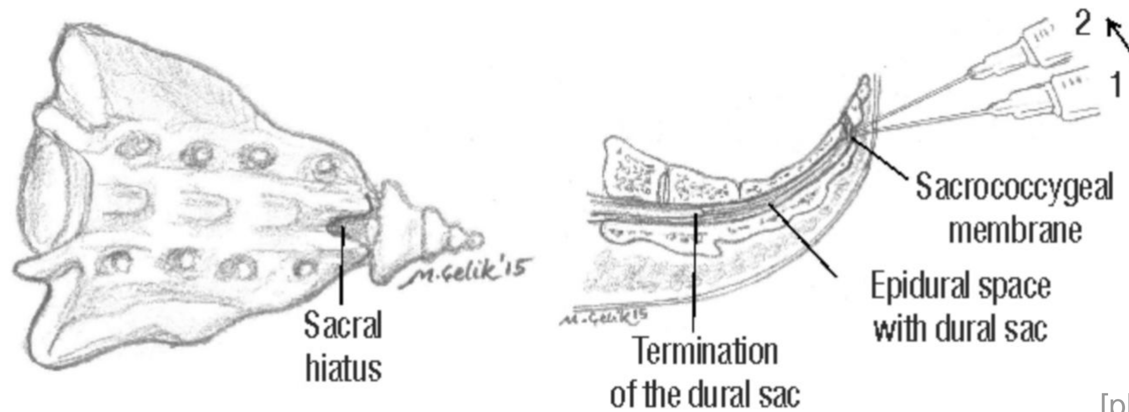
Route

Caudal Epidural Analgesia





[photo by Altun]

Route

Caudal Epidural Analgesia

- Sacrum flatter and more narrow than adults
- Sacral vertebral fusion incomplete until 8 years of age
  - May continue to 21 years
- Sacral hiatus more cephalad in young children
- Dural sac may extend to S4 in infants
  - S2 in older pediatric population and adults
- Complications (2%)
  - Failure of block (1%) > aspirated blood > positive test dose/intravascular > intrathecal injection > cardiac arrest

Stanford Children's Health
Stanford University

Route

Thoracic & Lumbar Epidural

- Differing rate of vertebral column and spinal cord growth
  - Conus medullaris located at L3 in infants (L1 beginning ~ 12 mos. old)
- Pediatric epidural space typically at depth approximately 0.1cm/kg
- Structures encountered with various approaches
  - Paramedian: subcutaneous - erector spinae - ligamentum flavum
  - Midline: subcutaneous - supraspinous ligament - interspinous ligament - ligamentum flavum
- Progression of loss with dosing:
  - Pain > temperature > touch > proprioception > skeletal muscle tone

Route

Intrathecal “Spinal”

- Neonatal spinal cord non-myelinated
  - Lower concentration of local anesthetic may be used
- Proportionally more CSF in infants (4mL/kg) than adults (2mL/kg)
- Pediatric cardiac output relatively greater than adults
  - Increased rate of systemic absorption of local anesthetics
  - Toxic plasma levels; shorter block duration
- High concern in volume compromised patients

Route

Confirmatory Techniques

- Test dosing
  - >25% increase in T wave after injection of epinephrine 0.5mcg/kg
  - Spontaneous ventilation if possible
    - Depression: LAST
    - Tachypnea: pain on injection
    - Tachypnea followed by bradypnea: spinal
- Imaging:
  - Ultrasound
  - Radiography
  - Electrical stimulation (safety not verified)

Imaging

Notes on Radiation Guidelines

- Skin entrance doses as high as 6-10 Gy in interventional procedures
  - 2Gy - erythema and epilation
  - 6Gy - permanent epilation
  - 10Gy - dry desquamation, dermal atrophy, telangiectasia
  - 15Gy - moist desquamation and necrosis of other organs
- kVp vs mA
  - 15% increase in kVp is equivalent to doubling the mA
  - Goal: increase kVp as needed, minimize mA
- Annual dose limit of radiation in physicians:
  - Effective whole-body dose: 5REM
  - Thyroid, extremity, gonads 50REM
  - Lens of eye: 15REM
  - Fetal: 0.5REM/gestational period
  - General public: 0.1REM/year
- NOTE: 1Gy = 100rad = 100rem = 1Sv

Dosing

Epidural Dosing

- Loading Bolus
  - Caudal
    - Volume-Based
      - 0.5mL/kg for sacral dermatomal coverage
      - 1.25mL/kg for high lumbar spread
      - 1.5mL/kg for low thoracic levels
  - Epidural
    - 0.05mL/kg/dermatome spread from catheter/needle tip
- Continuous Infusion
    - Bupivacaine maximum 0.5mg/kg/hr
    - Ropivacaine maximum 0.6mg/kg/hr

Local Anesthetics

Amide LAs with "i" preceding "-caine"

	Local Anesthetic	Epidural Onset (min)	Duration Alone (min)	Duration w/Epi (min)	Potency	Toxicity
Ester	Chloroprocaine	5-15	30-45	30-90	Low	Low
Amide	Lidocaine	15	30-120	120-360	Moderate	Moderate
	Mepivacaine	15	60-140	140-200	Moderate	Moderate
	Bupivacaine	10-20	120-240	180-240	High	High
	Ropivacaine	15	120-360	-	Moderate	Low

Adjunctive Medications

Clonidine

- Mechanism
  - Stimulation of α-2
    - Diminishes pain transmission via descending inhibition
    - Increases acetylcholine levels in CSF → cholinergic action at dorsal horn
    - Intrinsic inhibitory action of Aδ and c fibers
    - Additive with neuraxial opioids
      - Dose reduced by 60% when used in conjunction with clonidine
- Dose
  - 0.5-2 mcg/kg epidural
  - 0.01-0.1 mcg/kg intrathecal

Adjunctive Medications

Opioids

- Morphine: Bimodal respiratory depression
  - Initial secondary to systemic absorption (30-90 min)
  - Later from rostral spread via CSF to brainstem (6-18 hours)
- Opioid dosing: "Rule of 10s"
  - Epidural dose 1/10 systemic dose
  - Intrathecal dose 1/10 epidural dose
- Pruritus[Kumar]
  - Transmission similar to pain: via small, unmyelinated c-fibers
    - Prostaglandin release enhances c-fiber transmission
  - 5-HT3 and μ (κ is inhibitory) at dorsal horn and trigeminal nucleus
  - Itch selective secondary neurons at lamina I of spinal cord
    - Inhibition by wide dynamic range (WDR) neurons
      - Opioids weaken WDR response
  - Nalbuphine, naloxone infusion, etc.

Adjunctive Medications

Ketamine

- Potentiates analgesic effects of neuraxial local anesthetics and opioids
- Shortens time to onset of epidural local anesthetics
- Animal studies of spinal cord damage with intrathecal administration
  - Attributed to preservatives rather than medication[Malinovsky]
- Epidural, preservative-free ketamine without notable side effects[Acosta]
  - Low concentration ketamine (0.2%) administered
- No definitive studies in pediatrics

Potential Complications

Thoracic & Lumbar Epidural

- Direct needle trauma
- Hematoma
  - Appropriate anticoagulation guidelines
- Infection
- Subdural placement
  - Gradual, delayed onset
  - Extensive sensory & minimal motor block
  - Hypotension (less than total spinal)
  - Intracranial spread resulting in dyspnea, loss of consciousness
- Total spinal anesthesia - suspected in hypotension
  - Cardiovascular instability uncommon in typical pediatric neuraxial
  - Supportive treatment; CSF lavage with crystalloid possible
- Systemic toxicity
- Postdural puncture headache

Potential Complications

Local Anesthetic Systemic Toxicity (LAST)

- Absorption: intrapleural > intercostal > caudal > epidural > brachial plexus > femoral/sciatic > subcutaneous > intra-articular > spinal
- Signs & Symptoms
  - Lidocaine: neurologic precede cardiovascular
  - Bupivacaine: cardiovascular occur first
  - Neurological:
    - Tongue/perioral numbness, paresthesias, restlessness, tinnitus, muscular fasciculations & tremors, tonic-clonic seizures, global CNS depression, decreased LOC, apnea
  - Cardiovascular
    - Early: hypertension & tachycardia
    - Late
      - Peripheral vasodilation, profound hypotension
      - Sinus bradycardia, AV block
      - Ventricular dysrhythmias
      - Cardiac arrest

Potential Complications

Local Anesthetic Systemic Toxicity (LAST)

- Treatment
  - Intralipid 20% 1.5mL/kg over 1 minute
    - 15 mL/kg/hr infusion
  - Avoid
    - Beta blockers, calcium channel blockers, local anesthetics
    - Vasopressin, individual epinephrine doses >1mcg/kg
      - Increased afterload; impaired pulmonary gas exchange

Local Anesthetic	Toxic dose (mg/kg)
Bupivacaine	3.0
Ropivacaine	3.0
Lidocaine (w/wo epinephrine)	4.5/7
Mepivacaine (w/wo epinephrine)	4.5/7
Chloroprocaine	12

Contraindications

Epidural Analgesia Contraindications

- Absolute
  - Patient refusal, inability to cooperate
  - Severe coagulopathy
  - Allergy to local anesthetic
  - Infection at site of puncture
  - Uncorrected hypovolemia (intrathecal)
- Relative
  - Low platelets but no bleeding diathesis
  - Infection remote from site of lumbar puncture
  - Pre-existing neurological deficit in region to be blocked
  - Progressive neurological disease
  - Raised intracranial pressure
  - Hypovolemia
  - Fixed cardiac output states

Placement Guidelines

Anticoagulation

- American Society of Regional Anesthesia and Pain Medicine (ASRA)
  - Guidelines for anticoagulation - frequently updated
- NOTE: Peripheral blocks
  - Superficial blocks may be safely performed by ultrasound in residual anticoagulation
  - Deep blocks: guidelines for neuraxial apply[Horlocker]

TABLE 22. Stratification of Risk According to Procedures

Low Risk		Intermediate Risk		High Risk	
Regional Guidelines	**Pain Guidelines**	**Regional Guidelines**	**Pain Guidelines**	**Regional Guidelines**	**Pain Guidelines**
Superficial and compressible plexus/peripheral nerve blocks	Peripheral nerve blocks Joint injections Sacroiliac joint and sacral lateral branch blocks	Other procedures based on based on compressibility, patient body habitus, comorbidities, and the degree and duration of anticoagulation	Neuraxial injections Facet procedures Visceral sympathetic blocks Pocket revision	Neuraxial blocks Deep and noncompressible plexus/peripheral nerve blocks	Spinal cord stimulator trial and implant Intrathecal pump trial and implant Vertebroplasty and kyphoplasty Epiduroscopy

Narouze et al,[18] with permission.

Questions ???

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