Acute Pain

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Objectives

- Understand the basic mechanism of action for local anesthetics
- Understand the difference between neuraxial and peripheral nerve blocks
- Name some of the benefits and risks associated with regional anesthesia
- Be familiar with common regional techniques
SPECIAL ARTICLE

History of the Development and Evolution of Local Anesthesia Since the Coca Leaf

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THE development of anesthesia in general and local anesthetics, in particular, required a cultural change. The concept of pain (especially obstetric pain) was linked to the concept of original sin, and the ability to endure pain was regarded as a sign of character and, in up to 0.7–1.8% by weight. Many species of this genus have been grown in Nicaragua, Venezuela, Bolivia, and Peru since pre-Columbian times. The earliest cultivation and use of the coca leaf in the Bolivian and Andean region date back to 700 B.C., though

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First Topical Anesthetic: Cocaine - 1884

Karl Koller
Infiltration and Nerve Block

Anesthesia - 1885

William Stewart Halsted

Mandibular Nerve Block
Epidural Anesthesia: Corning in 1885

Space Identification

Thoracic & Lumbar Placement

Epidural Catheters
Spinal Anesthesia: Bier in 1898
Local Anesthetics: What do they do?

- Temporarily alter neuronal transmission when injected near nerve fibers
- Produce motor and sensory blockade
- Provide sensory blockade while preserving motor function (dilute concentrations)
Local anesthetics slow the rate of depolarization of the nerve action potential.
Mechanism of Action

- Mechanism of Action
  - Local Anesthetics cross nerve membranes where they alter axonal conduction
- Local Anesthetics exist in 2 forms
  - The unionized weak base form .....LA
    - crosses nerve membranes
  - The ionized form..........................LAH⁺
    - binds NA channels preventing depolarization
Regional anesthesia: Sequence of onset

- Sequence of onset of anesthesia
  - Depends on the rise of LA concentration near the nerves and the length of the fiber exposed to the LA

- Clinically observed sequence:
  1. **Sympathetic nervous system fibers**
     (B fibers: Vasodilation, skin temperature ↑)
  2. **Temperature and pain conduction** (Aδ and C fibers)
  3. **Proprioception and touch** (Aγ and Aβ fibers)
  4. **Motor function** (Aα fibers)
Motor and Sensory Block
Local Anesthetic Structure

Aromatic Ring

Intermediate Chain

Tertiary Amine
Local Anesthetic Structure

NH₂ \( \text{O} \) \( \text{C} \) \( \text{CH}_2 \)

Intermediate Chain

- Determines Local Anesthetic Class and Metabolism
Local Anesthetics: types

**Esters**
- Procaine
- Chloroprocaine
- Tetracaine
- Cocaine

**Amides**
- Lidocaine
- Mepivacaine
- Bupivacaine
- Prilocaine
- Ropivacaine
## Local anesthetics - Classes
(Rule of “i’s”)

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In 1943, the first modern local anesthetic agent was lidocaine, trade name Xylocaine®.
- Sets on quickly and produces a desired anesthesia effect for several hours.
- It’s accepted broadly as the local anesthetic in United States today.
Drug specific properties and effects

- What determines **time to onset of action**?
  - $\text{pK}_a \downarrow = \text{(ionization} \downarrow) = \text{time to onset} \downarrow$

- What determines **potency**?
  - Lipid solubility $\uparrow = \text{potency} \uparrow$

- What determines **duration of action**?
  - Protein binding $\uparrow$ and lipid solubility $\uparrow = \text{duration of action} \uparrow$

**Local anesthetics**

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<tr>
<td>Bupivacaine</td>
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Types of Regional Anesthesia

- **Neuraxial Anesthesia**
  - Local anesthetic is injected into the neuraxis
  - Site of action: nerve root
  - Produces motor and/or sensory block with dermatomal pattern
  - Includes epidural and spinal anesthesia

- **Peripheral Nerve Blockade**
  - LA injected near peripheral nerves
  - Block follows innervation of each particular nerve
Why Regional Anesthesia?

- Benefits of a Regional Technique
  - avoids general anesthesia
  - no airway instrumentation
  - no risk of malignant hyperthermia
  - less risk of post-op nausea and vomiting
More Benefits....

- Decreased risk for DVT, PE
- Reduced intraoperative blood loss
- Improved pain control and patient satisfaction
- Less opioid use
- Earlier ambulation and improved rehabilitation outcomes
Risks of Regional Anesthesia

- **Block Failure**
  - Direct Tissue Damage
    - hematoma formation
    - nerve trauma
    - damage to other organs or structures
- **Local Effects**
  - neuro toxicity
More Risks...

- Systemic Effects
  - Allergic reactions
  - Excessive or high block
    - hypotension
    - bradycardia
    - loss of airway
  - Local anesthetic toxicity
    - seizures
    - CV collapse
Neuraxial Anesthesia: spinal and epidural

- Results in dermatomal pattern of blockade
Epidural, Spinal, & Combined Spinal Epidural

- epidural catheter placement for labor analgesia
Anatomy

- Vertebral body
- Anterior spinal root
- Paravertebral nerve
- Posterior spinal root
- Subarachnoid space
- Spinal cord
- Dorsal root ganglion
- Dura mater
- Epidural space
- Ligamentum flavum
Epidural Catheter Placement
Peripheral Nerve Blockade

- Common Block Procedures
  - Popliteal Fossa
  - Sciatic Nerve
  - Femoral Nerve
  - Lumbar Plexus
  - Lumbar Plexus
  - Brachial Plexus
  - Interscalene, Supraclavicular
  - Infraclavicular, Axillary
Peripheral Nerve Blockade

- Single injection popliteal nerve block for foot and ankle surgery
Peripheral Nerve Blockade

- Sciatic nerve block for LE surgery
Peripheral Nerve Block

- Femoral Nerve block for post-op pain control following knee surgery
Peripheral Nerve Blockade

- Lumbar Plexus block placing LA into the lumbar plexus
- Utilized in hip replacement surgery
Peripheral Nerve Blockade

- Supraclavicular approach to the brachial plexus
- Used in upper extremity surgery
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