Pain and Anxiety

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The Ideal Local Anesthetic
- Water soluble/stable in solution
- Non-irritating to nerve
- Low systemic toxicity
- Short induction period
- Adequate duration of action
- No post anesthetic side effects
- Vasoconstriction effect

Dental cartridge
Each cartridge is 1.8cc

Percent Solution
- Different anesthetics come in various concentrations
- These concentrations are given as a percentage
  - .5% = 5 mg/cc
  - 1% = 10 mg/cc
  - 2% = 20 mg/cc
- Multiply by 1.8cc to determine how many mg are in a dental cartridge

Contents of a dental cartridge
- Anesthetic agent eg: lidocaine, mepivacaine etc
  - Anesthesia, vasodilation
- Vasoconstrictor: epinephrine or levonordefrin
  - Decreases absorption of anesthetic agent into blood, thereby increasing the duration of action and decreasing its toxicity
- Sodium metabisulfite
  - Vasoconstrictor preservative
- Isotonic sodium chloride

Contents cont:
- In multi-dose vials
  - Methylparaben may be present
    - Preservative for the anesthetic agent
    - Moderate incidence of allergic reaction
- Not present in single-dose dental cartridges
Concentration of vasoconstrictor

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Milligrams per milliliter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1000</td>
<td>1.0</td>
</tr>
<tr>
<td>1:2500</td>
<td>0.4</td>
</tr>
<tr>
<td>1:10,000</td>
<td>0.1</td>
</tr>
<tr>
<td>1:20,000</td>
<td>0.05</td>
</tr>
<tr>
<td>1:50,000</td>
<td>0.035</td>
</tr>
<tr>
<td>1:50,000</td>
<td>0.02</td>
</tr>
<tr>
<td>1:100,000</td>
<td>0.01</td>
</tr>
<tr>
<td>1:200,000</td>
<td>0.005</td>
</tr>
</tbody>
</table>

More common concentrations of vasoconstrictors in dental cartridges include:
- 1:50,000
- 1:100,000
- 1:200,000

**Chemical Configuration of Local Anesthetic Compounds in Dentistry**

- Amides
- Esters

**Locals are Comprised of:**

- An aromatic lipophilic group
- Ester or amide linkage
- A hydrophilic secondary or tertiary amino group, which forms water soluble salts when combined with acids

**Amides vs Esters**

- Major difference is method of metabolism
  - Amides: majority of the drug is metabolized in the liver
    - Use with caution in patients with severe liver disease
    - Use lower dose to avoid toxicity
  - Esters are metabolized in the plasma by pseudocholinesterase
    - PABA is a major metabolite of ester metabolism
      - Known allergen
      - Atypical pseudocholinesterase deficiency
        - Patients will not be able to metabolize; toxicity may ensue
Amide Local Anesthetics
- Articaine
- Bupivacaine
- Etidocaine
- Lidocaine
- Mepivacaine
- Prilocaine

Ester Local Anesthetics
- Butacaine
- Cocaine
- Hexylcaine
- Piperoxane
- Tetracaine
- Benzocaine

Pharmacology and Physiology

Nerve Conduction
- Resting membrane potential -60 to -90
- Stimulus
- Slow depolarization
- Threshold reached causing action potential
- Repolarization

Nerve conduction
At resting potential
- Axoplasm is negative (around -70mV)
- Membrane is freely permeable to K⁺ and Cl⁻
- Membrane is only slightly permeable to Na⁺

Nerve excitation causes
- Increase in the permeability of the membrane to Na⁺
- The rapid influx of Na⁺ to the interior of the nerve cell causes the axoplasm to become more positive
- The firing threshold is reached (-50 to -60mV)
- An action potential is created
**Nerve conduction**

Repolarization
- At the end of the action potential, the electric potential is positive (+40mV)
- The nerve membrane becomes impermeable to Na+
- There is an efflux of K+ and there is a return to normal resting potential

**Mechanism of Action of Local Anesthetic Agents**

- There are different unproven theories to explain the exact mechanism of action of local anesthetics
- The basic fact is that sodium channels are blocked preventing sodium ions from crossing the membrane
- This causes blockage of the formation of an action potential

**Mechanism of Action of Local Anesthetic Agents**

- Depression of rate of electrical depolarization
- Failure to achieve threshold potential level
- Lack of development of AP
- Conduction blockade

**Clinical characteristics of Local Anesthetics**

- Onset
- Duration of action
- Dosing

**Henderson hasselbach equation**

- Determines how much of a local anesthetic will be in a non-ionized vs ionized form
- Based on tissue pH and anesthetic Pk_a

**Henderson Hasselbach cont**

- Injectable local anesthetics are weak bases (pK_a=7.5-9.5)
- When a local anesthetic is injected into tissue is is neutralized and part of the ionized form is converted to non-ionized
- The non-ionized base is what diffuses into the nerve
- The ionized form is responsible for action
**Henderson Hasselbach cont**

- If the tissue is infected, the pH is lower (more acidic) and according to the HH equation; there will be less of the non-ionized form of the drug to cross into the nerve (rendering the LA less effective).
- Once some of the drug does cross; the pH in the nerve will be normal and therefore the LA re-equilibrates to both the ionized and nonionized forms; but there are fewer cations which may cause incomplete anesthesia.

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**Factors affecting LA action**

- Lower $pK_a$ = more rapid onset (more LA in non-ionized form to diffuse through)
- Increased lipid solubility = increased potency
- Increased protein binding = longer duration of action

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**Maximum Recommended Doses of Local Anesthetics**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Formulation</th>
<th>MHD mg</th>
<th>(mg/kg)</th>
<th>Author's MHD mg</th>
<th>(mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine</td>
<td>With epinephrine 5%</td>
<td>2.8 (mg)</td>
<td>(7.6)</td>
<td>3.75 (mg)</td>
<td>(10)</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>5%</td>
<td>0.6</td>
<td>(1.6)</td>
<td>0.6</td>
<td>(1.6)</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>2%</td>
<td>1.9</td>
<td>(5.2)</td>
<td>2.0</td>
<td>(5.5)</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>0.5%</td>
<td>2.0</td>
<td>(5.5)</td>
<td>2.0</td>
<td>(5.5)</td>
</tr>
<tr>
<td>Eutectacaine</td>
<td>2%</td>
<td>1.0</td>
<td>(2.7)</td>
<td>1.0</td>
<td>(2.7)</td>
</tr>
<tr>
<td>Procaine</td>
<td>2%</td>
<td>0.05</td>
<td>(0.14)</td>
<td>0.05</td>
<td>(0.14)</td>
</tr>
</tbody>
</table>

*Manufacturer's recommendation*
**Lidocaine HCL (Xylocaine)**

- 2% concentration
  - Pulpal anesthesia 5 minutes
  - Onset of action is 2-4 minutes
  - Vasoconstrictor concentration
    - 1:100,000 epinephrine
    - 1:50,000 epinephrine
    - Pulpal anesthesia for 60-90 minutes

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**Mepivacaine HCL (Polocaine, Carbocaine)**

- 3% concentration without vasoconstrictor
  - Sulfite free
  - Onset of action 30 sec - 4 min
  - Operating anesthesia time of 20-40 minutes
- 2% concentration with 1:20,000 levonordefrin
  - Operating anesthesia time of 1-5.5 hours

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**Long Acting Local Anesthesia**

- 1.5% etidocaine with 1:200,000 Epi
  - Duranest: not currently available
- 0.5% bupivicaine with 1:200,000 Epi
  - Marcaine
  - Max dose 1.3mg/kg; total max 90mg
  - Duration of action pulpal: 90-180 min, soft tissue: up to 12 hrs

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**Vasoconstrictors**
**Naturally Occurring Vasoconstrictors**
- Epinephrine
- Norepinephrine

**Adrenergic Agents**
- Alpha: vasoconstriction
- Beta 1: cardiac smooth muscle
  - + chronotrope
  - + ionotrope
- Beta 2: bronchiolar smooth muscle
  - bronchodilation

**Clinical Effects of Vasodilation**
- Increase rate of absorption
  - Decreases duration of pain control
  - Increases anesthetic blood level
  - Increases potential for overdose

**Vasoconstrictors should be included unless contraindicated**

**Mode of Action**
- Attach to and directly stimulate adrenergic receptors
- Act indirectly by provoking the release of endogenous catecholamine from intraneuronal storage sites
- Combination of 1 and 2

**Epinephrine (Adrenalin)**
- Most potent vasoconstrictor used in dentistry
- Concentrations of 1:50,000 to 1:200,000 in dental cartridges
Concentrations of Vasoconstrictors in Local Anesthetics

<table>
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<tr>
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<tbody>
<tr>
<td>1:50,000</td>
<td>0.020mg/ml</td>
<td></td>
</tr>
<tr>
<td>1:100,000</td>
<td>0.010mg/ml</td>
<td></td>
</tr>
<tr>
<td>1:200,000</td>
<td>0.005 mg/ml</td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{calculation} \\
1:50,000= \\
1\text{gram/50,000ml} = \\
1000\text{mg/50,000ml} = \\
1\text{mg/50ml} = 0.02\text{mg/ml}
\]

Levonordefrin (Neo - Cobefrin)
- One fifth as active as epinephrine
- Acts on alpha sites

Vasoconstrictors - Unstable in Solution
Sodium metabisulfite added
Known allergen

Metabolism of Adrenergic Agonists
- Re-uptake
- Inactivation by catechol-o-methyltransferase COMT
- Monoamine oxidase MAO

Max dose of vasoconstrictors
- Healthy patient approximately 0.2mg
- Patient with significant cardiovascular history: 0.04mg
- How many carpules of 2% lidocaine with 1:100,000 epi is max dose for CV patient?
**Max Dose for Vasoconstrictors (CV patient)**

- 1 carpule = 1.8cc
- $\frac{1}{100,000} = 0.01$ mg/cc
- $0.01 \times 1.8cc = 0.018$ mg
- $\frac{0.04}{0.018} = 2.22$ carpules

**In a healthy adult patient**

- $0.2/0.018 = 11.1$ carpules

**Toxic Reactions and Side Effects**

- Systemic toxicity
  - Inadvertent intravascular injection
  - Administration of large quantities
  - Altered drug metabolism
- Local tissue responses
- Idiosyncratic reactions
- Allergic reactions

**Allergens in Local Anesthesia**

- The agent itself
- PABA
- Sodium metabisulfite
- Methyl paraben

**Systemic Toxicity of Local Anesthesia**

- Convulsions
  - usually self limiting
  - can be treated with:
    - Diazepam
    - Barbital
    - Succinylcholine
- Respiratory depression
- Cardiovascular collapse

**In a healthy adult patient**

- $0.2/0.018 = 11.1$ carpules

**Allergens in Local Anesthesia**

- The agent itself
- PABA
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Thanks