Patients rate “painless injections” as the most important criteria in evaluating their dentist (or hygienist).

90% of all patients report being anxious about going to the dentist or hygienist and receiving a shot.

Methods for lessening the pain of shots:

1. Use of distraction techniques
2. Use of topical anesthetic before injecting
3. Slow injection of the anesthetic solution
4. Buffering of the anesthetic solution
5. Warming of the anesthetic solution
6. Use of appropriate needle gauge
7. Use of an aspirating syringe
8. Use of relaxation techniques
9. Explanation of the procedure
10. Confidence in yourself and in your techniques

White Coat Syndrome

90% of all patients report being anxious about going to the dentist or hygienist and receiving a shot.

Physiology of Anesthetic Agents

- How do we assess anesthesia?
  - Soft tissue only
  - Pulpal tissue
- How is anesthetic success defined in studies?
  - Ideal: 2 consecutive 80/80 readings with EPT within 15 minutes of injection (and sustained for 60 mins)
  - Delayed pulpal onset: occurs in the mandible of 19 – 27% of patients (even though soft tissue is numb)
  - Delayed over 30 minutes in 8%
Physiology of Anesthetic Agents

- Onset of anesthesia:
  1. Dependent upon anesthetic agent
     - Concentration
     - Diffusion to the site
     - Lipid solubility
     - Protein binding to receptor sites
  2. Dependent upon technique, block versus infiltration
     - Infiltration has faster onset
     - Block has longer duration

<table>
<thead>
<tr>
<th>Agent</th>
<th>Lipid Solubility</th>
<th>Protein Binding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine</td>
<td>2.9</td>
<td>65%</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>1</td>
<td>75%</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>1.5</td>
<td>55%</td>
</tr>
<tr>
<td>Articaine</td>
<td>49.5</td>
<td>95%</td>
</tr>
</tbody>
</table>

Blocks versus Infiltrations

- Advantages of infiltrations
  1. Faster onset
  2. Simple
  3. Safe
  4. Good hemostasis (with vasoconstrictor)
- Disadvantages of infiltrations
  1. Multiple injections for multiple teeth
  2. Shorter duration of anesthesia

Dental anesthetic agents: all amides

1. Lidocaine – (plain or) with vasoconstrictor
2. Mepivacaine – plain or with vasoconstrictor
3. Prilocaine – plain or with vasoconstrictor
4. Articaine – with vasoconstrictor
5. Bupivacaine – with vasoconstrictor
Blocks versus Infiltrations

- Duration of anesthesia and onset:
  1. Dependent upon anesthetic agent
     - Concentration
     - Diffusion to/from the site
     - Lipid solubility
     - Protein binding to receptor sites
  2. Dependent upon technique, block versus infiltration
  3. Dependent upon vasoconstrictor presence, but NOT vasoconstrictor concentration

Physiology of Anesthetic Agents

1. Overall diameter (size) of the nerve bundle
   - Time for entire nerve bundle to be penetrated
   - Central Core Theory:
     - Peripheral fibers anesthetized first
     - To most proximal structures (molars)
     - Central fibers anesthetized last
     - To most distal structures (incisors)

2. Amount of myelin (lipid) sheath present
   - For infiltration injections, ½ to ¾ cartridge is generally ideal
   - For an inferior alveolar nerve block,
     - Less than ½ cartridge tends to be ineffective
     - ¾ – 1 cartridge is ideal
     - An additional cartridge may increase profundity & decrease onset time

3. Critical length = 3 nodes minimum (5 – 8 mm)
   - Anesthetic volume, tissue space & density
   - The “right” volume depends on many variables
   - For infiltration injections, ½ to ¾ cartridge is generally ideal
   - For an inferior alveolar nerve block,
     - Less than ½ cartridge tends to be ineffective
     - ¾ – 1 cartridge is ideal
     - An additional cartridge may increase profundity & decrease onset time

How do local anesthetics work?

- BH⁺ = acidic, ionized form:
  - Can’t pass through nerve membrane (water soluble)
- B⁻ = basic, unionized form:
  - Can pass through nerve membrane (lipid soluble)
Troubleshooting Local Anesthesia

Is this failed anesthesia?
Frequency Dependent Conduction
Wait!
I Still Feel That!

Physiology of Anesthetic Agents

- Frequency Dependent Conduction

Anesthesia Delivery Assistance Devices

- Devices that vibrate – Frequency Dependent Conduction
  Vibration produces low-level nerve stimulation, allowing greater anesthetic access to receptor sites to produce better anesthesia

Anesthesia Delivery Assistance Devices

- The Gate Control Theory of Pain
  - Upon injection of anesthetic solution:
    - Nociceptors send much of pain messaging to the brain via slow conducting, thin C nerve fibers
    - By contrast, vibration stimuli of the oral mucosa are transmitted by rapid conducting, large A-beta fibers
  - By applying the vibrations before starting the injection, the vibration sensations reach the brain first and cause release from inhibitory interneurons, blocking the C fiber pain stimulation by "closing the pain gate"

Reasons for Anesthetic Failures

1. Anatomical/physiological variations
2. Technical errors of administration
3. Patient anxiety
4. Inflammation and infection
5. Defective/expired solutions

Reasons for Anesthetic Failures

- Inflammation and infection
  - Causes increased tissue acidity (decreased pH)
  - Less anesthetic solution can enter into the nerve due to change in dissociation equilibrium
  - Result is decreased anesthetic effect
Reasons for Anesthetic Failures

**Inflammation and infection**

- Increased tissue acidity (decreased pH)
- Decreased anesthetic disassociation
- Decreased anesthetic effect

*Injecting too much anesthetic, or injecting it too fast, may decrease the tissue buffering capacity.

### Troubleshooting Anesthesia

- **The “Hot” Tooth**
  - First, give a block injection
  - Well away from the site of any local inflammation or infection
  - The low pH will prevent the disassociation of the anesthetic agent
  - A needle should not be inserted into an area of active infection, such as a periapical abscess
  - The volume of anesthetic is likely to increase the pain
  - There is the potential for spreading the infection


- Second, give a periodontal ligament (PDL) or intraosseous injection
  - Intraosseous injections are more reliable and have better duration

  Haase et al, Comparing anesthetic efficacy of articaine versus lidocaine at a supplemental buccal infiltration of the mandibular first molar after an inferior alveolar nerve block, J Am Dent Assoc, Vol 138 No 9, Sept 2008

- Or, give a buccal & lingual infiltration with articaine (or prilocaine)


- **Trouble shooting Anesthesia**

### Troubleshooting Anesthesia

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- **Infiltration Anesthesia**

  - Works well for the maxilla, but for the mandible...
  - Works fairly well for anteriors and bicuspids
  - More variable predictability for molars
  - Greater success using articaine & faster onset
    - Lidocaine 45 – 67%; articaine 75 – 92%
    - Lidocaine 6.1 – 11.1 minutes; articaine 4.2 – 4.7 minutes

  Why not infiltrate both buccally and lingually? Use ½ cartridge of articaine for each

  Meechan, Practical Dental Local Anesthesia, Quintessence, 2002
Pharmacology of Anesthetic Agents

- From a meta-analysis of 13 clinical trials:
  - Evidence strongly supported articaine’s superiority over lidocaine for infiltration anesthesia
  - Evidence was weak for any significant difference between lidocaine and articaine for block anesthesia

- Articaine was 4 times more effective, with greater duration, than lidocaine as an infiltration injection when used for teeth diagnosed with irreversible pulpitis

Troubleshooting Anesthesia

- The “Hot” Tooth
- Why is the “hot” tooth so hard to anesthetize?
  - Inflammation may cause an increase in anesthetic-resistant sodium channels that exist in pain neurons.
  - Inflammation may cause an increase in the number and in the receptive field of pain neurons.
  - The barrage of pain impulses to the CNS produces “central sensitization”: an exaggerated CNS response to even gentle peripheral stimuli.
  - Apprehensive patients have a reduced pain threshold.

- First, give a block injection
  - Well away from the site of any local inflammation or infection
- Second, give a periodontal ligament (PDL), an intraosseous injection, or a buccal and/or lingual infiltration with articaine
- Third, give an intrapulpal injection
  - The last resort!

Reasons for Anesthetic Failures

5. Defective solutions: extremely rare
   - Oxidation
   - Contamination
   - Precipitation
   - Past expiration date

- There is no contraindication for combining any of the amide anesthetic agents
- Plain anesthetics have better dissociation in a site of infection (but will wash out faster!)
- Using plain anesthetic for “pre-injection”, then using anesthetic with vasoconstrictor
  - Anesthetic with vasoconstrictor: pH ~3.5
  - Plain anesthetic: pH ~6.5
  - Plain has less “burning” sensation
- Using a plain anesthetic first may mildly increase cardiovascular side-effects of vasoconstrictor

- Past expiration date
  - May discard in regular trash if empty
  - Should place in sharps container if broken or breakage is anticipated
- Expired anesthetic is a regulated pharmaceutical waste
  - Dispose of separately from sharps and medical waste
  - Use as endodontic irrigant
One more possible difficulty:

Do redheads have a lower pain tolerance?

And do redheads therefore need more local anesthetics for dental treatment?

Pain sensitivity varies significantly among human beings

Mutation in the melanocortin-1 receptor (MC1R) gene results in excess pheomelanin, which produces red hair

MC1R does have a relation to pain sensitivity, although the exact mechanism is uncertain

Redheads did show a lower percentage of successful pulpal anesthesia with an IAN block

But the difference was statistically insignificant

However, a statistically critical difference was seen in the dental anxiety level reported by redheads

MC1R revealed a higher correlation to dental care-related anxiety, fear of dental pain, and dental care avoidance in general

Conclusions:

The MC1R gene does play a role in sensing pain and thus does affect the efficacy of dental local anesthetics in redheads

The MC1R gene does influence the anxiety level of redheads, and the fear of dental care is believed to interfere with the efficacy of local anesthesia

Therefore, red-haired people may require higher dosages of local anesthetics due to greater pain sensitivity and their higher levels of dental anxiety

Buffer with sodium bicarbonate immediately before delivery

Increases dissociation of anesthetic agent for rapid uptake into the nerve

Potentially more comfortable

Potentially faster onset

Potentially more profound

Potentially higher success rate

Buffering of Local Anesthetics
New Technology: OnSet

OnSet™ assembled and ready to buffer anesthetic cartridge
Anesthetic Cartridge
Onset™ Cartridge Connector
3 mL Sodium Bicarbonate Cartridge
Onset™ Buffering Pen
Dosing indicator

OnSet mixing pen: insert anesthetic cartridge, mix, load in syringe, and inject – for best results, inject within 30 seconds of mixing

New Research: Intranasal Delivery

Utilizing the BD ACCUSPRAY® technology currently used in the Flumist® nasal product
Tetracaine plus the vaso-constrictor oxymetazoline
The goal is to produce a regional block enabling invasive quadrant dentistry on maxillary (& mandibular?) teeth

New Technology: OnSet

- Improve patient satisfaction
- More comfortable injections
- More predictable anesthesia
- More profound anesthesia
- Decrease appointment times
  - Less waiting for anesthetic onset (1 – 2 minutes)
  - See more patients
    - Emergency patients
    - Hygiene patients
- See more patients
- Emergency patients
- Hygiene patients

New Research: Intranasal Delivery

- Anesthetic enters the trigeminal neural pathway within the nasal cavity
- Orofacial structures can be targeted
- Particularly effective from maxillary bicuspid to bicuspid
- “Sniff” administration
- Non-invasive, painless, rapid
- Patients could self-administer
- Phase 3 clinical trials are in progress to submit the product to the FDA for approval

Pharmacology of Anesthetic Agents

- Dental anesthetic agents: all amides
  1. Esters: high incidence of allergic reaction
     - Frequent cross-reactivity
     - No longer available in U.S. in dental cartridges
     - Available in multidose bottles
  2. Amides: <1% incidence of allergic reaction
     - True allergy very rare
     - Sensitive patients usually not reactive to other amide agents
     - Recommend patch testing by allergist
     - Note: This is not entirely reliable

Pharmacology of Anesthetic Agents

- Lidocaine HCl:
  1. 2% plain (not available in dental cartridges)
     - Pulpal anesthesia for 5 to 10 minutes
     - Soft tissue anesthesia for 1 to 2 hours
  2. 2% with 1:100,000 or 1:50,000 epinephrine
     - Pulpal anesthesia for 1 to 2 hours
     - Soft tissue anesthesia for 3 to 5 hours
  3. Xylocaine, Octocaine, Lignospan, etc.
### Pharmacology of Anesthetic Agents

#### Mepivacaine HCl:
1. 3% plain
   - Pulpal anesthesia for 20 to 40 minutes
   - Soft tissue anesthesia for 2 to 3 hours
2. 2% with 1:20,000 levonordefrin (Neo-Cobefrin)
   - Pulpal anesthesia for 1 to 1½ hours
   - Soft tissue anesthesia for 3 to 5 hours
3. Carbocaine, Polocaine, Isocaine, Scandonest, etc.

#### Prilocaine HCl:
1. 4% plain = Citanest
   - Pulpal anesthesia for 40 to 60 minutes*
   - Soft tissue anesthesia for 2 to 3 hours
2. 4% with 1:200,000 epinephrine = Citanest forte
   - Pulpal anesthesia for 1 to 1½ hours
   - Soft tissue anesthesia for 3 to 8 hours
   - * Only if via block technique; 5 – 10 minutes as infiltrate

#### Articaine HCl:
1. 4% with 1:100,000 or 1:200,000 epinephrine
   - Pulpal anesthesia for 1 to 1½ hours
   - Soft tissue anesthesia for 2 to 4 hours
2. Septocaine, Zorcaine, Articadent, Orabloc (U.S.) Ultracaine, Septonest (Canada, Europe)

#### Bupivacaine HCl:
1. 0.5% with 1:200,000 epinephrine
   - Long-acting by block injection only
   - Pulpal anesthesia for 1½ to 4 hours, up to 7 hours
   - Soft tissue anesthesia for 5 to 12 hours
2. Marcaine, Vivacaine

### Pharmacology of Anesthetic Agents

- **Common usage:**
  - (Expected duration of pulpal anesthesia)
  - Short procedures: less than 1 hour
    1. Mepivacaine 3% plain (as infiltrate or block)
    2. Prilocaine 4% plain (as block)
  - Routine procedures: 1 to 2 hours
    1. Lidocaine 2% with vasoconstrictor
    2. Mepivacaine 2% with vasoconstrictor
    3. Articaine 4% with vasoconstrictor
    4. Prilocaine 4% with vasoconstrictor

- **Common usage:**
  - Long procedures: more than 2 hours or for post-operative analgesia
    1. Bupivacaine 0.5% with vasoconstrictor

- **Difficult to anesthetize patients:**
  1. Prilocaine 4% with vasoconstrictor
  2. Articaine 4% with vasoconstrictor

*Clinical Research Associates Newsletter, June 2001*
Pharmacology of Anesthetic Agents

A Practical Armamentarium:
- 2% Lidocaine with 1:100,000 epinephrine
  - For one to two hour procedures and most block injections
- 3% Mepivacaine plain
  - For short duration procedures or the rare “no vasoconstrictor” patient
- 4% Articaine with 1:200,000 epinephrine
  - For infiltrations and “hard to anesthetize” patients
- 0.5% Bupivacaine with 1:200,000 epinephrine
  - For prolonged pain control and long duration procedures
- And some OnSet buffering agent

Pharmacology of Anesthetic Agents

Adverse reactions to anesthetic agents:
1. Psychogenic reactions
   - Syncope the most common reaction
   - 76% of medical emergencies in the dental office are related to stress and anxiety
   - Low blood sugar, lack of sleep, and/or dehydration may also cause syncope
   - To avoid syncope:
     - Give injections with the patient lying supine, then slowly sit the patient upright

Pharmacology of Anesthetic Agents

Adverse reactions to anesthetic agents:
2. Allergic reactions
   - Question the patient carefully
   - Get a full history of the incident
   - Was it really an allergic reaction?
   - Allergy to an amide anesthetic is very rare

Pharmacology of Anesthetic Agents

Adverse reactions to anesthetic agents:
3. Toxic reactions - uncommon

4. Idiosyncratic reactions
   - Emotional factors may play a key role in producing unusual symptoms that cannot be related to pharmacology or anatomy

Pharmacology of Anesthetic Agents

Adverse reactions to anesthetic agents:
- Management of syncope:
  - Lay patient supine with legs above head
  - Maintain airway; may administer O₂
  - Monitor pulse, blood pressure & breathing
  - Loosen tight collar; keep patient warm
  - Calmly reassure the patient

Pharmacology of Anesthetic Agents

Adverse reactions to anesthetic agents:
4. Idiosyncratic reactions
   - Emotional factors may play a key role in producing unusual symptoms that cannot be related to pharmacology or anatomy

Most adverse drug reactions develop during the injection or within 5 to 10 minutes post-injection.

Malamed, Handbook of Local Anesthesia, 5th Ed, Elsevier, 2004
Pharmacology of Anesthetic Agents

- Adverse reactions to anesthetic agents:
  2. Allergic reactions
    - Anaphylaxis
      - Initial signs and symptoms: warm moist skin, apprehension, diffuse erythema/hives, itching, angioedema
    - Subsequent signs: abdominal cramps, vomiting, wheezing, dyspnea, difficulty talking
    - Progressive signs and symptoms develop very quickly!

- Adverse reactions to anesthetic agents:
  2. Allergic reactions: mild to moderate
    - Reactions
      - Urticaria
        - Diphenhydramine (Benadryl)
      - Angioneurotic edema
        - 25 to 50 mg orally if no mucous membrane respiratory or circulatory compromise
        - Continue every 6 hours for 2 to 3 days
      - Bronchodilator: Albuterol or Alupent inhaler

- Adverse reactions to anesthetic agents:
  2. Allergic reactions: severe
    - Reactions
      - Anaphylaxis
        - Have front desk call 911
      - Airway restriction
        - Give positive pressure O₂
      - Hypotension
        - Epinephrine 1:1000 (Epi pen)
        - 0.3 – 0.5 cc intramuscularly, repeat every 10 – 15 mins, if needed
      - “something wrong”
      - “sick feeling”
        - Diphenhydramine 2 mg/kg IV or IM

- Adverse reactions to anesthetic agents:
  2. Allergic reactions
    - Primary reasons for allergic reactions to dental local anesthetics:
      - The preservative for the anesthetic: Methyl paraben
        - FDA ordered removed from all U.S. dental cartridges in 1984
      - Ester anesthetics: high allergic incidence; cross-reactive
        - Replaced with amide anesthetics in mid 1990’s
      - Latex in cartridge stopper and diaphragm: molecules leached into the anesthetic solution
        - Replaced with silicone in early 2000’s
      - The antioxidant for the vasoconstrictor: Sodium metabisulfite (0.50 mg/ml)
        - Possible sulfite sensitivity, especially for corticosteroid-dependent asthmatics (10 – 20%)
        - Ask about food sensitivities: Dried fruits, beer and wine, salami and pepperoni-type meats: all have sulfites

- Adverse reactions to anesthetic agents:
  2. Allergic reactions
    - What are the contents of a cartridge of 2% lidocaine with 1:100,000 epinephrine?
      - Lidocaine HCl 2% concentration
      - Epinephrine (as the bitartrate dilution)
      - Sodium chloride 10.2 mg
      - Citric acid 0.34 mg
      - Sodium metabisulfite 0.85 mg
      - Distilled water

References:
- Carfield SW & Sugar TR, A guideline to local anesthetic allergy testing. Anesth Prog Vol 34, 1987
- Manufacturer package insert information, 2014
Pharmacology of Anesthetic Agents

- Adverse reactions to anesthetic agents:
  2. Allergic reactions
    - If an allergy to an amide anesthetic is suspected:
      1. Have patient patch tested (skin “prick” test followed by intradermal injection) for all amides and for at least one ester anesthetic (send dental cartridges with patient)
      2. A challenge test to duplicate symptoms can be used if there is no response to skin testing; this is more reliable
      3. May use 1% diphenhydramine (Benadryl) with 1:100,000 epinephrine as an alternative anesthetic

  Short duration (infiltrant), may require multiple injections

  Canfield DW & Gage TW. A guideline to local anesthetic allergy testing. Anesth Prog, vol 24, 1987

- Toxic reactions: Uncommon
  - Signs:
    1. Low: sedation, analgesia
    2. Intermediate: lightheadedness, slurred speech, drowsiness, euphoria/dysphoria, diplopia, muscle twitching
    3. High: disorientation, tremors, respiratory depression, tonic/clonic seizures
    4. Lethal: coma, respiratory arrest, cardiovascular collapse

  Progression may be very rapid with local anesthetics


- Toxic reactions: Contributing factors
  - Type of anesthetic
    - Plain anesthetics have rapid systemic absorption
  - Dosage of anesthetic
  - Route of administration
  - Rate of administration
  - Patient’s physical condition and health
    - Includes previous exposure
  - Drug interactions
  - Psychological response

- Local anesthetic dosage
  - Calculating dosage:
    In dental cartridges,
    ~18 mg anesthetic/% concentration
    - 2% lidocaine 36 mg/cartridge*
    - 3% mepivacaine 54 mg/cartridge*
    - 4% prilocaine 72 mg/cartridge*
    - 4% articaine 68 mg/cartridge*

  Cartridge volume officially 1.78 to 1.82 ml; all labeled as 1.7 ml.
  *These are approximate mg/cartridge numbers

  (FDA approved max. dosage)*
  1. 2% lidocaine w/epi 3.2 mg/lb
  2. 4% articaine w/epi (500 mg max. for any patient)
  3. 3% mepivacaine plain 3.0 mg/lb
  2% mepivacaine w/levo (400 mg max. for any patient)
  4. 4% prilocaine or w/epi 4.0 mg/lb
  (600 mg max. for any patient)
  5. 0.5% bupivacaine w/epi 0.6 mg/lb
  (90 mg max. for any patient)

  *Within a 24 hour timeframe
### Pharmacology of Anesthetic Agents

- **Local anesthetic dosage (FDA approved max. dosage)**
- **Calculating dosage: 150 lb. adult**

<table>
<thead>
<tr>
<th>Anesthetic</th>
<th>Dosage Details</th>
<th>Calculation</th>
<th>Maximum for Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% lidocaine with epinephrine</td>
<td>150 lb. x 3.2 mg/lb. = 480 mg</td>
<td>480 mg / 36 mg/cartridge = 13.33 cartridges</td>
<td>14 cartridges is the maximum for any patient ≥ 156 lb.</td>
</tr>
<tr>
<td>3% mepivacaine plain</td>
<td>150 lb. x 3.0 mg/lb. = 450 mg</td>
<td>400 mg / 54 mg/cartridge = 7.40 cartridges</td>
<td>7 cartridges is the maximum for any patient ≥ 135 lb.</td>
</tr>
<tr>
<td>2% mepivacaine with levonordefrin</td>
<td>150 lb. x 3.0 mg/lb. = 450 mg</td>
<td>400 mg / 36 mg/cartridge = 11.11 cartridges</td>
<td>11 cartridges is the maximum for any patient ≥ 135 lb.</td>
</tr>
<tr>
<td>4% prilocaine plain or with epinephrine</td>
<td>150 lb. x 4.0 mg/lb. = 600 mg</td>
<td>600 mg / 72 mg/cartridge = 8.33 cartridges</td>
<td>8 cartridges is the maximum for any patient ≥ 150 lb.</td>
</tr>
<tr>
<td>4% articaine with epinephrine</td>
<td>150 lb. x 3.2 mg/lb. = 480 mg</td>
<td>480 mg / 68 mg/cartridge = 7.05 cartridges</td>
<td>7 cartridges is the maximum for any patient ≥ 156 lb.</td>
</tr>
<tr>
<td>0.5% bupivacaine with epinephrine</td>
<td>150 lb. x 0.6 mg/lb. = 90 mg</td>
<td>90 mg / 9 mg/cartridge = 10 cartridges</td>
<td>10 cartridges is the maximum for any patient ≥ 150 lb.</td>
</tr>
</tbody>
</table>
Pharmacology of Anesthetic Agents

- Local anesthetic dosage (FDA approved max. dosage)
  - Calculating dosage: For children
    - Maximum recommended dosage is 2.0 mg/lb. for all anesthetics*, and use of a vasoconstrictor is strongly recommended
    - Note: Children have a higher metabolic rate, which means that more anesthetic enters their bloodstream in a shorter time.
    - Hence the reduction of maximum dosage to 2.0 mg/lb. for children for all anesthetics
  - *Systemic absorption of topical anesthetics must also be considered when calculating total anesthetic dosage

Guidelines on the Use of Local Anesthesia for Pediatric Dental Patients, American Academy of Pediatric Dentistry, 2009

Pharmacology of Anesthetic Agents

- Local anesthetic dosage
  - Calculating dosage: For adults
    - Using 2.0 mg/lb. for all anesthetics, the lowest maximum for any anesthetic
    - 150 lb. adult:
      - 2% lidocaine w/epi or 2% mepivacaine w/levo = 8.33 cartridges
      - 3% mepivacaine plain = 5.55 cartridges
      - 4% prilocaine or articaine = 4 cartridges
    - Maximum dosage for 150 lb. adult:
      - 2% lidocaine w/epi = 13 cartridges
      - 2% mepivacaine w/levo = 11 cartridges
      - 3% mepivacaine plain = 7 cartridges
      - 4% prilocaine = 8 cartridges
      - 4% articaine = 7 cartridges

Pharmacology of Anesthetic Agents

- Vasoconstrictors in local anesthetics
  - All anesthetic agents are vasodilators
  - Vasoconstrictors
    1. Slow the rate of uptake into the bloodstream
      - Lidocaine plain reaches a maximum blood level at 10 minutes after injection
      - Lidocaine with epinephrine reaches maximum blood level at 60 minutes after injection and at a lower concentration
    2. Increase the duration of anesthesia
    3. Induce localized hemostasis
Pharmacology of Anesthetic Agents

- **Vasoconstrictors in local anesthetics**
  - Are they safe to use?
    1. Review patient’s health history
    2. Is the patient medically stable?
    3. OK to use unless physician consult says “No!”
    4. Always aspirate
    5. Inject slowly
    6. Minimize volume injected

15

Pharmacology of Anesthetic Agents

1. Review patient’s health history
2. Is the patient medically stable?
3. OK to use unless physician consult says “No!”
4. Always aspirate
5. Inject slowly
6. Minimize volume injected

Evers & Haegerstam, Introduction to Dental Local Anaesthesia, Mediglobe, 1990

Pharmacology of Anesthetic Agents

- **Vasoconstrictors in local anesthetics**
  - Local anesthetics, with or without vasoconstrictors, are remarkably safe at therapeutic doses.
  - Two basic concerns when treating medically complex patients
    1. Existing systemic diseases that may be exacerbated by the agent, and
    2. Medications that may have an adverse interaction with the agent

Pharmacology of Anesthetic Agents

- **Vasoconstrictors in local anesthetics**
  - Absolute contraindications:
    1. Unstable angina
    2. Myocardial infarction within 6 months*
    3. Coronary artery bypass surgery within 3 months*
    4. Refractory arrhythmias
    5. Untreated or uncontrolled hypertension
    6. Untreated or uncontrolled congestive heart disease
    7. Uncontrolled diabetes or other endocrine diseases

*The timeframe is variable; a physician consult is recommended

Pharmacology of Anesthetic Agents

- **Vasoconstrictors in local anesthetics**
  - Patients with stabilized hypertension or other cardiovascular diseases
    - The results of a number of studies indicate that the use of 1 or 2 cartridges of vasoconstrictor-containing anesthetic is of little clinical significance for most patients with stabilized hypertension or other CV diseases.
    - The benefits of maintaining adequate anesthesia for the duration of the procedure should not be underestimated.
    - The important issue: the patient’s tolerance of stress.

Pharmacology of Anesthetic Agents

- **Vasoconstrictors in local anesthetics**
  - **Cardiovascular side-effects**
    - Four different receptors throughout the CVS are effected by local anesthetics:
      1. Alpha 1 receptors
      2. Alpha 2 receptors
      3. Beta 1 receptors
      4. Beta 2 receptors

American Heart Association and American Dental Association, 1964

1:100,000 epinephrine = 0.018 mg/cartridge
1:200,000 epinephrine = 0.009 mg/cartridge

American Dental Society of Anesthesiology, The Pulse, Vol 41 No 1, 2008
Pharmacology of Anesthetic Agents

- Vasoconstrictors in local anesthetics
- Cardiovascular side-effects

<table>
<thead>
<tr>
<th>Agent</th>
<th>α1</th>
<th>α2</th>
<th>β1</th>
<th>β2</th>
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<tbody>
<tr>
<td>Epinephrine</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
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<tr>
<td>Levonordefrin</td>
<td>X</td>
<td>XX</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>--</td>
</tr>
</tbody>
</table>

Yagiela JA, Controversies in the medical management of dental patients, oral report, 2006

Pharmacology of Anesthetic Agents

- Vasoconstrictors in local anesthetics
- Cardiovascular side-effects

<table>
<thead>
<tr>
<th>Agent</th>
<th>Dysrhythmia</th>
<th>Heart rate</th>
<th>Cardiac output</th>
<th>Peripheral resistance</th>
<th>Mean blood pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epinephrine</td>
<td>↑</td>
<td>↑[β1]</td>
<td>↑[β2]</td>
<td>↓</td>
<td>-</td>
</tr>
<tr>
<td>Levonordefrin</td>
<td>↑</td>
<td>↑[β1]</td>
<td>↑[β2]</td>
<td>No[β2]</td>
<td>↑</td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>↑</td>
<td>↓</td>
<td>-</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

Yagiela JA, Controversies in the medical management of dental patients, oral report, 2006

Pharmacology of Anesthetic Agents

- Vasoconstrictors in local anesthetics
- Epinephrine has its primary effect on the alpha 1 receptors
- Produces localized vasoconstriction
- Increases peripheral blood pressure as it enters the bloodstream (minimal if over time)
- Caution to prevent intravascular injection
- Requires caution with hypertensive patients
- Check blood pressure before injecting
- Are they controlled?


Pharmacology of Anesthetic Agents

- Vasoconstrictors in local anesthetics
- Levonordefrin (Neo-Cobefrin)
  - Similar to epinephrine, but a little less beta effect on heart rate
  - Has a moderate effect on blood pressure
  - 1/5 the potency, therefore in 5x the concentration: 1:20,000
  - Contraindicated in the same patients as epinephrine
Pharmacology of Anesthetic Agents

- Vasoconstrictors in local anesthetics
  - Relative contraindications:
    - Patients taking tricyclic antidepressants (Elavil, Triptil, Aventyl)
    - No interactions with serotonin re-uptake inhibitors (Paxil, Zoloft, Prozac)
    - Patients taking phenothiazine antipsychotics (Thorazine, Compazine, Haldol)
    - Patients taking nonselective beta blockers (propanolol [Inderal], timolol)
    - Patients taking recreational drugs (cocaine, methamphetamines) or ADD/ADHD medications*

*ADA/PDR Guide to Dental Therapeutics, 5th Ed, 2009


Boakes AJ et al, Interactions between sympathomimetic amines and antidepressant agents in man, Brit Med Jour, Vol 1, 1973

Lexi-Comp Tricyclic Antidepressant update, Feb. 2012

Pharmacology of Anesthetic Agents

- Metabolism of local anesthetics
  - Amide agents primarily biotransformed in the liver by P-450 cytochrome enzymes
  - Articaine begins rapid biotransformation in the bloodstream due to its ester moiety, then completed in the liver
    - 90 – 95% metabolized in the blood stream;
    - 5 – 10% metabolized in the liver
  - Articaine may be a better local anesthetic agent for patients with impaired liver function

Donaldson M & Goodchild JH, Pregnancy, breast-feeding and drugs used in dentistry, J Am Dent Assoc, Vol 143(8), August 2012

Moore PA, Adverse drug interactions in dental practice: Interactions associated with local anesthetics, sedatives, and anxiolytics, J Am Dent Assoc, Vol 130, 1999

Pharmacology of Anesthetic Agents

- Metabolism of local anesthetics
  - Due to decreased liver function
    - Plasma levels of anesthetic stay elevated longer
    - Additional doses are additive: possible toxicity
    - Reduce maximum safe dosage figures for patients
      1. With liver impairment due to cirrhosis, hepatitis, etc., or
      2. Taking medications metabolized by the P-450 liver enzymes, which includes many, many medications

- Vasoconstrictors in local anesthetics
  1. Slow the rate of uptake into the bloodstream, reducing the risk of toxicity
  2. Increase the duration of anesthesia
  3. Induce localized hemostasis

Vasoconstrictors increase safety

Pharmacology of Anesthetic Agents

- Treating medically complex patients
  - Local anesthetics, with or without vasoconstrictors, may be safely used in most medically complex patients.
  - Observance of simple safety guidelines for administration of local anesthetics should be universally applied to all patients.

Pharmacology of Anesthetic Agents

- Safety Guidelines for local anesthesia
  1. Aspirate carefully before injecting to reduce the risk of unintentional intravascular injection.
  2. Inject slowly! A maximum rate of 1 minute per cartridge.
  3. Monitor the patient for unusual reactions both during and after the injection.

Pharmacology of Anesthetic Agents

- Safety Guidelines for local anesthesia (contd.)
  4. Select the anesthetic agent and whether to use it with or without a vasoconstrictor based upon the duration of anesthesia needed for the planned procedure.
  5. Use the minimum amount of anesthetic solution that is needed to achieve adequate anesthesia to keep the patient comfortable throughout the procedure.
  6. An additional guideline useful for the majority of medically complex patients is to reduce the amount of vasoconstrictor containing anesthetic to no more than 2 cartridges if possible.

- If additional volume of anesthetic solution is required, consider switching to a plain, non-vasoconstrictor containing agent.
Troubleshooting Anesthesia

- The tooth is only partially numb!
- Or the tooth is numb, but duration is short and/or anesthesia is not profound
- Solution: give a second injection in the same site with a different anesthetic agent
- Increases the volume at a correct site
- Addresses patient sensitivity variations to anesthetic agents
- There is no contraindication for combining any of the amide anesthetic agents
- If a different anesthetic, or combination of anesthetics, is found to work better for a patient, record that fact and start with that anesthetic at the next appointment

Pharmacology of Anesthetic Agents

- There is no contraindication for combining any of the amide anesthetic agents
- However, all of the amide anesthetics are additive in dosage,
- Therefore, you should not exceed the maximum safe dosage for the agent with the highest concentration.

- Local anesthetic dosage
- Calculating dosage: For adults
- 150 lb. adult [FDA approved max. dosage]
  - 2% lidocaine w/epi = 13 cartridges maximum
  - 4% prilocaine = 8 cartridges maximum
  - Lidocaine & prilocaine together = 8 cartridges maximum
  - 4% articaine = 7 cartridges maximum
  - Lidocaine & articaine together = 7 cartridges maximum

  Use of nitrous oxide/oxygen analgesia/anxiolysis does not require reduction of local anesthesia dosage

Pharmacology of Anesthetic Agents

- Preventing local anesthetic complications
- One more suggestion:
  - In severely immunocompromised patients, an antimicrobial rinse such as chlorhexidine prior to injection can reduce the risk of infection from the injection — a risk that is normally very low.

  It's the thought that counts!

4% Dental Anesthetic Agents

Articaine (Septocaine)
- Released in the U.S. in 2000
- Released in Europe in 1975 (Germany), and in Canada in 1983

Prilocaine (Citanest & Citanest forte)
- Released in the U.S. in 1965
- Released in Europe in 1960, Canada shortly thereafter
4% Dental Anesthetic Agents

- Articaine is a unique “hybrid” amide anesthetic:
  - Contains a thiophene ring rather than a benzene ring — increases lipid solubility
  - Contains both ester and amide chemical groups

Attributes of Articaine

1. Fast onset
   - 1 to 6 minutes
2. Greater diffusion/penetration
   - Often obtain adequate anesthesia with infiltrations alone
3. More profound anesthesia
4. Greater success
   - With hard to anesthetize patients
   - Fewer missed blocks
5. Low allergenicity
   - Amide characteristic
6. Rapid metabolism
   - Ester characteristic
   - Half-life in bloodstream 27 minutes (lidocaine 90 minutes)

Potential for Nerve Injury

Articaine (Septocaine) and prilocaine (Citanest) were more likely to be associated with paresthesia injuries compared with other anesthetics, and this was statistically significant when compared to the distribution of use.

Haas DA & Lennon D; A 21 year retrospective study of reports of paresthesia following local anesthetic administration. J Can Dent Assoc, Vol 61 No 4, 1995
Potential for Nerve Injury

- All 143 paresthesias in mandibular arch
- 92 involved tongue; 42 lower lip; 9 both
- Number of reported cases low until 1984, then gradually increased
- Articaine introduced in Canada in 1983
- 102 cases where anesthetic(s) used were known
  - Articaine 49.0% Lidocaine 4.9%
  - Prilocaine 42.2% Mepivacaine 3.9%

Haas DA & Lennon D, A 21 year retrospective study of reports of paresthesia following local anesthetic administration, J Can Dent Assoc, Vol 61 No 4, 1995

Potential for Nerve Injury

- In 1993, 14 paresthesias occurred from an estimated 11,000,000 injections
- Incidence of 1 paresthesia/785,000 injections
- Of the 14 paresthesias
  - 10 were with articaine, 4 with prilocaine
  - Probability of paresthesia using articaine = 2.27/million injections
  - Probability of paresthesia using prilocaine = 1.7/million injections

Haas DA & Lennon D, A 21 year retrospective study of reports of paresthesia following local anesthetic administration, J Can Dent Assoc, Vol 61 No 4, 1995

Potential for Nerve Injury

- Conclusions:
  - Articaine (Septocaine) and prilocaine (Citanest) were more likely to be associated with paresthesia injuries compared with other anesthetics
  - This was statistically significant when compared to the distribution of use
  - Although it can occur, the risk of paresthesia from injection itself is extremely low
  - The extremely low risk does not warrant advising every patient prior to injection

Haas DA & Lennon D, A 21 year retrospective study of reports of paresthesia following local anesthetic administration, J Can Dent Assoc, Vol 61 No 4, 1995

Potential for Nerve Injury

- CRA, in a study of 13,000 patient treatments by 94 dentists using articaine, reported 2 paresthesias.
  - Both were associated with "mandibular" blocks
  - Both resolved: Incidence = 0.03%

CRA follow-up 2005: 73% of articaine paresthesias were with "mandibular" nerve block injections

Clinical Research Associates Newsletter, June 2005

Potential for Nerve Injury

- Distribution of anesthetic agents:
  - Articaine: 109 (59.9%)
  - Prilocaine: 29 (15.9%)
  - Lidocaine: 23 (12.6%)
  - Mepivacaine: 6 (3.3%)
  - Bupivacaine: 0 (0.0%)
  - Combination: 15 (8.2%)
  - In 99 cases (54.4%), 1 cartridge was used

Gaffen AS & Haas DA, Retrospective review of voluntary reports of nonsurgical paresthesia in dentistry, J Canadian Dent Assoc, Vol 75 No 8, October 2009
Potential for Nerve Injury

Reported incidence of paresthesia:
- Prilocaine 1:332,000 injections*
- Articaine 1:410,000 injections*
- Mepivacaine 1:839,000 injections
- Lidocaine 1:2,580,000 injections

*Significantly greater frequency of paresthesia than expected based on usage frequency


From the U.S. FDA Adverse Event Reporting System data:
- 248 paresthesias from 1997 to 2008
- 94.5% associated with the inferior alveolar nerve block
- Prilocaine associated injuries 7.3 times greater than expected
- Articaine associated injuries 3.6 times greater than expected

Garisto et al, Occurrence of paresthesia after dental local anesthetic administration in the United States, J Am Dent Assoc, Vol 141, July 2010

If Injury Does Occur

- Anesthesia-induced nerve injuries are VERY rare (Temporary 0.13 – 0.54%; permanent 0.0001 – 0.01%)
- Most paresthesias are reversible, resolving within 2 to 8 weeks
- Mandibular nerve injuries are far more common than maxillary
- The lingual nerve is involved over two times more often than the inferior alveolar nerve


Nerve Paresthesia Injury

- Theories of causes:
  1. Injury due to direct contact of the needle with the nerve (traumatic injury)
  2. Injury due to direct contact of the anesthetic solution with the nerve (toxicity injury)
  3. Injury due to hematoma within the nerve sheath or in close proximity to the nerve (compression injury)
  4. Injury due to stretching of the nerve (morphology injury)*


Nerve Paresthesia Injury

- Theories of causes:
  1. Injury due to direct contact of the needle with the nerve (traumatic injury)
    - Experiments have shown that the needle will usually pass between nerve fascicles
      - Blunt injury may occur if the nerve is pinned against bone
      - A blunted, barbed needle tip may injure the nerve upon withdrawal after contacting bone

Meechan, Practical Dental Local Anesthesia, Quintessence, 2003


Nerve Paresthesia Injury

- Incidence of “painful” injection:
  - Approximately 57% (47 of 83 patients referred for assessment of nerve injury) reported severe pain during the injection.

  Recommendation:
  - If patient reports unusual pain during the injection:
    1. Stop! Withdraw the needle completely
    2. Start the injection over

Pogrel MA & Thamby S, Permanent nerve involvement resulting from inferior alveolar nerve blocks, J Am Dent Assoc, Vol 131, 2000

Nerve Paresthesia Injury

- Theories of causes:
  2. Injury due to direct contact of the anesthetic solution with the nerve (toxicity injury)

  - Injury correlation with anesthetic agent

<table>
<thead>
<tr>
<th>Lido</th>
<th>Mepiv</th>
<th>Prilo</th>
</tr>
</thead>
<tbody>
<tr>
<td>US usage</td>
<td>54%</td>
<td>15%</td>
</tr>
<tr>
<td>Injuries</td>
<td>35%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Articaine + lidocaine, prilocaine + lidocaine, bupivacaine: <2% each

Conclusion: Prilocaine appears to have the highest incidence of injury; articaine less risk than prilo.

Gaffen AS & Haas DA, Retrospective review of voluntary reports of nonsurgical paresthesia in dentistry, J Canadian Dent Assoc, Vol 75 No 8, October 2009

Nerve Paresthesia Injury

- The rapid breakdown of articaine and the apparent inactivity of its metabolites imply that articaine is a safer local anesthetic agent than other available agents.

- Two very important points must be emphasized:
  1. Articaine, like lidocaine, has a maximum dose of 3.2 mg/lb for healthy adults
  2. Articaine, like prilocaine, is a 4% solution; patients will tolerate fewer cartridges as compared with a 2% solution

*Articaine has 68 mg of anesthetic/cartridge; lidocaine has 36 mg of anesthetic/cartridge


Nerve Paresthesia Injury

- Local anesthetic dosage
  - FDA approved max. dosage for 150 lb. adult:
    - 2% lidocaine w/ epi = 13 cartridges
    - 4% prilocaine w/ epi = 8 cartridges
    - 4% articaine w/ epi = 7 cartridges

- To reduce the risk of toxicity when using Citanest (prilocaine) or Septocaine (articaine):
  1. Inject less, usually about half the dosage, than for lidocaine or mepivacaine

Wynn RL et al, Paresthesia associated with local anesthetics: A perspective on articaine, General Dentistry (Journal AGD), Nov/Dec 2003
## Nerve Paresthesia Injury

To reduce the risk of nerve injury when using Citanest or Septocaine:

1. Inject less, usually about half the dosage, than for lidocaine or mepivacaine

2. Inject that reduced volume more slowly – about twice as long as the rate with lidocaine or mepivacaine – particularly with the inferior alveolar nerve block technique

### Prevention:

There is no guaranteed method to prevent nerve injuries due to injections.

Such injuries are not de facto indications of improper technique; they are a risk of carrying out intraoral injections.

### Prevention:

What is the influence of technique?

- Inferior alveolar block versus alternatives?
Nerve Paresthesia Injury

- Management of nerve injuries:
  1. See the patient immediately and document the injury carefully
  2. Advise the patient that the symptoms may continue for an indefinite time
  3. Contact the patient after 24 hours
  4. If no improvement after 2–4 weeks, consider referral to a nerve injury specialist.

Most injection-type injuries will show some sign of improvement within 2–4 weeks. Contact the patient after 24 hours. If symptoms have improved, GREAT! If no improvement, use careful judgment to set up intervals for follow-up visits. Most injection-type injuries will show some sign of improvement within 2–4 weeks. If no improvement after 2–4 weeks, consider referral to a nerve injury specialist.

Pharmacology of Anesthetic Agents

- A Practical Armamentarium:
  - 2% Lidocaine with 1:100,000 epinephrine for one to two hour procedures and most block injections
  - 3% Mepivacaine plain for short duration procedures or the rare “no vasoconstrictor” patient
  - 4% Articaine with 1:200,000 epinephrine for infiltrations and “hard to anesthetize” patients
  - 0.5% Bupivacaine with 1:200,000 epinephrine for prolonged pain control and long duration procedures
  - And some OnSet buffering agent

Mandibular Anesthesia

- The risk of nerve injury with administration of prilocaine (Citanest) or articaine (Septocaine) may be reduced by using “high” mandibular division block techniques
  - Gow-Gates technique
  - Vazirani – Akinosi technique

The No Fault Theory

It is important to note that complications with oral injections are not always preventable, and their occurrence does not necessarily imply poor technique by the dentist (or hygienist). Dentists and dental hygienists must carefully weigh the risks and benefits of the agent and the technique preferred for each clinical situation.

The No Fault Theory

It is important to note that complications with oral injections are not always preventable, and their occurrence does not necessarily imply poor technique by the dentist (or hygienist). Dentists and dental hygienists must carefully weigh the risks and benefits of the agent and the technique preferred for each clinical situation.
Anesthetic Alternatives

- Techniques to minimize the discomfort of all injections, especially palatal injections
  1. Topical anesthesia
    - Pre-injection anesthesia for all techniques
  2. Pressure distraction/analgesia
  3. Slow injection with small volumes
  4. Buccal and intraseptal infiltrations
  5. Explain all that you do to minimize the discomfort

Topical Anesthetics

- Penetrate 2 – 3 mm
- Adequate anesthesia for minor/superficial procedures
- Pre-injection anesthesia for all techniques

Topical Anesthetics

- Lidocaine 2 – 5% (amide)
- Benzocaine ≤ 20% (ester)
- Tetracaine 0.2 – 2% (ester)
- Cetacaine (benzocaine 14%, butamben 2%, tetracaine HCl 2% - esters)
- Anbesol (benzocaine 10%, phenol 0.5%, alcohol 70% - ester)
- Compounded topicals: combine amide and ester
  (Profound, Profound PET (Profpet), TAC 20 percent Alternate, TheBestTopicalEver)
  *Therefore, a decreased safety margin, especially with children

Topical Anesthetics

- Compound formulas:
  - Profound – 10% lidocaine, 10% prilocaine, 4% tetracaine
  - Profound PET (Profpet) – same as above plus 2% phenylephrine, more viscous
  - TAC 20 percent Alternate – 20% lidocaine, 4% tetracaine, 2% phenylephrine
  - TheBestTopicalEver – 12.5% lidocaine, 12.5% tetracaine, 3% prilocaine, 3% phenylephrine

- Refrigerant application: Pain Ease (Gebauer, Cleveland)
  - 1,1,1,3,3-pentafluoropropane/1,1,1,2-tetrafluoroethane
  - 5 second application
  - FDA approved for oral tissues
  - Nonirritant to oral mucosa
  - Nontoxic if inhaled
  - Significant reduction in posterior palatal injection pain
  - Good evidence from medical studies
  - Limited dental anecdotal reports

*Note: esters have better absorption through mucosa

**Therefore, a decreased safety margin, especially with children

Topical Anesthetics

- **EMLA** = Eutectic Mixture of Local Anesthetics
  - 2.5% lidocaine, 2.5% prilocaine
  - Not approved for intraoral use
  - However... we now have...

Topical Anesthetics

- **Oraqix**
  - 2.5% lidocaine, 2.5% prilocaine periodontal gel
  - Approved for intraoral use
  - 30 second onset
  - 20 minute duration (range 14 – 31 min.)

Topical Anesthetics

- **Dyclone (Dyclonine HCl)**
  - Currently commercially unavailable
  - Available from compounding pharmacies
  - 0.5%, or 1.0% DS
  - Apply with swab or as a diluted rinse
    - ~45ml for 1 minute (swish & spit)
    - Slow onset, 5 – 10 minutes
    - Duration ~30 minutes

Computer-Controlled Delivery Systems

- The “Wand”: Single Tooth Anesthesia (STA) system
  - Milestone Scientific
- The Comfort Control Syringe
  - Dentsply, Inc.

- Objective is to deliver the anesthetic at a rate and pressure that is below the threshold of pain
  - Potentially pain-free injections
  - Reduced volumes of anesthetic injected

Computer-Controlled Delivery Systems

- The “Wand”: STA
  - Can give all traditional injections
  - Safer PDL injections
  - Painless palatal injections

Can use for primary or secondary anesthetic injections
Computer-Controlled Delivery Systems

- The Wand STA system
- The Comfort Control Syringe

<table>
<thead>
<tr>
<th>TABLE 1: PREPROGRAMMED INJECTION RATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injection Technique</td>
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<tr>
<td>Block</td>
</tr>
<tr>
<td>Infiltration</td>
</tr>
<tr>
<td>PDL</td>
</tr>
<tr>
<td>Intranasal</td>
</tr>
</tbody>
</table>

Pressure injectors
- 2 – 4+ mm depth of penetration
- Good for infiltrations only
- Higher incidence of intravascular injection?

Needleless Injectors
- INJEX needleless injector system
- Meechan, Practical Dental Local Anesthesia, Quintessence, 2002

Electronic Anesthesia
- The ultimate on/off switch?
- TENS units
- H – wave machine
- 3M machine
- Cedeta
- Cell Demodulated Electronic Targeted Anesthesia

This was the promise...

- Dentistry without the needles or the drill!
- We are closer, but...

OraVerse Reversal Agent
- Indicated for reversal of soft-tissue anesthesia, i.e., anesthesia of the lip and tongue, and the associated functional deficits resulting from an intraoral submucosal injection of local anesthetics containing a vasoconstrictor
- Restores normal sensation twice as fast*
- Accelerates return to normal function so patients can speak, smile and drink normally

* Versus control group in clinical trials

OraVerse Reversal Agent
- Pulpal anesthesia wears off in 45-60 minutes
- Soft tissue numbness can last 3-5 hours

<table>
<thead>
<tr>
<th>Local Anesthetics with Vasoconstrictors</th>
<th>Pulpal Anesthesia</th>
<th>Soft Tissue Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine 4% + epinephrine 1:100,000</td>
<td>45-60</td>
<td>100-300</td>
</tr>
<tr>
<td>Lidocaine 2% + epinephrine 1:100,000</td>
<td>60</td>
<td>100-300</td>
</tr>
<tr>
<td>Mepivacaine 2% + levoamphetamine 1:20,000</td>
<td>60</td>
<td>100-300</td>
</tr>
<tr>
<td>Prilocaine 4% + epinephrine 1:200,000</td>
<td>60-90</td>
<td>180-480</td>
</tr>
</tbody>
</table>
OraVerse Reversal Agent

- Loss of Function can result in:
  - Difficulty with speaking
  - Difficulty in smiling
  - Difficulty with eating
  - Difficulty with drinking
  - Uncontrolled drooling
  - Biting of lip or cheek
  - Patient’s perceived sense of altered appearance

OraVerse (Phentolamine Mesylate)

- Phentolamine mesylate (alpha adrenergic antagonist) is a vasodilator used in medical indications since 1952
- Administered by injection
  - With standard dental syringe, same injection site, and identical technique used for delivery of the original local anesthetic agent(s)
- Dilates blood vessels at the anesthetic site, speeding up vascular removal of the anesthetic
  - Reverses the effect of vasoconstrictors

OraVerse Reversal Agent

- Recovery time:
  - Median time to recovery of normal lip sensation
  - Lower lip:
    - 70 minutes for OraVerse group vs. 155 minutes for control group (121% faster)
    - Reduced median time to normal sensation by 85 minutes
      - After 1 hour: 41% OraVerse patients normal vs. 7% of controls
  - Upper lip:
    - 50 minutes for OraVerse group vs. 133 minutes for control group (166% faster)
    - Reduced median time to normal sensation by 83 minutes
      - After 1 hour: 59% OraVerse patients normal vs. 12% of controls

OraVerse Reversal Agent

- Safety Profile
  - Across all studies:
    - No contraindications
    - No evident toxicity
    - No known drug interactions with OraVerse
    - No difference in adverse events versus control
      - Only 1% difference in transient injection site pain for OraVerse group (5%) versus the Control group (4%)
      - All adverse events were mild and resolved within 48 hours

OraVerse Reversal Agent

- Dosage
  - 1:1 ratio to local anesthetic
  - Maximum recommended dose:
    - 2 cartridges for adults & adolescents 12 and older
    - 1 cartridge for patients 6-11 years of age and over 66 lbs.
    - ½ cartridge for children weighing 33-66 lbs.
    - Effective and safe in adults and children aged 6 and over and weighing 15 kg (33 lbs) or more

Evidence from 3 multi-center, double-blind, randomized controlled clinical trials involving patients aged 4 through 92

OraVerse Reversal Agent

- When to use:
  - Patients who have received anesthetic with a vasoconstrictor
  - Procedures where post-procedural pain is not anticipated:
    - Cavity preparations
    - Crown preparations
    - Crown placements
    - Inlays
    - Onlays
    - Veneers
    - Non-surgical periodontal scaling and root planning
  - Patients who may not be able to control post-op tendency to bite themselves
OraVerse Reversal Agent

Case Selection:
- Special needs patients
- Children going back to school or to after-school activities
- People that want to get back to work, to their day
  - “As a busy executive, not allowing me the option to pay for this product is a complete disservice... In this economy I can’t afford to lose work; not giving me the option to purchase this product is just wrong!!”
- People who dislike being numb

A patient service that may distinguish your practice from others

This is a service, an option, to be able to offer your patients

It’s the thought that counts!

Pharmacology of Anesthetic Agents

A Practical Armamentarium:
- 2% Lidocaine with 1:100,000 epinephrine
  - For one to two hour procedures and most block injections
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  - For short duration procedures or the rare “no vasoconstrictor” patient
- 4% Articaine with 1:200,000 epinephrine
  - For infiltrations and “hard to anesthetize” patients
- 0.5% Bupivacaine with 1:200,000 epinephrine
  - For prolonged pain control and long duration procedures
- And some OnSet buffering agent and OraVerse reversal agent

Reasons for Anesthetic Failures

1. Anatomical/physiological variations
2. Technical errors of administration
3. Patient anxiety
   - Anxiety lowers the threshold of pain.
4. Inflammation and infection
   - Therefore, even non-painful stimuli are likely to be perceived as painful.
5. Defective/expired solutions

What defines success?

“Adequate anesthesia to insure patient comfort for the duration of the procedure”

- Different for each procedure
- Different for each patient

When patients sense that the dentist/hygienist is sincere in doing everything possible to insure the patient’s comfort, they will relax!

Keys to Success

- Anesthetic failures happen
- The “Three Strikes Rule”
  - 3 attempts at anesthesia, then stop

- It’s not about “fault”
  - It’s not the patient’s fault
  - It’s not your fault
  - Failures happen

Reschedule the patient!