NUMB, NUMB-ER, NUMB-EST: AN UPDATE ON LOCAL ANESTHESIA

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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

Meechan MG et al. Effects of a vibratory device on pain from anesthetic injections, Compendium. Vol. 35(4), April 2014

Use of Distraction Techniques

1. Shaking the lip or cheek
2. Pressure against the palate
3. Music or videos
4. Photographs on the ceiling
5. “Think about your favorite ____________”
6. Vibration

Use of Distraction Techniques

- Vibration
  - Creates a mucosal surface distraction
  - Enhances mucosal penetration of topical anesthetics
- Devices that create ultrasonic vibration
  - Produce low-level nerve stimulation, allowing greater anesthetic access to receptor sites to produce better anesthesia
  - Also activate the Frequency Dependent Conduction phenomenon

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”

Topical Anesthetics

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

Meechan MG et al. Practical Dental Local Anesthesia, Quintessence 2002
Topical Anesthetics

- **Lidocaine** 2 – 5% (amide)

Note: esters have better absorption through mucosa*

- **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)

*Therefore, a decreased safety margin, especially with children

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**Topical Anesthetics**

- **Compounded 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

Are neither FDA regulated nor unregulated:

"Unapproved drug products whose benefits may not outweigh their risks"

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**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.)

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**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

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**Slow Injection of Anesthetic Solutions**

- **Safety Guidelines for local anesthesia**
  - Inject slowly! A maximum rate of 1 minute per cartridge
  - Computer-controlled anesthetic 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
Reasons for Anesthetic Failures

4. Inflammation and infection

- Increased tissue acidity (decreased pH)
- Decreased anesthetic dissociation
- 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 dissociation of the anesthetic agent
    - A needle should not be inserted into an area of active infection, such as a periodontal or periapical abscess
    - The volume of anesthetic is likely to increase the pain
    - There is the potential for spreading the infection

Troubleshooting Anesthesia

- **The “Hot” Tooth**
  - First, give a block injection
  - Second, give a periodontal ligament (PDL) or intraosseous injection
  - Intraosseous injections are more reliable and have better duration

Intraligamentary Anesthesia

- **The periodontal ligament (PDL) injection**
  - Requires separate injection for each root

Intraligamentary Anesthesia

- **The periodontal ligament (PDL) injection**
  - Requires separate injection for each root
  - Duration unpredictable, generally quite short
  - Less volume of anesthetic used compared to other techniques
  - Patients frequently report post-op discomfort
  - Recommended to use plain, non-vasoconstrictor containing anesthetic agents
  - Injecting into a highly vascular space
  - Patients are more likely to experience cardiovascular side effects if vasoconstrictor is used

Intraligamentary Anesthesia
- The periodontal ligament (PDL) injection
  - Cautions:
    1. Some case reports of bone and root resorption
       - Most reversible, but isolated irreversible cases
       - Incidence increases with increased force of injection
    2. Pediatric patients with primary or mixed dentition
    3. Prophylaxis recommended for “at risk” cardiac conditions (artificial valves, prior endocarditis, etc.)

Intraosseous Anesthesia
- Penetrate the cortical plate between the roots of two neighboring teeth
- Inject directly into the cancellous bone
- Will anesthetize both teeth
  - The Stabident System
  - The X-Tip System
  - The IntraFlow System
  - Hypo intraosseous needles

Intraosseous Anesthesia
- First assess with radiograph for adequate perforation space
  - Impaction?
  - Abscess?
  - Periodontal disease?

Troubleshooting Anesthesia
- The “Hot” Tooth
  - First, give a block injection
    - Well away from the site of any local inflammation or infection
  - Second, give a periodontal ligament (PDL) or intraosseous injection
    - Intraosseous injections are more reliable and have better duration
  - Or, give a buccal & lingual infiltration with articaine (or prilocaine)

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

Intraosseous Anesthesia
- Reliable: 89% success rate
- Longer duration than PDL injections
  - 15 to 30 minutes duration with non-vasoconstrictor containing anesthetic agent
    - Can extend duration with second injection in same site
  - Only a small volume of anesthetic is needed (~0.9 ml)
  - Pulpal anesthesia of tooth on either side of injection site
  - No lip anesthesia for anterior smile line assessment
  - Little to no post-op discomfort at the injection site
  - Recommended to use plain, non-vasoconstrictor containing anesthetic agents
    - Patients are more likely to experience cardiovascular side effects if vasoconstrictor is used

Hassani et al., Comparing anesthetic efficacy of articaine versus lidocaine as a supplement to buccal infiltration of the mandible, Int J Dent Assoc, Vol 139 No 4, 2008
Kanaa et al., Articaine buccal infiltration enhances the effectiveness of lidocaine inferior alveolar nerve block, Int Endo J, Vol 42, 2009
Meechan, Practical Dental Local Anesthesia, Quintessence, 2002
Robertson et al., The anesthetic efficacy of articaine in buccal infiltration of mandibular posterior teeth, JADA, Vol 138 No 8, 2007
Pharmacology of Anesthetic Agents

- A Practical Armamentarium:
  - 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

- 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 an anesthetic with a vasoconstrictor is advantageous for better duration
  - Articaine tends to work well in an infected, low pH environment
  - But proper dissociation of any anesthetic solution may be a problem

Buffering of Local Anesthetics

- 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

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

New Research: Intranasal Delivery

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

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
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 (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

Anesthetic Cartridge Warmers

- Intent is to warm the anesthetic a little above body temperature
  - Mechanism is not known
- Evidence in support is good in medicine
- Evidence not clear for intraoral injections


Needles

- **Length**
  - Long: 30 – 35 mm
  - Short: 20 – 25 mm
  - Ultra-short: ~10 mm
- **Gauge (25, 27, or 30)**
  - Patients report no perceived difference in pain due to needle gauge
  - Aspiration requires more force the smaller the gauge

Recommendation: 30 gauge short for infiltrations only; 25 or 27 gauge long needles are best for blocks

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**Evolution**

**Deflection**

Larger gauge needles provide for less deflection as the needle passes through soft tissue

**Breakage**

Tri-bevel needle

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**Size doesn't matter: Needle gauge and injection pain**, General Dentistry, May – June, 2007

**Flanagan T et al.**

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**Needles**

- **Gauge**: 25, 27, 30
  - Aspiration: larger gauge more reliable
  - Comfort: larger gauge less injection pressure

**Deflection**

**Breakage**

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**Aspiration During Injections**

1. Aspirate carefully before injecting to reduce the risk of unintentional intravascular injection
2. Stop the injection and re-aspirate once or twice during the injection
3. Monitor the patient for unusual reactions both during and after the injection

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**Hematoma**

- A hematoma may form independently of aspiration results.
- Aspiration results merely report the contents at the needle tip at the time of aspirating

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**Hematoma**

- The vessels most commonly associated with hematomas are
  1. Pterygoid venous plexus
  2. Posterior superior alveolar vessels
  3. Inferior alveolar vessels
  4. Mental vessels

**Haas DA, Localized complications from local anesthesia, J Calif Dent Assoc, Vol 26 No 9, 1998**

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**Aspiration During Injections**

**Liebgott**, The Anatomical Basis of Dentistry, 2nd Ed, Mosby, 2001

**Agur & Lee**, Grant's Atlas of Anatomy, 10th Ed, Lippincott Williams & Wilkins, 1999

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**Aspiration During Injections**

- **Safety Guidelines for local anesthesia**
  1. Aspirate carefully before injecting to reduce the risk of unintentional intravascular injection
  2. Stop the injection and re-aspirate once or twice during the injection
  3. Monitor the patient for unusual reactions both during and after the injection
Relaxation Techniques

- Patient anxiety
  - Office environment is important!
  - Calm, clean, quiet setting
  - Positive, supportive attitude of all personnel
  - Explanation of all measures you take to insure patient comfort
  - Work quickly and efficiently

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

Learn to give comfortable palatal injections!

Physiology of Anesthetic Agents

- How do we assess anesthesia?
  - Question the patient
  - Probe the area
  - Electric pulp tester
  - Cold test
  - Soft tissue only
  - Pulpal tissue
  - Delayed pulpal onset: occurs in the mandible of 19 – 27% of patients (even though soft tissue is numb)
    - Delayed over 30 minutes in 8%

  - reasons for delayed or failed onset
  - Disassociation rate, transport/perfusion rate, re-association rate, binding rate

  BH⁺ = active, ionized form: Can’t pass through nerve membrane (water soluble)
  BH⁻ = inactive, unionized form: Can pass through nerve membrane (lipid soluble)

Physiology of Anesthetic Agents

- 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*

  - 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

  *Baluga JC et al. Allergy to local anesthetics in dentistry: Myth or reality? Allergol Immunopathol, 28(1), 2000


  Nussstein et al, Anesthetic efficacy of different volumes of lidocaine with epinephrine for inferior alveolar nerve blocks, Gen Dent, Vol 50, 2002

Pharmacology of Anesthetic Agents

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

Pharmacology of Anesthetic Agents

- Common usage:
  - 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

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 and OroVerse reversal agent
Pharmacology of Anesthetic Agents

**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

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**FDA approved max. dosage**

1. 2% lidocaine w/epi 3.2 mg/lb
2. 4% articaine w/epi 4.0 mg/lb
3. 3% mepivacaine plain 3.0 mg/lb
   2% mepivacaine w/levo (400 mg max. for any patient)
4. 4% prilocaine plain 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)*

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**Calculating dosage:**

**150 lb. adult**

- 2% lidocaine with epinephrine
  - 150 lb. x 3.2 mg/lb. = 480 mg
  - 500 mg is the maximum for any patient!

  \[
  \frac{480 \text{ mg}}{36 \text{ mg/cartridge}} = 13.33 \text{ cartridges}
  \]
  *14 cartridges is the maximum for any patient ≥ 156 lb.*

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- 3% mepivacaine plain
  - 150 lb. x 3.0 mg/lb. = 450 mg
  - But...400 mg is maximum for any patient!

  \[
  \frac{400 \text{ mg}}{54 \text{ mg/cartridge}} = 7.40 \text{ cartridges}
  \]
  *7 cartridges is the maximum for any patient ≥ 135 lb.*

---

- 2% mepivacaine with levonordefrin
  - 150 lb. x 3.0 mg/lb. = 450 mg
  - But...400 mg is maximum for any patient!

  \[
  \frac{400 \text{ mg}}{36 \text{ mg/cartridge}} = 11.11 \text{ cartridges}
  \]
  *11 cartridges is the maximum for any patient ≥ 135 lb.*

---

- 4% prilocaine plain or with epinephrine
  - 150 lb. x 4.0 mg/lb. = 600 mg
  - 600 mg is maximum for any patient!

  \[
  \frac{600 \text{ mg}}{72 \text{ mg/cartridge}} = 8.33 \text{ cartridges}
  \]
  *8 cartridges is the maximum for any patient ≥ 150 lb.*
Pharmacology of Anesthetic Agents

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

  4% articaine with epinephrine
  150 lb. x 3.2 mg/lb. = 480 mg
  500 mg is the maximum for any patient

  480 mg
  \[
  \frac{68 \text{ mg/cartridge}}{} = 7.05 \text{ cartridges}
  \]

  7 cartridges is the maximum for any patient \(\geq 156 \text{ lb.}\)

- 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

  Malamed, Handbook of Local Anesthesia, 5th Ed., Elsevier 2004

Troubleshooting Mandibular Anesthesia

- The tooth is only partially numb!
- Or the tooth is numb, but duration is short and/or anesthesia is not profound

  Go higher and deeper for a second injection?
  Risk higher incidence of positive aspiration


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

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

  0.5% bupivacaine with epinephrine
  150 lb. x 0.6 mg/lb. = 90 mg
  90 mg is the maximum for any patient

  \[
  \frac{90 \text{ mg}}{} = 9 \text{ mg/cartridge} = 10 \text{ cartridges}
  \]

  10 cartridges is the maximum for any patient \(\geq 150 \text{ lb.}\)

- Local anesthetic dosage (FDA approved max. dosage)

  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.

  Jong RH & Boren JD, Mixtures of local anesthetics are no more toxic than the parent drugs, Anesthesia, Vol 54 No 3, 1981
Pharmacology of Anesthetic Agents

- Local anesthetic dosage
  - Calculating dosage: For adults
  - 150 lb. adult (FDA approved max. dosage*):
    - 2% lidocaine with 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
  *Within a 24 hour timeframe

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:
    - Unstable angina
    - Myocardial infarction within 6 months*
    - Coronary artery bypass surgery within 3 months*
    - Refractory arrhythmias
    - Untreated or uncontrolled hypertension
    - Untreated or uncontrolled congestive heart disease
    - Uncontrolled diabetes or other endocrine diseases
  *The timeframe is variable; a physician consult is recommended

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, methamphetamine, etc.) or ADD/ADHD medications*
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 bloodstream; 5–10% metabolized in the liver
    - Articaine may be a better local anesthetic agent for patients with impaired liver function

Pharmacology of Anesthetic Agents

- Other local anesthetic complications
  - Excessive doses (injectable or topical) have been associated with drug-induced methemoglobinemia
  - Risk may be increased in presence of oxidizing drugs such as acetaminophen, nitroglycerin, or sulfonamides.
  - Particular caution recommended with use of prilocaine (Citanest) in patients at risk
    - Respiratory obstruction: COPD, emphysema
    - Anemia
    - Pregnancy

Mandibular Anesthesia

- Long buccal nerve block
  - Accessory innervation to mandibular molars
    - Depth 2 – 4 mm
    - Needle Short
    - Amount ½ - ¾ cartridge
    - Comfort level Moderate to high

Mandibular Anesthesia

- Mylohyoid nerve block
  - Between mandible and sublingual fold
  - Just distal to last tooth to be worked on
  - Approximate apices of roots
  - Easiest for anterior teeth
  - Access to molars may be difficult
Mandibular Anesthesia

- Mylohyoid nerve block
  - Depth: 2 – 4 mm
  - Needle: Short
  - Amount: 1/3 – 1/2 cartridge
  - Comfort level: High
  - Good for any mandibular tooth

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

- Complete Mandibular Division Nerve blocks
  - Gow-Gates
  - Vazirani – Akinosi

Agur & Lee, Grant’s Atlas of Anatomy, 10th Ed, Lippincott Williams & Wilkins, 1999

- Gow-Gates mandibular division block
  - Target: Contact bone at the neck of the condyle
  - The mouth must be open wide!

Agur & Lee, Grant’s Atlas of Anatomy, 10th Ed, Lippincott Williams & Wilkins, 1999

- Gow-Gates mandibular division block
  - Depth: 25 – 28 mm (contact bone)
  - Needle: Long
  - Amount: 1 – 2 cartridges
  - Comfort level: Moderate to high

Meechan, Practical Dental Local Anaesthesia, Quintessence, 2002

Mandibular Anesthesia

- Vazirani – Akinosi mandibular division block
  - A closed mouth technique

Meechan, Practical Dental Local Anesthesia, Quintessence, 2002

- Depth: 25 – 30 mm (no bone contact)
- Needle: Long
- Amount: 1 cartridge
- Comfort level: Moderate

Injection site visibility difficult with mouth closed

Mandibular Anesthesia

- Success rate of techniques
  - Conventional*: 65 – 86%
  - Gow-Gates *†: 90 – 100%
  - Vazirani – Akinosi*: 76 – 93%

* What volume of anesthetic is being used?
† An additional cartridge may increase profoundity & decrease onset time


Mandibular Anesthesia

- Onset of Anesthesia

<table>
<thead>
<tr>
<th>Technique</th>
<th>At 5 min.</th>
<th>At 10 min.</th>
</tr>
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<tbody>
<tr>
<td>Conventional</td>
<td>72 – 85%</td>
<td>79 – 90%</td>
</tr>
<tr>
<td>Gow-Gates</td>
<td>45%</td>
<td>90%</td>
</tr>
<tr>
<td>Vazirani – Akinosi</td>
<td>90%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Medial Lateral


Mandibular Anesthesia

- Reliably anesthetizes the most nerve branches with a single injection

Mandibular Anesthesia

- Incidence of Positive Aspiration
  - Conventional: 3.6 – 22%
  - Gow-Gates: 0 – 2%
  - Vazirani – Akinosi: 2%

- Incidence of Other Undesirable Side Effects
  1. Hitting a nerve
  2. Piercing a muscle
  3. Injecting the parotid gland
     - Most common with IA block

- Comparison of mandibular division nerve block techniques
  - Gow-Gates technique
    - Advantages:
      - Very high success rate (90 – 100%)
      - Extremely low incidence of positive aspirations
      - Significantly reduced incidence of trismus and/or paresthesia
    - Disadvantages:
      - Single injection for anesthesia of inferior alveolar, lingual, long buccal, and mylohyoid nerves
      - Potential single injection for anesthesia of inferior alveolar, lingual, long buccal, and mylohyoid nerves

  - Vazirani – Akinosi technique
    - Advantages:
      - Moderate to high success rate (76 – 93%)
      - Extremely low incidence of positive aspirations
      - Significantly reduced incidence of trismus and/or paresthesia
      - Potential single injection for anesthesia of inferior alveolar, lingual, long buccal, and mylohyoid nerves
      - Less threatening to apprehensive patients (closed mouth)
      - Ability to anesthetize both sensory and motor nerve branches uniquely useful for patients with severe trismus
**Mandibular Anesthesia**

- Comparison of mandibular division nerve block techniques
  - Vazirani – Akinosi technique
  - Disadvantages:
    - Increased potential for operator error due to no bone contact
    - Higher incidence of unexpected and unusual side effects
    - Least reliable technique to achieve anesthesia of long buccal nerve

**Troubleshooting Mandibular Anesthesia**

- Repeated failure to achieve adequate anesthesia
- Take a panoramic radiograph
  - Incidence of bifid IA nerve: 4 patients in 5,000 films
  

**Mandibular Anesthesia**

- Mental (& incisive) nerve block
  - Depth: 3 – 6 mm
  - Needle: Short
  - Amount: 1/3 -1/2 cartridge
  - Comfort level: High

  After injection, massage site

  Jastak, Yagiela & Donaldson, Local Anesthesia of the Oral Cavity, WB Saunders Co, 1995

**Maxillary Anesthesia**

- Two basic types of injections
  1. Infiltrations
  2. Blocks

  Infiltrations
  - Work well throughout maxilla
  - Greater success using articaine
  - Faster onset and longer duration
  - Frequent palatal anesthesia with buccal infiltration

  Costa DG et al, Onset and duration periods of articaine and lidocaine on maxillary infiltration, Quintessence Int, Vol 36 No 3, 2005

**Maxillary Anesthesia**

- Anterior & middle superior alveolar nerve block
  - The AMSA palatal approach (P-AMSA injection)

  Meechan, Practical Dental Local Anesthesia, Quintessence, 2002
Maxillary Anesthesia

- Anterior & middle superior alveolar nerve blocks
  - The AMSA palatal approach (P-AMSA injection)
    - Depth: 2 – 4 mm
    - Needle: Short
    - Amount: ≤1/4 cartridge of articaine
    - Comfort level: Moderate

Maxillary Anesthesia

- Maxilla: Nerve blocks
  - The ASA palatal approach (P-ASA injection)
    - To bilaterally anesthetize:
      - Incisor pulps
      - Buccal gingiva
      - Anterior palatal tissue

Maxillary Anesthesia

- Complete maxillary division block
  - With 2 injections
  - With 1 cartridge
  - Two approaches
    - PSA (lateral) approach
    - Greater palatine canal approach

Maxillary Anesthesia

- Bilateral anterior superior alveolar nerve block
  - The ASA palatal approach (P-ASA injection)
    1. Inject from side of incisive papilla initially, then gently shift to vertical orientation as enter incisive canal
    2. SLOWLY inject 1/4 – 1/3 cartridge of articaine
Maxillary Anesthesia

- Complete maxillary division block
  - Greater palatine canal approach
    1. Give greater palatine block injection
    2. Re-palpate the greater palatine foramen
    3. With a single penetration, gently probe for the foramen
    4. Passively insert needle up canal

- Depth Varies, ~15 mm
- Needle Long
- Amount 1 cartridge
- Comfort level Moderate

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.

Potential for Nerve Injury

- Focused only on reports of paresthesia
- "All forms of altered nerve sensation"
- All cases involving surgery were excluded (304)
- 143 paresthesias "from injection alone"
- Average = 6.8 paresthesias per year
  - High = 20 (1990); low = 0 (1973 & 1979)

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%

Clinical Research Associates Newsletter, June 2001

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

Clinical Research Associates Newsletter, June 2005

Potential for Nerve Injury

- In a second publication by Haas and Gaffen using the same source:
  - 182 paresthesias from 1999 to 2008
  - 180 associated with the inferior alveolar nerve block
    - 172 inferior alveolar block alone
    - 8 inferior alveolar block combined with 1 or more other injections
  - Incidence of 1/609,000 injections

Gaffen AS & Haas DA. Retrospective review of voluntary reports of nonsurgical paresthesia injuries, J Can Dent Assoc, Vol 75 No 8, October 2009

Potential for Nerve Injury

- 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
Potential for Nerve 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)


Potential for Nerve Injury

- Theories of causes:
  2. Injury due to direct contact of the anesthetic solution with the nerve (toxicity injury)
    - All agents are neurotoxic, however, the higher the concentration, the higher the risk of causing neurotoxicity
    - Injury correlation with anesthetic agent
      
      | Agent   | US Usage | Injuries |
      |---------|----------|---------|
      | Lido    | 34%      | 35%     |
      | Mepiv   | 15%      | 0%      |
      | Prilo   | 6%       | 30%     |
      | Arti    | 25%      | 30%     |

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

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

  * Pogrel MA, Permanent nerve damage from inferior alveolar nerve blocks— an update on articaine, J Calif Dent Assoc, Vol 36 No 4, April 2007

Potential for Nerve Injury

To reduce the risk of nerve injury when using prilocaine (Citanest) or articaine (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

Potential for Nerve Injury

- Theories of causes:
  1. Injury due to direct contact of the needle with the nerve (traumatic injury)
  2. Incidence of “electric shock” injection:
    - Occurs once every one to two weeks in “average” practices
    - Approximately 8% of these result in some form of paresthesia
    - Incidence of permanent paresthesia is very low from these injections


Potential for Nerve Injury

What is the most likely cause of injury?

- One single cause is unlikely

- It appears that it may be the higher dose of drug (neurotoxicity) combined with a mechanical insult that predisposes the nerve to injury.

  * 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

To reduce the risk of nerve injury when using prilocaine (Citanest) or articaine (Septocaine):

1. 75 – 95% of all paresthesia injuries from injections are with the inferior alveolar block injection

2. Due to apparent potential neurotoxicity injury, prudent clinicians may consider avoiding use of high-concentration (4 percent) anesthetic formulations for inferior alveolar nerve blocks in cases where there are viable alternatives.

Hillerup S et al, Trigeminal nerve injury associated with injection of local anesthetics: Needle lesion or neurotoxicity, J Am Dent Assoc, Vol 142(5), May 2011

Potential for Nerve Injury

Anesthesia-induced nerve injuries are VERY rare (Temporary 0.15 – 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


Potential for Nerve Injury

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.

Haaas DA, Localized complications from local anesthesia, J Calif Dent Assoc, Vol 26 No 9, 1998

What is the influence of technique?

Inferior alveolar block versus alternatives?

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 and OraVerse reversal 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