TURN IT ON AND OFF: WHAT’S NEW IN LOCAL ANESTHESIA

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Physiology of Anesthetic Agents

- How do we assess anesthesia?
  - Question the patient
  - Probe the area
  - Electric pulp tester
  - Cold test

- 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

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

\[ BH^+ = \text{active, ionized form:} \]

Can’t pass through nerve membrane (water soluble)

\[ \text{Can pass through nerve membrane (lipid soluble)} \]

\[ B = \text{inactive, unionized form:} \]
Anesthesia Delivery Assistance Devices

- Devices that vibrate – Frequency dependent conduction
  - Vibration stimulates nerves, allowing greater anesthetic access to receptor sites to produce better anesthesia

DentalVibe
Anesthesia Delivery Assistance Devices

- **The Gate Control Theory of Pain**
  - Upon injection of anesthetic solution:
    - Nociceptors send pain messages 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
  - 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

4. 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

4. 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*
## Reasons for Anesthetic Failures

4. Inflammation and infection

| Condition                        | pH       | 24% of injected anesthetic is unionized | pH 5.0 = 0.13%  
|                                 |          |                                      | (1/20 of 7.4 pH) |
|                                 |          |                                      | pH 4.0 = 0.013%  
|                                 |          |                                      | (1/200 of 7.4 pH) |
|                                 |          |                                      | pH 3.0 = 0.0013%  
|                                 |          |                                      | (1/2000 of 7.4 pH) |
| Normal tissue                   | pH = 7.4 |                                      |                   |
| Intraneuronal                   | pH = 7.0 | 11.2 % to B                           |                   |
| Inflammation or infection       | pH = 5.0 to 3.0 |                                  |                   |
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 abcess
    - 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

➢ The Gow-Gates mandibular division block has a significantly higher success rate than all other techniques

   Gow-Gates            52%
   Vazirani-Akinosi     41%
   Conventional IA     36%
   Buccal-plus-lingual infiltration 27%

   All with 4% articaine with 1:100,000 epinephrine

➢ No technique was fully acceptable by itself

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 &/or lingual infiltration with articaine (or prilocaine)

Hasse et al, *Comparing anesthetic efficacy of articaine versus lidocaine as a supplemental buccal infiltration of the mandibular first molar after an inferior alveolar nerve block*, JADA Vol 139 No 9, Sept 2008

Kanaa et al, *Articaine buccal infiltration enhances the effectiveness of lidocaine inferior alveolar nerve block*, Int Endo J 42, 2009
Infiltration Anesthesia

- Works well for the maxilla, but the mandible...
- Work fairly well for anteriors and bicuspids
- Widely varying 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


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

Pharmacology of Anesthetic Agents

- There is no contraindication for combining any of the amide anesthetic agents
- 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

- Plain should have better dissociation in a site of infection (but will wash out faster!)
- Using plain first may mildly increase cardiovascular side-effects of vasoconstrictor
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.

Jong RH & Bonin JD, *Mixtures of local anesthetics are no more toxic than the parent drugs*, Anesthes 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 w/epi = 13.33 cartridges
    - 4% prilocaine = 8.33 cartridges
    - Lidocaine & prilocaine together = 8.33 cartridges
    - 4% articaine = 6.66 cartridges
    - Lidocaine & articaine together = 6.66 cartridges
Buffering of Local Anesthetics

- Buffer with sodium bicarbonate immediately before delivery
- Increases dissociation of anesthetic agent for uptake into the nerve
  - Potentially more comfortable
  - Potentially faster onset
  - Potentially more profound
  - Potentially higher success rate
New Technology: OnSet

OnSet™ assembled and ready to buffer anesthetic cartridge

Onset™ Cartridge
Anesthetic Carpule
Onset™ Buffering Pen
Dosing indicator

Onset™ Cartridge Connector

3 mL Sodium Bicarbonate Cartridge

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

- **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
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)
Nerve Injuries

- 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

- In North America, more injuries have been reported with prilocaine than with articaine
Nerve Injuries

There are multiple theories of cause:

- One of the leading theories:
  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

It is noteworthy that in Denmark, where prilocaine is marketed as a 3% solution, 2 studies have linked paresthesia to 4% articaine use, but not to prilocaine use.

Nerve Injuries

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.

Nerve Injuries

Management of nerve injuries:

1. Advise the patient that the symptoms may continue for an indefinite time

- 85% (to 94%)* of injuries caused by injections recover spontaneously within 2 to 12 weeks
- ~5% will recover within 9 months
- Up to 10% of remaining injuries will likely never recover completely


Nerve Injuries

Management of nerve injuries:

2. 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

3. If no improvement after 2 weeks, consider referral to a neurologist or to an oral surgeon familiar with management of nerve injuries.

Most injuries will show some sign of improvement within 2 weeks
Nerve Injuries

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


Local anesthetic dosage

- FDA approved max. dosage for 150 lb. adult:
  - 2% lidocaine w/ epi = 13.33 cartridges
  - 4% prilocaine = 8.33 cartridges
  - 4% articaine = 6.66 cartridges
Nerve Injuries

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
Nerve Injuries

- To reduce the risk of nerve injury when using prilocaine (Citanest) or articaine (Septocaine):
  - 75 – 95% of all paresthesia injuries from injections are with the inferior alveolar block injection

3. 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*, JADA 142(5), May 2011
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

Mandibular Anesthesia

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

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

- Comparison of mandibular division nerve block techniques
  - Conventional (Halsted) technique
  - Advantages:
    - Most familiar and most widely used
    - Good success rate (65 – 86\%+)
  - Disadvantages:
    - Higher success rates associated with increased incidence of positive aspiration
    - Moderate incidence of trismus and/or paresthesia
    - Multiple injections required for anesthesia of inferior alveolar, lingual, long buccal, and mylohyoid nerves
Mandibular Anesthesia

- 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
    - Single injection for anesthesia of inferior alveolar, lingual, long buccal, and mylohyoid nerves
  - Disadvantages:
    - Technically a more difficult technique to master
    - Slower onset of anesthesia
Mandibular Anesthesia

- Comparison of mandibular division nerve block techniques
  - 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

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 20 percent Alternate, TheBestTopicalEver)

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

Topical Anesthetics

Compounded formulas:
- Maximum recommended dose is unknown
- Narrow difference between optimal therapeutic dose and toxic dose level
- Vary in composition, quality, and strength

Recommendation to avoid tissue sloughing:
- Apply for maximum of 60 – 90 seconds
- Rinse area thoroughly after application

Topical Anesthetics

- 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 in 1 study
    - Good evidence from medical studies
    - Limited dental anecdotal reports

Kosaraju A & Vandewalle KS, A comparison of a refrigerant and a topical anesthetic gel as preinjection anesthetics: A clinical evaluation, JADA Vol 140, Jan 2009
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 Comfort Control Syringe
  - Can give all traditional injections
  - Safer PDL injections
  - Painless palatal injections
  - Primary or secondary anesthesia
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-blinded, 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
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!