Advanced Local Anaesthesia
“What You Need To Know”

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TOPICS
- Reasons for incomplete anaesthesia
- Pain reduction ideas
- Choosing a local anaesthetic
- Toxicity and drug interactions
- Vasoconstrictor considerations
- Products besides needle & syringe
  - Oraqix, OraVerse, Onset, DentalVibe, Injex, Intranasal Injections

~13,000,000 injections per yr. in Ontario
~30,000,000 in Canada
~250,000,000 in the U.S.

GRADE “A” ANAESTHESIA
GRADE “B” ANAESTHESIA
GRADE “C” ANAESTHESIA?

Reasons For Incomplete Anaesthesia

1. Hot teeth, inflammation and pain
2. Needle too short
3. Needle deflection
4. Inadequate volume
5. Starting procedure too soon
6. Anatomy (skeletal & neuro)
7. Stale-dated
8. Patient characteristics
9. pH of LA or tissue

1. IANB Failure Rates

- Normally ~20%
- Irreversible pulpitis needing RCT:
  - Failure rate ~55%
  - Failure rate 50 – 80%**

*Claffey et al J of Endo Aug, 2004
Blocks and Inflammation

- Mediators of inflammation (e.g. histamine, kinins, prostaglandins...) ↑ neuronal excitability.
- Inflammatory substances can move up nerve tract.
- ↑ prostaglandins in inflamed pulps.
- Acidity of infection / inflammation?
- LA is less effective

Patients With Pain: Study

- 3 groups, all RCT, mandible, molar
- Grouped according to pre-tx pain level
  1. Mild pain
  2. Moderate pain
  3. Severe pain
- Does level of pain affect success of LA?


Results:

<table>
<thead>
<tr>
<th></th>
<th>Mild Pain</th>
<th>Moderate Pain</th>
<th>Severe Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success of Anaesthesia</td>
<td>20/60 (33%)</td>
<td>17/60 (28%)</td>
<td>9/57 (16%)</td>
</tr>
</tbody>
</table>


Study: Premed With NSAID

- 150 subjects, irreversible pulpitis, in mandibular molars
- 3 groups of 50, 1 hr. before tx given:
  1: 75 mg indomethacin OR
  2: 600 mg ibuprofen OR
  3: Placebo
- IANB 1.8 ml lidocaine 1:100,000

Patriokh et al J Endo, 36: 1450-54, 2010

Results

<table>
<thead>
<tr>
<th>Group</th>
<th>Success (%)</th>
<th>Failure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placebo</td>
<td>16 (32)</td>
<td>34 (68)</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>39 (78)</td>
<td>11 (22)</td>
</tr>
<tr>
<td>Indomethacin</td>
<td>31 (62)</td>
<td>19 (38)</td>
</tr>
</tbody>
</table>

Significant for NSAIDS compared to placebo

Patriokh et al, J Endo, 36:1450-1454, 2010

Hot Teeth

- Patients in pain:
  - Are more apprehensive
  - Have lower pain thresholds

This ↓ the effectiveness of LA

Take a PA radiograph
2. Needle Length

- 41 mm
- 35 mm
- 25 mm
- 10 mm

3. Needle Deflection

- 30 gauge deflects 4 mm
- 27 gauge deflects 2 mm

TruJect Needles
- Double bevel
- 28 gauge

Accuject and Septoject

- 97% failure with 30 gauge
- 89% failure with 27 gauge
- 2% failure with 25 gauge

Aspiration

Manual syringes – manual aspiration

What Hurts When We Inject?

- Location of injection?
- Temperature of LA?
- Choice of needle?
- Acidity of local anaesthetic?
- Speed of injection?

Temperature of the LA?

- No difference in reported pain from warmed LA vs. room temp LA

Rogers et al, Gen Dent, 37:496-499, 1989

Gauge of the Needle?

- No difference in pain from 25, 27 or 30 gauge during IANB**+
- Needle blunts even if bone not touched
  - ↑ pain with used needles*

*Meechan et al, Anes Prog, 52:91-4, 2005

25 vs. 30 Gauge in Kids

- Compared pain from IANB in kids*
- 25 vs. 30 gauge
- No difference

Brownbill et al Anes Prog 34:215-219, 1987

and...

- U.S.: ~30 needle breaks / yr.
- ~99% of needles that break are 30 ga.*
- Break occurs at hub

Requires surgery for recovery

Factors Related to Broken Needles
- 30 gauge
- Injecting to the hub
- Bending needles
- Hitting bone during IANB
- Kids
- Sudden movement with pain

Needles
What’s the difference?
- Length
- Gauge
- Quality – sharpness
- Price
- Expiry date. Shelf life ~ 3 yrs.

Standardized Needle Colour Code
<table>
<thead>
<tr>
<th>Needle</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 Gauge Extra Short</td>
<td>Purple</td>
</tr>
<tr>
<td>30 Gauge Short</td>
<td>Blue</td>
</tr>
<tr>
<td>27 Gauge Short</td>
<td>Orange</td>
</tr>
<tr>
<td>27 Gauge Long</td>
<td>Yellow</td>
</tr>
<tr>
<td>25 Gauge Long</td>
<td>Red</td>
</tr>
</tbody>
</table>

Poor Quality Needles

Excellent Quality Needles

- Septoject XL 27 gauge
  - Triple bevel
  - 43% wider
  - 1.8X less pressure to inject

- Standard 27 gauge
Septoject Evolution
- Patented scalpel design
- Dental Products Best Needle 2014
- Sizes:
  - 27 and 30 g. short (25 mm)
  - 30 g. extra short (9 mm)
- No 35 mm length, not for blocks

- Smoother easier penetration
  - 29% less force needed for insertion
  - 4th insertion still less force needed compared to standard needle
- Less tissue displacement
- Reduced needle deflection

Steele et al, submitted for publication
Meechan et al, submitted for publication

pH of the LA?
- What causes acidity in cartridge?
- Pain research disagrees

pH of Local Anaesthetics

<table>
<thead>
<tr>
<th>Anaesthetic</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine, 1:100,000</td>
<td>5.8</td>
</tr>
<tr>
<td>Articaine, 1:200,000</td>
<td>6.1</td>
</tr>
<tr>
<td>Bupivacaine, 1:200,000</td>
<td>5.8</td>
</tr>
<tr>
<td>Lidocaine 1:50,000 – 1:100,000</td>
<td>3.6 – 3.8</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>6 – 6.5</td>
</tr>
<tr>
<td>Prilocaine plain</td>
<td>6</td>
</tr>
<tr>
<td>Prilocaine 1:200,000</td>
<td>5.7</td>
</tr>
</tbody>
</table>

Onpharma’s Buffering System “Onset”
- Basic solution added to LA cartridge
- FDA approved for use with lidocaine
- Three components:
  1. Sodium bicarbonate (3 ml cartridges)
  2. Mixing pen
  3. Cartridge connector

Bicarbonate replaces = amount of LA

Buffering Rationale
- LA’s with vasoconstrictor are acidic
- This can cause??:
  - ↑ pain when injected
  - ↑ tissue damage
  - ↑ post-op pain
  - Slower onset
  - ↓ efficacy in areas of infection
  - ↓ lipophilic molecules. (pH from 3.5 to 7 will ↑ lipophilic molecule concentration 6000x)
Buffered Anaesthetic & Injection Pain

Literature review 1966 – 2001:
- Buffering LAs with sodium bicarbonate significantly reduces injection pain


Buffering For Symptomatic Irreversible Pulpitis

- Lidocaine + epinephrine buffered vs. non-buffered
- Compared anaesthetic success & injection pain
- Buffering did not ↑ success or ↓ injection pain


Pressure & Tissue Distention?

- Infiltration mandibular cuspid area
- Wand: slow (160 s/ml) vs. fast (30 s/ml) injection speed
- Significant ↑ pain & anxiety with fast speed

Kudo, Anes Prog, 52:95-101, 2005

Slow IANBs are more effective!!

Negative Responses To Max. Pulp Test:

<table>
<thead>
<tr>
<th></th>
<th>Slow IANB (60 sec)</th>
<th>Fast IANB (15 sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molars</td>
<td>220</td>
<td>159</td>
</tr>
<tr>
<td>Premolars</td>
<td>253</td>
<td>216</td>
</tr>
<tr>
<td>Lateral Incisors</td>
<td>119</td>
<td>99</td>
</tr>
</tbody>
</table>

Kanaa et al, J Endod 32:919-923, 2006
4. Volume & Time

- Amount
- Neuroanatomy (nerve diameter)
- Anatomical Factors
  - Sphenomandibular ligament
  - Intravascular injections
- What is the real onset for an IANB?

Onset For IANB
Pulpal Anaesthesia

- Fast onset ~ 1 minute
- Typical ~ 4 minutes
- Gow-Gates block ~ 10 – 12 minutes
- Slow onset, up to 30 minutes *


5. Surgically Removing LA From Injection Site

- Infiltration
- Raise flap quickly in area of injection
- Begin surgery quickly
- Flap may remove some LA from site
- Could reduce duration of anaesthesia

Where Is The Mandibular Foramen?

19mm Above Occlusal Plane
Occlusal Plane

Neuroanatomy

Incidence of mylohyoid innervation to mandibular teeth is 60%

Blanton et al, JADA, 134, 753-60, 2003

Location of Mylohyoid Nerve

- On average, mylohyoid nerve leaves IAN 14.7 mm above mandibular foramen
- This is superior to the location of IANB
- Gow-Gates block may be advantageous


Location of Lingual Infiltration

- Vertical wall (avoid floor of mouth)
- Unattached gingiva
- 0.5 ml
7. Molecular Degradation
- Do not repeatedly warm / autoclave cartridges
- Avoid light exposure: Especially lidocaine
- Do not stockpile
- Store between 59 – 86 °F
- Look for air or wax flakes
- Do not violate vacuum until needed (esp levo)

Hondrum et. al. Anes Pain Control in Dent 2:4 1993

History of Drug Abuse
- No scientific answer
- Opioid abuse (e.g. heroin), causes constant opioid receptor stimulation.
- Repeated recreational drug use causes:
  - ↑ level of fear and anxiety
  - ↓ emotional capacity to respond to pain
  - ↑ defensive behavior

9. pKa and pH: Pharmacology
Local Anaesthetic Structure

What Changes Tissue pH?
- Infection
  - Infected tissue pH ~5
- The local anaesthetic itself

Remember: ↑ pH 3.5 to 7 ↑s concentration of lipophilic molecules by 6000X
- LA $pK_a = 7.4$
- Tissue pH = 7.4

\[ \text{LA} \quad B \longleftrightarrow BH^+ \]

- 50% Lipid soluble
- 50% Water soluble

\[ \text{pK}_a \text{ of Local Anaesthetics} \]

<table>
<thead>
<tr>
<th></th>
<th>$pK_a$</th>
<th>% B at pH 7.4</th>
<th>~Onset (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mepivacaine</td>
<td>7.6</td>
<td>40</td>
<td>2 to 4</td>
</tr>
<tr>
<td>Articaine</td>
<td>7.8</td>
<td>29</td>
<td>2 to 4</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>7.9</td>
<td>25</td>
<td>2 to 4</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>7.9</td>
<td>25</td>
<td>2 to 4</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>8.1</td>
<td>18</td>
<td>5 to 8</td>
</tr>
<tr>
<td>Procaine</td>
<td>9.1</td>
<td>2</td>
<td>14 to 18</td>
</tr>
</tbody>
</table>

- LA $pK_a = 7.8$ (articaine)
- Tissue pH = 7.4

\[ \text{Henderson-Hasselbalch Equation} \]

\[ pK_a - pH = \log_{10} \frac{\text{ionized (BH}^+) \quad \text{unionized (B)}}{\text{unionized (B)}} \]

Example: Lidocaine, normal tissue

\[ pK_a - pH = \log_{10} \frac{\text{ionized (BH}^+) \quad \text{unionized (B)}}{\text{unionized (B)}} \]

\[ 7.9 - 7.4 = \log_{10} \frac{\text{ionized (BH}^+)}{\text{unionized (B)}} \]

\[ = \frac{3}{1} \]

Example: Lidocaine, acidic tissue

\[ pK_a - pH = \log_{10} \frac{\text{ionized (BH}^+) \quad \text{unionized (B)}}{\text{unionized (B)}} \]

\[ 7.9 - 6.4 = \log_{10} \frac{\text{ionized (BH}^+)}{\text{unionized (B)}} \]

\[ = \frac{30}{1} \]
Local Anaesthetic Colour Code

<table>
<thead>
<tr>
<th>Local Anaesthetic</th>
<th>Colour Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% Lidocaine + 1:100,000 Epi</td>
<td>Red</td>
</tr>
<tr>
<td>2% Lidocaine + 1:50,000 Epi</td>
<td>Green</td>
</tr>
<tr>
<td>2% Lidocaine Plain</td>
<td>Light Blue</td>
</tr>
<tr>
<td>2% Mepivacaine Plain</td>
<td>Tan</td>
</tr>
<tr>
<td>2% Mepivacaine + 1:20,000 Levo</td>
<td>Brown</td>
</tr>
<tr>
<td>4% Prilocaine</td>
<td>Yellow</td>
</tr>
<tr>
<td>4% Prilocaine Plain</td>
<td>Black</td>
</tr>
<tr>
<td>4% Articaine + 1:100,000 Epi</td>
<td>Gold</td>
</tr>
<tr>
<td>4% Articaine + 1:200,000 Epi</td>
<td>Silver</td>
</tr>
<tr>
<td>0.5% Bupivacaine + 1:200,000 Epi</td>
<td>Blue</td>
</tr>
</tbody>
</table>

ADA Council on Scientific Affairs, 2003

Factors

- Duration
  - Short, medium, long
- Concentration
  - 2, 3, or 4%
- Vasoconstrictor vs. plain
- Difficulty obtaining anaesthesia
- My office stocks it
- Price

Methemoglobinemia

- ↑ doses of prilocaine, articaine, benzocaine or inborn errors of metabolism
- Can occur after extreme exercise
- Methemoglobin cannot carry O₂
  - usually ~ 1%
  - ↑ to > 20%
- Blood rust-brown, respiratory distress, cyanosis, lethargy, dizziness - a few hrs. after tx
- Hospital and methylene blue? (O₂ not helpful)

LA Use In Ontario, 2007

Gaffen AS, Haas DA, JCDA, Vol 75, No 9, 2009

Cartridge of Articaine

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount mg/ml</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine HCl</td>
<td>40</td>
<td>Anaesthesia</td>
</tr>
<tr>
<td>Epi tartrate</td>
<td>0.018</td>
<td>Vasoconstriction</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>1.6</td>
<td>Isotonicity</td>
</tr>
<tr>
<td>Sodium metabisulphite</td>
<td>0.5</td>
<td>Vasoconstrictor antioxidant</td>
</tr>
<tr>
<td>Distilled water</td>
<td>1.0 ml</td>
<td>Volume</td>
</tr>
</tbody>
</table>

Articaine

- Metabolism: 90% by plasma esterase
  - Pseudocholinesterase deficiency ok
- Half life: 27 – 40 min.
- Shape of molecule
- Block and infiltration efficacy
- 4% solutions and paresthesia
Pseudocholinesterase Deficiency

- Usually diagnosed after GA
- Prolonged emergence: cannot metabolize succinylcholine
- Cannot metabolize procaine

LA Half-Lives

<table>
<thead>
<tr>
<th>LA</th>
<th>Half-Life (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine</td>
<td>20 - 40</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>90</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>90</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>115</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>210</td>
</tr>
</tbody>
</table>

4 Half Lives = 94% Drug Elimination

<table>
<thead>
<tr>
<th>LA</th>
<th>( t \frac{1}{2} ) (50%)</th>
<th>( 2^{nd} t \frac{1}{2} ) (75%)</th>
<th>( 3^{rd} t \frac{1}{2} ) (87.5%)</th>
<th>( 4^{th} t \frac{1}{2} ) (94%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine</td>
<td>40 min</td>
<td>80</td>
<td>120</td>
<td>160</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>90 min</td>
<td>180</td>
<td>270</td>
<td>360</td>
</tr>
<tr>
<td>Prilocaine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>115 min</td>
<td>230</td>
<td>345</td>
<td>460</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>210 min</td>
<td>420</td>
<td>630</td>
<td>840</td>
</tr>
</tbody>
</table>

4% Articaine vs. 2% Lidocaine

- Study compared pulpal anaesthesia in mandibular 1st molars after buccal infiltration:

   Effectiveness of articaine greater than lidocaine – statistically significant!!


Study: Mandibular Infiltration

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Articaine 1:100</th>
<th>Lidocaine 1:100</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd Molar</td>
<td>75% (45/60)</td>
<td>45% (27/60)</td>
<td>.0001</td>
</tr>
<tr>
<td>1st Molar</td>
<td>87% (52/60)</td>
<td>57% (34/60)</td>
<td>.0001</td>
</tr>
<tr>
<td>2nd Premolar</td>
<td>92% (55/60)</td>
<td>67% (40/60)</td>
<td>.0001</td>
</tr>
<tr>
<td>1st Premolar</td>
<td>86% (49/57)</td>
<td>61% (35/57)</td>
<td>.0001</td>
</tr>
</tbody>
</table>


Articaine vs. Lidocaine: Block + Infiltration Study

1. IANB 4% articaine 1:100,000
2. Then, buccal infiltrate beside lower 1st molar with 4% articaine 1:100,000 OR 2% lidocaine 1:100,000

<table>
<thead>
<tr>
<th>Tooth</th>
<th>4% Articaine</th>
<th>2% Lidocaine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandibular 1st molar</td>
<td>88%</td>
<td>71%</td>
</tr>
</tbody>
</table>

Haase et al, JADA Vol 139, 2008
Infiltrating Mandibular 1st Molars: Summary of Studies

<table>
<thead>
<tr>
<th>Local Anaesthetic</th>
<th>% Anesthetized</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>4% Articaine 1:100</td>
<td>64</td>
<td>Kanaa et al, 2006</td>
</tr>
<tr>
<td>2% Lidocaine 1:100</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>4% Articaine 1:100</td>
<td>87</td>
<td>Robertson et al, 2007</td>
</tr>
<tr>
<td>2% Lidocaine 1:100</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>4% Articaine 1:100</td>
<td>88</td>
<td>Haase et al, 2008</td>
</tr>
<tr>
<td>2% Lidocaine 1:100</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>4% Articaine 1:100</td>
<td>64 - 70</td>
<td>Corbett et al, 2008</td>
</tr>
<tr>
<td>4% Articaine 1:100</td>
<td>54</td>
<td>Jung et al, 2008</td>
</tr>
<tr>
<td>4% Articaine 1:100</td>
<td>64</td>
<td>Lindsay et al, 2009</td>
</tr>
</tbody>
</table>

Consider Infiltrating For Patients With Bleeding Disorders:
- Hemophilia
- von Willebrand's disease
- Factor deficiencies
- Other hemostatic abnormalities
- Avoid injecting into vascular areas (IANB, PSANB)

Articaine vs. Lidocaine
Maxillary Infiltration

<table>
<thead>
<tr>
<th></th>
<th>1st Premolar</th>
<th>1st Molar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>30%</td>
<td>80%</td>
</tr>
</tbody>
</table>

Irreversible pulpitis
- Buccal infiltration only
- Success of pulpal anaesthesia

Comparing Techniques: Mandibular Molars
Irreversible Pulpitis

Study compared 4 techniques after a failed IANB with lidocaine:
1. A second IANB
2. Articaine buccal infiltration
3. PDL injection
4. IO injection

Results

<table>
<thead>
<tr>
<th></th>
<th>2nd IANB</th>
<th>PDL</th>
<th>IO</th>
<th>Articaine Buccal Infiltration</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Success For Pulpal Anaesthesia</td>
<td>30.4%</td>
<td>49.4%</td>
<td>68.2%</td>
<td>84%</td>
</tr>
</tbody>
</table>

Articaine is superior to lidocaine for infiltration anaesthesia

Articaine 3.81X more likely to provide pulpal anesthesia via infiltration vs. lidocaine

Weak evidence to suggest articaine is better for blocks (anecdotal)

Brandt et al, JADA 142(5), 2011

4% vs. 2%?
- 4% articaine still better for infiltration compared to 4% lidocaine and 4% prilocaine*
- Shape of molecule?
  - Thiophene ring & hydrogen on molecule may cause it to fold when penetrating bone**
- Better lipid solubility & tissue diffusion due to ester chain?

**Skjevik AA., et al, Biophys Chem, 53(6), 2601-11, 2011

Retrospective Paraesthesia Study #1 (1973 – 1993)

<table>
<thead>
<tr>
<th>LA</th>
<th># of Cases</th>
<th>%</th>
<th>% Market Share 1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine</td>
<td>50</td>
<td>33.6</td>
<td>37</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>43</td>
<td>28.9</td>
<td>21</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>5</td>
<td>3.4</td>
<td>26</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>4</td>
<td>2.7</td>
<td>14</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Unknown</td>
<td>47</td>
<td>31.5</td>
<td>-</td>
</tr>
<tr>
<td>Total Cases</td>
<td>149</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Haas, Lennon, JCDA Vol 61(4), 1995

1973 - 1993 Considerations:
- No record for duration of paresthesia
- Articaine available in Canada in 1983
- 4% solutions higher incidence of paraesthesia compared to market share
- Lingual nerve 64% of cases


Retrospective Paraesthesia Study #2 (1999 – 2008)

<table>
<thead>
<tr>
<th>LA</th>
<th># of Cases</th>
<th>%</th>
<th>% Market Share 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine</td>
<td>109</td>
<td>59.9</td>
<td>44</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>29</td>
<td>15.9</td>
<td>6</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>23</td>
<td>12.6</td>
<td>40</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>6</td>
<td>3.3</td>
<td>9</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Multiple</td>
<td>15</td>
<td>8.2</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Gaffen AS, Haas, DA, JCDA Vol 75(9), 2009

1999 - 2008 Considerations:
- Lingual nerve 79% of cases.
- For 4% solutions, ~ 1 in 609,000 IANBs lead to paraesthesia (non surgical cases)

Gaffen AS, Haas DA, JCDA, 75( 9), 2009
Retrospective Paresthesia Study #3 U.S. 1997 - 2008

- Reports to FDA, excluded surgical cases

<table>
<thead>
<tr>
<th>LA</th>
<th># Of Cases</th>
<th>%</th>
<th>% Market Share 1997 - 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine</td>
<td>116</td>
<td>51.3</td>
<td>14</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>97</td>
<td>42.9</td>
<td>6</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>11</td>
<td>4.9</td>
<td>58</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>1</td>
<td>0.4</td>
<td>18</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>1</td>
<td>0.4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>226</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Caristo G et al, JADA 141, 836-44, July 2010

Incidence of Reported Paresthesia

<table>
<thead>
<tr>
<th>U.S. Study*</th>
<th>Ontario Study #1 **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mepivacaine</td>
<td>1:623 million</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>1:181 million</td>
</tr>
<tr>
<td>Articaine</td>
<td>1:4.1 million</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>1:2 million</td>
</tr>
</tbody>
</table>


U.S. FDA Safety & Efficacy Studies For Articaine

- Compared single dose of articaine vs. lidocaine, 1:100,000 epi
- n = 1325
- Both groups < 1% paraesthesia (no ↑ risk for articaine)

Malamed et al, JADA 132(2), 177-85, 2001

Nerve Injury Study

- Denmark
- University Oral Surgery Center
- Mandatory national center for referral after nerve injury
- 2001 – 2007
- Danish drug registry tracks LA use

Hillerup et al, JADA, 142(5), 2011

Results

<table>
<thead>
<tr>
<th>LA Used</th>
<th># of Events (%)</th>
<th>% Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine</td>
<td>4%</td>
<td>41.2</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>2%</td>
<td>27.7</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>3%</td>
<td>11.8</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>3%</td>
<td>19.4</td>
</tr>
<tr>
<td>Total</td>
<td>69 (100)</td>
<td>100</td>
</tr>
</tbody>
</table>

- Lingual nerve 70% of injuries

Hillerup et al, JADA, 142(5), 2011

Risk Management Advice

“Until more research is done…prudent practitioners may wish to consider scientific literature before using a 4% solution for mandibular blocks”

RCDS Dispatch, Summer 2005
Paraesthesia following LA in nonsurgical cases is so rare that dentists are not legally required to warn patients of the possibility of temporary or permanent paresthesia as part of informed consent.”

Paraesthesia = abnormal sensation
NSAIDs and steroids within 30 hrs?
Gabapentin?
Low-level laser therapy?
Patient return right away, then bi-monthly
Map area of anaesthesia / paraesthesia
Referral?

3rd molar only tooth to develop after birth
At 4 – 5 yrs. tooth bud near IANB:
- Where body of mandible meets ramus at level of occlusal plane, medial to curve on coronoid notch and ~ 4 - 5 mm from IOBR
~20% of people don’t get all 3rd molars

3rd molar only tooth to develop after birth
At 4 – 5 yrs. tooth bud near IANB:
- Where body of mandible meets ramus at level of occlusal plane, medial to curve on coronoid notch and ~ 4 - 5 mm from IOBR
~20% of people don’t get all 3rd molars

3rd molar only tooth to develop after birth
At 4 – 5 yrs. tooth bud near IANB:
- Where body of mandible meets ramus at level of occlusal plane, medial to curve on coronoid notch and ~ 4 - 5 mm from IOBR
~20% of people don’t get all 3rd molars

Hypothesis: Can IANB in kids < 6 yrs. stop development of a 3rd molar?
Studied children 7 – 12 yrs. missing one mandibular 3rd molar
Compared children who had IANB before age 6 to those who didn't

<table>
<thead>
<tr>
<th>% of Subjects Missing One Mandibular 3rd Molar</th>
</tr>
</thead>
<tbody>
<tr>
<td>No IANB Age 2 – 6 yrs.</td>
</tr>
<tr>
<td>Had IANB Age 2 – 6 yrs.</td>
</tr>
</tbody>
</table>

Summary:
- LAs are neurotoxic
- Low % LAs are used for spinals to avoid nerve damage
- Neurotoxicity is related to concentration
- Thicker nerves may be more resistant

The Dilemma:
- Can’t clinically study concentration vs. paraesthesia
  - LA molecules may = ↑ efficacy
  - Even if no scientific significance, ↑ efficacy maybe seen clinically (e.g. 1 less failure/week)
LA in Pregnancy
- Safe in pregnant & nursing patient
- Avoid 1st trimester if possible
- Avoids prolonged antibiotic, analgesic use
- Lidocaine & prilocaine highest FDA rank (Category B)
- Prilocaine better at crossing placenta barrier
- Choose lidocaine since 2%

ASPIRATE WITH 25 GAUGE!!

Local Anaesthetics & Pregnancy

<table>
<thead>
<tr>
<th>Anaesthetic</th>
<th>FDA Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine</td>
<td>B</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>B</td>
</tr>
<tr>
<td>Articaine</td>
<td>C</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>C</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>C</td>
</tr>
<tr>
<td>Lidocaine Topical</td>
<td>B</td>
</tr>
<tr>
<td>Benzocaine Topical</td>
<td>C</td>
</tr>
<tr>
<td>Tetracaine Topical</td>
<td>C</td>
</tr>
</tbody>
</table>

Study: LA Safety In Pregnancy
- 210 pregnant ♀ had dental tx (RCT, extraction, resto, perio) with lidocaine (112 in 1st trimester)
- Compared pregnancy outcomes to 794 ♀ not exposed to teratogens & no dental tx.
- No difference in major birth / pregnancy anomalies, miscarriages, gestational age at delivery, birth weight

Hagal A et al, JADA 146(8): 572-80, 2015

Study Cont.
- Conclusion: lidocaine and dental tx during pregnancy do not pose a teratogenic risk.


Epinephrine In Pregnancy
- Some obstetricians say no epinephrine
- Does this make sense?
- Epinephrine reduces systemic uptake of LA
- Low doses of epinephrine used in dentistry unlikely to affect uterine blood flow*

*Haas D.A., JCDA, 68:546-51, 2002

Septanest Product Monograph:
“Safe use of local anaesthetics during pregnancy not established with respect to adverse effects on fetal development. Careful consideration should be given before administering LAs to pregnant women.”
FDA categories for nursing infants (LA is secreted in breast milk):

- **S**: Safe
  - Lidocaine with epi & bupivacaine
- **S?**: Safety unknown
  - Other LAs
- **S**: Potential significant effect
- **NS**: Not safe

LA is secreted in breast milk
- Stays in breast milk for ~ 6X the half life
- “Pump and dump” for:

<table>
<thead>
<tr>
<th>LA</th>
<th>T ½ (min.)</th>
<th>Time in Milk (Hrs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine</td>
<td>90</td>
<td>9</td>
</tr>
<tr>
<td>Articaine</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>Epinephrine</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

Local Anaesthetic Toxicity

**Change % to mg/ml**

Example: 2% lidocaine
- 2% means $\frac{2 g}{100 ml}$
- This = $\frac{2000 mg}{100 ml}$ or $\frac{20 mg}{1 ml}$
  - $\frac{20 mg}{1 ml} = \frac{x mg}{1.8 ml}$
  - $x = 36 mg$ of drug / cartridge

**Maximum Recommended Dose (mg)**

<table>
<thead>
<tr>
<th>Vasoconstrictor</th>
<th>No Vasoconstrictor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine</td>
<td>500</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>500</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>400</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>500</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>90</td>
</tr>
</tbody>
</table>

- For average healthy 70 kg adult
- Must adjust for age and weight

**Maximum Dose By Weight**

<table>
<thead>
<tr>
<th>MRD</th>
<th>Equivalent # of Cartridges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine 7 mg/kg (up to 500 mg)</td>
<td>7</td>
</tr>
<tr>
<td>Bupivacaine 1.3 mg/kg (up to 90 mg)</td>
<td>10</td>
</tr>
<tr>
<td>Lidocaine 7 mg/kg (up to 500 mg)</td>
<td>13</td>
</tr>
<tr>
<td>Lidocaine Plain 4.5 mg/kg (up to 300 mg)</td>
<td>7 or 11*</td>
</tr>
<tr>
<td>Mepivacaine 6.6 mg/kg (up to 400 mg)</td>
<td>7</td>
</tr>
<tr>
<td>Prilocaine 8 mg/kg (up to 500 mg)</td>
<td>7</td>
</tr>
</tbody>
</table>

*7 for 3%, 11 for 2% mepivacaine
For healthy 70 kg adult
Toxicity: Systemic Effects

- Cardiovascular system
- Central nervous system

Mild ➔ Moderate ➔ Severe

Toxicity & The Elderly

- May have reduced liver function
  - 50% reduced liver function by 65 yrs.
  - Must reduce total dose

- May have compromised cardiac function
  - Reduce or eliminate vasoconstrictor

LA Toxicity Patient Factors

- Age
- Weight
- Tolerance – Bell curve
- Liver function

LA Toxicity: Clinical Factors

- Dose too large
- Speed of injection
- Inadvertent IV injection
- Intraosseous injection
- No vasoconstrictor
- Complacency
- Reaction occurs 5–40 min after injection
- Use lower LA doses in combo with other CNS depressants (sedatives) esp. kids

LA Toxicity Algorithm

Mild:
P: Comfortably Reassure
CAB
D: O₂
Allow recovery

Severe:
P: Supine
CAB
D: Airway!
CAB
D: Protect patient IV anti-convulsant?

LA Overdose: Pediatric Deaths

- Occur every year
- Watch for sedation from LA
- Most common used LA in deaths is: 3% mepivacaine (plain)
- Used more in children
  - Try to ↓ numb lip
  - Mistaken belief it's less toxic with no epi
Example: Pedo Calculation

- 15 kg child (~ 30 lbs.)
- Pediatric dose for articaine 7 mg/kg
- 7 mg/kg x 15 kg = 105 mg toxic dose
- 72 mg of drug / cartridge (1.8 ml x 4%)
- Toxic dose = 1.45 cartridges

15 kg Child: Maximum Dose of LA

<table>
<thead>
<tr>
<th>LA</th>
<th>Mg per Cartridge</th>
<th>MRD (mg/kg)</th>
<th># of Cartridges</th>
<th>Maximum Volume of LA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% Lidocaine</td>
<td>36</td>
<td>7</td>
<td>2.9</td>
<td>5.2 ml</td>
</tr>
<tr>
<td>2% Mepivacaine</td>
<td>36</td>
<td>6.6</td>
<td>2.7</td>
<td>4.8 ml</td>
</tr>
<tr>
<td>3% Mepivacaine</td>
<td>54</td>
<td>6.6</td>
<td>1.8</td>
<td>3.2 ml</td>
</tr>
<tr>
<td>4% Prilocaine</td>
<td>72</td>
<td>8</td>
<td>1.6</td>
<td>2.8 ml</td>
</tr>
<tr>
<td>4% Articaine</td>
<td>72</td>
<td>7</td>
<td>1.4</td>
<td>2.5 ml</td>
</tr>
</tbody>
</table>

Summary of Factors

1. Good child
2. Size & physiology
3. Greed - $
4. Complacency
5. Sedation
6. Bell Curve

The Ideal Pediatric LA

- 2% with a vasoconstrictor
- Vasoconstrictor does not significantly change duration of soft tissue anaesthesia

Epinephrine

- A catecholamine, aka adrenalin
- Acts as a hormone & neurotransmitter
- Produced in adrenal medulla
- Used in “fight or flight” response
  - ↑ blood flow to muscles
  - ↑ cardiac output
  - ↑ blood sugar
  - Pupil dilation

Epinephrine

- Acts on α and β receptors
- Fast onset ~ 5 minutes
- Short half-life < 5 minutes
- Short duration ~ 10 minutes
- Can re-administer in 15 minutes safely
Available Epinephrine Concentrations

- 1:50,000
- 1:80,000 (not in North America)
- 1:100,000
- 1:200,000

*for hemostasis and anaesthesia, always use lowest possible dose.

Endogenous Epinephrine

- Life stressors
- Personality type
- Anxiety (dental phobia)
- Pain (inadequate local anaesthesia)

- Epinephrine can ↑ 50 X during stress

Epinephrine Receptor Actions

<table>
<thead>
<tr>
<th>Strength</th>
<th>Action</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>α</td>
<td>Vasoconstriction of local, small submucosal vessels</td>
<td>↑ SBP</td>
</tr>
<tr>
<td>β₁</td>
<td>Cardiotropic: Stimulate receptors in SA node and heart muscle</td>
<td>↑ HR, Contractility and ↑SBP</td>
</tr>
<tr>
<td>β₂</td>
<td>Vasodilation of large peripheral arteries (due to systemic absorption) &amp; Bronchodilation</td>
<td>Slight ↓ DBP*</td>
</tr>
</tbody>
</table>

*Minor change in MAP with small epi doses
With large epi doses, α predominates = ↑ DBP & SBP

Why Add Epinephrine To A Local Anaesthetic?

- Delays absorption of LA
  - ↓ toxicity
  - ↑ duration
  - No advantage with more than 1:200,000

- Surgical hemostasis
  - ↑ concentration is advantageous

↓ Toxicity of LA

- 1:200,000 epi (5 µg epi):
  - ↓ systemic toxicity of 1 ml of LA by ~ ⅓*

- Epinephrine concentration > 1:200,000 is not better at reducing toxicity**


Study: Epi Concentration & Efficacy For 3rd Molar Removal

- Compared articaine 1:100 vs. 1:200 for
  - Pain during surgery
  - Bleeding
  - Duration of anaesthesia
  - Duration of post-op anaesthesia

Conclusion: No significant difference

Compared cardiac effects of articaine 1:100,000 vs. 1:200,000 10 min. after injection:

- ↑ mean SBP
- ↑ HR

Statistically significant

Hersh et al: JADA vol 137, Nov 2006

% change of HR and SBP on healthy adults:

<table>
<thead>
<tr>
<th></th>
<th>HR</th>
<th>SBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Cartridges of Articaine 1:100,000</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>7 Cartridges of Articaine 1:200,000</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Study: Cardiovascular Effect of Epinephrine, 1:100,000 vs. Plain

Compared cardiac effect:
- 3 cartridges of 2% lidocaine vs. 2% lidocaine + 1:100,000 epinephrine (5.4 ml)

Results: Adding epinephrine significantly:
- ↑ heart rate
- ↑ stroke volume
- ↑ cardiac output (determines SBP)
- ↓ peripheral resistance (determines DBP)
- No change in mean arterial pressure

Dionne et al, Anesth Analg, 63:640-6, 1984

4. Epinephrine Drug Interactions

- MAO Inhibitors
- Tricyclic Antidepressants
- Cymbalta (depression, anxiety, fibromyalgia)
- Atomoxetine, Vyvanse
- Diet meds
- Decongestants
- Thyroxin
- Cocaine
- Beta blockers

Cocaine

Cocaine causes:
- ↑ heart rate
- ↑ blood pressure
- ↑ contractility
- Stress (exercise, pain, anxiety…), LA, epi potentiate this cardiac effect
- Dysrhythmia………cardiac arrest

Beta Blockers

Indications:
- Blood pressure
- Heart failure
- Angina
- Migraines
- Glaucoma
- Panic disorders
**Beta Blockers**

- **Cardioselective:**
  - acebutolol: Monitan, Rhotral, Sectral
  - atenolol: Tenormin
  - metoprolol: Betaloc, Lopressor

- **Non-cardioselective (older agents):**
  - nadolol: Corgard
  - oxprenolol: Trasicor
  - pindolol: Visken
  - propranolol: Inderol
  - sotalol: Sotacor
  - timolol: Blocadren, Timoptic

**Epinephrine + -Blocker**

- **Cardioselective**
  - 1 Cardiotropic
  - 2 Vasodilation
  - α Vasoconstriction

- **Non-cardioselective**
  - 1 Cardiotropic
  - 2 Vasodilation
  - α Vasoconstriction

Severe hypertension with reflex bradycardia leading to potential stroke or cardiac arrest.

**Blood Pressure Protocol**

For ASA III and IV patients:
- Take baseline BP pre-op
- Inject local anaesthetic
- Retake BP 5 mins later
- Monitor BP every 10 mins

**Understanding Concentrations**

- 1:100,000 means 1 g : 100,000 ml

\[
\frac{1 \text{ g}}{100,000 \text{ ml}} = \frac{1000 \text{ mg}}{100,000 \text{ ml}} = \frac{0.01 \text{ mg}}{1 \text{ ml}}
\]

- 1.8 ml has 0.018 mg of epinephrine (~20 µg)
- 1:50,000 has double (0.036 mg ~ 40 µg)
- 1:200,000 has half (0.009 mg ~ 10 µg)

**Maximum Dose**

<table>
<thead>
<tr>
<th># Of Cartridges</th>
<th>mg/ml</th>
<th>mg/1.8ml</th>
<th>Healthy Cardiac Impaired</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:20,000 Levo</td>
<td>0.05</td>
<td>0.09</td>
<td>11</td>
</tr>
<tr>
<td>1:50,000 Epi</td>
<td>0.02</td>
<td>0.036</td>
<td>5</td>
</tr>
<tr>
<td>1:100,000 Epi</td>
<td>0.01</td>
<td>0.018</td>
<td>11</td>
</tr>
<tr>
<td>1:200,000 Epi</td>
<td>0.05</td>
<td>0.009</td>
<td>20</td>
</tr>
</tbody>
</table>

Epi MRD for healthy 70 kg adult = 0.2 mg
Epi MRD for cardiac impaired (ASA III) = 0.04 mg

**LA Reversal Agent: OraVerse**

- By Septodont
- Aim: Reverse soft tissue anaesthesia

- **Phentolamine:** a vasodilator, blocks α receptors. Used for:
  - Hypertensive emergencies, cocaine OD and pheochromocytoma
**OraVerse Pharmacology**
- Reverses epi induced vasoconstriction by α mediated vasodilation, then faster LA clearance
- Slight ↑ of lidocaine in CVS after OraVerse
  - No issue with articaine due to fast metabolism
- Possible hypotension and reflex tachy
  - Not seen in studies as concern
- Pregnancy Category C (not tested yet)
- No known drug interactions with OraVerse

**OraVerse Indications**
- Avoid self-inflicted soft tissue injury
- Special needs patients
- 6 yrs. & older, weight greater than 33 lbs.
- Diabetics (can eat sooner)
- Back to work sooner
- People with swallowing problems
- Block quad 3 & 4 in same visit
- Esthetic assessment

**OraVerse Disadvantages**
- 2nd injection
  - Slight ↑ pain, bruising in injection area
- Will faster LA offset = ↑ post-op pain?
  - Not indicated post surgery, endo or if plain LA is used
- Cost (~$3 - $4 per cartridge)

**OraVerse**
- Injected after tx
- Inject = volume of OraVerse to LA
- Max dose is:
  - 2 cartridges: for 12 yrs. and older
  - 1 cartridge: 6 – 11 yrs. & over 66 lbs.
  - ½ cartridge: for age 6 weight 33 – 66 lbs.
- ↓ soft tissue anaesthesia duration by ½

**Median Recovery Time From Soft Tissue Anaesthesia (min.), Teens & Adults**

<table>
<thead>
<tr>
<th></th>
<th>Phentolamine</th>
<th>Sham</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandibular Lip</td>
<td>70</td>
<td>155</td>
</tr>
<tr>
<td>Tongue</td>
<td>60</td>
<td>125</td>
</tr>
<tr>
<td>Maxillary Lip</td>
<td>50</td>
<td>133</td>
</tr>
</tbody>
</table>

Hersh et al, JADA Vol 139, Aug 2008
Median Recovery Time From Soft Tissue Anaesthesia (min), 6 - 11 Yrs.

<table>
<thead>
<tr>
<th>Lip Anaesthesia</th>
<th>Phentolamine</th>
<th>Sham</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
<td>135</td>
</tr>
</tbody>
</table>

Children aged 4 - 5 tested for safety. Could not answer subjective questions

Tavares et al, JADA Vol 139, Aug 2008

“Non-Injectable” Local Anaesthetics
1. Oraqix
2. HurriPak
3. Citacaine

Oraqix®
- Approved indication: Scaling & root planing for adults
- Onset 30 seconds
- Duration 17 - 20 min.
- Hygienist
- “Needle-free”

Oraqix
- 2.5% lidocaine + 2.5% prilocaine
- Fluid at room temp
- Gel at body temp
- Maximum dose = 5 cartridges
  ~1 cartridge / quadrant is required

* Herdevall et al ACTA Odontol Scand 61, 2003

Oraqix Cartridge
- Unique colour marking
- Safety collar

QAQ
- Quaternary ammonium-azobenzene-quaternary ammonium
- Light switch LA
- cis and trans form changed by specific wavelength of light
- Only one form able to penetrate nerve ion channel
Safety & Efficacy Studies

3 placebo-controlled studies:

- Oraqix statistically better than placebo
  - Pain scores reduced by at least 50%
  - Jeffcoat MK et al, J Perio, July 2001
  - Magnusson I et al, J Perio, May 2003

Apply to gingival margin:

- Retraction cord
- Temp crown removal
- Rubber dam clamp
- Primary tooth M3+ extraction
- Removing implant healing cap

Fill sulcus:

- Retraction cord placement, Oraqix vs. placebo
  - Oraqix group significantly lower pain ratings than placebo group

Other Indications (Off-Label)

- Allergy
- Liver disease
- Methemoglobinemia
- Children (< 18 yrs.)
- Precaution nursing and pregnancy
- Watch toxicity with injectable LA
**HurriPak**

- Beutlich Pharma; 20% benzocaine
- No “thermo-setting” agent
- Kit = 6 syringes + 6 Luer-lock tips
- Flavour

**Citacaine**

- By Cetylite
- 14% benzocaine, 2% butamben, 2% tetracaine
- Luer-lock connection
- Max. dose 0.4 ml.
Gow-Gates Advantages

- Perceptible end point
- Anaesthetize accessory nerves
  - Including long buccal nerve
- Decreased vascularity
  - ~2% aspiration rate vs. 10 – 15% for IANB
- Decreased nerve damage
- Longer duration of anaesthesia?
- Good vision


Gow-Gates Disadvantages

- Mouth open wide
- Slower onset
- Extra-oral landmarks

Neuroanatomy

19mm Above Occlusal Plane
Occlusal Plane
Chin up, mouth open wide
Landmark
Initial puncture
Check side of face
Gently touch bone
Pull back 1 mm
Aspirate

Intraosseous Anaesthesia

Anaesthetizing a tooth by injecting LA directly into surrounding cancellous bone.

Other Delivery Techniques
- Intraosseous injections
- PDL injections
- Computers
- Vibration systems
- Needle-free devices
- Intra-nasal delivery
IOA Steps

1. BW radiograph
2. Topical anaesthetic
3. Preparatory infiltration
4. Perforate bone
   - Over attached gingiva
   - Perpendicular to buccal cortex
   - Pecking motion for < 5 sec
5. Slowly inject ½ a cartridge / tooth
6. Max. 1 cartridge per appointment

Anatomy: Considerations

- Thick cortical bone
- Midline
- Mental foramen
- Mixed dentition

Blunted bevel

X-tip

IOA Contraindications

- Long procedures
- Cardiac disease
- Infection / periodontal disease
PDL Injections

- Waste 3/4 of contents of cartridge
- Embed needle into PDL space
  - 27 ga short, bevel to tooth
- Inject 0.2 ml per root
- Blanching of tissues
- Allow back-pressure to ↓
- Begin tx immediately

PDL Injections

- LA goes into surrounding cancellous bone
- About 15 minutes pulpal anaesthesia
- No difference in solution effectiveness

PDL injections are intraosseous injections:

McLean ME et al, Anesth Pain Control Dent, 1(4), 207-13, 1992

Intraosseous vs. PDL

- IO greater success and longer duration than PDL
- Due to ↑ solution
- However PDL may be easier to do

Citoject by Athena

Paroject by Septodont

3 squeezes of lever per root

The Wand (STA System)

By Aseptico

Calaject
VibraJect

- Gate control theory
- Battery-operated motor
- Rechargeable battery option
- Attaches to syringe
- ~$200

ITL Dental

DentalVibe

- “Vibrations close pain gate”
- Cordless, rechargeable
- Proprietary “vibraPulse”: Ultrasonic vibrations
- Different tips for different injections
- Audible distraction & flashlight
- ~$300 - $350

DentalVibe Study

- Tufts University
- Adolescents 10 – 17 yrs.
- Max and md buccal infiltration
- Grp 1: DentalVibe during injection
  Grp 2: Just injection
- DentalVibe group less pain. Statistically significant


Needle-Free Injectors

- Syrijet
- MadaJet
- Injex

Needle-Free Injectors

- Spring-loaded
- Audible click
  - Prepare patient
- Heavier than syringe
- Control recoil
Needle-Free Injectors

**Indications**
- Diabetics
- Growth hormone injections
- Global vaccination programs
- Botox
- Minor skin surgery
- Dentistry?

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**Injex**

- Invented in 1998
- Produced in Germany
- Sold by Marketing Medical Canada

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**Ready for injection**

- Move green safety ring towards LA
- Depress silver tongue to inject

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**Injex: Advantages**

- No needle
- ↓ dose of LA
- ↓ area of soft tissue numbness
- ↓ onset of anaesthesia
- Reduced risk of needle-stick injury
- ↓ pain?

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**Injex**

- Mandible: only anterior teeth
- Maxilla: anterior and premolars
- Dry, attached gingiva
- Hold firm, perpendicular to buccal plate
- 0.3 ml per injection
- Spring lasts for 5000 injections
- ~ $500 + ~ $2 / injection for disposables
Injex: Disadvantages
- Recoil
- Click
- Haematoma, bleeding and swelling

Ont. Occupational Health & Safety Act: Bill 168 – Needle Safety Regulations
- As of Jul 1, 2010, SENs are mandatory
- For any use of hollow-bore needle
- Enforced by Ministry of Labour
- Also, OHSA act # 527: “Must not re-cap waste needles”

Cost of Injury
- Disease transmission
  - HBV, HCV, HIV
- Loss of work for health-care worker
- Emotional
- In U.S., ~$2500 for medical care after injury
  - Antiviral drugs, blood tests.....

Exceptions To Bill 168
- Use of SEN poses greater risk of harm to patient or worker
- After reasonable effort, no appropriate SEN is available
- Emergency exists & SEN not available

Avoiding Needle Injuries
1. Dentists:
   - Mirror to retract lip, not finger
   - Re-cap needle - scoop technique
   - HBV vaccination
   - Re-capping device

2. Assistants:
   - Never pass uncapped needle
   - Only remove needle from syringe if capped
   - Use sharps containers
   - Do not allow sharps container to over-flow
   - HBV vaccinations
Topical anaesthetics that give pulpal anaesthesia
- Pain fiber specific local anaesthesia
- Intranasal local anaesthesia

Intranasal Anaesthesia
- Atomizer creates an aerosol
- Plume of anaesthesia into one or both nostrils

Intranasal Anaesthesia
- Middle & anterior superior alveolar nerves
- Pulpal anaesthesia 2nd premolar to central
- Established medical use with:
  - 3% tetracaine + 0.05% oxymetazoline & with cocaine
  - Dental studies looking at lidocaine

Intranasal Study
Compared:
- 0.1 ml 3% tetracaine + oxymetazoline intranasal vs.
- 1 ml 2% lidocaine + 1:100,000 epi injected
- Restorative procedures in maxilla:
  - 1st molars to centrals

Ciancio S et al, J Dent Res, 89(B), 2010

Intranasal Study Results
- Intranasal success: 83%
- Injection success: 93%
- Intranasal success eliminating 1st molars: 100%

Kovanaze
- Pre-filled sprayer with 0.2 ml of:
  - 6 mg tetracaine and 0.1 mg oxymetazoline
  - For 15 – 25 and all primary teeth
  - Children > 40 kg
  - By St. Renatus

Ciancio S, et al, J Dent Res, 89(B), 2010
Kovanaze

- Adults 2 sprays 4 – 5 min apart & 1 rescue spray 10 min later if needed
- Same for kids > 40 kg but no rescue spray
- No lip numbness
- Refrigeration required
- Boxes of 30

Kovanaze

Contraindications:
- Allergy to tetracaine (PABA)

Precautions:
- MAOI’s
- Nonselective β blockers
- Tricyclic antidepressants

In combo with oxymetazoline will ↑ BP

Kovanaze

Side Effects (~ 10% of patients):
- Rhinorrhea
- Nasal congestion
- Mild nose bleed
- Dizziness
- Dysphagia
- Transient ↑ in SBP

Resolves same day

10 Success-Enhancing Ideas

1. Minimize vasoconstrictor
2. Optimize volume
3. Try long 25 or 27 gauge needles
4. Inject slowly and wait
5. Try higher blocks
6. Lingual infiltrations
7. Landmark
8. Elicit patient co-operation
9. Try anti-inflammatories and/or N₂O
10. Consider alternative techniques