Mythbusters – Local Anesthesia Edition

Myth #1: “My Dentist Still Uses Novocain”

We all know this myth is totally BUSTED, but let’s briefly look back at the history of Novocain... by the way there is no “e” in Novocain (the brand name for procaine)

Historical Perspective

- The first local anesthetic was Cocaine
- Carl Koller (September 1884) used cocaine as a local anesthetic during a surgical procedure (for glaucoma)
- “The facts are that neither Freud nor I discovered that cocaine is a local anesthetic. This was discovered by Dr. Albert Niemann, who extracted the potent principle from coca leaves in 1860” ~ Dr. Koller (JAMA 1941;117(15)1284.)
- Dr. Koller was nominated for the Nobel Prize several times but never received it, mostly because his discovery was made 17 years before the Nobel Prize was created. (www.dentaleconomics.com/articles/print/volume-89/issue-3/features/the-story-of-local-anesthesia.htm)
- William Halsted (November 1884) developed the principles of nerve block using Cocaine
- Infraorbital and IA blocks were performed on him as a “guinea pig” it took him 3 years to overcome his resulting Cocaine addiction (Ann Surg 1997 May;225(5):445-58.)
- Due to the unfavorable therapeutic index of Cocaine the search was on for a less toxic compound with LA properties:
  - 1904 – Alfred Einhorn synthesized the ester Procaine (Novocain)
  - 1943 – Nils Lofgren synthesized Lidocaine which possessed:
    - Less allergenicity
    - More potency
    - More rapid onset of action
    - First brand name = Xylocaine (Astra Pharmaceutical)
  - 2000 – Articaine granted FDA approval in the US
  - 2008 – OraVerse (phentolamine mesylate) approved

A little more info on Procaine...

- First synthetic injectable local anesthesia used in dentistry
- Produced the greatest amount of vasodilation of all currently used local anesthetics
- Ester type – capable of allergy - PABA
- \( pK_a = 9.1 \), slow onset (6-10 minutes) and at physiologic pH existed as 90% charged (inactive) and 10% uncharged (active)
- Duration of action (epinephrine can be added to prolong action)
- Pulpal anesthesia (mx infiltration) lasts about 5 minutes.
- Soft tissue anesthesia lasts for approximately 30 minutes
- Blocks are not recommended (slow onset, ultra short duration)
- Systemic toxicity negligible because procaine is rapidly destroyed in the plasma
1.7mL vs. 1.8mL on Local Anesthetic Cartridges

- Average cartridge volume in U.S. is 1.76mL (JADA 2007;138:1104–1112.)
- During the approval process for Articaine in the 1990’s the FDA asked the manufacturer, “Can you guarantee that each and every cartridge contains at least 1.8mL of solution?” the answer was “No.” (Malamed SF. Clinical Action of Specific Agents. In: Handbook of Local Anesthesia. 6th Edition. 2014. p 56.)
- Therefore, manufacturers began printing a volume of 1.7mL on the cartridges

Lots of Brand Names for local anesthetic solutions...
- Retail costs for local anesthetics $30-50
- Exception is Bupivacaine ~$60
**Myth #2: “Doctor, I’m allergic to epinephrine!”**

Again, we know this myth is BUSTED, but this is such a common patient report that is worth looking into!

Pharmacokinetics of Epinephrine

- Naturally occurring
- It is on the World Health Organization's List of Essential Medicines, the most important medications needed in a basic health system
- Onset of action: 1-2 minutes
- Duration of action: 1-2 minutes
- Acts directly on alpha and beta adrenergic receptors (50:50, alpha constricts and beta dilates)
- Antagonizes the effects of histamine
- Stimulates the liver to produce and raise blood glucose levels
- Increases HR, cardiac contractility, and systemic vascular resistance
- Increases myocardial oxygen demand

Epinephrine – Historical Progression

- In 1986, the AHA emphasized safety by concluding, “Vasoconstrictor agents should be used in local anesthesia solutions during dental practice only when it is clear that the procedure will be shortened or the analgesia rendered more profound. When a vasoconstrictor is indicated, extreme care should be taken to avoid intravascular injection. The minimum possible amount of vasoconstrictor should be used.”

- Malamed and Bennet, proposed 0.04mg as a maximum dose of epinephrine for patients with severe cardiac disease

![Table I. Contraindications to vasoconstrictors in dentistry](image)

### Absolute contraindications

- Heart diseases
  - Unstable angina
  - Recent myocardial infarction
  - Recent coronary artery bypass surgery
  - Refractory arrhythmias
  - Untreated or uncontrolled severe hypertension
  - Untreated or uncontrolled congestive heart failure

- Uncontrolled hyperthyroidism
- Uncontrolled diabetes
- Sulfite sensitivity; steroid-dependent asthma
- Pheochromocytoma

### Relative contraindications

- Patients taking tricyclic antidepressants
- Patients taking phenothiazine compounds
- Patients taking monoamine oxidase inhibitors
- Patients taking nonselective β-blockers
- Cocaine abuser

References:


The “Reaction”
- But what about those patients who suffer from the following symptoms after local anesthetic injection?
  - Heart palpitations or racing heartbeat
  - Pale, sweaty skin
  - Dizziness
  - Nervousness
  - Headache
  - Most likely to occur during IANB
- Rates of positive aspiration for IANB:
  - 5.8% in approximately 6000 injections (Ann Anat 1999;181:105-6.)
  - 8.1% in 731 injections (JADA 1999;130:496-9)
  - Other authors have suggested a wider range (2.6-30%) with factors such as needle size and anatomy playing a role (JADA 1992;123:69-73)

<table>
<thead>
<tr>
<th>Technique</th>
<th>Needle Gauge</th>
<th>Needle Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palatal Approach (ASA)</td>
<td>30</td>
<td>Ultrashort</td>
</tr>
<tr>
<td>PSA Nerve Block</td>
<td>27</td>
<td>Short</td>
</tr>
<tr>
<td>Infiltration</td>
<td>27</td>
<td>Short</td>
</tr>
<tr>
<td>Buccal (Long) Nerve Block</td>
<td>27</td>
<td>Short</td>
</tr>
<tr>
<td>PDL Injection</td>
<td>27</td>
<td>Short</td>
</tr>
<tr>
<td>IA Nerve Block</td>
<td>25</td>
<td>Long</td>
</tr>
<tr>
<td>Gow-Gates Nerve Block</td>
<td>25</td>
<td>Long</td>
</tr>
<tr>
<td>Vazirani-Akinosi Nerve Block</td>
<td>25</td>
<td>Long</td>
</tr>
</tbody>
</table>

Take home message...
“The addition of a suitable vasoconstrictor in adequate concentration increases the efficiency of local anaesthetic preparations and reduces the toxicity; their presence is therefore desirable. There is far greater danger of untoward reactions from the use of preparations without a vasoconstrictor than from the small amount of adrenaline normally present.”

Recommendations:
- The “Reaction” is most likely to occur during IANB in the mandible
- Use the right size needle (avoid 30ga for IANB in adults and kids) (Dent Clin North Am 2010;54:745–756.)
- Aspirate (twice)
- Slow injection technique – fast injection technique may cause back pressure within the vessel and decrease chances of positive aspiration (Ann Anat 1999;181:105-106)
- Consider reduced/no epinephrine dose formulations:
  - 4% articaine with 1:200,000 (multiple brands)
  - 4% Citanest Forte with 1:200,000 epi (Prilocaine, Dentsply Sirona)
  - 3% mepivacaine (multiple brands)
  - 4% Citanest (Prilocaine, Dentsply Sirona)
Myth #3: “First, I give a local anesthetic without epinephrine to my patients, because it stings less.”

Background: Some dentists believe that by using a plain local anesthetic solution (ie, no epi) that the patient won’t feel a pinch, sting, or burn at injection.

Could be related to pH. It is well-known that solutions containing a vasconstrictor (eg, epi) have a lower pH then plain solutions.

Local Anesthetic Ph (Source: Compend Contin Educ Dent 2016 May;37(5):e6-e12.)

- Average pH of solutions containing epinephrine: 3.82
- Average pH of plain solutions: 6.34
One more thing… who has heard of buffering local anesthetics?

- Local anesthetic buffering involves adding Sodium Bicarbonate to low pH solutions to raise the pH closer to physiologic levels
- Possible benefits include:
  - Faster onset
  - Better efficacy
  - Less injection pain
  - The data on whether buffering decreases injection pain is equivocal (Gen Dent 2015;63(6):74-78.)
  - All the studies look at buffered vs. non-buffered lidocaine or articaine
  - We need to look at buffered vs. prilocaine!
Myth #4: “I use small needles for my injections because they are less painful to the patient compared to larger needles.”

Background: There is a long-standing belief in dentistry that using a smaller gauge needle will cause less discomfort to the patient.

This myth has long persisted despite some early evidence:
- “patients are unable to differentiate among 23-, 25-, 27-, and 30-gauge needles” (NY State Dent J 1972;38:425-426.)
- “no significant differences in the perception of pain produced by 25-, 27-, and 30-gauge needles during inferior alveolar nerve blocks in adults” (JADA 1979;99:822-824.)

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Table 1. Overall results for needle gauge and pain.

<table>
<thead>
<tr>
<th>Needle gauge</th>
<th>Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>27</td>
<td>2</td>
</tr>
<tr>
<td>30</td>
<td>33</td>
</tr>
<tr>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
</tr>
<tr>
<td>27</td>
<td>19</td>
</tr>
</tbody>
</table>

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Table 1. Participants’ preferences with regard to needle gauge.

<table>
<thead>
<tr>
<th>Needle gauge</th>
<th>Most painful</th>
<th>Intermediate</th>
<th>Least painful</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G</td>
<td>15</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>23G</td>
<td>12</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>27G</td>
<td>5</td>
<td>19</td>
<td>21</td>
</tr>
</tbody>
</table>

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**The Verdict...UNCLEAR**

**Recommendations**
- Use the right size needles!
- Why? Not for patient comfort but for reasons such as:
  - Needle deflection
  - Ability to aspirate (less pressure required)
  - Decreased risk of breakage
- For IANB use 25- or 27-ga long needles
- For infiltrations use 27-ga (or 30-ga) short needles
- To help avoid needle breakage:
  - Minimize bending of needles
  - Minimize reorienting needles when in tissue
  - Avoid hubbing the needle

Why Long Needles? No Hubbing!
Myth #5: “My Obstetrician says I can get Local Anesthesia, just no Epi.”

Changes in 2014:
- On 12/13/2014, the FDA published the Pregnancy and Lactation Labeling Final Rule (PLLR), which changed the labeling requirements for the pregnancy and lactation sections for prescription drugs and biological agents.
- The final rule removed the pregnancy letter categories, and created descriptive subsections.
- Labeling changes from this rule begin on June 30, 2015. Previously approved drugs from June 30, 2001 will switch to the new labeling gradually.
- This rule does not apply to OTC medications.

What is a TERATOGEN?
Any agent that can disturb the development of an embryo or fetus. Teratogens may cause a birth defect in the child. Or a teratogen may halt the pregnancy outright. The classes of teratogens include radiation, maternal infections, chemicals, and drugs.
The Facts:

- Medication use during pregnancy is common; two out of every three women take prescription medications during pregnancy. (American Journal of Obstetrics and Gynecology 2004; 191:398-407.)
- Medication use during pregnancy still causes great anxiety and misunderstanding among both the public and health care professionals.
- The majority of birth defects have an unknown cause, however one early publication estimated that 2-3% of birth defects are thought to be caused by medications taken during pregnancy. (Teratology 1973; 7:3-15.)

<table>
<thead>
<tr>
<th>Local Anesthetics</th>
<th>Pregnancy Category</th>
<th>Safe during Pregnancy?</th>
<th>Safe during breastfeeding?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articaine</td>
<td>C</td>
<td>Use with Caution</td>
<td>Use with caution</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>C</td>
<td>Use with Caution</td>
<td>Yes</td>
</tr>
<tr>
<td>Lidocaine (with or without epinephrine)</td>
<td>B</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mepivacaine (with or without levonordefrin)</td>
<td>C</td>
<td>Use with Caution</td>
<td>Yes</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>B</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Benzocaine (topical)</td>
<td>C</td>
<td>Use with caution</td>
<td>Use with caution</td>
</tr>
<tr>
<td>Dyclonine (topical)</td>
<td>C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lidocaine (topical)</td>
<td>B</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tetracaine (topical)</td>
<td>C</td>
<td>Use with caution</td>
<td>Use with caution</td>
</tr>
</tbody>
</table>

Source: JADA 2012;143(8):858-871.

The Concern:
The effects on the uterus, specifically:
- Uterine blood flow (alpha effects)
- Uterine muscle tone (beta effects)

A true contraindication to epinephrine in local anesthetics for pregnant dental patients is if the pregnancy is complicated by hypertension.

References:
The Verdict...

This myth is BUSTED. Your safest choices if a local anesthetic is indicated for a pregnant patient are:

Lidocaine with or without EPI
Prilocaine with or without EPI
Myth #6: “I don’t use articaine for blocks because it causes paresthesia.”

- A paresthesia as an abnormal sensation, such as of burning, pricking, tickling, or tingling
- Paresthesias are one of the more general groupings of nerve disorders known as neuropathies
- Paresthesias may manifest as total loss of sensation (ie, anesthesia), burning or tingling feelings (ie, dysesthesia), pain in response to a normally nonnoxious stimulus (ie, allodynia), or increased pain in response to all stimuli (ie, hyperesthesia)

Articaine important dates: (Malamed SF. Articaine 30 years later. Oral Health. Feb 2016)
- 1969: Developed in Germany
- Entered clinical use
  - 1976: Germany
  - 1983: Canada
  - 1998: United Kingdom
  - 2000: United States
  - 2005: Australia

Myth #6: the Evidence

The study revealed a higher than expected frequency of paresthesia following the use of articaine and prilocaine²

A follow-up study by Haas in 2008 also found a higher than normal frequency of nerve injuries for articaine during a 10-year period (1999-2008)²
- Articaine: 109
- Lidocaine: 23
- Prilocaine: 29
- Multiple agents: 15
A 2003 study showed a range in the number of fascicles present within the lingual nerve, being anywhere from 1 to 8. Of the 12 nerves studied, 4 (33%) had only 1 fascicle.

The investigators speculated that a unifascicular nerve may be injured more easily than a multifascicular one.

To date, this seems to be the most plausible explanation for the finding of the predilection of the lingual nerve for permanent paresthesia.

References:
Let’s keep it real… PARESTHESIA IS A RARE EVENT!

The mechanism is UNCLEAR

Factors thought to be involved with Paresthesia:
- Direct needle trauma
- Intra-neural hematoma
- Extra-neural hematoma
- Edema (extra- and intra-neural)
- Chemical neurotoxicity of articaine

“Weber Effect”:

where a new product when introduced to the marketplace is subject to a closer level of scrutiny by users than more traditional, well-known products

At some point you see… fewer reports of adverse events despite increased use

Reference:
- JADA 2010;141(7):836-844.
- www.OralHealthGroup.com
Neurotoxicity?
- Articaine may be less neurotoxic than other local anesthetics
- 4% versus 2%?

**The Verdict... UNCLEAR**
- Despite reports about paresthesias and articaine – the data linking the two is largely anecdotal and of insufficient quality to make clinical guidelines - retrospective and biased
- Controlled studies are needed!
- Clinical neurotoxicity of 2% vs. 4% solutions is unclear and unproven
- The risks ratios are all over the map!
- Change technique rather than local anesthetic?

So what should I do?
- Use articaine for IANB injections
- If not convinced, use lidocaine (buffered?)
- Or, use lidocaine for IANB, use articaine via buccal infiltration
- Or, use articaine only on the maxilla or not at all