Updates and Advances in Local Anesthesia: Improving the Patient Experience

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Dr. Sean Boynes has served as a consultant to Novocol of Canada Inc., Septodont, Inc., and Novalar Pharmaceutical Inc. regarding development of new agents and/or devices for dentistry. He has also served as an investigator for FDA required Phase II, Phase III, and Phase IV clinical research contracts awarded by Wyeth Consumer Healthcare, Novocol of Canada Inc., Septodont, Inc., Hospira Pharmaceutical Inc., Church & Dwight, Pfizer Pharmaceutical, and Novalar Pharmaceutical Inc. Henry Schein, Septodont, Cetylite Industries, and Ultralight Optics have partially sponsored continuing education courses Dr. Boynes has presented.

Commercial Bias: Today’s presentation was supported in part by Septodont, Inc.
Dental Lore and Pain

- The majority of patients have a dislike of the anesthetic injection and closely associates dental care with pain.
- Associated pain tends to be the first thing the patient thinks about when considering any dental care.
- The needle/pain is very influential in a person’s perception of the dental profession.

Matthews et al. Factors affecting patients and potential patients choices... J of Dentistry 2001; 29:173-179
De St Georges : How dentists are judged by patients. Dent Today 2004; 23:96-99
Patient Dissatisfaction

• The injection is related to many dissatisfaction reports
• #1 way dentists are judged
• Obviously, a comfortable appointment is considered the best practice builder
• Most reports of bad dental experience relate to pain during care


De St Georges : How dentists are judged by patients. Dent Today 2004; 23:96-99
Fear and Anxiety

They’re anti-anxiety pills...

But I’m afraid to take them!!
CSC Parent of Patient Anxiety Evaluation

• Ongoing prospective questionnaire-based analysis (early stage of data collection)
• Evaluating
  • Anxiety levels
  • Dental knowledge
  • Parent dental treatment history
  • Evaluation of communication process between parent and pediatric patient
Corah’s Anxiety Scale

• A series of questions relating to a dental visit
• Anxiety rating:
  • 9 - 12 = moderate anxiety but have specific stressors that should be discussed and managed
  • 13 - 14 = high anxiety
  • 15 - 20 = severe anxiety (or phobia). May be manageable with the Dental Concerns Assessment but might require the help of a mental health therapist.

• All respondents (AR): 11.63
  • Parents of patients that required referral to moderate or deep sedation/general anesthesia (RP): 13.74
Dental Knowledge Score

• A series of five questions that gauge basic dental knowledge
  • Cavities and brushing
• Restoration placement
  • Home oral hygiene
  • Timing of dental examination
  • Use of mouthrinse
• AR: 3.37 (67.4%)
• RP: 3.00 (60.0%)
Parent Interaction & Communication

- Parent needs sedation care
  - AR: No (57.1%)
  - RP: Yes (75.0%)

- Discuss appointment with child
  - AR: Yes (85.7%)
  - RP: Yes (75.0%)

- Discuss parent’s dental visits in past
  - AR: Yes (60.0%)
  - RP: No (67.0%)

- Description of dental visit to child
  - AR:
    - Positive (66.7%)
    - Negative experience (19.0%)
    - Negative experience, but told (14.3%) them there appointment would be better
Parental History

• Parent had a bad experience with dental care in the past
  • AR: 57.1%
  • RP: 62.9%

• Description of parent bad experience (total selections)
  • 1 - Pain during procedure
  • 2 – Getting a shot
  • 3 – Dentist’s attitude, the way you were treated
  • 4 – I did not get numb and the dentist continued drilling anyway
The Hypodermic Dental Needle
<table>
<thead>
<tr>
<th>Needle Type</th>
<th>Percentage of Market (2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 Gauge</td>
<td>≈ 2.0%</td>
</tr>
<tr>
<td>27 Gauge</td>
<td>≈ 40.5%</td>
</tr>
<tr>
<td>30 Gauge</td>
<td>≈ 57.5%</td>
</tr>
</tbody>
</table>

Practice Characteristics

• Over the last 30 years, shift toward the use of smaller diameter needles
• Based on assumptions of less trauma and discomfort with smaller needle
• Assumptions contradicted by published research using intraoral needles and evaluation of pain

Needle Properties

• Exists considerable variation in how a needle is selected
  • Needle types (not manufacturer necessarily) familiar with during training
  • Peer influence
  • Economics
  • “A needle is a needle”
• Differences in manufacturing/design
Needle Gauge

- The diameter of the needle (25, 27, 30) – higher the gauge the smaller the diameter
- Shift to using smaller diameter needles
- Conjecture that smaller needles equal smaller pain perception
Needle Gauge

- Comparisons by Fuller and Brownbill have shown that a 25-gauge needle can be used as painlessly as a 30-gauge needle.
- Hamburg reported that patients are unable to differentiate among different gauge needles.
- Flanagan et al concluded that there was no statistically significant difference in pain perception among subjects analyzed.

Fuller: Perception of pain to three different intraoral penetration of needles. JADA 1979; 99:822-824.
The Bevel

- Sloping tip of the needle
- Five main types of bevel

![Diagram of different types of bevel needles]
The Bevel

• The role of the bevel is to provide a cutting surface that offers little resistance to mucosa as the needle penetrates and withdraws from tissue

• As opposed to needle gauge, several researchers advocate that the sharpness and structure of the bevel plays a more important role in decreasing pain response

Kaufman: A survey of pain, pressure and discomfort induced by commonly... Anesth Prog 2005; 52:122-127
Better Bevel = Decreased Force

Completed as comparison to standard bevel versus the Evolution™ scalpel needle
The Bevel

- As resistance to tissue decreases patient comfort has been reported to improve
- Designs with low tissue resistance
  - Multibeveled point design
  - Scalpel bevel design

Aldous: Needle deflection: a factor in the administration of local anesthetics. JADA 1968;77:602-604
The Bore or Lumen

• The hollow portion or tube of the needle
• The bore design correlates with patient comfort due to injection pressure
  • *There exists a variable with provider technique*
The Bore or Lumen

- Injection Pressure
The Bore or Lumen

- Injection pressure was found to directly influence the intensity of pain perceived by patients.
- Pashley et al. revealed that the pressure generated during LA administration had high values:
  - 325-675 PSI


The Lumen (Injection Pressure)

- Injection pressure is created when the plunger of the cartridge is depressed creating a flow of solution into the tissue
- Std. syringe requires the operator to overcome resistance of tissue (back pressure) by applying larger hand force to keep the plunger progressing and maintaining fluid deposition
  - When this process occurs, a narrow bore needle produces jet under pressure
  - Larger bore needles have been found to reduce pain and edema after injection

Diggle: Effect of needle size on immunogenicity and reactogenicity... Br Med J 2006;333:571-578
Hochman: Intersitital tissue pressure associated with dental injections... Quintessence Int 2006;37:469-467.
Complications/Adverse Events
Needle Breakage
Needle Breakage

Table 4
Summary of reports of broken dental needles

<table>
<thead>
<tr>
<th></th>
<th>.. .J</th>
<th>PSA</th>
<th>30-Gauge</th>
<th>27-Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refs. 23-47</td>
<td>15</td>
<td>5</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Pogrel 21</td>
<td>15</td>
<td>1</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Malamed</td>
<td>32</td>
<td>1</td>
<td>33</td>
<td>1</td>
</tr>
<tr>
<td>Reed</td>
<td>17</td>
<td>0</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Manufacture,</td>
<td>n/a</td>
<td>n/a</td>
<td>27</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>79</td>
<td>7</td>
<td>100</td>
<td>5</td>
</tr>
</tbody>
</table>

Prevention of Needle Breakage

- Avoid using smaller-gauge needles (30 gauge and higher)
- Eliminate the practice of administering the standard inferior alveolar nerve block technique with a short needle
- Never advance the needle to a point where the hub is flush with the mucosal surface
- Avoid bending the needle
- Do not produce excessive lateral force during injection
- Exercise caution and vigilance when administering local anesthesia to children, special needs patients, and dental phobic patients
Needle Barbing
Needle Barbing

• The barbing of needles is most often reported with IANB injections.

• Overall, reports of barbing incidence are demonstrated between 30% and 78% of the time with a higher occurrence for injections in which bone is contacted.

Barbing & Needle Design

- A needle with manufacturing defects is more likely to have existing, or easily created, barbing and splintering.
- Creation of the irregularities is related to both the cutting process and the quality of steel being used.
- The ISO (the International Organization for Standardization) is a worldwide organization that provides standards on the type of stainless steel as well as the minimum thickness of steel used in needle manufacturing.


Barbing and Needle Design

- However, a recent study evaluating the most commonly purchased needles found that the homogeneity in the metal alloys did not generally conform to international manufacturing guidelines.
- In addition, the authors concluded that a wide variation between applied standards existed and it appeared that most manufacturers applied their own standards to the manufacturing process.

Selecting a Quality Needle

• The selection of a needle is usually based on the practice of an individual provider and his or her perceptions of the needs a patient population.

• Currently, there is not an universal acceptance of what needle is the best for dental providers to use.
Selecting a Quality Needle

• However, a review of available research does provide the ideal needle characteristics such as: multi-beveled / scalpel-bevel point; a bevel design that is centralized with the long axis of the needle; larger bore needles; silicon coating; appropriate metal alloy used in manufacturing; non-deflecting needle design, and appropriate metal finishing.

• Ultimately, the design should aid the practitioner in providing the most effective and safe anesthetic administration while causing the least amount of pain as possible.
Selecting a Quality Needle

• Overall, the availability of comparative needle studies is limited.
• However, some accord can be ascertained by evaluating the few existing studies available.
Microscopic Assessment

- A recent microscopic assessment of un-used needles evaluated 7 different brands to verify the quality of the bevel zone of each needle.
- The authors concluded that the needles with a good finish are Carpule from the Heraeus Kulzer Company and Terumo from the Terumo Company, while the Septoject needle from the Septodont Company offered the best overall quality.

Sanchez: Microscopic assessment of dental needles. Guardalajara University. 
Microscopic Assessment
OraVerse™

(Phentolamine Mesylate) Injection
0.4 mg/1.7 mL

For Intraoral Submucosal Injection Only.
Usual Dosage; See Package Insert.
Contents: 10 Cartridges
Rx Only
Positive Benefit / Risk

• OraVerse significantly accelerated time to return to normal sensation and function

• Within one hour of injection, 51% of patients undergoing mandibular procedures and 58% patients undergoing maxillary procedures had recovered normal function
  • Only 20% of patients receiving no injection reached this level of normal function
Phentolamine Mesylate - OraVerse®

- Proposed Mechanism of Action
  - Increase vasodilation
  - Increase elimination and clearance
  - Decrease soft tissue effects of local anesthetic deposition
Time to Recovery of Normal Sensation in the Lower Lip

Time to Recovery Maxilla

Lip Sensation Analysis

Clinical Benefit
• Results from CareSouth Carolina Local Anesthetic Complication Study
  
  • After approval from the CareSouth Carolina Clinical Review Board, a prospective survey-based study was performed on 923 consecutive local anesthetic dental care cases

The age range of the survey subjects are 3 to 17 years of age with a mean age of 8.03 ±2.64.

The sex of the patients in the study is fairly distributed with fifty-four percent female and forty-six percent male.

The American Society of Anesthesiologists (ASA) physical status reports as: ASA I: 84.6%; ASA II: 15.3%; and ASA III: 0.1%.

The majority of patients (81.9%) report with no medical history. Of the 18.1% reporting with a medical condition, **asthma** is seen most often, 46.1% (n=167), followed by: attention deficit hyperactivity disorder (ADHD) (22.8%); intellectual and developmental disabilities (IDD) (7.8%); and **Autism spectrum disorder** (6.0%).
• Procedures Represented

• Restorative - 78.7%
• Oral Surgery - 9.9%
• Perio/Preventive 6.5%
• Restor & OMFS 2.4%
• Other 2.5%
### Type of Anesthetic

- ART$_{200}$ 43.9%
- LIDO$_{100}$ 40.4%
- ART$_{100}$ 6.4%
- MEPIV$_{W/O}$ 5.9%
Complication Rate

• CSC Study: 5.3% in pediatric patients
  • All of the complications (n=49) are considered to be mild (73.5%) or moderate (26.5%); there are no reports of severe events.
• German Study (Daublander et al): Complication rate 4.5% in adults
• Other studies very rarely report overall complication rate; most likely focus on specific complication (varied reports: 4-18%)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Occurrences (n=49)</th>
<th>Overall Occurrence Rate (n=923)</th>
<th>Anesthetic Reported Most Often</th>
<th>Mean Amount of Anesthetic Deposited per Report</th>
<th>Mean Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self Inflicted Injury - Lip Bite</td>
<td>18</td>
<td>1.95%</td>
<td>LIDO (11)</td>
<td>0.98 ± 0.56</td>
<td>7.77 ± 2.66</td>
</tr>
<tr>
<td>Self Inflicted Injury – Cheek Bite</td>
<td>8</td>
<td>0.87%</td>
<td>ART200 (4)</td>
<td>1.40 ± 0.81</td>
<td>5.25 ± 0.89</td>
</tr>
<tr>
<td>Self Inflicted Injury – Tongue Bite</td>
<td>2</td>
<td>0.22%</td>
<td>LIDO (1) ART200 (1)</td>
<td>0.75 ± 0.81</td>
<td>7.50 ± 3.53</td>
</tr>
<tr>
<td>Re-administration / Inadequate Anesthesia</td>
<td>11</td>
<td>1.19%</td>
<td>LIDO (10)</td>
<td>2.05 ± 1.36</td>
<td>9.36 ± 2.29</td>
</tr>
<tr>
<td>Trismus</td>
<td>3</td>
<td>0.32%</td>
<td>LIDO (3)</td>
<td>1.00 ± 0.25</td>
<td>13.3 ± 2.31</td>
</tr>
<tr>
<td>Pain at Injection Site</td>
<td>3</td>
<td>0.32%</td>
<td>LIDO (3)</td>
<td>0.83 ± 0.28</td>
<td>11.0 ± 1.00</td>
</tr>
<tr>
<td>Prolonged Anesthesia</td>
<td>1</td>
<td>0.11%</td>
<td>LIDO</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Undesired Nerve Block</td>
<td>1</td>
<td>0.11%</td>
<td>ART200</td>
<td>0.75</td>
<td>8</td>
</tr>
<tr>
<td>Hematoma</td>
<td>1</td>
<td>0.11%</td>
<td>LIDO &amp; ART200</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Bleeding Related to Anesthesia Administration</td>
<td>1</td>
<td>0.11%</td>
<td>LIDO</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>
Moderate Complications

• Analysis of the moderate complications (n=13) reveals that the majority of these reports are self inflicted soft tissue injuries (lip bite-10; tongue bite-1; and cheek bite-1).

• The other moderate complication is a prolonged anesthesia following the administration of Lidocaine 2%, with 1:100,000 epinephrine for an IANB. [10 hours]
Moderate Complications

- Overall, events reported as moderate complications are associated with a mean age of 6.15 ±1.78 years of age;
- Most likely involved an IANB injection, and
- Were doubtfully administered phentolamine mesylate.
- Required additional active chair time.
• The complication rate with the group administered PM is 2.6%, 10 reports.
  • It should be noted that 6 additional complication reports with the PM group are associated with the re-administration of anesthetic/ineffective anesthesia prior to PM administration.
• The incidence of complications for the group administered phentolamine mesylate (2.6%) is lower than that seen with the overall study population (5.3%) and the group not administered PM (6.1%).
• Self inflicted soft tissue injury is more likely reported in the group not administered PM with 25 of the 28 (89.3%) total soft tissue injury reports.

• It should also be noted that the three cases of trismus (0.33%; n=923) involves the administration of PM.
  • All reported as mild
  • Risks versus benefits
ADHD and Complication Rate

• Evaluation of the medical history and complication occurrence demonstrates that patients with ADHD are more likely than other patients to have a complication occur.

• Additionally, ten of the twenty eight (35.7%) self inflicted soft tissue injury reports included ADHD in their medical history documentation.
Obesity and Complication Rate

- Of the 49 complication reports, overweight or obese children are included in 23 complications.
- The majority of these reports include self inflicted soft tissue injury, trismus, and the need for re-administration of local anesthetic.
  - Obesity is often reported as a potential complicating factor in dentistry.
  - The quantity of adipose tissue in the oral cavity can obscure anatomical landmarks that are essential for accurate administration of local anesthetics and decrease field of view for dental providers administering care.

Academic Impact Analysis

• Questionnaires distributed to 225 teachers located in schools serviced by CSCDM yielded a response of 167 (74.2%) returned forms.

• The teacher’s response revealed that children administered local anesthetics for comprehensive care within the CSCDM school based portable program are not disruptive to class (1.34 sd±1.14 on a ten point numerical scale) nor distracted in their ability to reorient to class work (1.48 sd±1.47 on a ten point numerical scale).
Dental Providers

- Analysis of complication rate difference between providers (dentists or local anesthesia certified dental hygienist) administering the anesthetic revealed no statistically different values.
The Role of Topical Anesthetics

• Benefits:
  • Minimizing apprehension
  • Managing injection discomfort
  • Decreasing need for injections
Common Topical Agents

• Lidocaine
• Benzocaine
• Tetracaine
• Dyclonine Hydrochloride
  • Non ester, non amide, ketone topical
  • Found in some OTC sore throat lozenges and sprays
OTC Benzocaine Topical Anesthetics
• Topical benzocaine marketed in 10% and 20% formulations
  • Regular/maximum strength
• FDA concluded that available data not adequate to establish the effectiveness of benzocaine as a “external analgesic/anesthetic for the temporary relief of pain due to minor irritation of mouth and gums, minor dental procedures..., sore mouth and sore throat”

Notice of proposed rulemaking for OTC oral health care products amendment to include relief of oral discomfort products [Docket #81N-0033]. Fed Reg 1991; 5:48302-48347.
• Hersh et al., 2013

• Compare efficacy and tolerability of 10% and 20% benzocaine gels compared to vehicle gel and assess compliance with dosing directions of new manufacturer label

_Hersh et al._ An evaluation of 10 percent and 20 percent benzocaine gels in patients with acute toothaches: efficacy, tolerability and compliance with label dose administration directions. _J Am Dent Assoc._ 2013; 144:517-526
• Results demonstrate primary efficacy endpoint of percentage of responders both 10% and 20% ‘B-gels’ were more efficient than vehicle
• 20% was significantly more efficacious than 10% for reducing tooth pain
• 20% with quicker onset of relief
• Polyethylene glycol (Hersh et al, 2005)
  • Added as solvent to aid water solubility
Methemoglobinemia & Benzocaine

• FDA recently issued a warning to general public on the ability of OTC benzocaine products to produce methemoglobinemia on rare occasions
Methemoglobinemia

1. Methemoglobinemia: increased quantities of hemoglobin with iron oxidized to the ferric form (Fe$^{3+}$).
2. High concentrations appear chocolate brown.
3. Normal levels 0-2%, Cyanosis 10-30%, Lethargy and Respiratory distress 30-60%, Death >70%.
4. Acquired: NADH cytochrome $b_5$ reductase deficiency.
5. Induced: nitrates, sulfonamides, tetracaine, benzocaine or prilocaine.
6. Prilocaine’s primary metabolite, ortho-toluidine, induces methemoglobinemia.
7. Treatment: Oxygen and methylene blue 1-2 mg/kg i.v. infusion.
FDA Warning - 2011

• The agency updated a product warning in April 2011 and remains particularly concerned about the use of OTC benzocaine products in children for relief of pain from teething.

• “This concern is fueled by the serious potential outcomes and the difficulty parents may have recognizing the signs and symptoms of methemoglobinemia when using these products at home. These symptoms may not always be evident or attributed to the condition.

• For these reasons, FDA recommends that parents and caregivers not use benzocaine products for children younger than 2 years, except under the advice and supervision of a health care professional.”

• [http://www.fda.gov/forconsumers/consumerupdates/ucm306062.htm](http://www.fda.gov/forconsumers/consumerupdates/ucm306062.htm)
Topical Anesthetic Toxicity

• Topical anesthetics are widely accepted and have a remarkable record of safety
• Adverse events usually associated with excessive dose
• MRDs for many topical anesthetics do not exist
• Difficulty determining how much was dispensed or absorbed

Bassett KB. Local Anesthesia for Dental Professionals. Pearson; 2010
Topical Anesthetic Toxicity

- Factors that affect topical anesthetic toxicity:
  - Concentration
  - Ability to penetrate tissue
  - Speed of systemic absorption
  - Total area of coverage (esp. with sprays)
  - Broken skin, inflamed/damaged mucosa, diseased periodontal pockets – exposed blood vessels
  - Compounded drugs created by commercial pharmacies

Bassett KB, et al. Local Anesthesia for Dental Professionals. Pearson; 2010
Compounding Topical Anesthetics

• Compounding legitimate use is intended for a single situation with a single patient [the FDA Modernization Act of 1997]

• Outside the guidelines
  • When using agents within a significant portion of their practice population
  • Maintaining a bulk supply of agent
  • Not following appropriate prescription guidelines and protocols


Combining Topical Anesthetics

• Some topical anesthetics formulated to create faster onset time and longer duration of action

• Optimize clinical use
  • Eutectic Mixtures
  • Combination topical anesthetics
Cetacaine
• The most common adverse reaction caused by local anesthetics is contact dermatitis characterized by erythema and pruritus that may progress to vesiculation and oozing.
  • This occurs most commonly in patients following prolonged self-medication, which is contraindicated.
• Cetacaine may not be right for everyone including those who are hypersensitive to any of its ingredients or are known to have cholinesterase deficiencies.
Topical Subgingival Application

Cetacaine® Liquid Clinical Kit

• Use only as much product as needed, up to 0.4 ml maximum dose
  • Estimate 0.1 ml per quadrant, on average
  • 30g bottle yields up to 300 quadrant applications
Topical Subgingival Application

- Microcapillary tip facilitates subgingival delivery

- Pleasant artificial banana flavor
## Comparing the two “combo” systems

<table>
<thead>
<tr>
<th>Onset Time</th>
<th>Duration of Action</th>
<th>Dose Packaging</th>
<th>Flavoring</th>
<th>Cost per Quadrant</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 secs</td>
<td>20 mins</td>
<td>Contained to 1.7 ml</td>
<td>None</td>
<td>5.00</td>
</tr>
<tr>
<td>30 secs</td>
<td>30-60 mins</td>
<td>Flexible to amount needed</td>
<td>Banana</td>
<td>0.50</td>
</tr>
</tbody>
</table>
Kovacaine® Mist Nasal Spray

- Currently in Development and Research
- Local anesthetic administered intranasally to provide profound pulpal anesthesia from #4 to #13
- 3% tetracaine and oxymetazoline
  (Afrin nasal spray)
Intranasal Administration

• The authors evaluated the cardiovascular effects and pharmacokinetics of an intranasal 3 percent tetracaine/0.05 percent oxymetazoline spray developed to provide needle-free anesthesia of maxillary teeth.

• Conclusion: Intranasal tetracaine /oxymetazoline mist generally was well tolerated in study participants.

Intranasal Administration

• Still in research development
• Business Report (*medtech insight*)
  • “At a price per dose of just $20,
  • The U.S. annual market revenue potential for Kovacaine Mist nasal spray dental anesthesia is about $2.1 billion.
  • Most new dental products expect market penetration of between 5 and 20 percent.”

Trahan R. Renatus to showcase world’s first needle free option to dental anesthesia via injection, at In³ [Accessed July 31, 2012.]

Buffering Dental Local Anesthetics

- Buffering is the addition of a chemical agent to a solution which increases its pH (to the body’s normal pH)
  - Decreases pain on injection
  - Possible catalytic effect of CO2
• Decreases Pain on Injection
  • Meta Analysis
    • Review of 12 published abstracts: 609 observations for buffered local anesthetic and 615 for unbuffered local anesthetic.
      • Buffered local anesthetic resulted in a statistically lower weighted mean difference in visual analog scale compared with unbuffered local anesthetic.
    • 63 publications, of these, 22 were human prospective randomized controlled trials directly assessing the pain of infiltration. Three papers were based on observations.
      • The evidence is that buffering with sodium bicarbonate significantly reduces the pain of local anesthetic injection.

Buffering- Catalytic Effect

- Sodium bicarbonate interacts with the hydrochloric acid to create water and CO2
- CO2 with lidocaine **HCL** potentiates the action of lidocaine
  - Depressed effect of axon by CO2
  - Concentrate anesthetic inside nerve trunk
  - Changes the anesthetic charge inside nerve trunk

Application in Dentistry

• Some studies present faster onset times and decrease in pain on injection that are dentistry specific.\textsuperscript{1-2}
• Some studies report no effect with buffering dental local anesthetics\textsuperscript{3}

\textit{Evaluation of these publications Reveals a Large Variable}

• Variation in injection technique
  • Improvement with procaine
• Accuracy of injection\textsuperscript{4}

New Study on Onset Time

- Malamed et al. - 2013
  - Onset from OnPharma
  - N=20 with IANB injection [LIDOCAINE ONLY]
    - Self report and EPT
  - 71% with pulpal effect in 2 min or less with buffering versus 12% without
  - Average time to pulpal analgesia 6.37 minutes without buffering versus 1.51 minutes with buffering

Malamed et al. Faster onset and more comfortable injection with alkalinized 2% lidocaine with epinephrine 1:100,000. Compendium 2013; 34:10-20.
Questions?????