Outline:

1- Definitions

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3- Mechanism of action of LA

4- Complications of LA

5- Failure of LA

6- Management of LA failure

Local anesthesia in Endodontics

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Dr. Ahmad El-Ma'aita

BDS, MSc, PhD, MEndo RCSEd

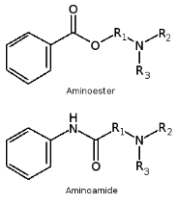
Local anesthetics:

a) Amino-esters: Procaine, Benzocaine, Cocaine

Metabolized in plasma by the enzyme pseudocholinesterase

b) Amino-amides: Lidocaine, Articaine, Prilocaine, Mepivacaine, Bupivacaine

Metabolized in liver excreted in the kidneys



Definitions:

Pain: "An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (*International association for the study of pain IASP*)

Effective local anesthesia is the bedrock of pain control in endodontics.

Localized loss of pain sensation should be referred to as "local analgesia" as opposed to local anesthesia which implies the loss of all sensation including touch, pressure, temperature and pain

Mechanism of action of LA:

At least nine subtypes of voltage-gated sodium channels (VGSCs)

VGSCs can be broadly divided into:

- Tetrodotoxin (TTX): channels that are blocked by a toxin (eg: local anesthetic)
- TTX-R: those that are resistant to the toxin and found primarily on nociceptors

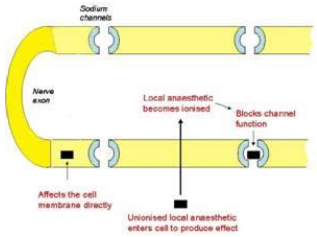
VGSCs consist of an alpha and a beta subunit. The alpha subunit serves as a voltage sensor, leading to channel activation and sodium ion passage when the channel detects an electrical field.

The biologic basis for an electrical pulp tester, therefore, is the generation of a small electrical field across the dental pulp that can activate VGSCs.

Mechanism of action of LA:

LA block sodium channels by partitioning into two types:

- The uncharged (basic) form which crosses cell membranes
- The charged (acid) form which binds to the inner pore of the sodium channel.



Effects of systemic disease on LA selection:

a) Several systemic disorders may require modification of LA dosage

Patients with the following conditions :

- Unstable angina pectoris
- Hx of MI or stroke within the past 6 months
- Severe hypertension
- Uncontrolled congestive heart failure
- Heart transplant

should not receive a local anesthetic containing a vasoconstrictor and should consult their physicians before undergoing endodontic treatment.

Mechanism of action of LA:

Sensitization of TTX-R channels by prostaglandins lowers the activation threshold and increases the amount of sodium ions that flow through the channel.

This may explain the increased responsiveness to electrical pulp testing seen in patients with irreversible pulpitis

Effects of systemic disease or conditions on LA selection:

c) Pregnancy:

Any of the commonly available local anesthetics are safe for use in pregnant or lactating patients.

The most important aspect of care with pregnant patients is to eliminate the source of pain by performing the indicated endodontic treatment because this reduces the need for systemic medications.

Issues with felypressin as a vasoconstrictor.

Effects of systemic disease or conditions on LA selection:

b) Alcoholism:

Several clinicians have reported that alcoholics appear to be more resistant to local anesthetics. However, in a comparison of pulpal responsiveness to electrical stimulation of a maxillary lateral incisor, no differences were noted between recovering alcoholics (mean 113 days in recovery) and age- and gender-matched controls.

Complications of LA:

1- Psychogenic: vasovagal attack

Effects of systemic disease or conditions on LA selection:

d) Interaction with other medications:

A thorough review of the medical history is an absolute requirement.

Potential drug-drug interactions occur primarily with the vasoconstrictors in local anesthetic formulations therefore judicious use of local anesthetic solutions without vasoconstrictors (e.g: 3% mepivacaine) is a reasonable alternative.

Complications of LA:

2- Toxicity (over-dose):

Overdosage is related to the plasma levels of LA which is affected by:

- Patient's age, weight, and state of health
- Other medication taken: TCA, phenytoin… can reduce the plasma proteins available for binding: increased levels of LA in plasma
- Speed of injection
- Intravascular injection

Complications of LA:

2- Toxicity (over-dose):

Often is the result of inadvertent IV administration or of a cumulative large dose (e.g., repeated injections)

Light headedness, excitability, circumoral paraesthesia and muscle twitching

More serious signs include: convulsions, loss of consciousness, respiratory depression and cardiovascular collapse.

Although systemic effects from LA are rare, they can include:

An initial excitatory phase:

Muscle twitching, tremors, grand mal convulsions

A subsequent depressive phase:

Sedation, hypotension and respiratory arrest

Complications of LA:

3- Intra-muscular injection:

May result in:

- Temporary and reversible myotoxicity
- Trismus and Hematoma:

  Adrenergic receptors in the tissues are of alpha type which responds to adrenaline by vasoconstriction. However in skeletal muscles the receptors are of B type which results in vasodilatation

Complications of LA:

2- Toxicity (over-dose):

Moore's rule of 25:

It is generally safe to use one cartridge of local anesthetic for every 25 pounds (11.25kg) of patient weight).

Complications of LA:

5- Facial palsy:

- Injection too deep into the Parotid gland.
- Temporary facial paralysis
- Eye coverage is mandatory

Complications of LA:

4- Temporary or permanent nerve damage

Articaine was shown to be associated with a five-fold higher incidence of paresthesia compared with Lidocaine.

Complications of LA:

7- Cardiovascular reactions:

Tachycardia after injection is not uncommon as a result of alpha adrenoceptor stimulation by systemic distribution of the vasoconstrictor throughout the vascular compartment.

The patient may also report heart palpitations associated with anxiety or fear and may experience transient tachycardia and changes in blood pressure.

To reduce this risk, the clinician should

- Always aspirate before making the injection
- Inject slowly
- Use dosages within accepted guidelines

Complications of LA:

6- Allergic reaction:

- True hypersensitivity to LA is extremely rare (<1% of reactions)
- Other components (preservatives) can cause allergic reactions
- Higher risk in the ester group than the amide
- The amide local anesthetics appear to have little immunogenicity and therefore have an extremely low rate of allergic reactions

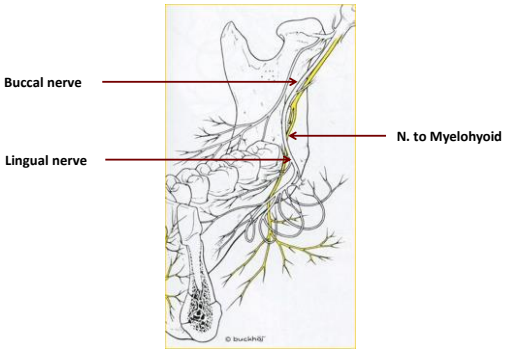
Local anesthetic failure:

- IDB are successful in 75-90% of the time in patients with normal healthy pulps.
- In patients with irreversible pulpitis: success rate is 20- 70% (8-fold failure rate)

Methods of confirming anesthesia:

- Asking the patient "Is your lip numb?"
- Soft-tissue testing
- By applying a cold refrigerant or by using an electric pulp tester
- Simply beginning treatment

b- Accessory innervation: N. to Myelohyoid??

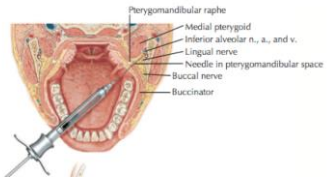


Hypotheses for local anesthesia failure:

1- Anatomic factors:

a- Difficult technique: inadequate amount of LA is deposited in close proximity to the IAN.

This can result in partial blockade which can be sufficient for healthy uninflammed pulps and the A-α fibers but not the inflamed C-fibers.



Hypotheses for local anesthesia failure:

2- Effect of inflammation on:

2.a) Local tissue pH

- Tissue pH does not equally ion-trap LA agents as they differ in their pKa.
- Mepivacaine has a lower pKa value and therefore less susceptible to ion trapping. Therefore more effective in endodontic pain
- Tissue pH adjustment may augment clinical anesthesia. Alkalinazation is done with sodium bicarbonate

Against this theory:

Injection site is distant to the inflamed site in IANB

Tissue acidosis is only minor in magnitude.

Inflammed tissues have a greater buffering capacity

Hypotheses for local anesthesia failure:

2- Effect of inflammation on:

2.a) Local tissue pH

- Local anesthetic agents are preserved in ionic form (acidic pH 3-4). Once injectded, the tissue pH and the drug pKa determine the distribution of the LA between the acid and base forms according to the Henderson-Hasselbalch equation: pKa – pH = Log (base/acid).
- The uncharged (basic) proportion of the drug is what is available to diffuse across the cell membrane. Once inside the cell, the drug repartitions into acid and base forms and the acid form is what blocks the sodium channels.
- Inflammation-induced tissue acidosis can cause ion-trapping in LA (i.e: trapped in the charged (acidic) ionic form, therefore unable to cross cell membranes.

Hypotheses for local anesthesia failure:

2.c- Activation of the LA resistant sodium channels (TTX- resistant):

Inflammation evokes an increase in the anesthetic-resistant subpopulation of sodium channels that exist on pain neurons.

This results in a barrage of electrical signals from the peripheral nerves.

Hypotheses for local anesthesia failure:

2.b-Effect of inflammation on blood flow:

Peripheral vasodilatation induced by inflammatory mediators would reduce the concentrations of LA by increasing absorption rate.

Based on this theory, the use of adrenaline 1:50,000 should be more effective in endodontic pain patients.

Hypotheses for local anesthesia failure:

2.e- Effect of inflammation on central sensitization:

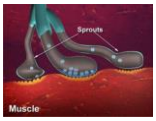
The afferent barrage of impulses sent to the Trigeminal nucleus and brain results in central sensitization (hyperexcitability of central neurons)

Hypotheses for local anesthesia failure:

2.d- Effect of inflammation on nociceptors:

Inflammatory mediators (eg: Bradykinin, and PGE_2) **activate** and **sensitize** nociceptors neurons.

- Nerve terminals sprout into areas of inflammation which increases the receptive field.
- Activation of the dormant TTX-resistant sodium channels
- PGE2 and bradykinin reduce the threshold for firing of the nociceptive neurons.
- This results in a barrage of neuronal impluses



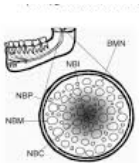
Hypotheses for local anesthesia failure:

4- The core theory:

Mandibular molars are innervated by the peripheral fibers of the IAN while the premolars and anterior teeth from the core.

Local anesthetic administration may not penetrate the IAN deep enough to anesthetize the core fibers.

Only explains failure of LA in ant and premolar teeth.



Hypotheses for local anesthesia failure:

3- Tachyphylaxis of LA

Administration of receptor agonist drugs often lead to reduced responsiveness to a subsequent administration of the drug.

No evidence from clinical studies

Chronic pain patients are treated with multiple administrations of LA over many years. Yet no tachyphylaxis cases have been reported.

Managing local anesthetic failure:

i) Identify patients who are likely to pose such a problem:

1- signs and symptoms of irreversible pulpitis

2- History of experiencing inadequate LA

3- High level of anxiety

Hypotheses for local anesthesia failure:

5- Psychological factors:

Anxious and apprehensive patients have reduced pain thresholds

Managing local anesthetic failure:

3- Deliver the 2nd LA cartridge higher in the pterygomandibular space:

Gow-Gates,

Varizani-Akinosi

in order to:

- Increase the length of the exposed IAN
- Block the N. to Myelohyoid

Managing local anesthetic failure:

ii) Use supplemental LA:

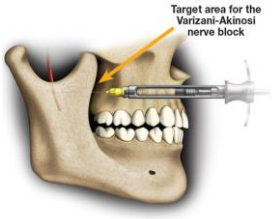
1- Increase the dose:

Exposes a greater length of the IAN

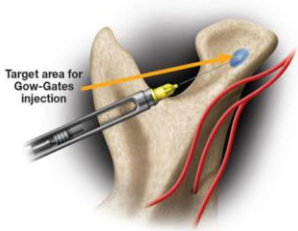
2- Use anesthetic with a lower pKA:

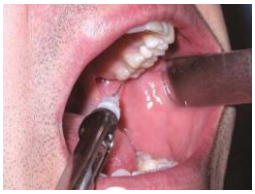
Eg: 3% Mepivacaine to decrease the potential for ion trapping

The Akinosi-Varizani technique:

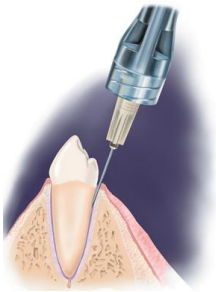


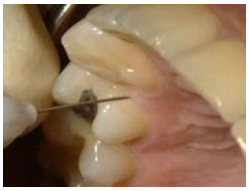
The Gow-Gates technique:

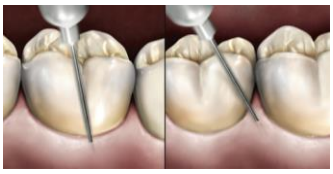




Intra-ligamentary injection:







Managing local anesthetic failure:

4- Use different routes:

- Intra-ligamentary
- Intra-osseous
- Intra-pulpal
- Buccal/ lingual infiltration

The intra-osseous route:

Delivers a local anesthetic solution directly into the cancellous bone adjacent to the tooth to be anesthetized.

Immediate onset but short duration.

Two intraosseous systems have been studied clinically:

- The Stabident system (Fairfax Dental, Miami, FL)
- The X-tip system (Dentsply, York, PA).

The Wand:

A computer-assisted LA delivery system can be used to administer intraligamentary injections.

Accommodates a standard local anesthetic cartridge that is linked by sterile microtubing to a disposable, penlike handpiece with a Luer-Lok needle.

The device is activated by a foot control, which automates the infusion of LA solution at a controlled rate (fast: 1.4 ml/min, slow: 1.4 ml/ 4 min 45 sec)

The slow rate is used for the intraligamentary injection.

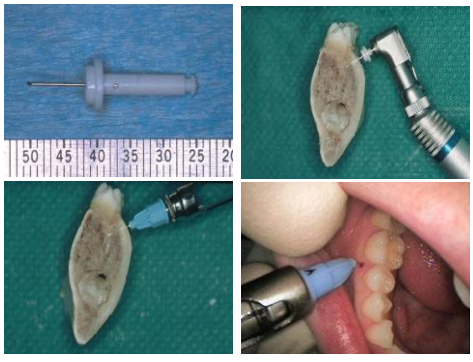
The intra-osseous route:

The Stabident system is composed of:

- A slow-speed handpiece-driven perforator: a solid 27-gauge wire with a beveled end that drills a small hole through the cortical plate.
- The injector needle: placed into the hole made by the perforator to deliver the LA solution directly into the cancellous bone.

The Alternative Stabident system uses a funnel-shaped guide sleeve, which is placed in the perforation site manually after the perforation has been made to facilitate needle placement.

The Stabident system:



The intra-pulpal route:

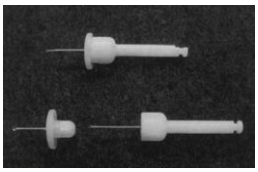
In about 5% to 10% of mandibular posterior teeth with irreversible pulpitis, supplemental injections, even when repeated, do not produce profound anesthesia and pain persists when the pulp is entered.

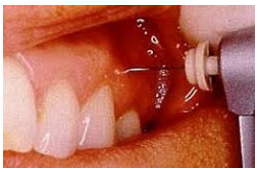
This is an indication for an intra-pulpal injection

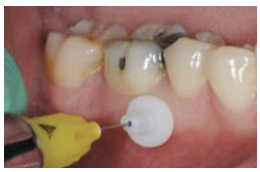
Drawbacks:

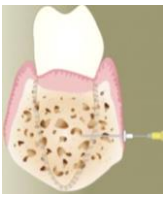
- Can be severely painful. should be given only after all other supplemental techniques have failed.
- Short duration of pulpal anesthesia.
- The pulp must be exposed to allow direct injection.

The X-tip system:









In the *Journal of Endodontics,* Miles a dentally trained neurophysiologist who needed endodontic treatment, reported intense pain when the intrapulpal injection was administered. He reported that although it was successful, success was achieved at a price. He stated that he felt a diminished confidence in the endodontist and increased apprehension

The intra-pulpal route:

Advantages:

- Produces profound anesthesia if given under back-pressure.
- The onset of anesthesia is immediate
- No special syringes or needles are required.

Depositing the anesthetic solution passively into the chamber is insufficient because the solution will not diffuse throughout the pulp

Managing local anesthetic failure:

iii) Use adjunctive drugs and techniques:

The 2 main events in LA failure seem to be:

- The effects of inflammation on peripheral nociceptors.
- The central nervous system processing of pain signals.

Therefore:

1- Use anti-inflammatory drugs: NSAIDs, steroids

2- Reduce anxiety:

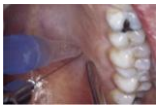
- Caring manner and confident approach
- Sublingual trizolam (oral sedation)
- Nitrous oxide (inhalation sedation)

Topical anesthesia:

Indicated for desensitizing the mucosa to needle pricks before local infiltration

Lidocaine (5% ointment, 10% spray), Benzocaine (7.5-20% gel), ice?

Positive psychologic effect on the patient??



Thank you!