

The background is split into two vertical sections. The left section features a blurred, colorful waveform in shades of green and purple, overlaid with a black circuit board pattern of lines and nodes. The right section is a solid teal color with a white circuit board pattern in the corners.

# **FEELING IT!** **TROUBLESHOOTING IN LOCAL ANAESTHESIA**

ONTARIO DENTAL ASSOCIATION ASM 2024

PETER NKANSAH

*Handbook of*

**LOCAL ANESTHESIA**

SEVENTH EDITION

**STANLEY F. MALAMED**

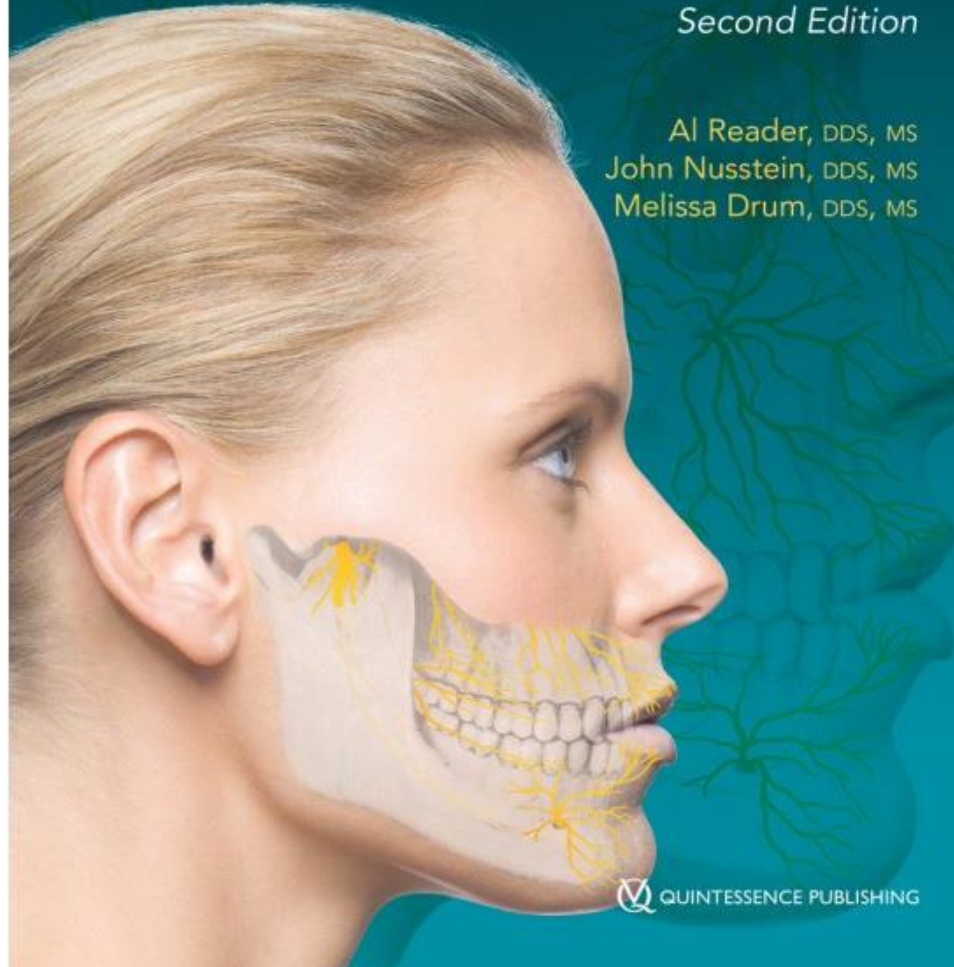
ELSEVIER

# Successful Local Anesthesia

FOR RESTORATIVE DENTISTRY AND ENDODONTICS

*Second Edition*

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John Nusstein, DDS, MS  
Melissa Drum, DDS, MS



 QUINTESSENCE PUBLISHING

# 7 THEORIES OF PAIN

Intensity Theory

Cartesian  
Dualistic Theory

Bell's Specificity  
Theory

Pattern Theory

Melzack and  
Wall's Gate  
Control Theory

Melzack's  
Neuromatrix  
Theory

Biopsychosocial  
Theory

REF.: M MOAYEDI AND KD DAVIS, J NEUROPHYSIOL, 109: 5–12, 2013;  
LA TRACHSEL *ET AL.*, STATPEARLS [INTERNET], APRIL 2023

3

Thoughts, feelings and beliefs change the pain signals into the individual's experience of "PAIN".

Prefrontal Cortex

**PAIN**

Somatosensory Cortex

Insular Cortex

Anterior Cingulate Cortex

Thalamus

Amygdala

Psychological Treatments

1

Painful Stimuli or tissue damage activate specialized nerve cells (nociceptors), which in turn send pain signals to the spinal cord.



4

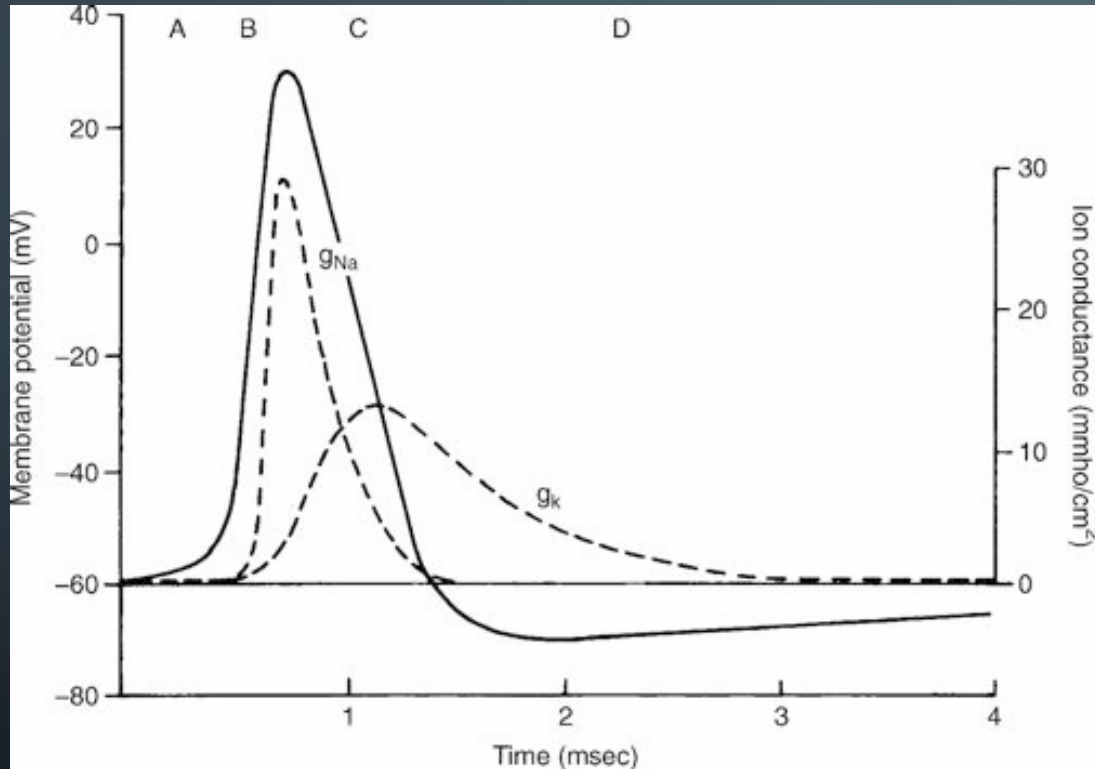
Certain parts of the brain generate signals that travel back down the spinal cord to reduce or increase pain signals at the interneuron.



2

Pain signals enter the dorsal horn of the spinal cord, where some are increased or decreased by the interneuron before continuing up to the brain.

# ACTION POTENTIALS



- A. Resting state ( $\text{Na}^+$  channels are closed)
- B. **Depolarization** phase ( $\text{Na}^+$  channels open )
- C. **Repolarization** phase ( $\text{Na}^+$  channels inactivated)
  - The nerve is refractory to stimulation
  - This is when local anaesthetics act
- D. Recovery phase ( $\text{Na}^+$  channels convert from inactivated to resting state)
  - The nerve regains its ability to transmit messages

# NOT ALL NERVES ARE CREATED EQUAL

- Nerve fibres categorize into three size groups:
  - **A fibres** – large and responsible for sensations of pressure and motor function
    - **A-delta** fibres carry information related to temperature and pain
  - **B fibres** – medium-sized, myelinated
  - **C fibres** – small, unmyelinated, transmit sensations of temperature, itch, and pain
    - Easiest fibres to block with local anaesthetics

# PURPOSE OF LOCAL ANAESTHETICS

- To stop the generation and conduction of nerve impulses
- To abort impulses from stimuli
- To decrease postoperative pain



# PK<sub>A</sub> OF LOCAL ANAESTHETICS

	pK <sub>a</sub>	% base at pH 7.4	Time to onset (min)
Mepivacaine	7.6	40	2-4
Articaine	7.8	29	2-4
Lidocaine	7.9	25	2-4
Prilocaine	7.9	25	2-4
Bupivacaine	8.1	18	5-8
Procaine	9.1	2	14-18

The image features a light blue gradient background with decorative circuit-like lines in the corners. These lines consist of straight segments and small circles, resembling a printed circuit board layout. The lines are positioned in the top-left, top-right, bottom-left, and bottom-right corners, framing the central text.

**COMFORTABLY NUMB?**



**GRADE "A" ANAESTHESIA**

**GRADE "B" ANAESTHESIA**

**GRADE "C" ANAESTHESIA**

**NB: TEST WITH COLD**



# REASONS FOR FAILURE

- Incorrect technique
- Practitioner impatience
- Intravascular injection
- Anatomical variability
- Accessory innervation
  - Including cross innervation
- Patient anxiety/perception
- Inflamed tissue
  - Increased circulation, ion trapping, nociceptor hypersensitivity
- Pre-operative pain
  - Activation of nociceptors/pain pathways/central sensitization
- Tetrodotoxin-resistant nerve fibres

# WHERE BLOCKS FAIL (MOST)

- Mandibular molars
- Areas with inflammation



**GOW-GATES  
MANDIBULAR BLOCK**

# GOW-GATES

## Indications:

- Work requiring numbness in the mandibular arch distal to the second premolar
- Best option if there is a history of failure and/or accessory innervation

## Objective:

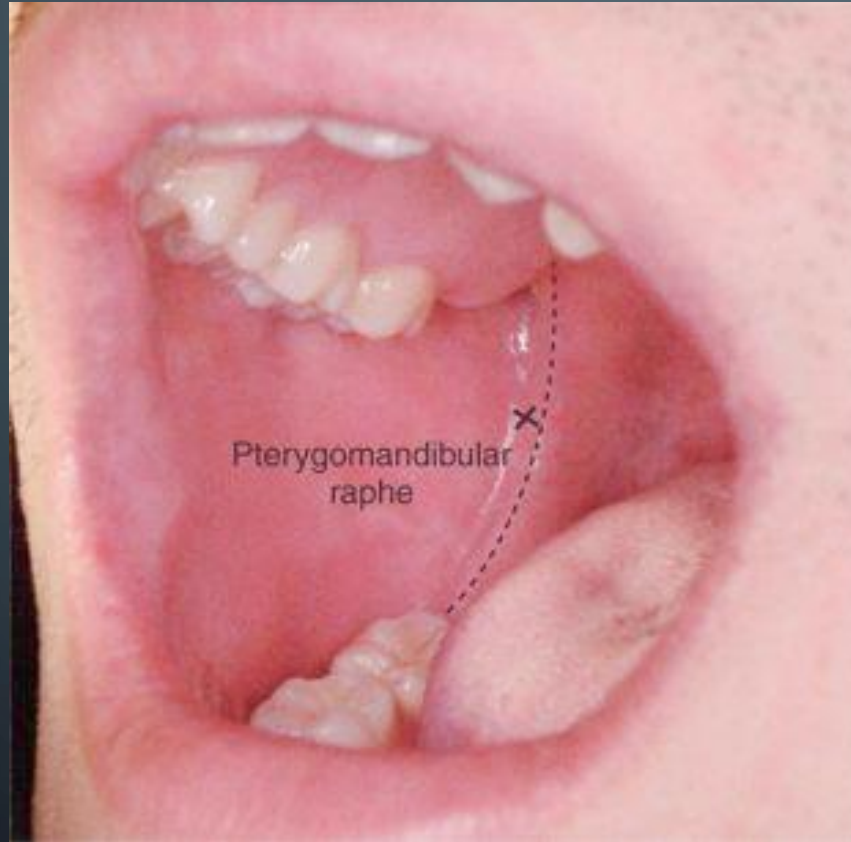
- Place needle tip anterior to the neck of condyle while the condylar neck is close to V3

# SHOULD ANAESTHETIZE:

- Mandibular teeth to midline
- Hard and soft tissue of buccal and lingual mandible
- Lower lip
- Anterior two-thirds of tongue
- Floor of mouth
- Skin over zygoma
- Posterior aspect of cheek and temporal region on the side of injection
- *Inject a full cartridge (maybe more)*

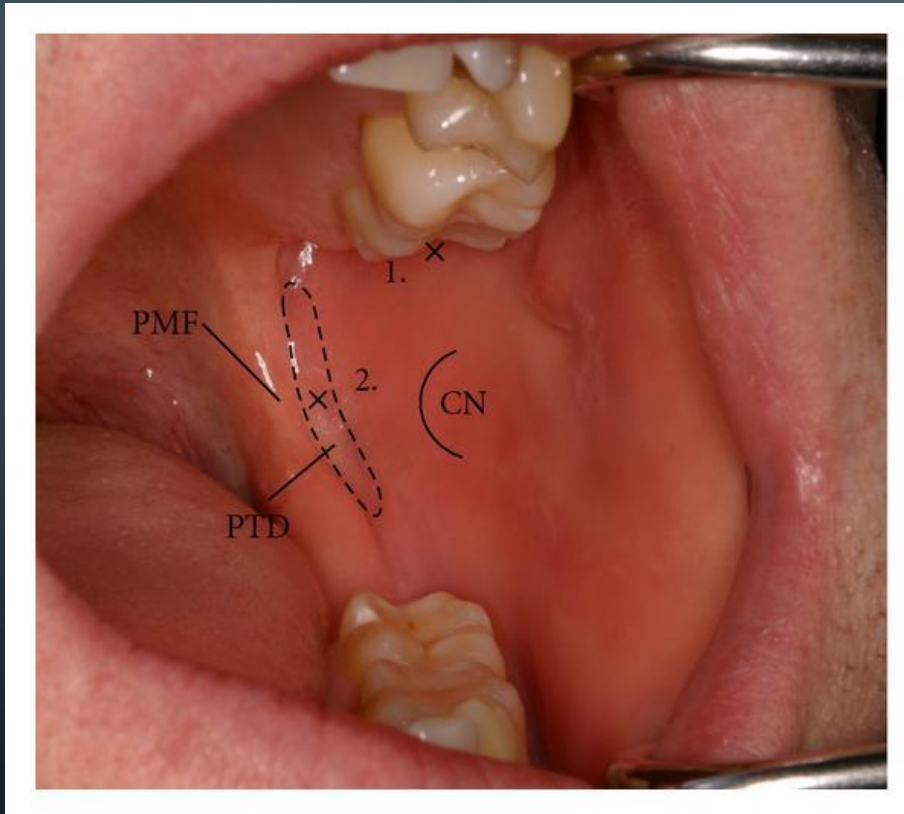


# INTRAORAL VIEW: PTERYGOMANDIBULAR DEPRESSION



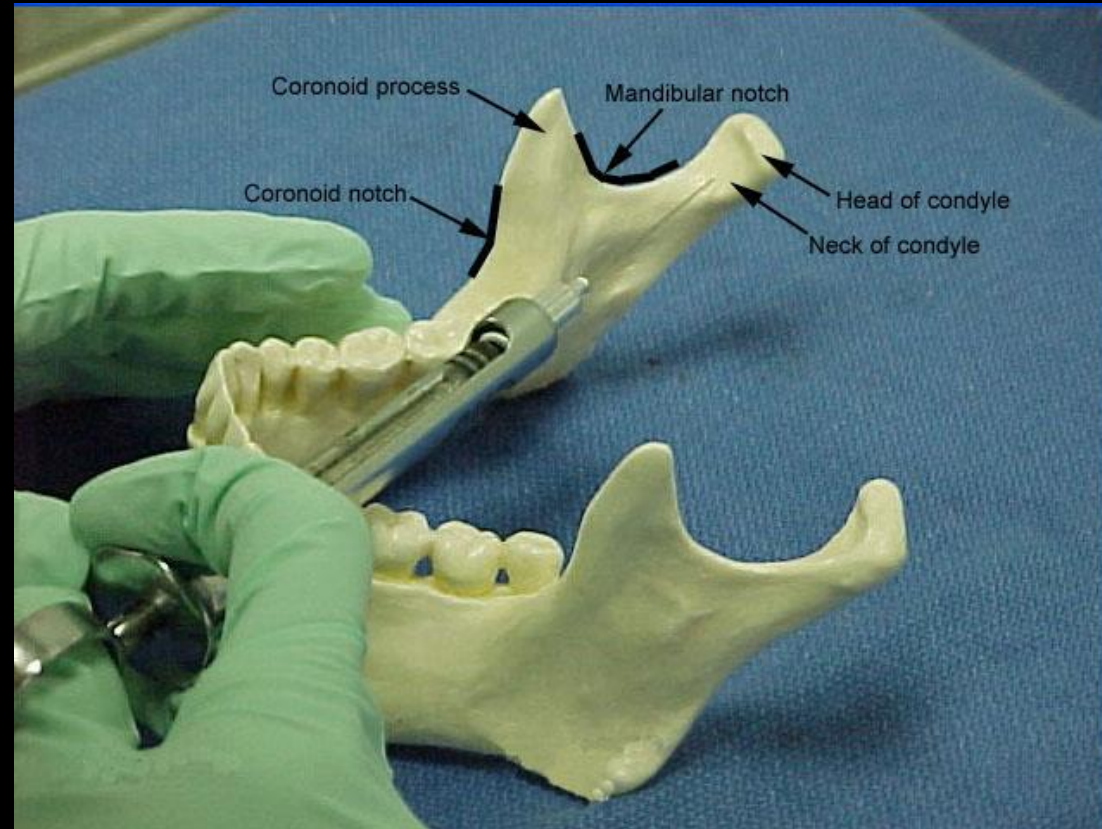
THE MAIN VISUAL LANDMARK IS THE PTERYGOMANDIBULAR RAPHE

# INTRAORAL VIEW: PTERYGOMANDIBULAR DEPRESSION



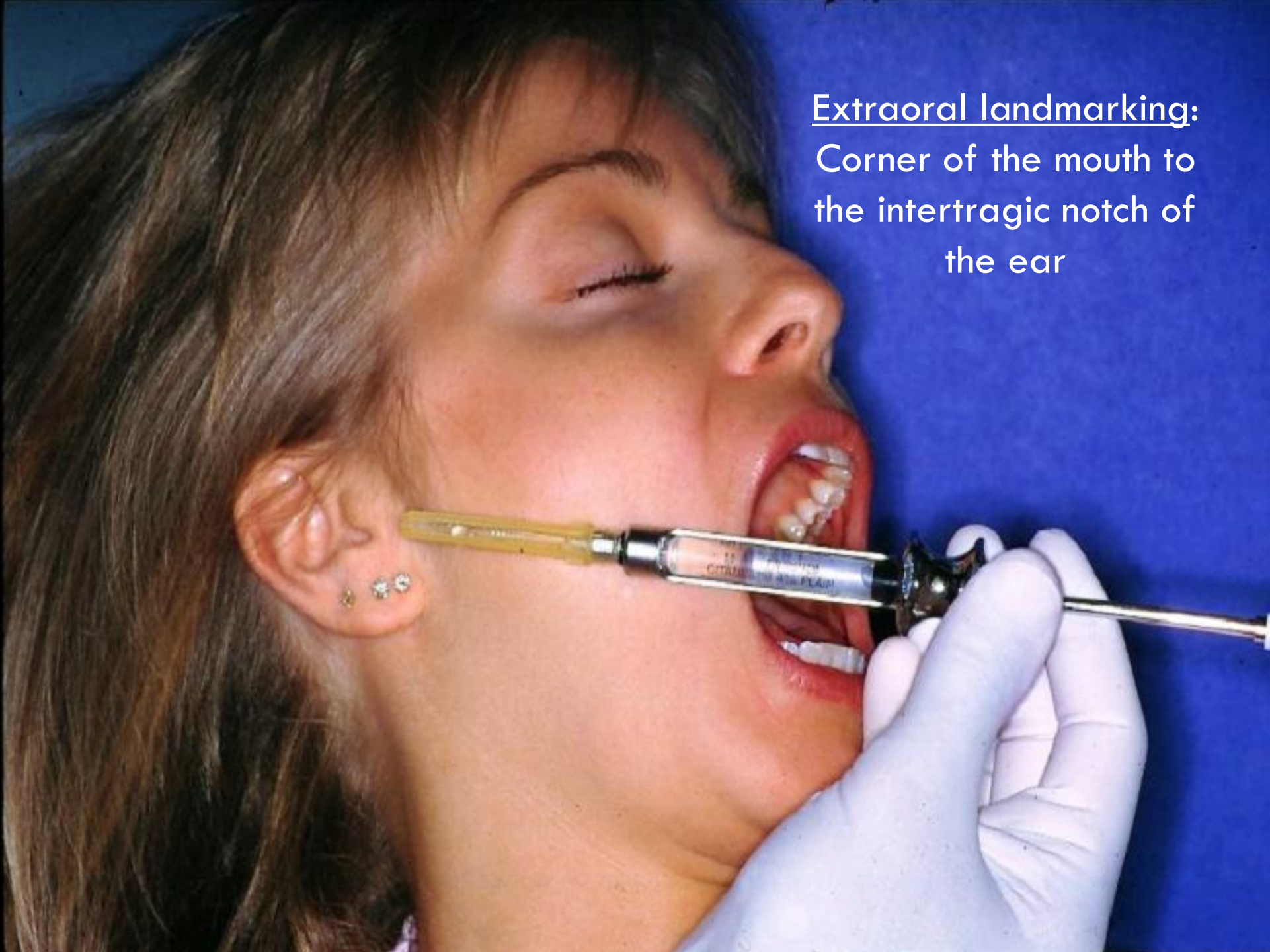
- CN = Coronoid Notch
- PMF = Pterygomandibular Fold/Raphe
- PTD = Pterygomandibular Depression

# GOW-GATES



THE NECK OF CONDYLE IS THE BONY ENDPOINT FOR NEEDLE INSERTION

Extraoral landmarking:  
Corner of the mouth to  
the intertragic notch of  
the ear



# GOW-GATES

- Aspirate
- Deposit one (or more) cartridges
- Ask your patient to stay open for 30-60 seconds after you remove the needle
- Wait

The image features a light blue-to-grey gradient background. In the four corners, there are decorative elements consisting of thin black lines that resemble circuit traces or a stylized tree structure, with small white circles at the end of the lines. The central text is written in a red, hand-drawn, slightly irregular font.

WHA'HAPPEN?

# REASONS FOR FAILURE

- Incorrect technique
- Practitioner impatience
- Intravascular injection
- Anatomical variability
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  - Including cross innervation
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- Inflamed tissue
  - Increased circulation, ion trapping, nociceptor hypersensitivity
- Pre-operative pain
  - Activation of nociceptors/pain pathways/central sensitization
- Tetrodotoxin-resistant nerve fibres

# INCORRECT TECHNIQUE

- Must consider the procedure to be done and the possible nerves involved
- For example:
  - Not providing anaesthesia for endodontic treatment on a maxillary first molar
  - Decreasing injected volume because of some medical concern



# IMPROPER TECHNIQUE

- Reasonably common practice to use 30-gauge and/or short needles for mandibular blocks
  - This is a bad idea
    - Needle deflection
    - Needle is too short to reach the intended end point
    - Unreliable aspiration results
    - Needle breakage

## PRACTITIONER IMPATIENCE

- Depending on the tooth, mandibular tooth pulpal numbness can take from 5.2 (2<sup>nd</sup> molar) to 13.6 (canine) minutes to set in
  - Possible exception for buffered local anaesthetic solutions

• **Wait!**

# “SUCCESSFUL PULPAL ANESTHESIA FOR SYMPTOMATIC IRREVERSIBLE PULPITIS”

- Drum cites published IANB success rates of 39% for premolars, 28% for first molars, 25% for second molars
  - Also notes a success rate difference between asymptomatic and symptomatic teeth

REF: M DRUM, *JADA*, 148(4):267-271, 2017

## TESTING, TESTING...

- Soft tissue numbness is a good (not excellent) indicator of pulpal anaesthesia
  - 23% failure for the lower first molar
  - Cold testing or electric pulp testing are more reliable

# INTRAVASCULAR INJECTION

- Aspiration results are most reliable with 25-gauge needles
- Intravascular injections do not allow the target nerve to be bathed in anaesthetic solution

# ANATOMICAL VARIABILITY

- Mandibular foramen location is quite variable
- The inferior alveolar nerve can be bifid or trifid
  - And has a variety of ways to enter the mandible
- The greater palatine foramen is often at or distal to the maxillary second molar
- The mental foramen is usually at the apex of the second premolar
  - And almost never at the first premolar
- The maxillary artery is (almost) in your way

# ANATOMICAL VARIABILITY

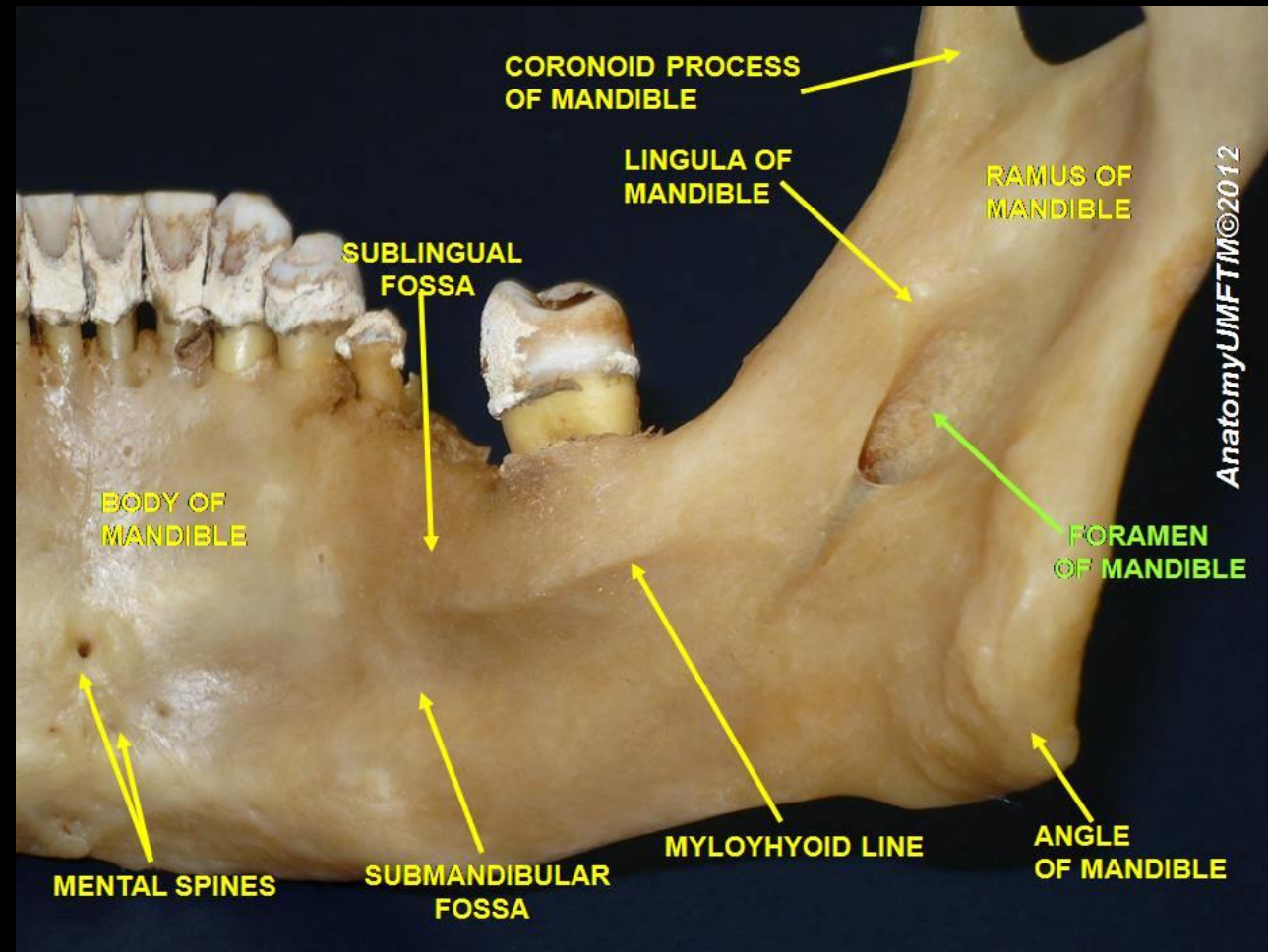
- Wolf *et al.* (2016) performed a literature review on IAN anatomy and its implications for clinical anaesthesia
  - The IAN can:
    - Exist as two distinct branches in the mandibular canal
    - Enter the mandibular foramen as a single nerve, then immediately trifurcate
    - Bifurcate high in the infratemporal fossa and send branches to the mandible via foramina in the retromolar area

# ANATOMICAL VARIABILITY

- Wide ramus flare can present difficulties in finding the bony endpoint for the IANB
  - Also creates greater distance between fluid deposition and the bony endpoint



# MANDIBULAR FORAMEN



## WHERE IS THAT MF?

- Nicholson (1985) dissected 80 cadavers and measured the position of the mandibular foramen
  - Usually anterior to the midpoint of the ramus
  - Below the occlusal surfaces of the molars 75% of the time

REF.: ML NICHOLSON, THE ANATOMICAL RECORD, 212:110-112 (1985)

## WHERE IS THAT MF?

- Lasemi *et al.* (2019) studied the MF location via 194 panoramic radiographs
  - MF = 5 mm above the occlusal plane
  - Mf = 16.5 mm beyond the anterior border of the ramus

# HELPFUL HINTS FOR THE IANB

1. Remember that misses are usually because of a final needle position that is too low and/or too medial

# HELPFUL HINTS FOR THE IANB

## 2. Landmark carefully

- Feel for the anterior (and posterior) border of the ramus
  - The mandibular foramen is at the halfway point
  - Bony landmarks are dependable
- Visualize the pterygomandibular depression
  - Point of insertion just above the centre of this depression or bisecting your thumb

## HELPFUL HINTS FOR THE IANB

3. Advance the needle until you contact bone (i.e., the *ramus mandibularis*)
  - You may need to put a slight bend at the hub of the needle

# HELPFUL HINTS FOR THE IANB

## 4. Inject slowly

- More comfortable for your patients and greater efficacy

REF: KAANA, *JOE*, 32(10): 919-923, 2006



# PATIENT ANXIETY/PATIENT PERCEPTION

- A study by Tickle *et al.* (2012) examined predictors of pain experienced during routine dental treatment
  - The strongest predictor was dental anxiety
    - Odds ratio = 4.98
      - Post-operative pain more likely (OR=5.85) with pain experienced during the procedure

REF.: M TICKLE ET AL., COMMUNITY DENTISTRY & ORAL EPIDEMIOLOGY, 40: 343-350, 2012



# INFLAMED TISSUE

- Inflammation and inflammatory mediators bring on increased circulation, decreased pH, and increases the number of nerve terminals
- Inflammatory mediators (e.g., Substance P, PGE<sub>2</sub>) activate and sensitize nociceptors

$$\text{pK}_a - \text{pH} = \log_{10} \frac{\text{Ionized (BH}^+\text{)}}{\text{Unionized (B)}}$$

**HENDERSON-HASSELBALCH EQUATION**

# DRUG IONIZATION

- Example: Lidocaine

$$pK_a - pH = \log [\text{ionized} / \text{un-ionized}]$$

$$7.9 - 7.4 = \log [\text{ionized} / \text{un-ionized}]$$

$$10^{0.5} = \text{ionized} / \text{un-ionized}$$

$$\sim 3 / 1 = \text{ionized} / \text{un-ionized}$$

# DRUG IONIZATION

- Example: Lidocaine *in site of infection*

$$pK_a - pH = \log [\text{ionized} / \text{un-ionized}]$$

$$7.9 - 5.5 = \log [\text{ionized} / \text{un-ionized}]$$

$$10^{2.4} = \text{ionized} / \text{un-ionized}$$

$$251 / 1 = \text{ionized} / \text{un-ionized}$$

NB: MEPIVACAINE IS RELATIVELY RESISTANT TO ION TRAPPING

# PRE-OPERATIVE PAIN

- There is a strong correlation between level of pre-operative pain and the likelihood of anaesthesia failure
  - If pain is an *experience*, the reasons for this association would be multifactorial

# TETRODOTOXIN-RESISTANT NERVE FIBRES

- There are several different types of sodium channels
  - Some of these channels in nociceptive C-fibres are members of the TTX-resistant class (vs. TTX-sensitive)
    - These channels are resistant to the effects of local anaesthetics

# AFTER A MISSED BLOCK



[This Photo](#) by Unknown Author is licensed under [CC BY-SA-NC](#)

The image features a light blue gradient background with decorative circuit board patterns in the corners. These patterns consist of thin black lines forming various shapes and paths, ending in small white circles, resembling a stylized PCB layout.

# **MANDIBULAR PARAPERIOSTEALS**



# MANDIBULAR PARAPERIOSTEAL/BUCCAL INFILTRATION INJECTIONS



REF.: DF FLANAGAN, LOCAL AND REGIONAL ANESTHESIA, 9: 1-6, 2016

# BUCCAL INFILTRATION STUDY

- Study by da Silva-Junior et al. investigated efficacy of articaine vs. lidocaine as a supplemental block
  - Looked at 160 patients for bilateral third molar extractions
    - Primary block with lidocaine
    - Supplemented with 0.9 mL of either lidocaine or articaine
    - Articaine infiltration group showed a statistically significant difference in experiencing pain
      - 90% vs. 73.8% ( $p=0.0138$ )
    - Other studies have produced similar findings

# MANDIBULAR PARAPERIOSTEAL INJECTIONS

- Lots of articles support this practice
- Best chance for success using articaine
  - Penetrates bone better because of greater lipid solubility than lidocaine

The image features a light blue gradient background with decorative circuit-like lines in the corners. These lines consist of straight segments and small circles, resembling a stylized PCB or network diagram. The text "HOW ABOUT...?" is centered in a bold, green, serif font.

**HOW ABOUT...?**



# REDHEADS VS. NUMBNESS

*TROUBLE OR NOT?*

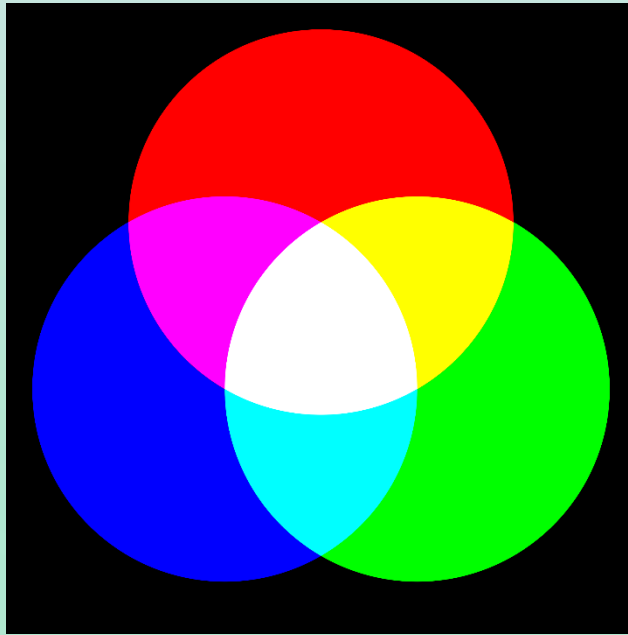
# INJECTING AS YOU ADVANCE



## ...OR TWO-STEP INJECTIONS

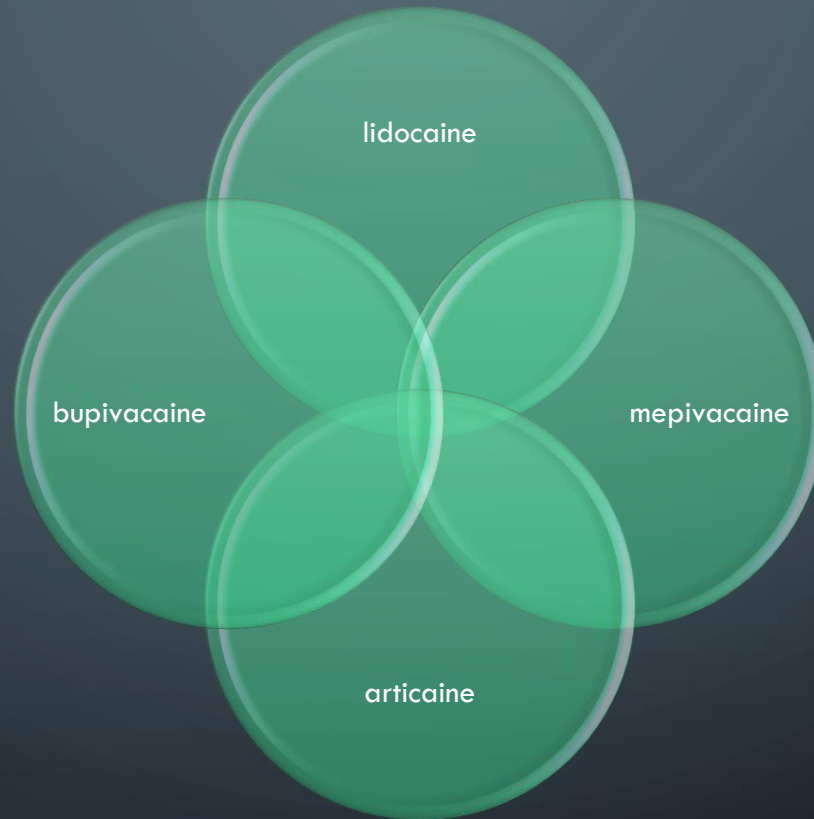
- The initial injection is an infiltration
- The second injection is the “proper” injection

# MIXOLOGY





# MIXOLOGY



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**WHAT'S DIFFERENT?  
WHAT'S NEW?**

# THE WAND<sup>®</sup> COMPUTER GUIDED ANESTHESIA SYSTEM

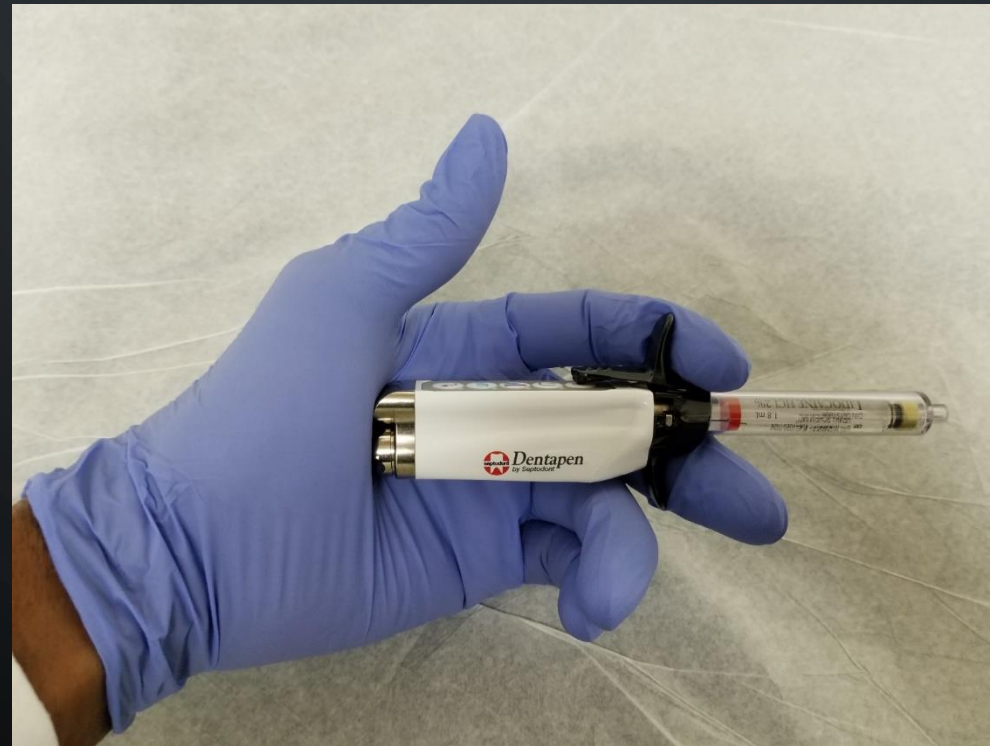


# CALAJECT

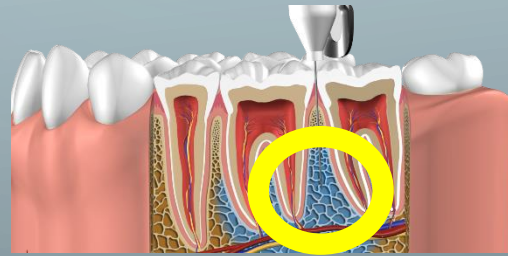


reddot award 2014  
winner

# DENTAPEN



# INTRAOSSEOUS ANESTHESIA



*DIRECT INJECTION IN THE CANCELLOUS BONE CLOSE TO THE APEX*

## **X-tip Anesthesia Delivery System**

**1. Red  
Cover**



**2. Guide Sleeve**



**3. Drill**



**4. Plastic Storage Vial**



Components  
of the X-tip  
system (left  
to right):

1. Red Cover
2. Guide Sleeve
3. Drill
4. Plastic Vial



*X-tip Technologies &  
Practical Endodontics*

# *QuickSleeper<sup>5</sup>*



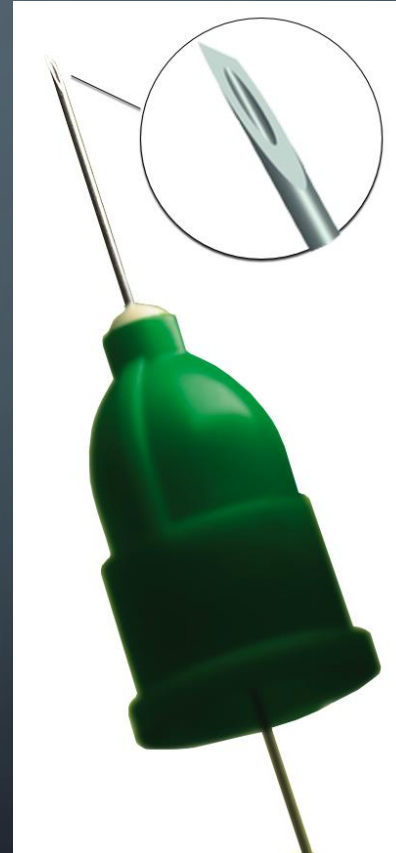


# QUICKSLEEPER 5



## QUICKSLEEPER 5

- “Painless” needles
- Cutting edge bevel



The image features a light blue-to-dark blue gradient background. In the four corners, there are decorative line-art patterns resembling circuit board traces and nodes. The top-left and bottom-left corners have more complex, branching patterns, while the top-right and bottom-right corners have simpler, more linear patterns.

**PRE- AND POST-**

The background features a light blue-to-dark blue gradient. In the four corners, there are decorative black line-art elements resembling circuit traces or neural network connections, with small circles at the end of the lines.

# **NSAID PREMEDICATION**

# NSAID PREMEDICATION

- Shantiaee *et al.* showed preoperative NSAIDs significantly increased the success rate of IANB in irreversible pulpitis cases
- Zanjir *et al.* showed increased efficacy for IANB with preoperative NSAIDs
- Optimal dose time is 1 hour preoperatively

REF.: Y SHANTIAEE *ET AL.*, INTERNATIONAL DENTAL JOURNAL, 67: 85-90, 2017  
M ZANJIR *ET AL.*, J OF ENDODONTICS, 45(12): 1435-1475, 2019

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**EXPAREL®**

# EXPAREL<sup>®</sup>

- Provides up to 96 hours of pain-relief
- Seen as a way to reduce or avoid opioid prescription and use
  - The first 48-72 hours after surgery represents the greatest consumption of analgesics
- More study needed for dental uses