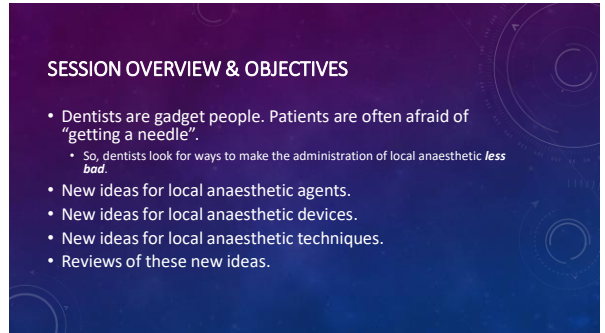
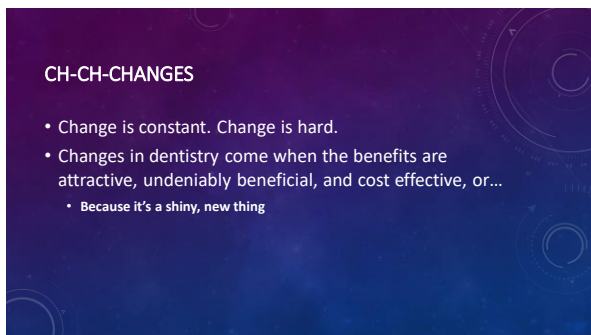


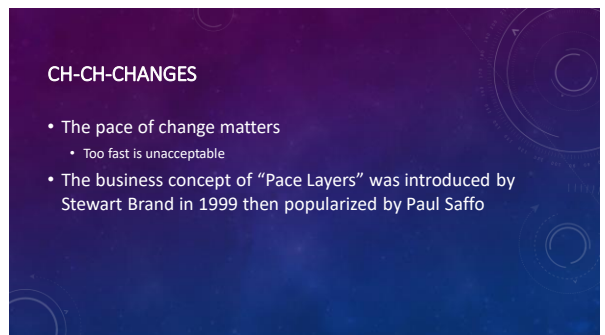
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CH-CH-CHANGES

- Some new ideas aren't new at all (e.g., OraVerse, digital scanners)

5

PAIN!

6

THE 7 THEORIES OF PAIN

- Intensity Theory (4th Century BCE)
- Cartesian Dualistic Theory (1644)
- Bell's Specificity Theory (1811)
- Pattern Theory (1929)
- Melzack and Wall's Gate Control Theory (1965)
- Biopsychosocial Theory (1977)
- Melzack's Neuromatrix Theory (2001)

Ref.: M Moayedi and KD Davis, J Neurophysiol, 109: 5-12, 2013;
LA Trachsel et al., StatPearls [Internet], April 2023

7

THE GOAL OF LOCAL ANAESTHESIA

- Bathe the trigeminal branch nerve(s) in local anaesthetic solution(s) to allow us to work painlessly and in a relatively blood-free zone.

8

METHODS FOR INDUCING LOCAL ANAESTHESIA

- Mechanical (e.g., pressure, rubbing)
- Cold
- Anoxia
- Chemical irritants (e.g., capsaicin)
- Neurotoxic agents (e.g., phenols)
- Sodium channel blockers (e.g., local anaesthetics)

9

DISTRACTION

10

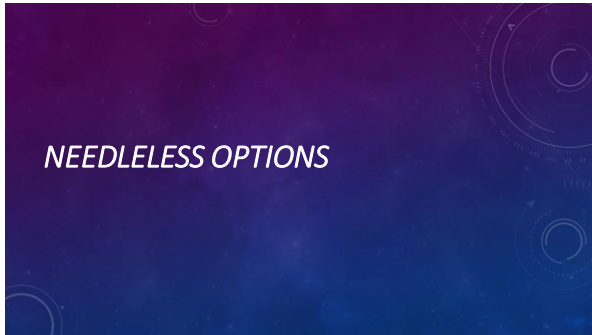
THE GATE CONTROL THEORY OF PAIN

- A peripheral stimulus travels through three locations in the spinal cord before getting to the brain
- One location, the substantia gelatinosa, modulates the signals getting through
 - Acts as a "gate"
- Gates can be opened or closed
 - Thought to be affected by cognitive and emotional states

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- Introduced in 1995
- Uses the Gate Control theory of pain*
 - Tactile (larger) nerve input closes gates and trumps pain (smaller) nerve input
- Distributed by PhysicsForceps
 - Retails for \$US0202.99
- Some studies have shown reduction in pain of injections

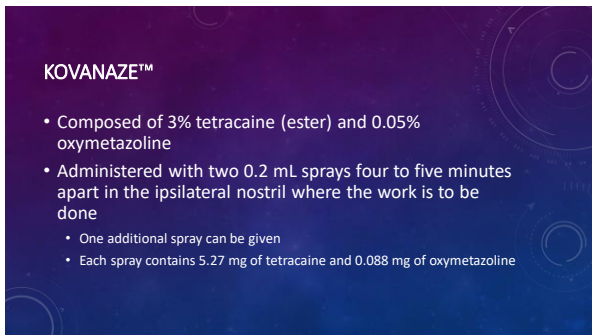
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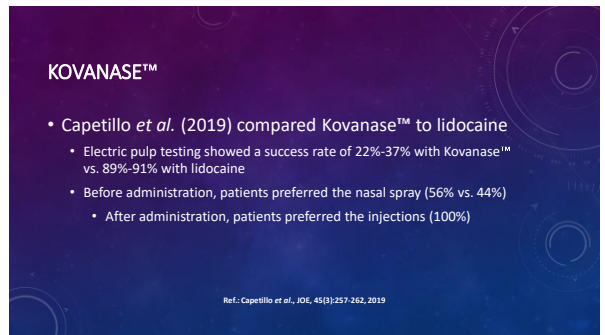
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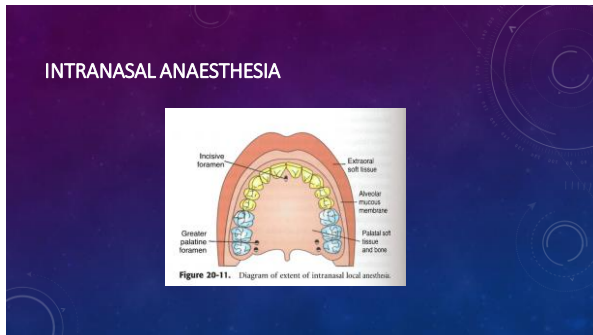


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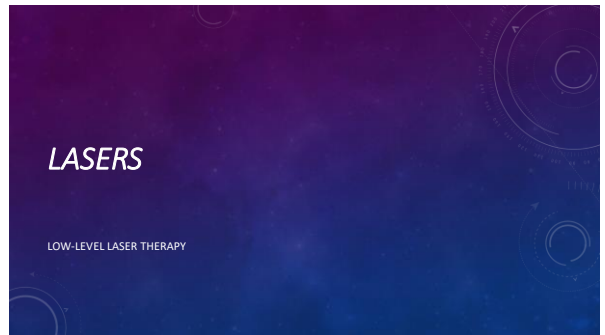


Ref.: Capetillo *et al.*, *IOE*, 45(3):257-262, 2019

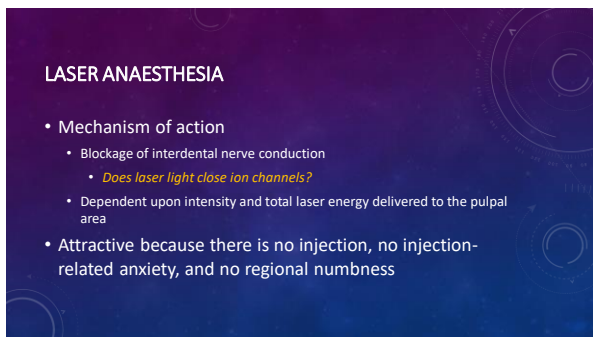
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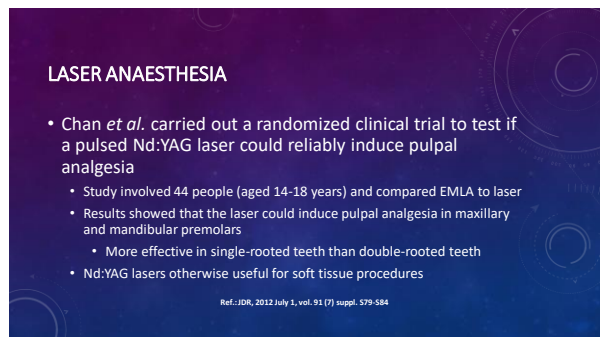
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20

LASER ANAESTHESIA

- Two types of dental lasers can operate on hard and soft tissues
 - Erbium family that operates from 2900 to 3000 nm
 - Isotropic CO₂ that operates at 9300 nm
- Kotlow reports that the Solea (Convergent Dental) isotopic CO₂ restorative laser at 9300 nm can produce reliable regional anaesthesia
 - The effects last long enough to use a conventional handpiece to finish or modify the cavity preparation

Ref.: Kotlow, Dentistry Today, Sept., 2015

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LASER ANAESTHESIA

- "Laser analgesia is a non-invasive, non-destructive, and non-thermal bio-modulating technique with the ability to reduce or suppress painful sensations..."
- Possible mechanisms:
 - Photo-acoustic effect within the gate control theory
 - Direct and indirect influences of laser energy on nerves and nociceptors
 - Modifications of the Na⁺-K⁺ pump systems
 - Bio-resonance and biochemical modifications induced by laser energy

Ref.: R. Poli et al., Dentistry Journal, 8: 128, doi:10.3390/dj8040128, 2020

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LASER ANAESTHESIA

- Predictable analgesic results (for restorative dentistry) may be achievable using erbium family lasers and one of two protocols
 - The "rabbit" or "hare" technique
 - High (ablative) energy used at the beginning of treatment with the handpiece 6-10 mm from the target (i.e., the CEJ) for up to 2 minutes
 - Tip is moved to 0.5-1 mm from the occlusal surface, then ablation starts

Ref.: R. Poli et al., Dentistry Journal, 8: 128, doi:10.3390/dj8040128, 2020

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LASER ANAESTHESIA

- Predictable analgesic results (for restorative dentistry) may be achievable using erbium family lasers and one of two protocols
 - The "turtle" or "tortoise" technique
 - Initial energy and power settings are low
 - Then the tip is placed at the ablative surface and the energy is increased

Ref.: R. Poli et al., Dentistry Journal, 8: 128, doi:10.3390/dj8040128, 2020

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LASER ANAESTHESIA

- No consistent protocols have been established yet
 - Therefore, highly technique sensitive
- Pain is a multifactorial phenomenon
- *Safe but not consistently effective*

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BUFFERED LOCAL ANAESTHETIC

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BUFFERED LOCAL ANAESTHETICS

- The theory is that increasing the pH of the LA solution will result in a more comfortable, faster-onset injection
- Mixes 8.4% sodium bicarbonate (NaHCO_3) into the LA cartridge
 - Solution pH of lidocaine goes to 7.35
 - Only approved for use with lidocaine currently
 - Carbon dioxide (CO_2) also produced at the time of mixing, which may have numbing properties

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ONSET®

- Buffered LA solutions
 - Branded as Onset
 - Uses sodium bicarbonate (8.4%) and CO_2 to raise the pH level of the LA solution
 - Theoretically results in faster onset and less discomfort during and after injections
 - Pulpal anaesthesia two minutes after IAN block



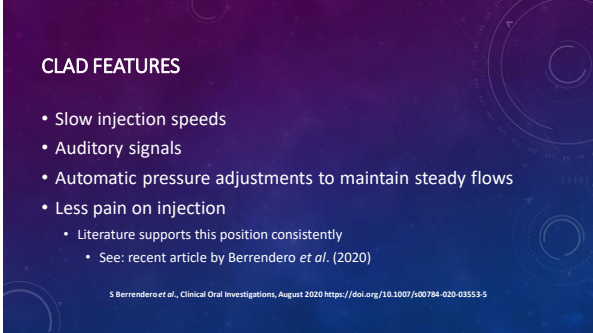
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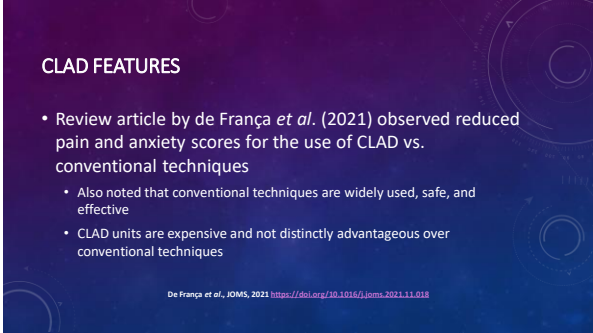
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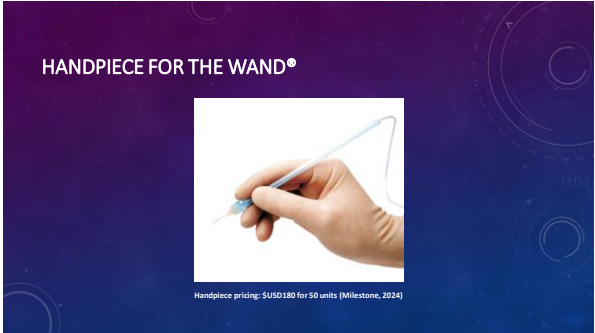
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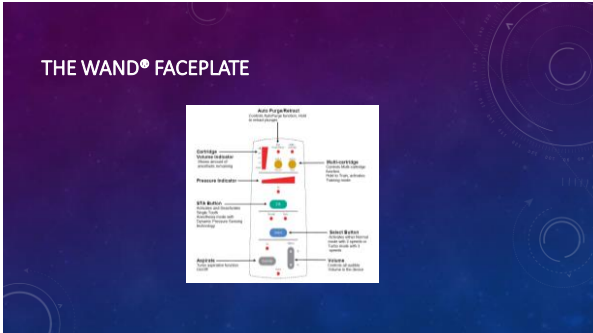
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CALAJECT™

- Introduced in 2021
- Distributed in Canada by Synca
 - Made by Rönvig in Denmark
- Uses standard dental needles
- Three injection programs
 - I – Palatal or PDL injections
 - II – Infiltration/Paraperiosteal injections
 - III – Nerve blocks

SCAD4699.00 from Henry Schein (March 2024)

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CALAJECT™

- Features:
 - Touch screen
 - Displays injection pressure
 - Has an automatic shut-off at excessive pressures
 - Has an acoustic signal during operation
 - Can see the cartridge during the injection

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INJECTION SPEEDS FOR THE CALAJECT™

- I – Intraligamental/Palatal program
 - Slow phase = 0.006 mL per second
 - 1 mL in 166 s
 - Fast phase = 0.009 mL per second
 - 1 mL in 111 s

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INJECTION SPEEDS FOR THE CALAJECT™

- II – Infiltration program
 - Slow phase = 0.006 mL per second
 - Fast phase = 0.03 mL per second
 - 1 mL in 33 seconds

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INJECTION SPEEDS FOR THE CALAJECT™

- III – Nerve block program
 - Slow phase = 0.006 mL per second
 - Fast phase = 0.04 mL per second
 - 1 mL in 25 seconds
 - Full cartridge in 45 seconds

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DENTAPEN

- Manufactured and distributed by Septodont
 - Launched in 2018
- Uses regular dental needles
- Has a “standard” finger grip
- Light (40 g in weight)



SCAD4699 from Henry Schein

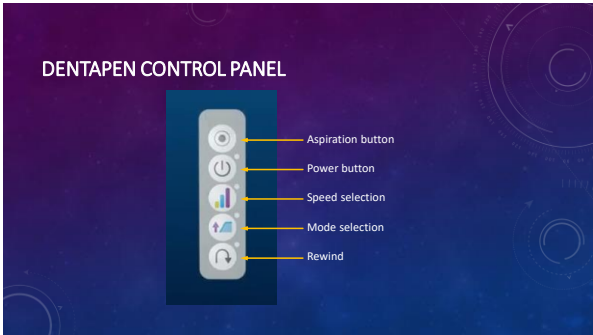
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DENTAPEN

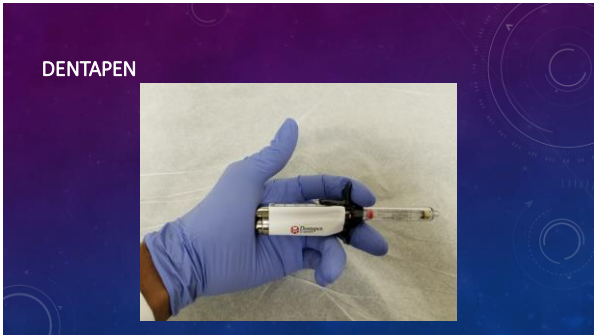
- Cordless
- Three injection speeds
 - Slow = 1 mL/90 sec
 - Medium = 1 mL/60 sec
 - Fast = 1 mL/30 sec
 - Full cartridge in 54 seconds



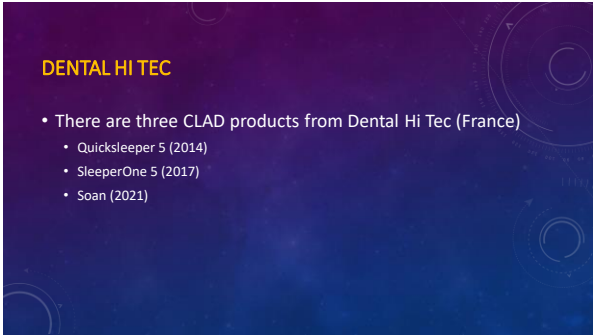
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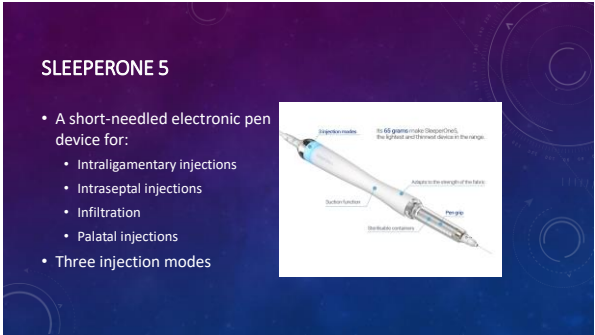
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SLEEPERONE 5



- Functions via a wireless foot pedal
 - Return/aspiration
 - Mode selection
 - Attached gingiva/palatal (#1)
 - Injection (#2)
- The handpiece is wired
- System needles are 30-gauge
 - 9 mm and 16 mm lengths

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SOAN



- Made by Dental Hi Tec
 - Wireless version of SleeperOne 5
 - Two injection modes (Hi and Lo)

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Soan

SleeperOne®

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QUICKSLEEPER 5



- An electronic intraosseous local anaesthetic delivery system
- The bone perforator, needle, and anaesthetic cartridge are all held in hand

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LOCAL ANAESTHETIC REVERSAL

53



54

PHENTOLAMINE MESYLATE

- A non-selective α -adrenergic antagonist
 - Increases the redistribution of local anaesthetics away from injection site
 - Approved as a systemic antihypertensive drug in 1953

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PHENTOLAMINE MESYLATE

- Local anaesthetic reversal agent for adults and children
 - Safe and effective for patients ≥ 6 years and ≥ 15 kg
 - OraVerse™ (Septodont) launched for dentistry in 2009
- 2003 report by Rafique *et al.* (Caries Research, 37: 360-364) noted that 86% of patients receiving LA had moderate dislike of postoperative numbness
 - 14% report high dislike

www.novalar.com

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PHENTOLAMINE MESYLATE

- Reduces duration of anaesthesia by 50%
- Non-toxic and well-tolerated in children as young as 4 years of age
 - Only observed significant adverse effects were a minor increase in postoperative pain shortly after return to normal sensation, and moderate at the injection site
 - Ref.: Hersh *et al.*, JADA, 139: 1080-1093 (2008)
 - Ref.: Tavares *et al.*, JADA, 139: 1095-1104 (2008)

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PHENTOLAMINE MESYLATE

- Administered via standard dental cartridge in a 1:1 volume dose ratio to local anaesthetic
 - Supplied as 0.4 mg/1.7 mL
 - \$9 per cartridge (March 2024)
 - LA cartridges are ~\$2 per cartridge
- Possible uses:
 - Bilateral mandibular work requiring local anaesthesia
 - Paediatric patients
 - Developmentally disabled patients
 - Greater patient convenience

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EXPAREL

INJECTABLE BUPIVACAINE LIPOSOME SUSPENSION

- Exparel® (Pacira Pharmaceuticals Inc.)
 - Marketed as an opioid-free way to manage post-surgical pain
 - Approved for various uses starting in 2011
 - Now approved for use in children older than 6 years
 - Consists of multivesicular liposomes (DepoFoam®) that release doses of bupivacaine as the chambers break down
 - Injected into/around the surgical site
 - Not used for nerve blocks

Ref.: <https://www.exparel.com>

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EXPAREL®

- A 1.33% bupivacaine suspension
- Maximum recommended dose for adults = 266 mg
 - Maximum use in dentistry is 133 mg (10 mL)
 - Not based on patient weight
- Can be mixed with non-liposomal bupivacaine for faster onset
 - Maximum HCl:Exparel ratio of 1:2
 - *Should not be mixed with other local anaesthetics*

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EXPAREL®

- First peak effect is at the time of injection
 - Second peak effect is 12 hours later
- Recommended: No additional administration of bupivacaine in the same site for 96 hours
- Half-life ($t_{1/2}$) is 24-34 hours, depending on the dose and the site of administration

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EXPAREL®

- 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

Ref.: Hersh et al., Curr Oral Health Reports, 4: 189-196, 2017

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NEW AGENTS

64

LEVOBUPIVACAINE

- Clinically similar to bupivacaine
- Less affinity for myocardium and CNS centres
 - Less toxic
- No dental preparations yet

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ROPIVACAINE

- Introduced in 1996
- A long-acting amide local anaesthetic
 - Clinically similar to bupivacaine
 - Not as lipid soluble
- Most often used for epidurals
 - No dental application yet

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CENTBUCRIDINE

- A quinolone derivative developed in 1983 (India)
 - Not an amide, not an ester
 - Has local anaesthetic, antihistaminic, and vasoconstrictive properties
- Comparative study with lidocaine by Dugal *et al.* (2009) showed good efficacy for "routine minor surgery cases" at 0.5%
 - Avoids the need for vasoconstrictor
- Not available for dental use at this time

Ref.: Dugal *et al.*, J Maxillofac Oral Surg., 8(3): 221-223, 2009

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ARTICAINE

- Introduced in Canada in 1982. Introduced in the US in 2000.
 - An amide local anaesthetic with a sulfur atom in its aromatic ring
 - More lipid soluble than other amide local anaesthetics
- Metabolized more quickly than other amide local anaesthetics
- Can cause methemoglobinemia with large doses
- Supplied in 4% solutions
 - With 1:100,000 or 1:200,000 epinephrine
- More commonly associated with paraesthesias than other local anaesthetics*

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NEXT?

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PHOTO-TRIGGERED LOCAL ANAESTHETIC RELEASE

- This idea injects a depot of local anaesthetic in a polymer carrier or modified liposomal carriers
 - Exposing a tetracaine-containing polymer carrier to blue LED light can release doses of the local anaesthetic
 - Exposing liposomal carriers that have been modified with gold nanorods to infrared light leads to a heat response that releases local anaesthetic
- No human trials as of 2021

Ref.: S Sari, *Curr Opin Crit Care*, 27:733-742, 2021

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TLC590

- Liposomal ropivacaine
 - Operates similarly to Exparel with fewer toxicity concerns
- Not approved for human use yet

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CAPSAICIN

- Capsaicin is what makes pepper "hot"
- Being researched from several angles:
 - a) As an enhanced introducer of local anaesthetic molecules to Na⁺ channels
 - b) As a nociceptor (C-fibre) desensitizer
 - **Pain is the *only* sensation reduced/eliminated**
 - Initially researched for topical application
- Shown to induce long-lasting desensitization *after* hyperalgesia (e.g., burning, stinging)

Ref.: EK Aasvang et al., *Anesthesia & Analgesia*, 107:282-91, 2008

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CAPSAICIN

- Initial algesia can be avoided by administering local anaesthetic first
- Potential uses:
 - Intraoperative local anaesthesia(?)
 - Post-operative analgesia

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MIXOLOGY

- Future advances may include agent mixtures
- Clonidine = alpha-2 receptor agonist
 - It can inhibit action potentials
 - It can increase the duration of anaesthesia and analgesia when mixed with local anaesthetics
- Dexamethasone = corticosteroid
 - Inhibits action potentials in C-fibres
 - Demonstrated to prolong (non-dental) blocks using bupivacaine and mepivacaine

Ref.: EA Shipton, Anesthesiology Research and Practice, Article ID 546409, 2012

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