REVIEW ARTICLE

Painless Anesthesia: A New Approach


Abstract

It is unfortunate that the methods used to control dental operative pain may themselves produce distress. It should be the aim of all caring practitioner to reduce injection sensation to minimum so as to alleviate the apprehension and fear from the patient’s mind. The fear of needle prick is a bigger reason of concern and the major cause of avoidance of dental treatment despite the detrimental effect of progressive dental caries. Various new anesthetic agents comprising of eutectic mixtures of anesthetics, anesthetic delivery devices which uses pressure and vibration and supplemental anesthesia into the osseous tissue have been introduced to lessen the pain and reduce the area to be anesthetized thus decreasing the failure rates of achieving local anesthesia and the unwanted residual effects of the anesthesia.


Key words: Painless anesthesia, eutectic mixtures, Vibrotactile devices, jet injection, Intraosseous anesthesia, Electronic Dental Anesthesia

Introduction

Pain management is the most important aspect of patient care. The advancement in anesthetic agents and techniques are probably the most significant advances that have occurred in dental science, enabling the profession to make tremendous therapeutic advances that would otherwise not be possible. Today’s anesthetics are safe, effective, and can be administered with negligible soft tissue irritation and minimal concerns for allergic reactions. This article provides an update on the most recently introduced local anesthetic agents as well as new technologies used to deliver local anesthetics.

Anesthetic Agents

Oraqix

Lidocaine 2.5% & Prilocaine gel 2.5%. Oraqix (Dentsply Pharmaceutical, York, PA, USA) is a topical anesthetic agent. It is a needle-free sub gingival anesthetic used to provide localized anesthesia in periodontal pockets during scaling and/or root-planing procedures. Oraqix is oil at room temperature, which allows it to be applied easily into periodontal pockets requiring root planing and scaling. Once applied it solidifies at

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body temperature into an elastic gel, enabling it to remain in place while the anesthetics take effect. It is applied on to the gingival margin around the selected tooth using a blunt-tipped applicator. Periodontal procedure can be started thirty seconds after the application, and the anesthetic effect remains for approximately twenty minutes. Oraqix has minimal risk for allergic reaction. Adverse reactions are similar as of injectable amides.

**EMLA**

EMLA (Eutectic Mixture of Local Anesthetics) is oil in water emulsion i.e. 5% cream of 25mg/g lidocaine, 25mg/g prilocaine in a ratio of 1:1 by weight. It is supplied in 5 or 30 g tube or as EMLA anesthetic patch or disc in a laminated foil bound with adhesive tape. It is applied orally for 2.5 to 5 minutes to achieve beneficial psychological or pharmacological effects prior to needle penetration. EMLA is effective as a Pediatric local anesthesia and for minor soft tissue surgical procedures. It is contra indicated in patients with congenital or idiopathic methemoglobinemia or patient with known sensitivity to amide type local anesthetic, where it may cause allergic dermatitis, transient skin blanching and erythma.

**Reversing Effect of Local Anesthesia**

Routine dental treatments leave unpleasant residual soft tissue anesthesia that lingers for many hours. OraVerse (Novalar Pharmaceuticals Inc, San Diego, CA, USA) is used to reverse these effects of local anesthetic. It is a formulation of phentolamine mesylate, which is α-adrenergic antagonist. Phentolamine acts as a vasodilator, resulting in faster diffusion of the local anesthetic into the vascular system. The FDA in 2009 approved OraVerse for the reversal of soft tissue anesthesia and the associated functional deficits resulting from a local dental anesthetic. OraVerse can be used in both adults and children; but it is not recommended for use in children younger than 6 years or weighing less than 15 kg. OraVerse is effective for those individuals who have had less invasive procedures and complain of the inconvenience or incapacity of not being able to eat, drink, or talk normally for several hours after their dental treatment because of their lip or tongue numbness.

Tavares and colleagues evaluated the safety and efficacy of phentolamine mesylate (OraVerse) for pediatric patients and found that it was safely tolerated in children between 4 to 11 years of age. The median recovery time to normal lip sensation was 60 minutes for the subjects in the study group versus 135 minutes for subjects in the control group. There were no differences in adverse effect, pain, analgesic use, or vital signs in either group. The phentolamine mesylate must be injected at the same site and in equal quantity as that of local anesthetic to produce desirable effect. With sub mucosal administration of oraverse adverse effects like tachycardia and cardiac arrhythmia can be avoided which are commonly evident with injectable α-adrenergic blocking agents.

**Delivery Devices**

Factors that influence injection discomfort are: the expectation of pain, needle gauge, rates of insertion, pH & temperature of anesthetic solution, and lastly most importantly the technique of injecting local anesthetic. The recent advancements in this field to overcome these shortcomings are given in the following paragraphs.

**Vibrotactile Devices**

Vibrotactile stimuli are used to relief pain of injection. Vibrations or pressure act as non noxious stimuli, which modify or interfere with pain signals by closing the neural gate of cerebral cortex. This reduces the perception of pain as cerebral cortex gets focused on the vibration hence the perception of “pain” from the pressure of the liquid entering the tissue is decreased due to distraction. Inui and colleagues suggested that pain reduction due to non noxious touch or vibration results from tactile induced pain inhibition within the cerebral cortex itself and that the inhibition occurs without any contribution at spinal level, including descending inhibitory actions on spinal neurons.

**VibraJect**

VibraJect (Miltex Inc, York, PA) is a small device that uses vibrations to block pain sensation during local anesthetic injections. It is a battery...
operated device which has an attachment that
snaps on to the standard dental syringe. It
produces vibrations at high frequency on to
the needle which inhibits pain sensation at
the time of injecting anesthetic. Nanitcos and
colleagues found this device to be effective in
decreasing injection pain and used the gate
control theory to explain their findings. Effectiveness of VibraJect,
however, has been mixed. Nanitos and
colleagues (2009),
Murray and colleagues (2003), and Blair
(2002) reported the device to be effective
whereas Saijo and colleagues (2005) and
Yoshikawa and colleagues (2003) reported no
significant pain reduction.

**DentalVibe**

DentalVibe (BING Innovations LLC, USA) is
a handheld cordless injection system, which consists
of a U-shaped vibrating tip attached to a
microprocessor-controlled Vibra-Pulse motor. The
device delivers a pulsed, percussive vibration with
enhanced amplitude, which gently taps the
mucosa in a synchronized but changing pattern
which keeps the α-β nerve fibers activated thus
diverting the pain sensation. The activated U-
shaped vibrating tip is first applied to the injection
site, and the dental needle may be inserted
anywhere in the vibration zone. It also illuminates
the injection area and has an attachment to retract
the lip or cheek.

**Accupal**

The Accupal (Hot Springs, AR, USA) is a
cordless battery operated device used for inferior
alveolar and palatal injections. It uses
vibration as well as pressure to precondition the
alveolar or palatal mucosa. Accupal provides
pressure and vibrates the injection site, 360°
proximal to the needle penetration this shuts the
pain gate mechanism which blocks the pain
sensation. The device has a hole headed slot
which is attached to motor. The head is placed at
the injection site with moderate pressure. The
head begins to vibrate & illuminates the area,
needle is then placed through a hole in the head to
express anesthetic solution without pain to the
patient.

**Single Tooth Anesthesia/CompuDent (WAND)**

Single Tooth Anesthesia system (Milstone
Scientific Inc, Livingston, NJ, USA), was
introduced in 2007 which also uses vibration to
decrease pain. The system is designed for single
tooth intra ligamentary injections. It even guides
proper placement and positioning of the needle
via real-time visual and audible feedback,
providing information about the pressure of the
anesthetic solution and the type of tissue
encountered. A computer program controls the
anesthetic flow to provide low-pressure injections
which results in pain-free & precise anesthetic
delivery, into loose connective tissue or firm
connective palatal mucous membrane.

It is a computerized unit that hubs a cartridge
containing anesthetic. A foot control drives a
plunger rod into the local anesthetic cartridge at
slow speed. A tube connects the unit to a hand
piece with a very tiny needle. The cartridge holder,
tube, and “wand” hand piece are all single-use
disposables.

Regardless of benefits, single tooth anesthesia
is costly to use and expensive in maintenance. It
produces a larger volume of hazardous waste. It
takes longer time than the standard injection and
extra space in storage which might pose problem

**The Comfort Control syringe**

It is an electronic, pre-programmed anesthetic
delivery device. It has a two stage delivery system:
the injection begins at an extremely slow rate to
prevent the discomfort associated with quick
delivery. After ten seconds the device
automatically increases speed to the pre-
programmed injection rate for the technique
selected. There are five pre-programmed
injection rates for specific injections.

- Infiltration - 0.007ml/sec
- Regional block - 0.02ml/sec
- Palatal - 0.008ml/sec
- Intraligamentary - 0.007ml/sec
- Intraosseous injections - 0.02ml/sec

It uses both dental cartridge and leur lock
dental needles. The Comfort Control syringe
aspirates by using a plunger-engaging device to
draw the plunger back along the cylinder to reduce
cartridge pressure. It is easy for operator to use. It is very successful in children as slow deposition of solution causes no or minimal pain.

**Jet Injection**

Jet-injector technology has been around for many years, but confined to intramuscular injections. Jet-injection technology is based on the principle of using mechanical energy to create a pressure sufficient to push a dose of liquid medication through a very small orifice. It creates a thin column of fluid with enough force that can penetrate soft tissue into the subcutaneous tissue without a needle. Jet injectors have advantages of being fast and easy to use, with little or no pain, less tissue damage, faster drug absorption and less chances of infection at the site. Controlled studies evaluating efficacy are lacking, and reports are primarily anecdotal. To date, the effectiveness of the technique in dentistry has been reported to be limited. Jet injector expresses only limited volume of anesthetic to provide adequate soft tissue anesthesia but inadequate pulpal anesthesia. It is mainly of use in children because of less bone density. During oral surgical procedures it is used for vasoconstriction or postoperative analgesia. Other uses include removal of fracture arch bars or ligature wires, the application of orthodontics bands and for small punch biopsies.

**Syrijet**

The Syrijet Mark II jet injector (Keystone Industries, Cherry Hill, NJ, USA) is mainly used by pedodontist. It uses the standard 1.8-ml cartridges of local anesthetic solution which permits the administration of a variable volume of solution from 0 to 0.2 ml. The Syrijet Mark II has a nozzle pressure of 2000 pounds per square inch (psi) which provides penetration of anesthetic solution comparable to that produced by needle injection to near 1 cm depth, with quantities up to 0.2 ml per injection.

**Med-Jet**

Med-Jet (Medical International Technologies, Montreal, QC, Canada) is needle-free injection system. It uses compressed air for injection delivery. The head of the device is placed firmly against the mucosa and the trigger is released, this forces the solution through mucosa to produce anesthesia. Injections can be intradermal, subcutaneous or intramuscular with a volume of 0.01 to 1 cc at 2000 psi. The depth of penetration can be adjusted mechanically. It is painless & ideal for Nasopalatine and Greater palatine injections but inadequate for regional or pulpal block. It is very successful in children. It can also be used for mass vaccination, psychiatry, dermatology and meso therapy, bio terror attacks, Army deployments. Hematoma at the site of anesthesia and high cost of device are its few drawbacks.

**Intraosseous Aids for Anesthesia**

The Intraosseous (IO) injection involves placement of a local anesthetic directly into the cancellous bone adjacent to the tooth to be anesthetized, and is used primarily in endodontic practice for patients with irreversible pulpitis and/or acute periapical inflammation. Clinical studies have reported that a single inferior alveolar nerve block injection of local anesthetic is ineffective in 30% to 80% of patients. Therefore, supplemental anesthesia with intra osseous route delivers higher doses of anesthetic closer to the apex, and clinical trials have indicated that the IO route of injection significantly enhances pulpal anesthesia after IAN block injection in endodontic pain patients. IO injections provide pulpal anesthesia for duration of less than 60 minutes with vasoconstrictor and approximately 15 to 30 minutes without vasoconstrictor when administered alone.

**Stabident**

The Stabident (Fairfax Dental Inc, Miami, FL, USA) is a device for supplemental anesthesia. It provides effective anesthetic effect in both maxillary as well as mandibular teeth. This system is composed of: (1) Perforator; a solid stainless-steel needle of 27 gauge (0.43 mm), beveled at the free end to enable it to drill through cortical bone, and mounted at the other end on a plastic shank with the standard grooved head of slow-speed dental burrs enabling it to be driven by the standard latch-type contra-angled hand piece. When activated, the perforator drills a small hole through the cortical plate without creating a large-diameter opening that would allow backflow of the anesthetic solution.(2) Injection needle; this is a
conventional 27-gauge injection needle but of ultra-short (8 mm) length, which is placed in the hole made by the perforator. The ultra-short needle is used to facilitate the reinsertion of the needle into the opening made by the perforator. The combination of a very short needle and holding the syringe like a pen gives point control over the needle and helps to force anesthetic safely at very high pressure. It is inexpensive and can be used with slow-speed contra angle hand piece for the perforator and standard dental anesthetic syringe for the needle.

The main disadvantage of the device is that the perforation needs to be made in a reasonably accessible and visible location in the attached gingiva distal to the tooth to be anesthetized. If the penetration zone is located in alveolar mucosa that moves once the perforator is withdrawn, it can be extremely difficult to locate the perforation site with the anesthetic needle. Even in attached gingiva, it can sometimes be difficult to relocate the perforation site. It is not unusual for the clinician to have to make a second or even a third perforation. Posterior teeth often require that the 9-mm long needle be bent at a 45° angle at the hub in order to obtain a comfortable path of insertion, thus running the risk of breakage.

X-Tip

The X-Tip anesthetic system (Dentsply International Inc, Tulsa, OK, USA) is a type of intraosseous injection. The X-Tip unit has a pilot drill which is a hollow tube through which a 27-gauge needle can pass through to express anesthetic solution. Even in attached gingiva, it can sometimes be difficult to relocate the perforation site. It is not unusual for the clinician to have to make a second or even a third perforation. Posterior teeth often require that the 9-mm long needle be bent at a 45° angle at the hub in order to obtain a comfortable path of insertion, thus running the risk of breakage.

IntraFlow

The IntraFlow Anesthesia System (Pro-Dex Medical Devices, Irvine, CA, USA) is a primary or supplemental technique of delivering anesthesia. It can be used for general dental procedures, endodontic therapy, oral surgery, cosmetic and restorative procedures, and implantology. It provided 87% successful pulpal anesthesia when compared to inferior alveolar block which had only 60% of success rate.

The IntraFlow Anesthesia System is composed of 4 core components:
1. The hand piece with a seat for the anesthetic carpule and quick disconnect: a rheostat and a coupling
2. The head attachment
3. The perforator: 24-gauge hollow stainless steel needle
4. The transfuser: ABS Shell & Slider with 20-gauge stainless steel cannula attaches to the head attachment and carries solution from the standard 1.8-ml dental cartridge to the perforator.

The device is connected to the standard slow-speed line. When the rheostat is pressed at full speed, the perforator is pushed through the gingiva, cortex, and into the cancellous spaces. It takes about 3 to 4 seconds to perforate. To carry out the injection, the rheostat is lightly pressed again, and 0.9 ml of the local anesthetic is slowly injected. The device is not withdrawn as it is a
one-step procedure. This single-step method is helpful in those penetration zones that are difficult to access, such as the first or second molar areas, in horizontal bone loss or a limited band of attached gingival. IntraFlow has high maintenance cost.\(^1\),\(^2\)

**Electronic Dental Anesthesia (EDA or TENS)**

It is the uses of electric current that stimulate nerves for relief of pain. EDA has an advantage that patient can control the effect of anesthesia with no unpleasant residual anesthetic effect but with residual analgesic effect which remains for several hours. EA devices are designed to change the frequency of electrical signals. The normal clinical range is in between 2-120Hz. It has a small control box which is battery operated & has two controls ; (1) Wave-width control- it is used to set signals from minimum to maximum. (2) Amplitude or mode control -to alter the intensity of the signal. There are of two types of electrodes: Intraoral and extra oral. Intraoral electrodes are U shaped, stiff plastic covered with cotton, orthodontic bands & rubber dam retainer. Extra oral electrodes are rectangular in shape with adhesive on the back side or wooden chopstick probe (hand held). For management of chronic pain EDA uses low frequency of 2Hz, this produces change in the blood levels of L-tryptophan, serotonin and beta endorphins. (Endogenous opioids) They possess analgesic action; hence elevate the pain reaction threshold\(^3\). The blood levels of serotonin and beta-endorphins remain elevated for several hours following the termination of EDA therapy, thus patients are benefited from residual analgesic action post treatment.\(^4\) Opioid analgesics used for post treatment pain are rarely required when TENS or EDA has been used.

For management of acute pain EDA uses high frequency i.e. 120 Hz or greater, which causes the patient to experience a sensation as vibrating, pulsing, throbbing or twitching. The electric current selectively stimulates large sensory fibers (A\(\alpha\), A\(\beta\)), closing the gate and preventing pain stimuli that reaches the brain via the small A\(\delta\) and C fibers. Elevated levels of serotonin and endorphins are also likely to play secondary but important role in controlling pain. It is an effective technique for children and patient with needle phobia.\(^5\) TMJ/MPD pain, non surgical periodontal procedures like root planning, scaling, comprehensive probing, restorative dentistry,\(^6\), crown and bridges and endodontic treatment especially in anterior teeth.\(^7\) EDA is contra indicated in pregnancy, epilepsy, older patient with senile dementia, patient on cardiac pace makers.

**Conclusion**

The methods used to achieve pain free anesthesia are time consuming and present a challenge to both dentist and patient. Both parties must work as a team. When the goal is achieved, the dentist obtains satisfaction and the patient has improved quality of care. The extra time spent is well worth the effort.

**References**


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