



Review Article

Local anaesthesia in pediatric dentistry — An overview

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ARTICLE INFO

Article history:

Received 27-04-2020

Accepted 10-07-2020

Published 31-08-2020

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[https://doi.org/](https://doi.org/10.38138/JMDR/v6i1.3)

10.38138/JMDR/v6i1.3

ABSTRACT

Local anaesthesia is the commonly employed technique of achieving pain control in dentistry. The vital reasons why children dislike dental treatment is the fear and anxiety related to the injection of local anaesthetics. Painful dental operations cause fear, whereas fear and anxiety increase the amount of perceived pain. This review includes the certain different aspects of administration of local anaesthesia and recent procedures and devices for LA application in dental practice to achieve painless local anaesthesia in children.

Keywords: Alternative methods in LA; Iontophoresis; Electronic dental anaesthesia; CCLAD's; jet injectors

1 INTRODUCTION

The practice of contemporary dentistry is implausible without the use of local anaesthesia. However, it's a paradox that the local anaesthesia procedure facilitates painless treatment in the mouth also causes discomfort and fear.⁽¹⁾

The distressing experience of needle is the cause for fear of dentist in children. Local anaesthesia in pediatrics not only aids the therapeutic procedure but allows the child to experience the procedure as pleasant and relaxed.

Local anesthetics are used for invasive dental procedures like cavity preparations, deep scaling, surgical procedures, or vital pulp therapy.⁽²⁾ Dental procedures are often accompanied by pain and discomfort by the patient. This is the key reason for dental fear and anxiety in children. For this reason alone, the painless administration of anesthetic may be a crucial step in avoiding fearful and uncooperative patients. So, it depends upon the dentist to select an appropriate technique which can adequately anesthetize the tooth.

2 ANATOMICAL CONSIDERATIONS

Anatomic structures in children are naturally smaller than those in an adult. There are three specific anatomic differences to be aware of in children.⁽³⁾

1. The proximity of blood vessels in the maxillary tuberosity area, where infiltrating deeply with the needle may cause damage to the pterygoid venous plexus or posterior superior alveolar artery and resultant hematoma.
2. The mandibular ramus is shorter and is narrower anteroposteriorly; therefore, for an inferior alveolar nerve block, the extent of infiltration of the needle must be decreased.
3. The bone is not completely calcified, permitting expatiated diffusion of the local anesthetic agent.

3 CONVENTIONAL TECHNIQUES OF LOCAL ANAESTHESIA

3.1 Infiltration is the preferred method to anaesthetize maxillary teeth successfully. The needle should penetrate the mucobuccal fold and injected to the depth of the apices

of the buccal roots of the teeth. The LA agent is deposited suprapariosteally and infiltrates via the alveolar bone to meet the root apex, as the alveolar bone in children is more penetrable than in adults. A small amount local anaesthetic may be sufficient to produce anaesthesia of teeth.⁽⁴⁾

Anesthesia of the mandibular primary molars may usually be achieved by infiltration in children up to the age of 5 years. A few studies⁽⁵⁾ have evaluated the efficiency of mandibular infiltration as an alternate to mandibular block for the restoration of primary molars. No significant differences between infiltration and block was found. In addition, the amount of anaesthesia was not considerably related to tooth location, age, or type of anesthetic agent.⁽⁵⁾

3.2 Mandibular block is the LA technique used when treating mandibular primary or permanent molars. Depth of anesthesia has been the benefit of this technique. Anesthesia of all the molars, premolars, and canines on the same side of injection allows for treating multiple teeth of the same quadrant at the same appointment.⁽⁶⁾

Inferior alveolar block- the patient is requested to open his mouth as wide as possible while the dentist places the ball of the thumb on the coronoid notch of the anterior border of the ramus. The needle is introduced between the internal oblique ridge and the pterygomandibular raphe.⁽⁶⁾ The level of the foramen changes with the child's age:

- In a young child (4 years old and younger) the foramen is sometimes located below the plane of occlusion.
- In children (4 – 10 years old), the foramen is located on the occlusal plane.
- As the child matures, it moves to a higher position above the occlusal plane.^(7,8)

The barrel of the syringe covers the primary mandibular molars on the other side of the arch and parallel to the occlusal plane. During this case, a small amount of solution should be injected, and, after a negative aspirate, the needle should advance until bony contact is acquired, very gently and slowly. When the inferior alveolar nerve block did not adequately anesthetize the teeth, long buccal anesthesia is required. This can be achieved by depositing a few drops of the anesthetic into the buccal sulcus just posterior to the molars.^(5,7)

3.3 The intraligamentary injection is given into the Pdl using a syringe specially designed. Intraligamentary injections can also be given with a conventional needle. In this technique, the needle is introduced at the mesiobuccally and advanced for maximum penetration. The needle does not penetrate deeply onto the Pdl but is wedged at the crest of the alveolar ridge. A 12 mm 30-gauge needle is proposed, and the bevel should face the bone. Intraligamentary anaesthesia has limitations but has been used to overcome failed conventional methods or as an adjunct.⁽⁸⁾ Intraligamentary injections produce significant bacteremia and hence should not be given to a patient at the

risk of infective endocarditis unless appropriate antibiotic prophylaxis has been provided.⁽⁹⁾

3.4 The intrapulpal method achieves anaesthesia because of pressure. Saline is reported to be as effective as an anesthetic agent when injected intrapulpally. When a small access cavity is available into the pulp, a needle which fits securely into the pulp is used and a small amount (about 0.1 mL) of solution is injected under pressure. There will be an initial feeling of discomfort during this injection but however, this is transient and anesthetic onset is rapid. When the exposure is large to allow a tight needle to fit, the exposed pulp should be bathed in a little local anesthetic for about a minute before inserting the needle as apically as possible into the pulp chamber and depositing under pressure.⁽¹⁰⁾

4 NEED FOR ALTERNATIVE TECHNIQUES OF LOCAL DRUG DELIVERY SYSTEM

4.1 Safe and effective pain control is necessary for today's dental practice; our current armamentaria for delivery of local anesthetic to maxilla and mandible normally are adequate for most clinical situations but sometimes there may be complexity in anaesthetizing.

4.2 The Difficult-to-Anesthetize Patient, many considerations may affect the success of local anesthesia, some within the practitioner's control and some not. While no single technique will be successful for every patient, guidelines exist that can help lower the incidence of failure. Due to several factors, such as thicker cortical plates; a denser trabecular pattern; larger, more myelin (lipid)-rich nerve bundles; and more unpredictable innervation pathways, more complications of inadequate anaesthesia occur in the mandibular arch than in the maxillary.

4.3 Reasons for failure of anesthesia

1. pKa-pH incompatibility
2. Needle jaw size discrepancy
3. Tissue vector force
4. Inadequate volume of solution
5. Anatomical variation

5 ALTERNATIVE TECHNIQUES OF LOCAL ANESTHESIA

Some of the most recent advances in anaesthetic methods that provide alternative to conventional methods include techniques:

- Computer controlled local anesthetic drug delivery system (CCLAD's)
- Jet injectors
- EMLA (Eutectic Mixtures of local Anesthesia)
- Topical anesthetic patches
- Electronic dental anesthesia
- Iontophoresis

5.1 Computer-Controlled Local Anaesthetic Delivery Systems^(11–13)

In 1997 the first computer controlled local anesthetic delivery (CCLAD) system was introduced into dentistry. The Wand (recently renamed: The Wand/Component; Milestone Scientific, Inc., Livingston, NJ) was designed to improve on the ergonomics and precision of the dental syringe. The system enables a dentist or hygienist to accurately manipulate needle placement with fingertip accuracy and deliver the local anesthetic with a foot-activated control. The lightweight hand- piece is held in a pen like grasp that provides increased tactile sensation and control compared with the traditional syringe.

At present, two CCLADs are available:

1. **The Wand/CompuDent system**
2. **Comfort Control Syringe**

5.1.1 The Wand/CompuDent system ⁽¹¹⁾ utilizes a single-use disposable "safety" handpiece. A conventional medical Luer-Lok needle (not a traditional dental needle) is attached to the handle. Luer-Lok needles are available in lengths and gauges similar to conventional dental needles. The handle (the "Wand") attaches to a cartridge holder via a 60-inch microtube, the inner diameter of which is 0.013 inch and can hold a volume of less than 0.2 ml of fluid. The cartridge holder accepts any standard 1.8 ml dental anesthetic cartridge.

The Wand handpiece provides increased tactile control and ergonomics. In two clinical trials operators were able to achieve a more comfortable needle puncture for patients when using The Wand handpiece compared with the traditional syringe. This was attributed to the lightweight ergonomically designed handpiece allowing for enhanced tactile sensation.

5.1.2 Comfort Control Syringe. ⁽¹²⁾ Introduced several years after The Wand, the Comfort Control Syringe (CCS) system attempts to improve on the CCLAD concept. The CCS system is an electronic, preprogrammed delivery device that provides the operator with the control needed to make the patient's local anesthetic injection experience as pleasant as possible. As with other CCLADs, this is achieved by depositing the local anesthetic more slowly and consistently than is possible manually. The CCS has a two-stage delivery system; be injection begins at an extremely slow rate to prevent the pain associated with quick delivery. After 10 seconds, the CCS (automatically increases speed to be preprogrammed injection rate for the technique selected. There are five preprogrammed injection rates for specific injections. ⁽¹³⁾

The hand piece controls are:

- The front button with the arrow and square controls the "Start/Stop" functions by initiating or terminating the selected program.

- The middle button activates the "Aspiration" function, by slightly retracting the plunger.
- The rear button initiates "Double Rate" and operates in the same manner as the Double Rate button on the unit. It doubles the preprogrammed injection rate. Selecting it again resumes the preprogrammed speed.

Standard dental local anesthetic cartridges and dental needles may be used in the CCS.

5.2 Jet Injector^(14–16)

In 1947, Hingson and Hughes ⁽¹⁴⁾ introduced an instrument and a technique termed jet injection, which delivered anesthesia efficiently without the use of a needle. This approach soon formed interest among dentists.

The use of this instrument has proven to be successful in other areas including insulin delivery, regional and digital blocks, anesthesia for incision of non-dental abscess and aspiration biopsy of lymph nodes and repair of lacerations to the head and extremities and mass immunizations. In all cases, there was a marked preference by patients for the jet injection instrument over more conventional injection procedures.

Clinical dental studies have been performed, in 1991 ⁽¹⁵⁾, reported that the instrument was useful intraorally or soft tissue procedure, removal of deciduous teeth, minor oral surgery procedures and restoration of anterior teeth. Any adverse side effects were considered due to misuse of the instrument.

Jet injection is based on the principle that liquids forced through very small openings, called jets, at very high pressure can penetrate intact skin or mucous membrane ⁽¹⁴⁾ (visualize water flowing through a garden hose that is being crimped).

The most commonly used jet injectors in dentistry ^(15,16) are

1. Syrijet mark II
2. Madajet XL

5.2.1. Additional Techniques

Jet Injector in root canal procedures - removing the distance cone (plastic tip) position the tip of the nozzle over the canal and firing anesthesia directly into the canal. The anesthesia provided by the Jet Injector is most sufficient in the removal of deciduous roots and loose teeth. ⁽¹⁶⁾ The technique employed is to inject at the inter-apical areas from the lingual and buccal aspects.

5.2.2. Special Injection Technique with the Jet Injector

Perhaps one of the most important advantages of this instrument is its ability to produce good anesthesia in the palate. By injecting on either side or adjacent to the papillae at the nasopalatine foramen, unusually good anesthesia can

be obtained. Since this can be done in almost all cases without pain, the technique deserves the interest of every dentist who must infiltrate this tissue with a needle and syringe.⁽¹⁶⁾

5.3 EMLA (Eutectic Mixture of Local Anesthetics)^(17–20)

Eutectic is defined as a mixture of 2 or more compounds with the lowest melting point. EMLA cream (composed of lidocaine 2.5% and prilocaine 2.5%) is an emulsion in which the oil phase is a eutectic mixture of lidocaine and prilocaine in a ratio of 1:1 by weight. It was designed as a topical anesthetic able to provide surface anesthesia of intact skin (other topical anesthetics do not produce a clinical action on intact skin, only abraded skin), and as such is used primarily before painful procedures, such as venipuncture and other needle insertions. Originally marketed for use in pediatrics, EMLA has gained popularity among needle-phobic adults and persons having other superficial, but painful, procedures performed (e.g., hair removal).

Procedures for application of EMLA⁽¹⁹⁾

1. The buccal sulcus in relation to the concerned tooth will be wiped free of saliva.
2. Isolation with cotton rolls and suction tip
3. About 0.5 gm of EMLA will be taken on a 2"x2" folded gauze piece.
4. It will be then placed on the buccal gingival nearer the sulcus and kept in position for 10 minutes.

EMLA is contraindicated for use in

1. Patients with congenital or idiopathic methemoglobinemia.
2. Infants under the age of 12 months who are receiving treatment with methemoglobin-inducing agents.
3. Patients with a known sensitivity to amide-type local anesthetics or any other component of the product.

5.4 Topical Anaesthetic Patches^(21–23)

Anesthetic patches containing lidocaine base that is dispensed through a bio adhesive matrix and applied directly to the oral mucosa recently have been approved by the U.S food and drug administration and are commercially available⁽²¹⁾ (Dent patch lidocaine transoral delivery system, oven pharmaceuticals Inc.) These patches are available in 10 and 20 percent concentrations, each containing approximately 23 and 46 milligrams of lidocaine base per 2 square centimeters of patch, respectively. The lidocaine contained in the matrix diffuses directly through the mucosa while patch is affixed. The anesthesia is absorbed within five minutes. According to the manufacturer, maximum effect is reached within 15 minutes and has a duration of 45 minutes.

Uses

1. Soft tissue procedures
2. Preinjection procedures
3. Restorations of primary teeth
4. Root planning and scaling
5. Surface or small fillings

5.5 Electronic Dental Anaesthesia^(24–28)

Electronic dental anesthesia requires a considerable degree of patient cooperation and participation to be successful. The use of EDA in younger populations, although not contraindicated, requires a more intensive evaluation of patients' abilities to both understand the concept of EDA and their ability to perform their tasks properly. To manage acute pain, higher frequency of electronic stimulation is necessary. The most often used frequency for acute pain management has been 120 Hz, although one EDA unit provided 16,000 Hz.⁽²⁹⁾

Two areas in which EDA has been used successfully in dentistry are:

Providing pain control for the administration of local anesthetics. EDA produces excellent soft-tissue anesthesia. It may be used when local anesthetic injections must be given, as in multiple palatal infiltrations to achieve hemostasis. Meechan and associates compared patient discomfort during inferior alveolar nerve block using no pretreatment, topically applied benzocaine, and EDA.⁽¹⁸⁾ Pain scores were significance decreased with TENS compared with both no pretreatment and topical anesthetic.

Reversing local anesthesia: After successful inferior alveolar nerve block with lidocaine with epinephrine, soft-tissue anesthesia of approximately 5 hours is to be expected but perhaps not welcomed by the patient. EDA (applied unilaterally) at its low-frequency setting (thereby maximizing vasodilation and muscle contraction) for a period of 10 to 15 minutes can successfully remove a large volume of residual anesthetic solution and thereby partially or totally reverse the anesthetic effect.⁽³⁰⁾

Indications

1. Ineffective local anesthesia
2. Instances where local anesthetics cannot be administered⁽³⁰⁾ (e.g., with a history of true, documented reproducible allergy)

Contraindications⁽³¹⁾

1. Cardiac pacemakers
2. Neurological disorders
 - Status post-cerebrovascular accident (stroke)
 - History of transient ischemic attacks
 - History of epilepsy
3. Pregnancy
4. Immaturity (inability to understand the concept of patient control of pain)

- Young pediatric patient
- Older patients with senile dementia
- Language communication difficulties

5.6 Iontophoresis (18,32)

Iontophoresis has a wide range of application in dentistry, one of which is to produce a non-invasive technique of anaesthesia. It can be used as a means of delivering local anaesthetics to deeper tissues after topical application. It aids in the penetration of positively charged agents such as lignocaine and adrenaline to tissues under the influence of electrical charge.^(33–35) With the avoidance of needle, this technique could offer better patient management and dentist-patient relationship.

Gangarosa described the use of iontophoresis for three basic applications in dentistry⁽³²⁾:

1. Treatment of hypersensitive dentine (e.g. in teeth sensitive to air and cold liquids) using negatively charged fluoride ions
2. Treatment of oral ulcers ('canker sores') and herpes labialis lesions ('fever blisters') using negatively charged corticosteroids and antiviral drugs, respectively.
3. Topical anesthesia

There is a lack of recent studies regarding the application of iontophoresis in dentistry. A clinical study⁽³⁶⁾ published in 1994 reported the use of iontophoresis for surgical extraction of deciduous teeth. Initial reports have shown an encouraging response from patients; however, further studies are necessary.

6 CONCLUSION

Good local analgesia requires highly skilled dental professionals to apply this knowledge coupled with a detailed understanding of the anatomical complexities to provide advanced pain management for the patients. Failure to achieve anesthesia can be a significant problem in the day to day practice of dentistry

The trend is changing as education, research and instrumentation reduce the cognitive and emotional barriers in the dentist's and child's perceptions of the local anesthesia experience. Child's emotions surrounding injections are some of the most powerful feelings that dentists routinely encounter in daily dental practice. Alternative technique can add to the dentist's skills in treating patients with comfort and efficiency.

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